AN ECONOMETRIC IMPORT DEMAND AND MARKET ANALYSIS: THE CASE OF PORK IN MEXICO 1973 - 1990

By

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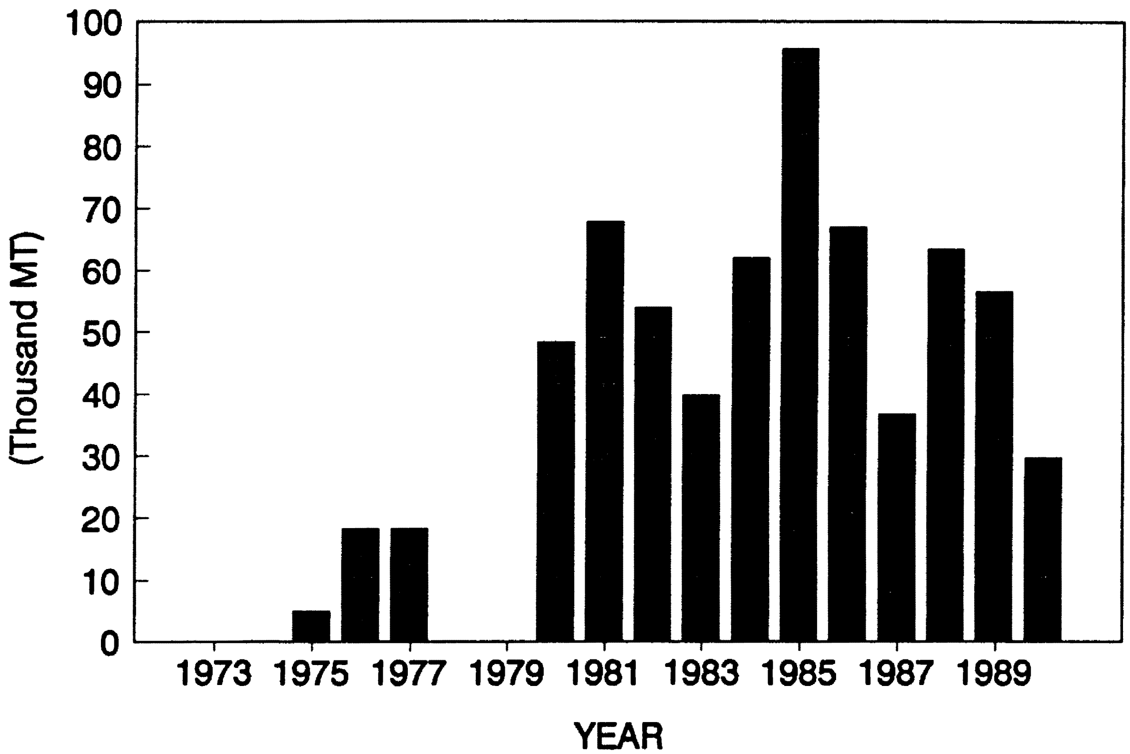
CHAPTER I

INTRODUCTION

As trade barriers are falling throughout the world, countries are realizing the importance of international markets in providing economic growth through international trade. This is specifically the case between the United States and Mexico. With its close proximity and growing economy, Mexico has become one of the fastest growing trading partners of the U.S. Total bilateral trade between the U.S. and Mexico totaled $59 billion in 1990. In the agricultural sector alone, trade between the two countries totaled approximately $5.1 billion in 1990, and has increased on average 3.6 percent per year (Foreign Agriculture, 1990-91).

The U.S. has been a primary benefitor of increased trade as exports to Mexico have grown from $1.4 billion in the mid-1980s to over $3 billion in 1991. Although Mexico has been a large export market for bulk commodities for many years, a substantial amount of this increase in exports has been from meat products, particularly fresh and frozen pork. Pork imports in Mexico have grown from near zero in the early 1970s to over 90 thousand metric tons by the mid 1980s (Figure 1). The U.S. has been Mexico's primary supplier of



Source: United Nations Calender Year Trade Data.

Figure 1. Mexican Pork Imports, 1973-1990

imported pork. On average, 96 percent of all Mexican pork imports were purchased from the U.S. between 1973 and 1990 (Figure 2). Although Mexico is our second largest export market of fresh and frozen pork, the quantity imported has been extremely variable between years. The purpose of this study is to determine the underlying factors which explain the variation in Mexican pork imports between 1973 and 1990.

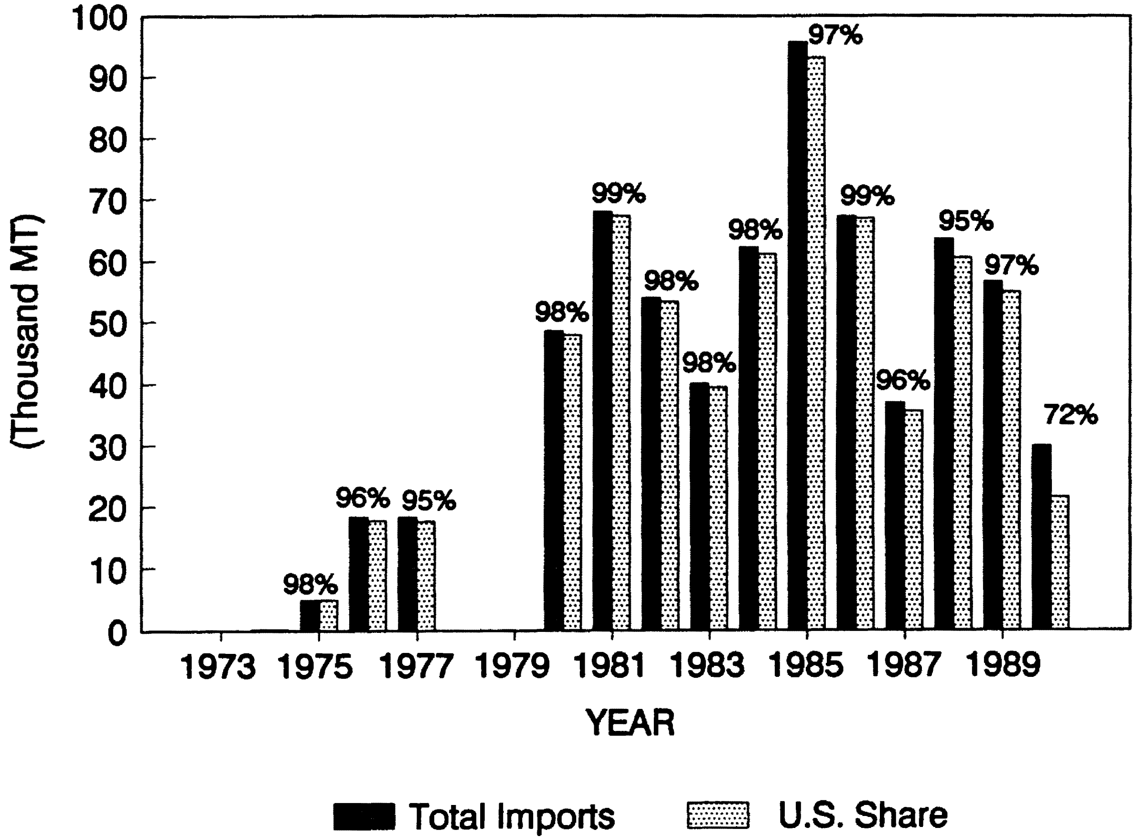
Objectives

The general objective of this study is to increase the capability of U.S. producers, processors, and policy makers in responding to changes in the Mexican pork market.

The specific objectives of this study are to:

1. provide an overview of the Mexican economy and pork industry;
2. review the literature and economic theory supporting import demand models and econometric procedures; and
3. specify and econometrically estimate a model which explains the relationship between the import demand for pork in Mexico and income, population, the price of pork, prices of other goods, and domestic supply.

The organization of this chapter begins with a overview of the Mexican economy to demonstrate how economic forces have impacted pork supply and demand in Mexico. Followed by a analysis of the demand for pork compared to other meats. Also included are sections on pork production in Mexico and throughout the world. The final segment will describe the



Source: United Nations Calender Year Trade Data.

Figure 2. U.S. Share of Mexican Pork Imports, 1973-1990

proposed North American Free Trade Agreement (NAFTA) and its impact on U.S. exports.

Overview of the Mexican Economy

The Mexican economy has made tremendous progress in overcoming the economic problems that plagued the growth and development of the country. To best understand Mexico's economic dilemma requires an examination of the economic policies followed since World War II. During this period, Mexican economic policy primarily focused on economic growth through industrialization, while the role of agriculture was to feed the rapidly growing population. Following a import substitution policy of not importing goods which could be produced domestically, international trade of agricultural and non-agricultural commodities was confined by the government through formidable tariff and non-tariff barriers. Exports were restricted through licenses and export tariffs to ensure that domestic needs were satisfied, while high import tariffs, quotas, and import permits were used to prevent imports from entering the country. Also, foreign investment was tightly regulated as the government feared control by other countries. During this period, the economy averaged 6 percent annual growth, one of the highest rates of any Latin American country.

For the two decades following World War II, Mexico's agricultural production increased by 5.7 percent annually, largely the result of increased investment in agriculture.

However, the growth of the agricultural sector began to stagnate by the late 1960s and continued during the 1970s as Mexico focused its investment on the industrial sector. Before 1970 Mexico was self-sufficient in agricultural production. But with an expanding population and several years of drought, by the late 1970s basic food commodities were imported on a large scale (Thompson and Hillman, 1989).

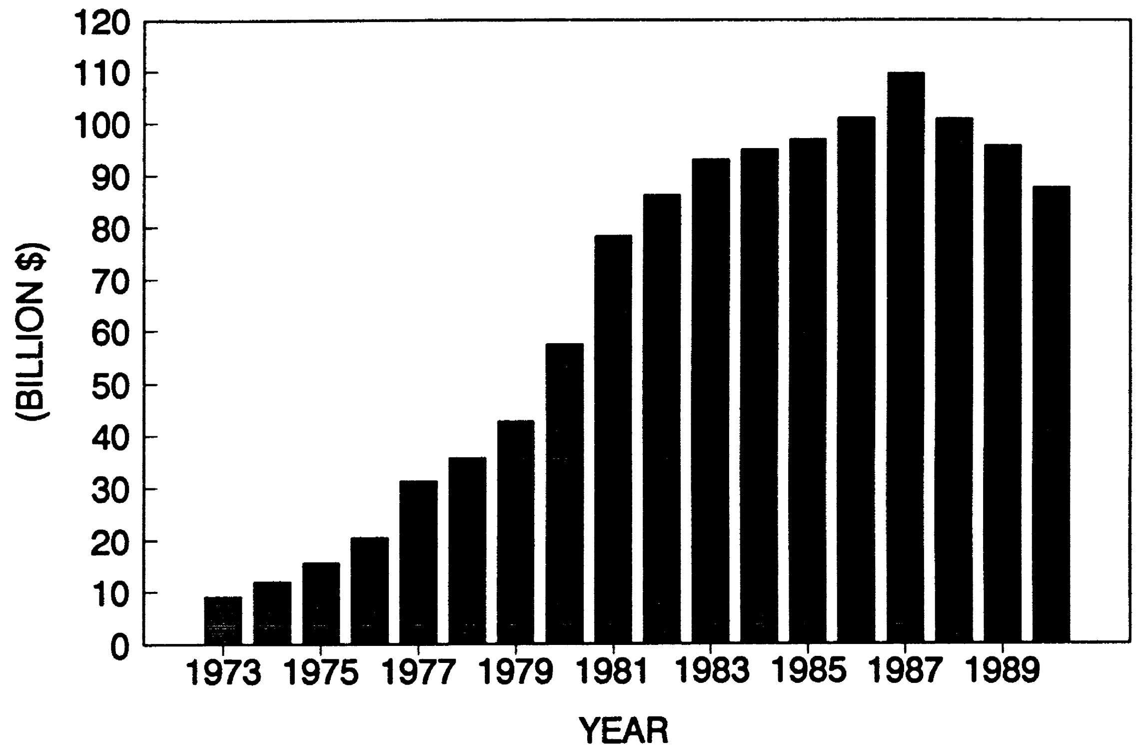
As a consequence of excessive government spending, Mexican consumers were confronted with rapid inflation. High inflation was also a consequence of Mexico's exchange rate policy. For many years, the Mexican peso was pegged to the value of the U.S. dollar through a fixed exchange rate system. But in 1971 the U.S. switched from its fixed exchange rate to a floating currency with its first of several devaluations. The Mexican peso remained tied to the value of the dollar, but was consequently over- and under-valued. In 1976 the Mexican government responded by abandoning its fixed exchange system and adopting a managed float system leading to the first of a series of massive devaluations of the Mexican peso (Villa-Issa, 1990).

Large oil reserves discovered in the late seventies helped to overcome Mexico's economic problems by increasing exports and bringing much needed foreign exchange into the country. Falling oil prices in the 1980s, coupled with high government spending, the government responded by borrowing short term capital at a time of high interest rates. In 1982 alone, approximately two-thirds of oil revenues were needed to pay the interest on foreign debt. Debt increased from approximately $9 billion in 1973 to over $109 billion in 1987 (Figure 3).

By 1987, the economic conditions had brought the economy to the brink of insolvency. Inflation had skyrocketed to over 150 percent, coupled with a growing deficit reaching 16 percent of the gross domestic product (GDP). The drastic economic conditions in Mexico during the 1980s, combined with a decline in agricultural production, forced the government to purchase agricultural commodities from countries that could finance their imports. The United States was their leading supplier through credit guarantees offered by the U.S. government.

Current Economic Outlook

Contrary to these economic problems, the Mexican government has made extraordinary progress. The previous import substitution policy has been abolished, and an export promotion policy has been adopted. The Mexican government now maintains that a free market and foreign investment are needed for sustained economic growth. Following their trade promotion strategy, resources are now focused on producing goods on which they have a comparative advantage, while importing goods which cannot be produced as efficiently. Their maximum tariff rate which previously was 100 percent has been reduced to 20 percent. Other non-tariff barriers



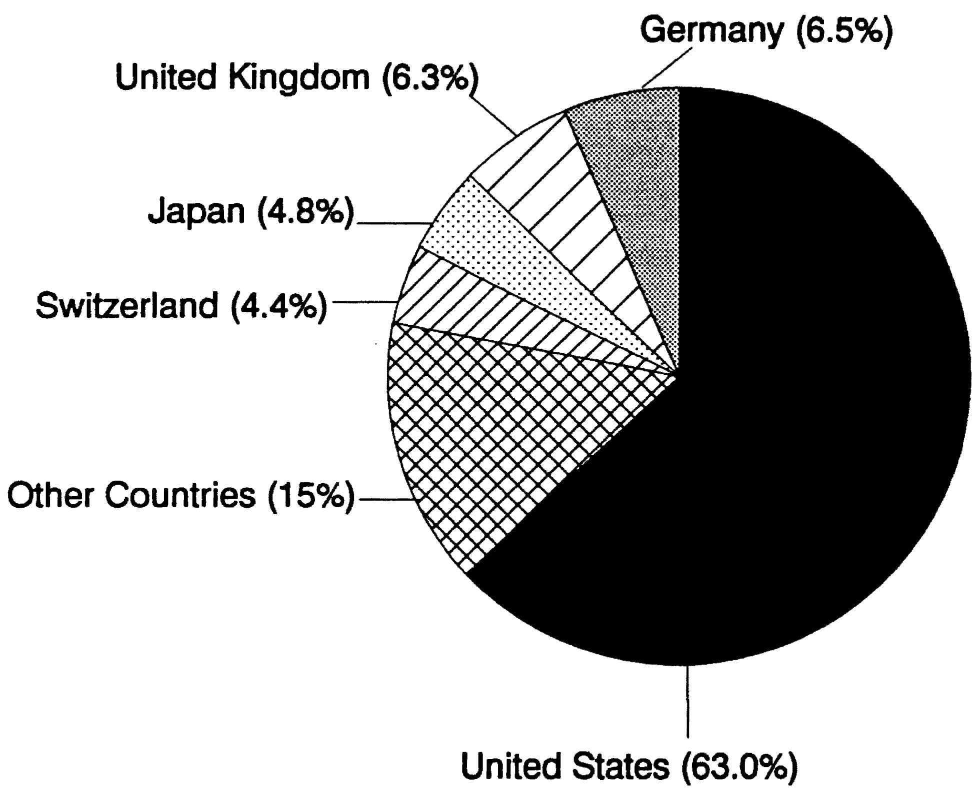
Source: United Nations Calender Year Trade Data.

Figure 3. Foreign Debt in Mexico, 1973-1990

such as import licenses and health requirements were eased or terminated to promote trade and in accordance to join the General Agreement on Tariffs and Trade (GATT) which Mexico was admitted to in 1986 (Agricultural Outlook, 1992).

More foreign investment has enabled the country's deficit to be partially financed by foreign enterprises rather than by borrowing and increasing debt. Direct foreign investment in Mexico totaled $4.4 billion in 1990, nearly double the amount in 1989. The United States has been the primary contributor of foreign investment with 63 percent (Figure 4). The goal of the Mexican government is to obtain $60 billion in foreign investment by 1995 (Farmline, 1992).

The reductions in debt and inflation are good indicators the Mexican economy is improving. After having the second largest debt of any Latin American country, Mexico is considered the most successful of debtor nations in overcoming its debt crisis. This was largely the result of the Brady Plan, designed by U.S. Treasury Secretary Nicholas Brady, to lower the amount of foreign debt repayments from heavily indebted countries. Under this plan, U.S. banks and other lenders agreed to reduce Mexico's foreign debt by more than 10 percent. These lower repayments have allowed more capital to be used for investment and purchasing imports rather than paying foreign debt (Shane and Stallings, 1991).



Source: Shane & Stallings (1991)

Figure 4. Foreign Direct Investment in Mexico (1990)

Also, changes in Mexico's monetary policy have helped to reduce the rate of inflation. The Mexican peso is now devalued by less than 5 percent per year through a crawling peg system (devaluing by 1/100 cent per day). The goal is to stabilize the exchange rate between the Mexican peso and the U.S. dollar when inflation in Mexico falls to 6 percent. Once the stabilization occurs, the inflation rate in Mexico will be partially influenced by the inflation rate in the U.S. (Shane and Stallings, 1991).

The Mexican government's economic reforms are showing signs of tremendous success. With the slowdown in the depreciation of the peso and growth of the money supply, inflation fell from 150 percent in 1987 to less than 13 percent in 1992. The government deficit which reached 12.5 percent between 1982 and 1988, today is almost nonexistent. The result of these reforms has been an increase in economic growth of 3.5 percent in 1991, and, based upon the current economic conditions, analysts are predicting this rate will continue for at least five more years (Farmline, 1992).

Agricultural Sector in Mexico

Mexico is the world's twelfth largest country in total area with approximately 192 million hectares of land, but only 15 percent of this land is arable. Mexico's different climatic regions support a wide range of agricultural production,including many fruits, vegetables, grains and livestock. Coffee is Mexico's leading agricultural export commodity, followed by cotton, tomatoes, and cattle. Their main agricultural imports have been grains, oilseeds, livestock and livestock products.

During most of the post war era, Mexican agricultural policies have often had conflicting goals, such as providing higher agricultural prices to farmers while keeping food prices low for consumers. Most agricultural prices were regulated through the National Company of Popular Subsistence (CONASUPO).[1] CONASUPO set support prices on basic crops such as corn, beans, and rice, to encourage production of certain commodities consumed by the population. Price ceilings were placed on consumer (retail) prices in order to keep the prices of basic commodities affordable by the Mexican population. Contrary to these policies, a large proportion of the Mexican consumer's income was used to purchase food. In 1977, The National Survey of Income and Household Expenditure determined that approximately 45 percent of the average income per family was spent on food. Corn is considered the base food in the Mexican diet, and accounts for about 10 percent of total food expenditures in the average household (Roberts and Mielke, 1986).

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[1]CONASUPO's role in Mexico is comparable to the United States Department of Agriculture.

Population Demographics

Like many developing countries, Mexico has had a substantial population growth. Increasing over 2 percent per year, the population was over 84 million people in 1992, equivalent to a third of the U.S. According to projections, the population is expected to grow at a rate of 3.3 percent, reaching 95 million by the year 1995 and 104 million by the year 2000. The median age of the population 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 constitute 27 million consumers, or 30 percent of the population in Mexico, and this segment is considered the most likely to purchase meats on a regular basis (Ag Exporter, 1991).

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 certain sectors constitute approximately 50 percent of the 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 demand for each sector in Mexico.

Self Service Stores. There are approximately 800 self-service stores (supermarkets) in Mexico that are owned by 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.

Hotels. 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. Of this, 20 percent is pork, 37 percent beef, and 33 percent chicken.

A large portion of this demand is from the growing tourist sector. In 1990, approximately six million foreign tourists visited Mexico and this number is estimated to increase to approximately ten million by 1994. Tourists have typically demanded higher-priced cuts which are primarily supplied through imports. As the number of tourists increases, the quantity of meats demanded by this sector will undoubtably grow (Pork, 1991).

Restaurants. There are approximately 13,000 to 15,000 restaurants in Mexico. The size of these businesses varies, but an estimated 80 percent are considered small or have less than 100 visitors per day. 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 request beef, 9 percent pork, and 22 percent chicken.

Industrial Caterers. 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.

Hospitals. 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 I) 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 I

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
Total	62,045	277,190	93,375

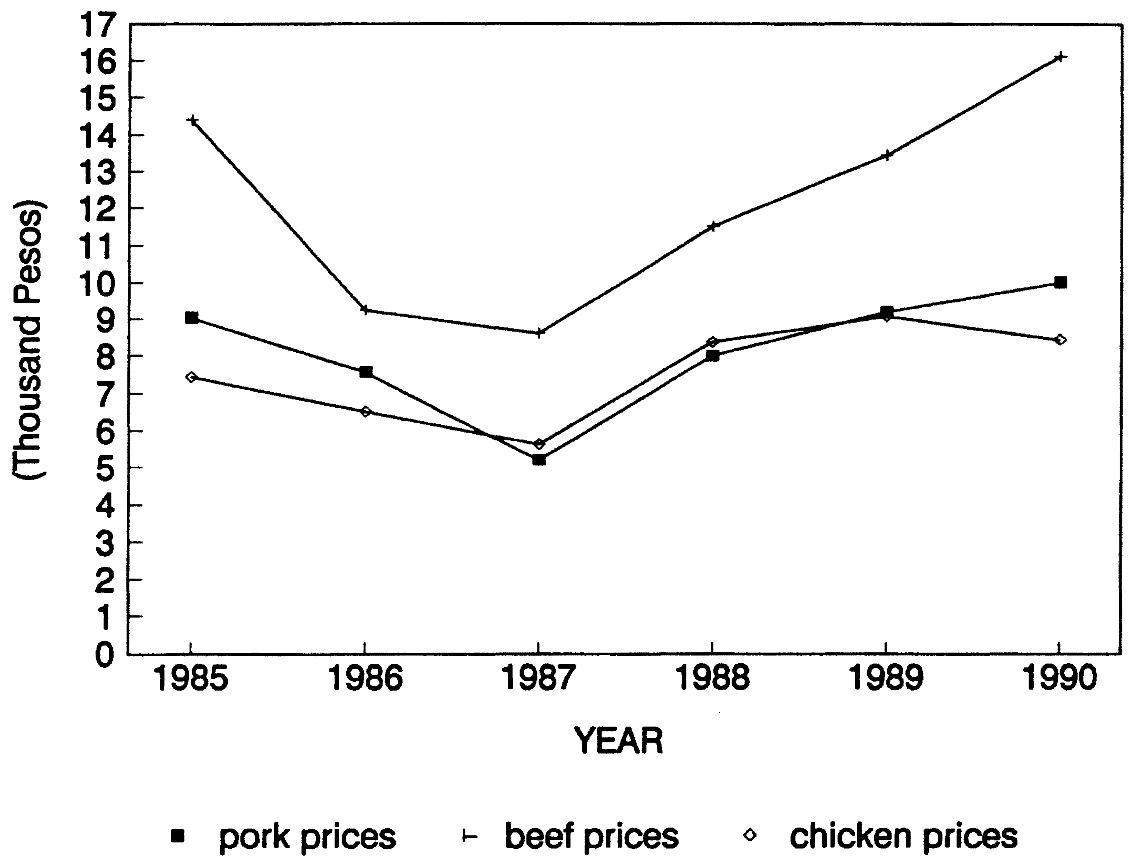
Source: Analysis and Opportunities of the Mexican Meat Market

Consumer Meat Prices

In terms of prices, between 1985 and 1990, beef was the highest priced, while pork and chicken were similar in prices over the five year period (Figure 5). In nominal terms prices rose annually at rates averaging 75 percent per year (Table II). Although in real terms consumer prices for these threecategories increased by approximately 2 percent per year after adjusting for inflation (Table III).[2]

While consumer pork prices declined between 1985 and 1987, there was also a decline in the real minimum salary of Mexican consumers between 1985 and 1989 (Figure 6). Since

[2]The consumer prices are based upon boneless pork, beef steak and whole chicken cuts.



Source: Analysis and Opportunities of the Mexican Meat Market (1990.

Figure 5. Mexican Consumer Prices of Pork, Beef, and Chicken, 1985-1990

TABLE II

CONSUMER MEAT PRICES (Current Pesos)

	1985	1986	1987	1988	1989	1990
Pork	695	1,080	1,730	5,710	7,650	10,000
Beef	1,108	1,320	2,870	8,210	11,205	16,125
Chicken	572	930	1,873	5,976	7,554	8,440

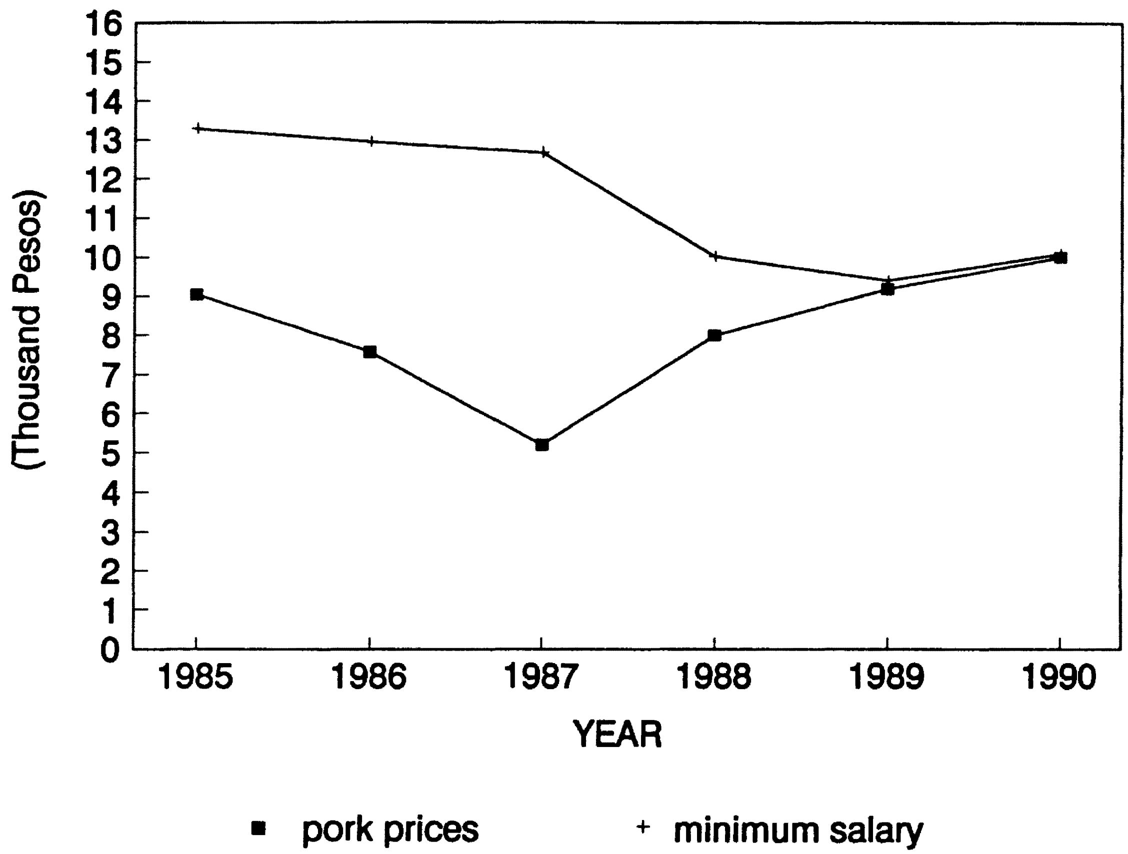
Source: Analysis and Opportunities of the Mexican Meat Market (1990)

TABLE III

CONSUMER MEAT PRICES (Constant Pesos)

	1985	1986	1987	1988	1989	1990
Pork	9,035	7,560	5,190	7,994	9,180	10,000
Beef	14,404	9,240	8,610	11,494	13,446	16,125
Chicken	7,436	6,510	5,619	8,366	9,065	8,440

Source: Analysis and Opportunities of the Mexican Meat Market (1990)



Source: Analysis + Opportunities of the Mexican Meat Market (1990).

Figure 6. Consumer Pork Prices and Decline in the Minimum Salary

the majority of Mexican consumers are in the low to middle income range, consumers may have decreased consumption of animal proteins such as pork and increased consumption of vegetable proteins such as beans in order to combat rising meat prices and declining wages (Thompson and Hillman, 1989).

Pork Consumption

Actual per capita consumption of pork in Mexico decreased between 1985 and 1990 (Table IV), the probable result of lower real incomes and increasing pork prices. 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.

TABLE IV

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)

Projected Meat Demand

With the 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 represents 15 percent of this market and is predicted to increase to 170,000 metric tons by 1995 (Analysis and Opportunities of the Mexican Meat Market, 1990).

World Pork Supply

On a global scale, more pork is produced and consumed than any other meat product, excluding fish. Although consumption of pork is worldwide, production tends to be centralized in only five regions. 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. Between 1975 and 1988, world production of pork increased by 4 percent from approximately 40 million metric tons to 60 million metric tons. China was the world's largest producer with one-third of total production in 1988.

The international trade of pork has bee very 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, and Taiwan.

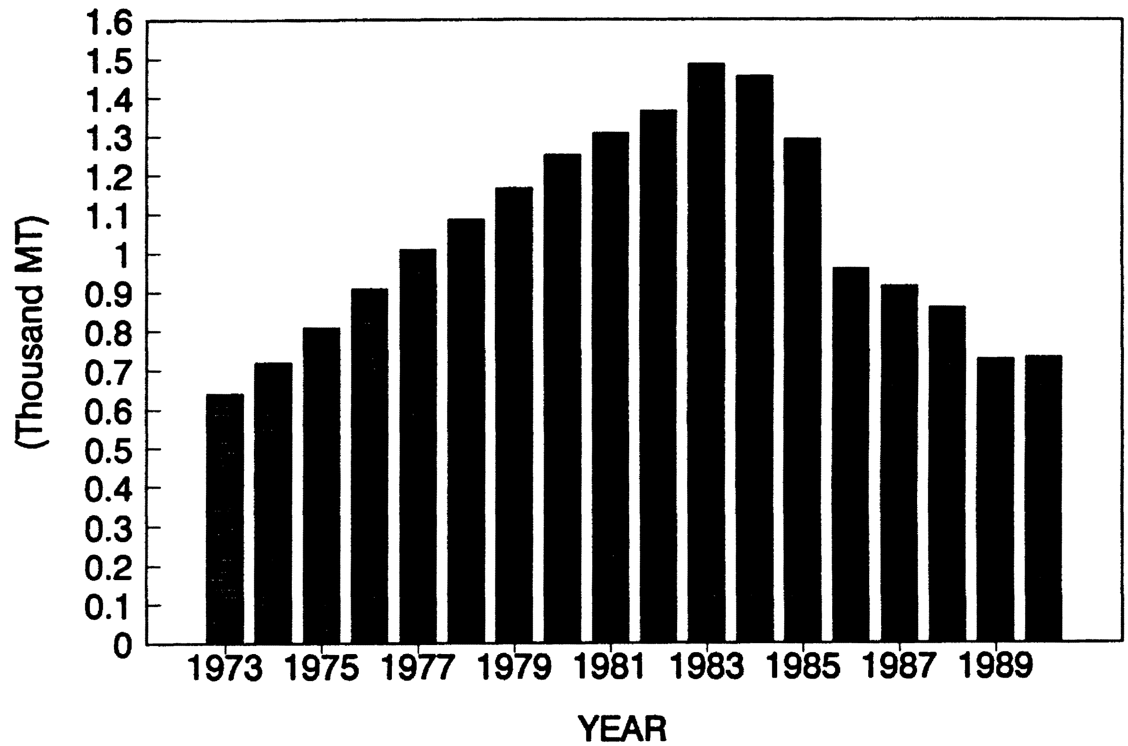
Coincidentally, the U.S. is not only one of the largest producers, but also is the world's largest importer of pork. Approximately 95 percent of pork imported throughout the world is in the U.S., Japan, the former Soviet Union, Hong Kong, and the European Community. With the majority of pork produced and imported in so few countries, any changes in pork production or import policies in these countries can have important implications on pork trade throughout the world (Shagam, 1990).

Trade Barriers

Diseases, such as hoof and mouth disease, have had a profound effect on pork trade patterns. Countries similar to the U.S., 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 had hoof and mouth disease, cannot export to the two largest pork import markets of the U.S. and Japan (Shagam, 1990).

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 (Figure 7). From 1985 to 1989, production declined, the likely



Source: World Bank

Figure 7. Pork Production in Mexico, 1973-1990

result of increasing production costs and price ceilings set on what producers could receive. Several years of drought during the 1980s led to lower feedgrain production and high feed prices for Mexican swine producers. Also, the Mexican government restricted the use of imported feed grains for livestock production. In 1988, the Mexican government enacted the Economic Solidarity Pact (ESP) which was an attempt to control prices from rising inflation. Prices of pork at the consumer level were fixed, while price ceilings were set on what producers could receive at the market. Thus, producers have been faced with rising input costs, while the prices they received for their product were restrained from increasing with the market and inflation. Combined, these problems have caused many smaller operations to disappear, leading to lower supply and production concentrated in larger operations.

Diseases, such as hog cholera, have also impaired pork producers in Mexico by restricting the amount of pork available for export. Because of hog cholera, countries like the U.S. prohibit imports of pork and live hogs from Mexico. Although Mexico has become hog cholera free, the U.S. continues to restrict pork imports from Mexico (Ag Exporter, 1991).

Pork Marketing Channel

There has been little vertical integration in the pork industry in Mexico. The marketing channel for pork usually begins at fattening farms (Figure 8). The finished animals are then sold to middlemen who control the quantity of hogs sent to slaughterhouses. Brokers further process the pork by separating the carcasses into smaller cuts, and sell the pork to the different meat market sectors where it reaches the final consumers. Although this appears an efficient distribution system, there have been problems with an excessive number of intermediaries in the pork marketing channel.

Slaughtering Facilities

In 1990, there were approximately 370 slaughtering facilities varying in technology and processing capacity located in Mexico. Most of these facilities do not meet the requirements of the Federal Meat Inspection Agency. In 1990, only 43 of the 370 processing plants satisfied the requirements of federal meat inspection. Of those that meet federal health requirements, most are used to process meats for export and for higher priced cuts. The low number of federally inspected plants needed to process meats for export has limited Mexican pork from reaching foreign markets.

The following are major problems confronting the pork industry in Mexico:

- low technology of producers in controlling disease;
- high cost of feed grains;
- excessive middlemen in the food chain;

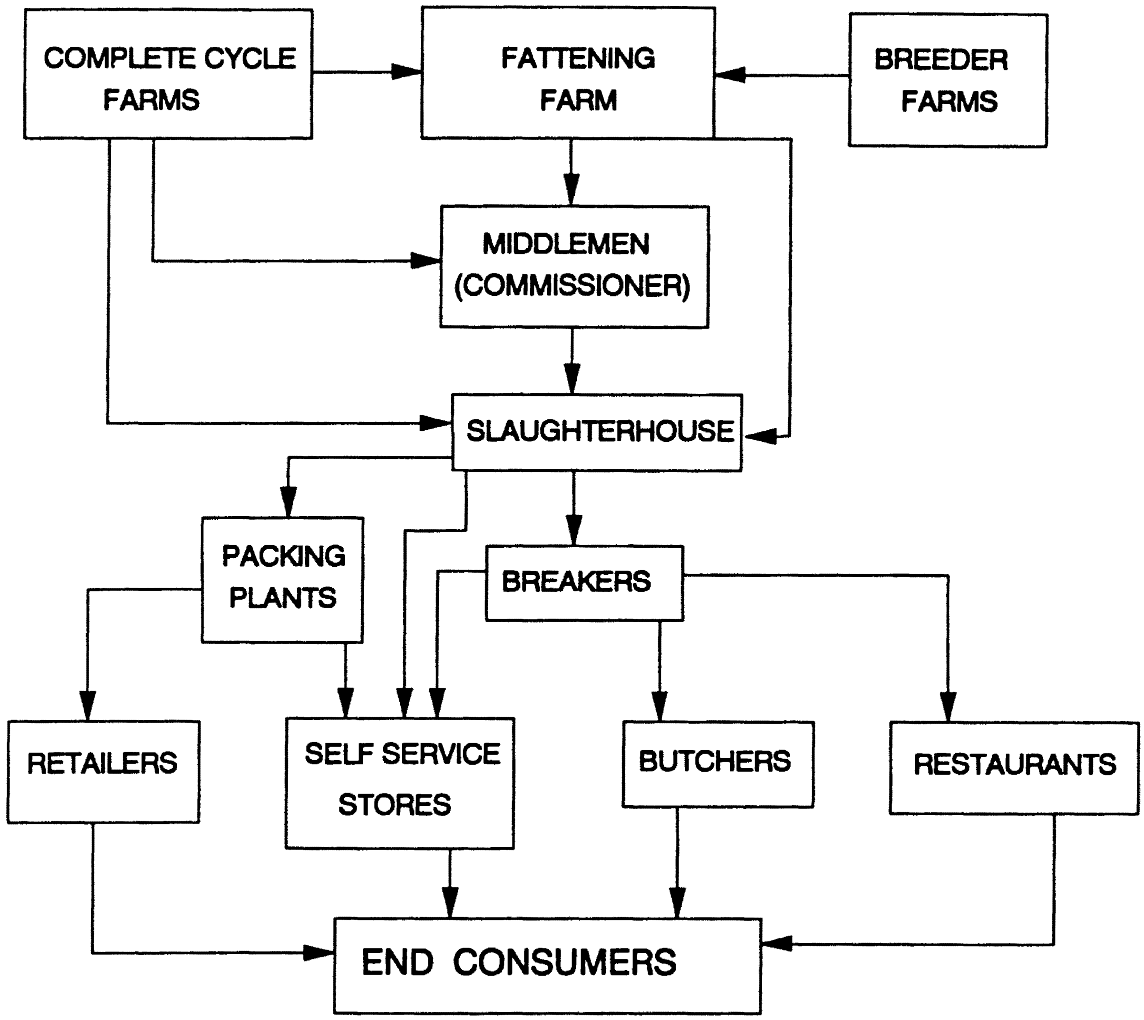


Figure 8. Pork Marketing Channel

- low number of federally inspected slaughtering facilities;
- lower tariffs have brought more 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. This resulted in increased exports of live hogs from the U.S. and a growing hog supply in Mexico in 1990-91. Mexico's hog supply is currently increasing by approximately 3 percent annually. The Mexican government is considering several policies to improve domestic pork industry, including: increased vertical integration, implementing a carcass grading system, and subsidizing pork producers.

Pork Imports in Mexico

With the decline in domestic pork production combined with the growing demand of consumers, there is a large demand for imported pork. As previously stated, between 1973 and 1990 the quantity of pork imported fluctuated considerably (Figure 1). Imports went from zero in 1978 and 1979 to over 95 thousand metric tons in 1985, with the U.S. supplying on average 96 percent of all imports (Figure 2). Mexico is the second largest market for U.S. pork next to

Japan and the largest export market of U.S. pork variety meats. As Table V suggests, Mexico is comprising a growing share of the U.S. pork export market. The increased exports of pork to Mexico from the U.S. in the mid-1980s can be partially attributed to the elimination of import tariffs and lower U.S. pork prices. However, in 1990 the amount of exports from the U.S. declined, largely the expected result of rising U.S. pork prices, and Mexico reinstated their 20 percent tariff rate on imported pork.

TABLE V

EXPORTS OF FRESH, CANNED OR PRESERVED PORK TO MEXICO FROM THE U.S.

Year	Quantity (Metric Ton)	Value (U.S. Dollars)	Percent of U.S. Export Market
1987	6,658	4,886,000	7.6
1988	12,948	30,437,000	20.5
1989	23,363	55,742,000	25.0
1990	14,604	36,869,000	17.7
1991	28,442	67,785,000	30.0

Source: The National Pork Producers Council (1992)

North American Free Trade Agreement (NAFTA)

To promote the growing trade alliance between the United States, Mexico, and Canada, President Bush of the United States, President Salinas de Gotari 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.

Current Pork Provisions of NAFTA

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 specified quota of pork imports from the U.S. and Canada to enter at the current NAFTA tariff rate. The size of the allotted quota will increase by 3 percent per year for the next ten years. Any imports over the allotted quota will be applied 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).

If NAFTA is approved, trade between the U.S. and Mexico will most likely result in increased exports of livestock products. Processed meat imports in Mexico, such as pork, are expected to increase and could double by the end of the phasing out period of the quota (USDA Fact Sheet, 1992; Rosson, Shulthies, and White, 1991).

Chapter Summary

The Mexican economy is overcoming past economic problems that have plagued the development of the country through new economic policies which promote a market economy. By undertaking policies aimed at easing inflation and foreign debt, economic growth in Mexico is increasing at a rate of 3.5 percent annually. The improving economic conditions, combined with an expanding population, will likely increase the demand for pork and other meat products in Mexico. With low domestic pork production and growing demand, the U.S. could benefit through increased pork exports to Mexico.

Organization of the Following Chapters

The following chapters will focus on determining an import demand model to aid in explaining the variation in pork imports in Mexico between 1973 and 1990. In Chapter II past import demand studies are reviewed and used as a basis for the model and methodology used in this study. Chapter III uses general economic theory of supply and demand to derive an import demand model. Chapter IV describes the model and econometric procedures used in this analysis and is followed by the empirical results of the models and conclusions of this study.

CHAPTER II

LITERATURE REVIEW

Literature on import demand can provide a strong foundation for estimating an import demand model. The following group of articles were chosen to provide a basis for the model and econometric procedures used in this study. The following sections describe the specification of the import demand model and determining which functional form of the model is most appropriate. Thereafter, empirical studies on import demand at the aggregated and disaggregated levels are reviewed. The final section pertains to specific issues in international trade.

Model Specification

Gardiner and Carter (1988) contributed a comprehensive study on the use of elasticities in international trade. Elasticities have provided researchers with the ability to test economic theories, forecast demand, determine the effects of policies, and analyze the structure of markets. Gardiner and Carter maintain that the specification of the model is the beginning stage of estimating elasticities, and this specification depends upon the model's purpose, the type of commodity being estimated, the market that the product is traded in, and the desired degree of regional disaggregation.

Two common models used in import demand studies are perfect substitutes and imperfect substitutes. Under perfect substitutability, domestic and imported goods are homogeneous. Thus the quantity of imports is determined by the difference between domestic supply and demand. If an imperfect substitutes model is used, imported and domestically produced goods are not homogeneous, and the demand for imports is obtained by estimating both supply and demand separately.

Functional Form

Khan and Ross (1977) questioned which functional form of the aggregate import demand equation is the most appropriate. The two most commonly used functional forms of import and export demand equations are linear and log-linear. The choice of form has often been determined by the objectives of the study. If forecasting is the main objective, a linear form is usually chosen. If trade elasticities are the primary object, a log-linear form is often chosen since the coefficients are the elasticities.

Khan and Ross maintain the choice of the functional form is important since the degree of influence of the explanatory variables is dependent upon which functional form is used. The choice of the wrong form can lead to statistical problems of biasness and inconsistency. They attempted to decide on empirical grounds which form is the most appropriate. Using quarterly data from 1960 to 1972 for the United States, Canada, and Japan, the following basic import demand model was estimated.

$$M^d = f(P, Y)$$

Where

M^d = the quantity of imports demanded;

P = ratio of the price of imports to the domestic price;

Y = real gross national income.

A maximum likelihood test was used to determine which functional form is best. The results indicated that neither the signs of the coefficients nor the t-values give any indication of which form is the most appropriate. But based upon the log-likelihood function, the log-linear form was preferred over a linear form. Since most demand studies are performed to estimate price and income elasticities, the log-linear form is often the most chosen.

Boylan, Cuddy and O'Muircheartaigh (1979) compared their results with those of Khan and Ross (1977) on establishing the optimal functional form. Although economic theory does not provide any basis to judge which form is best, they allege there are both economic and statistical reasons for choosing one form over another. The linear functional form implies an income elasticity close to unity and a decreasing price elasticity of import demand, while the use of a log-linear form implies that price and income elasticities are constant. If the functional form is misspecified, the result is a violation of the properties of the error term leading to estimates both biased and inconsistent.

To determine the optimal functional form, a generalized aggregate import demand equation was estimated for Ireland, Denmark, and Belgium using annual data from 1953 to 1975. The maximum likelihood test was used to determine which functional form was most appropriate. Based upon the value of the maximum likelihood estimates, it was determined the log-linear form is superior over a linear form, which was consistent with the results of Khan and Ross (1977).

Murray and Ginman (1976) addressed the question of which form of the import demand model will yield the most precise elasticity estimates. The size of these elasticity estimates is believed to be largely determined by the specification of the model.

Like most other demand models, the traditional import demand model has price and quantity inversely related with the quantity of imports determined by prices and income. In log-linear form the model is stated as:

$$\ln(Q) = \beta_0 + \beta_1 \ln(Y) + \beta_2 \ln(P) + \epsilon$$

Where

Q = quantity of imports;

Y = real GNP;

P = price index.

Demand theory hypothesizes the demand for imports is dependent upon both the price of imports and the price of domestically- produced goods. Under this assumption, a price index is used where the price of imports is divided by the price of domestic substitutes (Pm/Pd). They contend this constrains the elasticity of import demand since the price elasticity of imports must be equal and opposite in sign of the price elasticity of domestic goods. It also assumes consumers have no preference between goods that are produced domestically or foreign.

Murray and Ginman hypothesize that this constraint can be removed by estimating the domestic price and import price elasticities separately. The demand equation can now be specified as:

$$\ln(Q) = \beta_0 + \beta_1 \ln(Y) + \beta_2 \ln(Pm) + \beta_3 \ln(Pd) + \epsilon$$

Where

Pm = price of imports;

Pd = price of domestic goods.

This equation was estimated using data between Canada and the U.S. from 1950 to 1964. The result of separating the price of imports from domestic goods was smaller estimates of income and price elasticities. Their main conclusion was that the traditional import demand model of using a price index is inappropriate for estimating aggregate import demand elasticities. By separating the prices of imports and domestic goods, the estimates are believed to be more consistent with theoretical expectations.

Thursby and Thursby (1984) examined whether it is better to use the basic demand function with some modifications or a model that yields unbiased and consistent parameter estimates. To determine which models yield the best estimates, they selected nine models based upon past literature. Both linear and log-linear forms of the models were estimated using ordinary least squares. The signs and significance of the coefficients, Durbin-Watson test, and the regression specification error test (RESET) were used as the selection criteria.

Of the models accepted, most were log specifications which were consistent with Khan and Ross (1977) and Boylan, Cuddy and O'Muircheartaigh (1979). Also, the majority of the accepted models had lagged dependent variables. In several cases, the elasticities in the accepted models were significantly different than those of the rejected models. This supports the work of Murray and Ginman (1976) that incorrect specification of the model will yield inaccurate elasticity estimates.

Import Demand Studies

Leong and Elterich (1985) performed a study on the broiler market in Japan. The main objectives were to construct a model that explained the interrelationships of the Japanese market for broilers, to estimate the supply of broilers in Japan, and to estimate per capita and import demand of broilers from the U.S.

The time period of this study was monthly data from January 1974 to February 1982. To determine the supply of broilers in Japan the following production function was estimated:

$$JPC=f(Pfeed_{t-5},Pchick_{t-5},T,U_2)$$

Where

JPC= Japanese Production of broilers;

Pfeed = domestic Price of feed deflated by feed cost index Yen/kg;

Pchick = farm price of broilers in Japan deflated by the livestock index;

T = trend;

U_2 = disturbance term.

A lag of five months was chosen to allow for the decision to produce and time for the product to be marketed. The price of feed was used as a proxy for the total cost of inputs in production of broilers.

To determine the import demand for broilers in Japan the following model was estimated.

$$MUS=f(PUSB_{t-1},WPP_{t-1},PGNP_{t-1},JPC_{t-1},D1..D11,CDM_2,PDGNP,U_3)$$

Where

MUS = Japan's imports of broilers from U.S.;

PUSB = Wholesale price of U.S. broilers;

WPP = Wholesale price of pork;

WBEEF= Wholesale price of beef;

XR = Exchange rate ratio in Yen/dollar;

PCGNP= Per capita GNP;

JPC = Japanese domestic production of broilers;

CDM_2 = Constant dummy;

DPCGNP= Slope dummy for CGNP;

U_3 = Disturbance term.

A constant dummy variable was used to represent a parallel shift in the dependent variable over time. Also, monthly dummy variables were used to account for seasonality in demand.

Both equations were estimated in double log form to obtain elasticity estimates. Ordinary least squares was used for the supply equation. For the import demand equation, two stage least squares (TSLS) was used because of the right hand side endogenous variable. The results of the supply equation indicated Japanese broiler production was relatively price inelastic (producers were not very responsive to changes in price). On the demand side, the price of pork (substitute) had the largest effect on the import demand for broilers. The Japanese production of broilers was found to be an insignificant determinant of import demand. Both the exchange rate and income coefficients were highly significant determinants of Japan's import demand for American broilers.

Kim (1986) studied the effects of price policies and financial constraints on the import demand for corn in Mexico. Governments have often protected domestic prices from changes in the world market through pricing policies such as producer and consumer subsidies. These policies can have large impacts on the demand for products, especially if prices are fixed at a very low level.

Past Mexican agricultural policy has focused on providing low priced food for consumers while encouraging agricultural production. This has set the consumer price of corn at a low level, but the producer price of corn has been set high enough to increase production. The difference is paid through a government subsidy.

To determine the effects of price policies and financial constraints on the import demand for corn in Mexico, the following model was estimated.

$$M=M(PC_m, PC_w, Pf_m, Pf_w, PW_w, EX, S_{t-1}, W, Y, G, FE)$$

Where

Pc_m = Consumer price of corn;

Pf_m = Producer price of corn;

Pw_m = World border price of corn;

Pc_w = Consumer price of wheat;

Pf_w = Producer price of wheat;

Pw_w = World border price of wheat;

Y = Aggregate disposable income;

G = Government current expenditures;

FE = Foreign Exchange allotment;

S_{t-1} = Stocks previous year;

EX = Exchange rate;

W = Weather.

The Canonical Regression Instrumental Variable (CRIV) approach was used in this study. Ordinary least squares could not be used since the number of explanatory variables exceeded the time series of 1973 to 1982.

The results indicated the exchange rate and foreign exchange variables were not significant determinants of the import demand for corn. The positive sign on the government expenditures variable indicated the government spent more on producer subsidies than on consumer subsidies. It was further concluded that Mexico's corn imports could be substantially reduced by transferring small amounts of subsidies from consumers to producers.

Arnade and Dixit (1988) questioned the assumption inflation has no effect on import demand functions. Economics has implied that demand curves are homogeneous of degree zero in income and prices. This implies that if prices and income are increased, the demand for the product will not change. The reason for restricting import demand equations to zero homogeneity is derived from consumers maximizing utility which implies consumers cannot influence prices, while producers are assumed to maximize profit and also are not capable of influencing prices. Since import demand is the difference between domestic demand and supply, import demand equations are also restricted to the zero homogeneity condition.

Often in import demand functions the consumer price index (CPI) is used to account for changes in prices. This approach to account for inflation in import demand functions may be inappropriate since the CPI is determined by the inflation of both traded and non-traded goods. Thus, deflating by the CPI could lead to inaccurate elasticity estimates.

To determine the effects of restricting import demand equations to zero homogeneity the following import demand equation was estimated using ordinary least squares (OLS) with wheat and soybean data from 1960 to 1980. The countries of Brazil, Mexico, Spain, Japan, and Taiwan were chosen because of their different inflation rates.

$$\ln(IM) = \beta_0 + \beta_1 \ln(Y_m/CPI) + \beta_2 \ln(P_1/CPI) + \beta_3 \ln(P_2/CPI) + \beta_4 \ln(S)$$

Where

I_m = total imports;

Y_m = the importer's income;

CPI = the importer's consumer price index;

P_1 = price of good one;

P_2 = price of good two;

S = Supply.

The results indicated the income elasticities for Spain, Japan and Mexico are changed significantly when expressed in real and nominal terms. Particularly, when the CPI was included, the income elasticities were much higher. The equations where the CPI has been omitted had a much poorer fit. Therefore, import demand equations that are restricted by zero homogeneity should include the CPI in the model.

Melo and Vogt (1984) studied how increased wealth in Venezuela can affect the demand for imports. It is hypothesized that an increase in Venezuela's wealth or income would increase the demand for imported goods. They estimated the following model using data on total imports, tobacco and beverages, chemicals, machinery and transportation, food, and manufacturing from 1962 to 1979.

$$LogM_i=\alpha_{0_i}+\alpha_{1_{i\,log}}(PM_i/PD_i)+\alpha_2 logY+\alpha_{3_{iD_i}}+U_i$$

Where

M_i = Quantity demanded of the ith import commodity;

PM_i = Price of commodity i;

PD_i = Price of substitute;

Y = Real Gross Domestic Product;

U = Random disturbance term.

From 1974 to 1979 the price of oil had risen in Venezuela and significantly increased the income of the country. To account for this increase in income, a dummy variable was included which had a zero value from 1962 to 1973, and from 1974 to 1979 had a value of one.

The results indicate that the equation performed well as all of the estimates had the expected sign. All of the price elasticities of demand were significantly different from zero except for chemicals and manufacturing. Thus, it was concluded that the increase in wealth of Venezuela led to an increase in imports of the commodity groups estimated.

Jabara (1982) examined the import demand relationships for wheat in middle income developing countries. Rather than focusing on a single country study, pooled cross section and time series data were used to compare wheat import demand across countries. Data from 1976 to 1979 for twenty middle-income developing countries were used to estimate the following equation.

$$WM_{i_t} = \alpha + \beta_1 POP_{i_t} + \beta_2 Y_{i_t}(IMC_{i_t}) + \beta_3 WST_{i_t} - 1 + \beta_4 P_{m_{i_t}}(WP_{i_t})$$
$$+ \beta_5 PRODW_{i_t} + \beta_6 P_{s_{i_t}} + \beta_7 FAID_{i_t} + \epsilon_{i_t}$$

Where

WM	=	Total concessional and commercial imports of wheat for country i;
POP	=	Population in country i;
Y	=	Per capita gross national product of country i;
IMC	=	Import capacity of country i;
WST	=	Carry in wheat stocks in country i;
Pm	=	Consumer price of wheat in country i;
WP	=	World price of wheat in country i;
PRODW	=	Production of wheat in country i;
Ps	=	Consumer price index of country i (1975 base year);
FAID	=	Consessional wheat shipments to country i;
E	=	Random error term.

The generalized least squares (GLS) estimation procedure was used rather than ordinary least squares (OLS) because of uncorrected variation of the error term that is often present in pooling time series and cross section data.

The results indicated there are large differences in determinants of import demand among wheat-producing and non-producing countries. The foreign exchange availability and the consumer price were important determinants in the non-producing countries. In countries where wheat is produced, production, foreign exchange earnings, and income were important determinants.

Arize and Afifi (1987) estimated import demand functions for 30 developing countries with data from 1960 to 1982. Four basic import demand equations including two equilibrium and two disequilibrium models were estimated.

1. $M_{it} = M_{it} (TY_{it}, CY_{it}, P^m{}_{it}, P^d{}_{it})$
2. $M_{it} = M_{it} (TY_{it}, CY_{it}, P^m{}_{it}, P^d{}_{it}, M_{it-1})$
3. $M_{it} = M_{it} (TY_{it}, CY_{it}, P_{it})$
4. $M_{it} = M_{it} (TY_{it}, CY_{it}, P_{it}, M_{it-1})$

Where

M_i = The quantity of imports of country i;

TY_i = Trend level of real income in country i;

CY_i = The ratio of current real income to its trend;

P_i = Ratio of the value of imports (P^m) to the domestic price level (p^d) in country i.

Demand theory assumes there is a positive relationship between imports and income. This is supported by the reasoning that increases in income will cause an increase in consumption and more foreign goods will be purchased. Correspondingly, an increase in income can also result in an increase in investment which will induce purchase of more foreign goods.

Two stage least squares (TSLS) was the estimation procedure used to estimate the equilibrium models. The Sargan two stage least squares (STSLS) method was used to estimate the disequilibrium models. OLS was not used because the error term is correlated with an explanatory variable leading to biasness. In choosing the most appropriate model for each country, the signs and significance of the variables and the adjusted R squared were used.

The results indicated that prices do play an important role in determining the amount of imports in developing countries. In the thirty countries studied, the price elasticities were found to be very high, and consumers tended to respond more to changes in the price of domestic goods than to imported goods. These results have supported the hypothesis that basic import demand equations can be used to explain variation in imports.

Ortalo-Magne and Goodwin (1990) estimated the U.S. import demand for wheat gluten. Using observations from 1974 to 1987, the following equation was estimated using the Box-Cox flexible functional form.

$$ID = f(ID_{t-1}, P_t, P_t^c, Y_t, Z_t, X_t)$$

Where

ID = Import demand of wheat gluten in the U.S.;

P_t = Price of wheat gluten;

P_t^c = Price of flour;

Y_t = Income;

Z_t = Exogenous demand shifter;

X_t = Exogenous supply shifter.

The significance of the lagged import demand variable indicated that there is some degree of partial adjustment in the flow of wheat gluten. The price elasticity for wheat gluten in the U.S. was inelastic, indicating a quick adjustment, and that both short run and long run price elasticities are relatively similar. The results indicated flour supplies, income, and domestic protein supplies are important determinants of the import demand of wheat gluten.

Price and Thornblade (1972) studied the demand functions of United States imports for eleven developed countries. Data from 1964 to 1969 for twenty six classes of manufactured goods were used and disaggregated by country and commodity.

The following double log import demand equation was estimated using ordinary least squares.

$$\log M_{ij} = a + a_1 \log\alpha \frac{P_{ij}}{P_{dj}} + a_2 \log\alpha \frac{P_{ij}}{P_{c_{ij}}} + a_3 \log D_j$$

$$+ a_4 Q_2 + a_5 Q_3 + a_6 Q_4 + U_t$$

Where

M_{ij} = the quarterly quantity of U.S. imports from country i for class j;

P_{ij} = the unit value index for imports from country i for commodity j;

P_{dj} = the U.S. wholesale price index for a similar class of products;

P_{cij} = the composite unit value index for imports from other countries, other than country i, that supply commodity j;

D_j = the amount of expenditure in the U.S. for consumption of commodity j;

Q_2, Q_3, Q_4 = seasonal dummy variables;

U_t = the error term.

Unit values were used as a proxy for prices since actual import prices were not available. Since the unit values are calculated from imports that have arrived but were ordered earlier, a shipping time lag is reflected in the foreign price (P_i). However, the domestic price variable (P_d) was also lagged to be consistent.

The results were that the expenditure variable was the most significant in explaining the variation in imports. Better statistical results were obtained by aggregating commodities into large groups. Therefore, if the objective is to obtain price elasticities at a disaggregated level, then more complicated models which incorporate institutional changes are needed to explain the greater variation in imports.

Warner and Kreinin (1982) estimated import demand for nineteen industrialized countries to determine the effects of exchange rate variations on trade flows. Estimates were obtained using quarterly observations from 1957 to 1980. To determine the effects of changing from a fixed to floating currency, the time period was divided into periods of fixed and floating exchange rates.

$$\ln M=\alpha_1 \ln Y+\alpha_2 \ln \frac{P_m}{P_d}$$

Where

M = volume of a country's imports;

Y = real GNP;

Pm/Pd = ratio of import prices to domestic prices.

Because of the homogeneity assumption that the domestic price and imported price are equal in magnitude but opposite in sign, the above equation was also estimated with Pd and Pm specified separately. For the period of floating exchange rates, an import weighted exchange rate variable was added. The results indicated it is better to specify the domestic and import prices separately rather than a ratio of the two prices which contradicts the homogeneity assumption. Also, the exchange rate variable appears to significantly effect the demand for imports, but the direction of change varied between countries.

Trade Related Issues

Salas (1982) attempted to determine if changing income and price elasticities is the cause for the increase in Mexico's private sector imports during 1978 and 1979. As previously stated, during the 1960s and 1970s, Mexico experienced an increasing trade deficit combined with high inflation. However, in the late 1970s and early 1980s, large increases in oil exports boosted their economy and corresponded to an increase in imports into Mexico. Total imports increased by 38.5 percent in 1978 and by 57.1 percent in 1979. Salas concludes the increase in imports is the result of more liberal trade policies that were adopted to meet requirements to join the General Agreement on Tariffs and Trade (GATT). This was also the outcome of increased revenue from oil exports. Together these were the main factors for the increase in private sector imports during 1978 and 1979.

Braschler (1983) estimated whether a change in demand for pork and beef occurred in the U.S. during the 1970s. In the early 1960s and 70s single demand equations could result in fairly accurate forecasts of pork and beef prices. During the 1960s meat demand was relatively stable in the U.S., and prices could be predicted accurately from data on production and consumer income. However, the 1970s brought many economic changes that were consistent with structural demand changes for food. High inflation, interest rates, and declines in real consumer income all could be contributing causes for changes in the demand for food.

To estimate whether a change in demand for pork and beef occurred during the 1970s, annual data from 1950 to 1982 on the retail prices and per-capita consumption of pork, beef, and per capita income were used.

In comparing the price forecasting accuracy, the actual and predicted prices for 1982 compared with estimates of the two time periods. The prices predicted using the whole period were much higher than the actual prices for pork and beef which strengthens the hypothesis that a structural change in the demand for pork and beef occurred in the U.S. during the 1970s.

Mellor (1989) examined the food imbalances between developed and developing countries. Overall, the supply of food has shifted much faster than demand in developed countries, while the demand for food has increased faster in developing countries. Since the interaction of supply and demand is the predominant force controlling world prices, these prices are also a important determinant of food availability. The price mechanism is especially critical considering that food prices tend to be more elastic or have a greater impact on supply in developed countries, while the reverse is true in developing countries, where prices tend to be more elastic or have a greater impact on demand.

The problem has been the inability of developed countries to recognize the impact certain agricultural policies have on the demand for food in developing countries. Particularly, protectionist policies on agricultural commodities which have retained prices higher than normal have ultimately reduced the demand in developing countries.

Developing countries represent the most rapidly growing market for food products. This increase in demand is particularly the result of high population growth rates, income growth, and high elasticities of expenditure for food. For developed countries to promote export markets in lesser developed countries they must provide assistance. This aid can be through trade liberalization, such as removing both tariff and non-tariff barriers and other protectionist policies, to increasing their imports of labor intensive agricultural commodities supplied through developing countries.

Chapter Summary

As the previous chapter demonstrates, past research is comprehensive regarding import demand and other trade related issues. In this chapter, the primary topics addressed were choosing the preferred specification of the import demand model and determining which functional form of the import demand equation is the most appropriate, the choice being linear and log-linear. Of the actual import demand studies reviewed, emphasis was placed on the variables included and the methodology used to obtain the results. Together, these studies help strengthen the model and procedures used in the succeeding chapters.

CHAPTER III

THEORY

The following chapter provides an overview of basic economic theory to demonstrate how domestic demand and supply interact and to determine the demand of a commodity. Discussions on price and income elasticities are included since their estimation is a primary objective of this study. A review of international trade theory is used to explain the advantages of trade and how excess supply and demand functions are formed. The final section focuses on deriving import demand functions when commodities are considered perfect and imperfect substitutes.

Demand Theory

Economists use the theory of consumer demand to explain how consumers arrive at consumption decisions. Theory provides a basis to explain how income, prices, and preferences interact to determine consumer choices. With the diversity of consumers, economists base the theory of consumer behavior on several general propositions. First, it is assumed consumers can rank by preference all market baskets of goods. The second assumption is a consumer will prefer more of a good as long as the cost incurred is less than the benefit or utility gained. Thus, consumers attempt to maximize utility and will not consume an additional unit of a commodity if it corresponds to a net loss in utility (Browning, 1989).

Mathematically, a utility function is used to derive a consumer's ranking of commodities. In the simplest case where a consumer's purchases are confined to two commodities, the utility function can be written as $U=f(q_1,q_2)$, where q_1 and q_2 are the quantities consumed of goods Q_1 and Q_2. A consumer would desire to purchase the combination of these goods which would maximize their utility. However, a consumer can only purchase the combination of goods which is affordable. Therefore, the consumer faces the following budget constraint.

$$Y^0 = p_1 q_1 + p_2 q_2 \tag{3.1}$$

Where Y is the consumer's income and p_1 and p_2 are the prices of q_1 and q_2. The rational consumer would attempt to maximize utility subject to his budget constraint. Thus, the Lagrange function for utility maximization is formed.

$$V = f(q_1 q_2) + \lambda (Y^0 - p_1 q_1 - p_2 q_2) \tag{3.2}$$

λ is the Lagrangian multiplier or the marginal utility of income. In satisfying the first-order conditions for maximization, the partial derivatives of q_1, q_2 and λ are taken and set equal to zero:

$$\frac{\partial V}{\partial q_1} = q_2 - p_1 \lambda = 0 \tag{3.3}$$

$$\frac{\partial V}{\partial q_2} = q_1 - p_2\lambda = 0 \tag{3.4}$$

$$\frac{\partial V}{\partial \lambda} = Y^0 - p_1 q_1 - p_2 q_2 = 0 \tag{3.5}$$

The ordinary or (Marshallian) demand function of a consumer gives the quantity of a commodity purchased as a function of prices and income. By simultaneously solving equations 2.3, 2.4, and 2.5 for q_1 and q_2, the ordinary demand functions for q_1 and q_2 as a function of prices and income are derived (Henderson and Quandt, 1980).

$$q_1 = \frac{Y^0}{2p_1} \qquad q_2 = \frac{Y^0}{2p_2} \tag{3.6}$$

The same relationship between the two commodities can be derived graphically. A consumer's preference ranking or utility is illustrated by the indifference curves U_1, U_2, and U_3 in Figure 9. Each indifference curve represents a combination of q_1 and q_2 equally satisfactory to a consumer. The budget line B_1 represents the initial budget constraint identifying the basket of goods the consumer can afford. The point of tangency between B_1 and U_1 is the combination of q_1 and q_2 consumed given limited income and prevailing prices.

The demand curve for a commodity can be derived by isolating the effects of a price change on consumption while income, preferences, and the prices of other goods are held constant. In Figure 9, reductions in the price of q_1

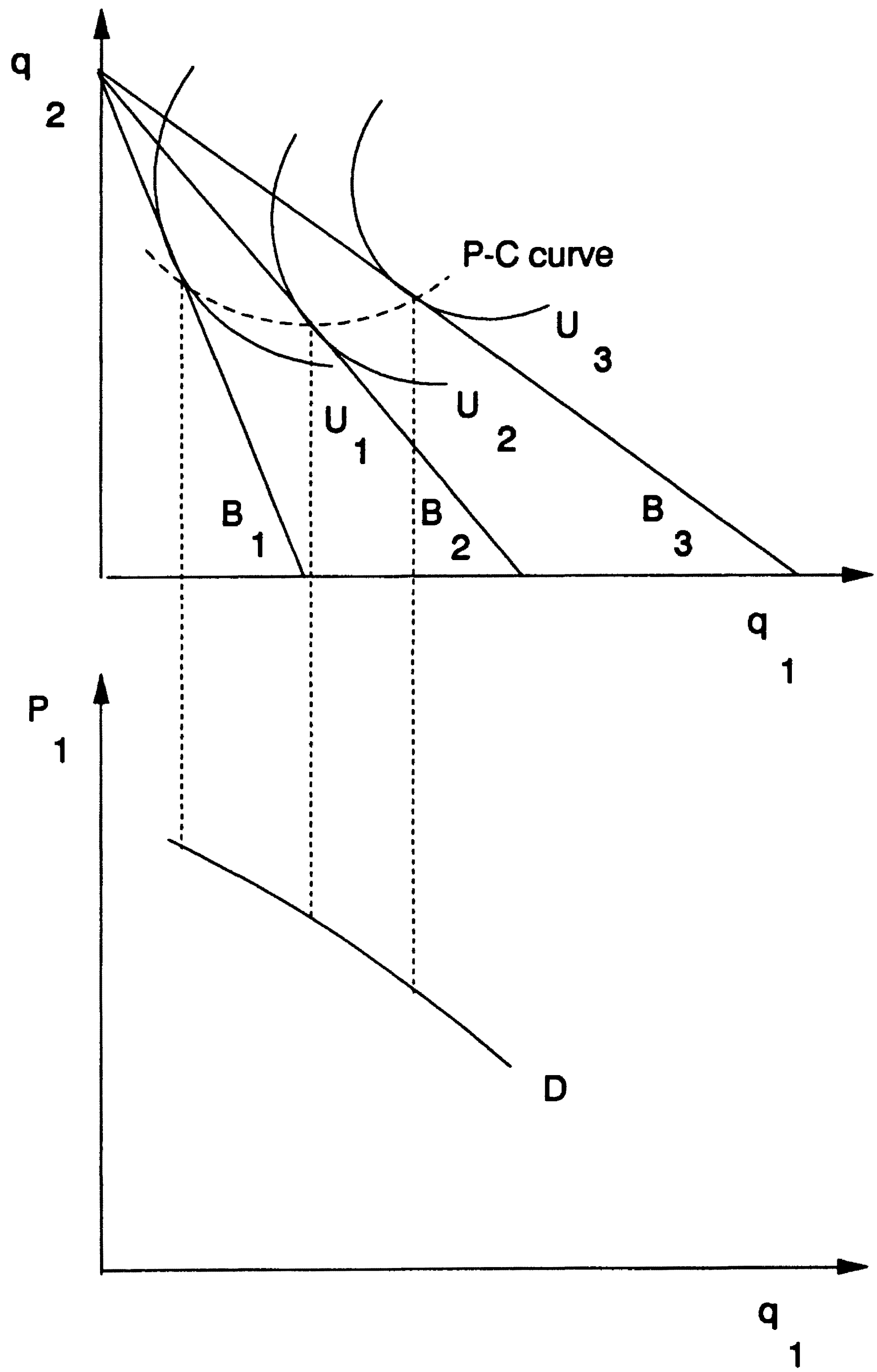


Figure 9. Derivation of a Demand Curve

rotates the budget line outward to B_2 and B_3. The points of tangency between the budget lines and the indifference curves form the price consumption (P-C) curve. Thus, the demand curve for q_1 is derived from the P-C curve, and shows the quantity of the good a consumer would purchase at various prices.

Market Demand

The market demand for q_1 is derived from the horizontal summation of the demand for all consumers in the market. Mathematically, the market demand is the sum of the quantities demanded by n consumers or:

$$Dq_1(p_1) = \sum_{i=1}^{n} q_{i1}(p_1) \quad i = 1, \ldots n. \tag{3.7}$$

Where Dq_1 is the aggregate quantity demanded for good 1, p_1 is the own price of good 1, and q_{i1} is the ith individuals demand for good 1 as a function of its own price p_1.

The market (aggregate) demand curve shows the various quantities of the commodity demanded at various prices. Figure 10 illustrates how consumers demand curves are aggregated to obtain the market demand curve, assuming there are only two consumers in the market. The market demand (D_M) is derived by aggregating the amounts each consumer will purchase at alternative prices. The slope of the market demand curve is flatter; hence market demand is more price elastic than individual demand.

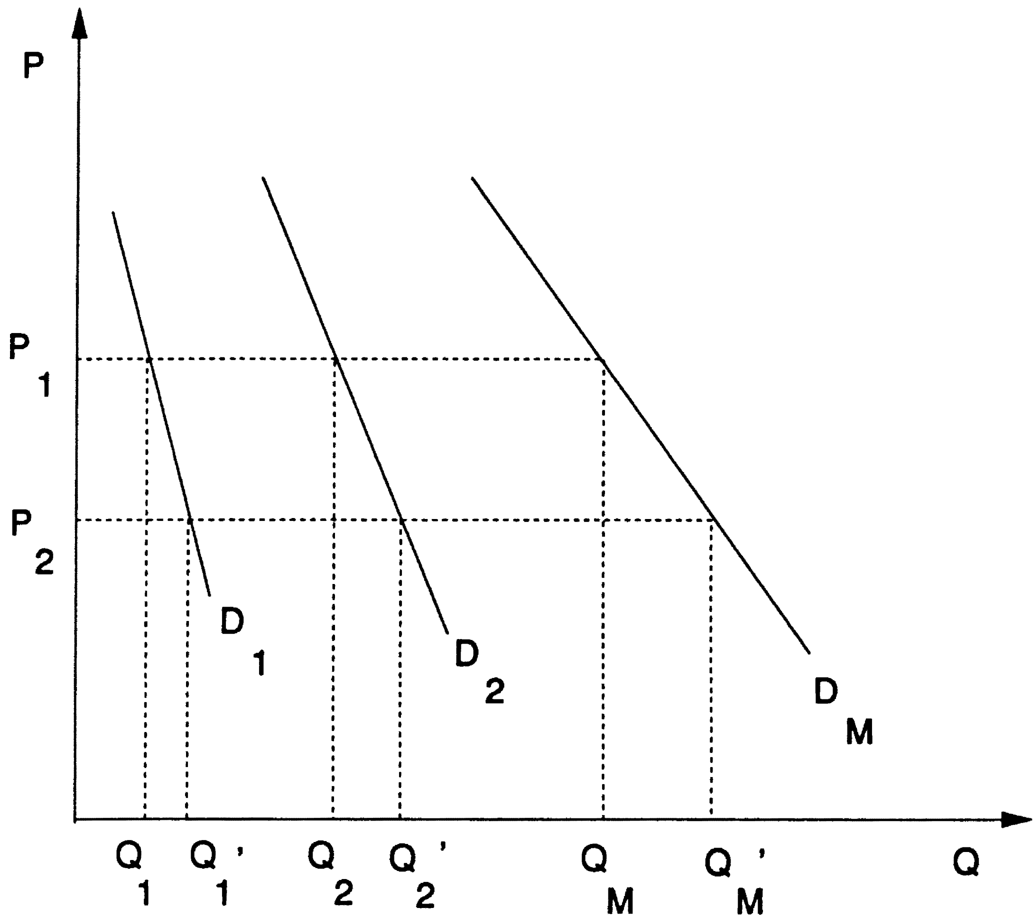


Figure 10. Individual to Market Demand

Price Elasticity of Demand

As previously illustrated, the demand for a good can be derived by isolating the effects of a change in its own price on consumption. The degree of variation in quantity purchased to a change in own price varies extensively between commodities. Often it is important to know a commodity's own price elasticity or how sensitive the quantity demanded (movement along a demand curve) of a commodity is to a change in its own price with the prices of other goods and income held constant (Henderson and Quandt, 1980).

Mathematically, the price elasticity of demand for q_1 is calculated as:

$$\epsilon_{11} = \frac{\partial(\ln q_1)}{\partial(\ln p_1)} = \frac{p_1}{q_1}\frac{\partial q_1}{\partial p_1} \tag{3.8}$$

The size of the elasticity primarily depends upon two factors. The price elasticity for a commodity often increases with the number of close substitutes available, and the price elasticity is larger the longer consumers have to adjust to a change in price. Commodities with high elasticities [$E_{11}<-1$] are often classified as luxuries, since a change in price results in a proportionately larger change in the quantity demanded. Commodities with smaller elasticities, [$E_{11}>-1$] are often classified as necessities. A change in the price of a necessity will result in a proportionately smaller change in the quantity demanded.

Cross Elasticity of Demand

At times, it is important to know how a change in other prices will affect the demand for a good. The cross elasticity of demand measures how responsive the quantity consumed of one good is to a proportionate change in the price of another good. With the previous example, the cross elasticity is calculated as:

$$\epsilon_{21} = \frac{\partial(\ln q_2)}{\partial(\ln p_1)} = \frac{p_1}{q_2}\frac{\partial q_2}{\partial p_1} \tag{3.9}$$

Commodities are said to be substitutes if each can be used to satisfy the same need, and they are complements if they are used together to satisfy a particular need. The sign of the cross elasticity of demand determines whether goods are substitutes or complements. If $\frac{\partial q_1}{\partial p_2} > 0$ then q_1 and q_2 are considered gross substitutes. In Figure 11, an increase (decrease) in the price of p_1 from p_1 to p_1' causes the demand curve for q_2 to shift to the right (left).

If $\frac{\partial q_1}{\partial p_2} < 0$ then q_1 and q_2 are considered gross complements. An increase (decrease) in the price q_1 will lead to the demand curve for q_2 to shift to the left (right). The size of the cross price elasticity of demand measures the degree of substitution or complementarity.

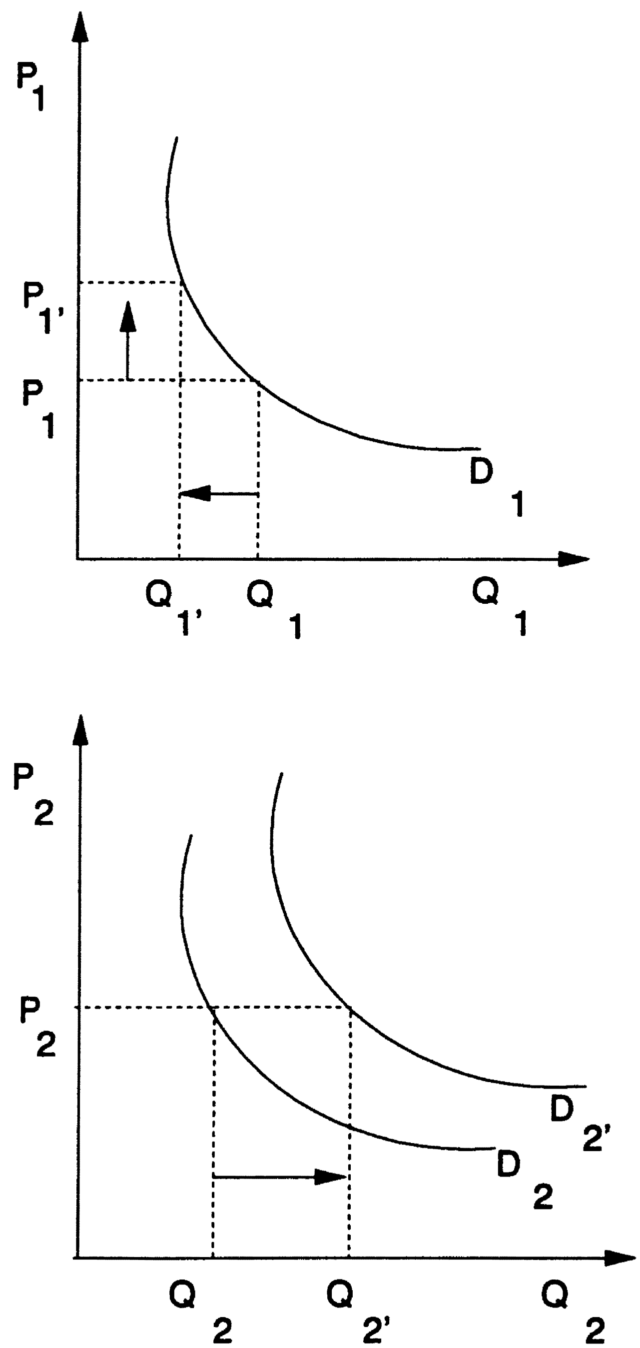


Figure 11. Effect of an increase in price of good 1 when goods 1 and 2 are substitutes

<u>Income Elasticity of Demand</u>

Often, changes in a consumer's income will affect the purchases of commodities. As a consumer's income increases, it is presumed the purchases of commodities will also increase. The income elasticity of demand measures how responsive consumption for a commodity is relative to changes in income holding prices constant. Mathematically, the income elasticity for good q_1 is obtained by:

$$\eta_1 = \frac{\partial(\ln q_1)}{\partial(\ln Y)} \tag{3.10}$$

If $\eta_1 > 0$, then the commodity is considered to be normal. An increase (decrease) in income will shift the demand curve for q_1 to the right (left) as consumers will be able to purchase more (less) at each price. Otherwise, if $\eta_1 < 0$, then the commodity is considered an inferior good, and an increase (decrease) in income will shift the demand curve to the left (right).

Supply Theory

Previously, it was assumed a rational consumer would maximize utility subject to income. Similarly, a rational producer may attempt to maximize output subject to cost. The competitive firm converts inputs used in production into outputs. The individual firm's output decision usually depends primarily upon input and output prices. In a basic production function where a firm produces one output (q) from two variable inputs (X_1 and X_2) the production function may be stated as: $q = f(X_1, X_2)$.

If the firms goal is to maximize profit, it will attempt to maximize the difference between total revenue and total cost. Where:

$$\Pi = P(q) - C(q) \qquad (3.11)$$

P(q) represents total revenue and C(q) represents total cost.

Thus, the firm would maximize:

$$\pi = pf(x_1, x_2) - r_1 x_1 - r_2 x_2 - b \qquad (3.12)$$

Where p is price of output (q), r_1 is the input x_1, r_2 is the input price of x_2, and b are fixed costs. The partial derivatives of each input are taken and set equal to zero.

$$\frac{\partial\pi}{\partial x_1} = pf_1 - r_1 = 0 \qquad \frac{\partial\pi}{\partial x_2} = pf_2 - r_2 = 0 \qquad (3.13)$$

The first order conditions for profit maximization require each input be utilized to the point where the value of the marginal product is equal to its price. Thus, the producer would add inputs of X_1 and X_2 to the point where:

$$pf_1 = r_1 \qquad pf_2 = r_2 \qquad (3.14)$$

This is the point where marginal revenue (MR) equals marginal cost (MC), or price (P) equals marginal cost.

Market Supply

The quantity supplied at the market (aggregate) level is a horizontal summation of individual firms production thus:

$$Q_j(P_j) = \sum_{i=1}^{n} Q_{ij}(P_j) \quad i=1,.,n \qquad (3.15)$$

Where Q_j is the total market supply of product j as a function of the market price P_j. Q_{ij} is the quantity of product j supplied by firm i as a function of its price P_j (Seleka, 1990).

A market supply curve identifies the various quantities of a commodity supplied by all firms at different prices while holding all other factors that can influence output constant. The upward slope of the supply curve demonstrates the concept that production costs rise as higher quantities are produced, thus a higher price is needed to extract a greater output.

In Figure 12, the market (aggregate) supply S_M is obtained by horizontally summing $(Q_1 + Q_2)$ the individual supply curves for the firms in the market. As the price increases from P_1 to P_2 the quantity supplied increases by S_M to S_M'. Similar to the market demand curve, the market supply curve is more elastic to price at the market level.

Market Equilibrium

For a market to be in equilibrium, the quantity demanded must be equal to the quantity supplied or $Q_D = Q_S$.

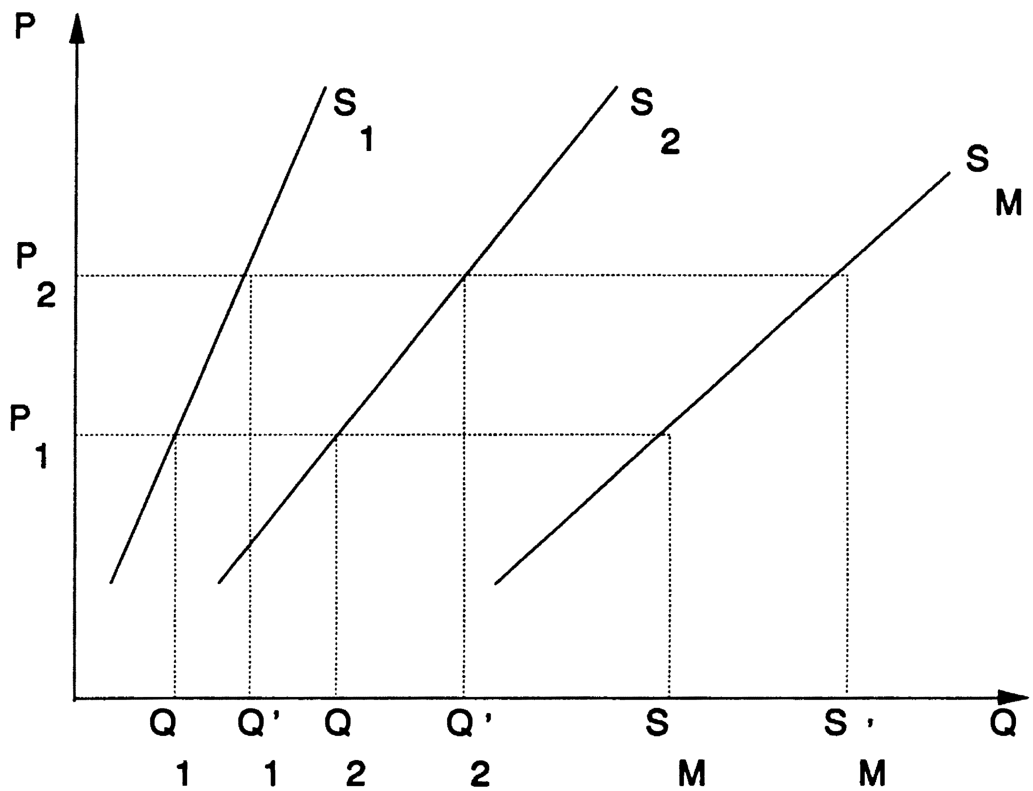


Figure 12. Individual to Market Supply

Since $Q_D = D(P,Y)$ and $Q_S = S(P)$, then the equilibrium position can be expressed as:

$$D(P,Y) - S(P) = 0 \quad (3.16)$$

In Figure 13 the equilibrium position of the market is represented by P_E or price equilibrium. At any point above P_E an excess supply or surplus would exist in the market. At prices below P_E there is excess demand and a shortage exists.

International Trade Theory

The excess supply and excess demand of goods are different in each country around the world. In many countries, the availability of resources used in production are scarce, limiting what goods each country can produce. Consequently without trade, countries could not obtain goods that could not be produced domestically. Through international trade, a country can specialize in the production of goods which it can produce cheaper or has a comparative advantage in production and trade for other goods produced elsewhere at a lower cost.

Since resources used in production are limited, the opportunity costs must be considered in producing an additional unit of a good in relation to the reduction in production of other goods foregone. A country should import when the world price is less than the domestic opportunity costs of producing an additional unit. Goods should be exported when the world price is higher than the domestic

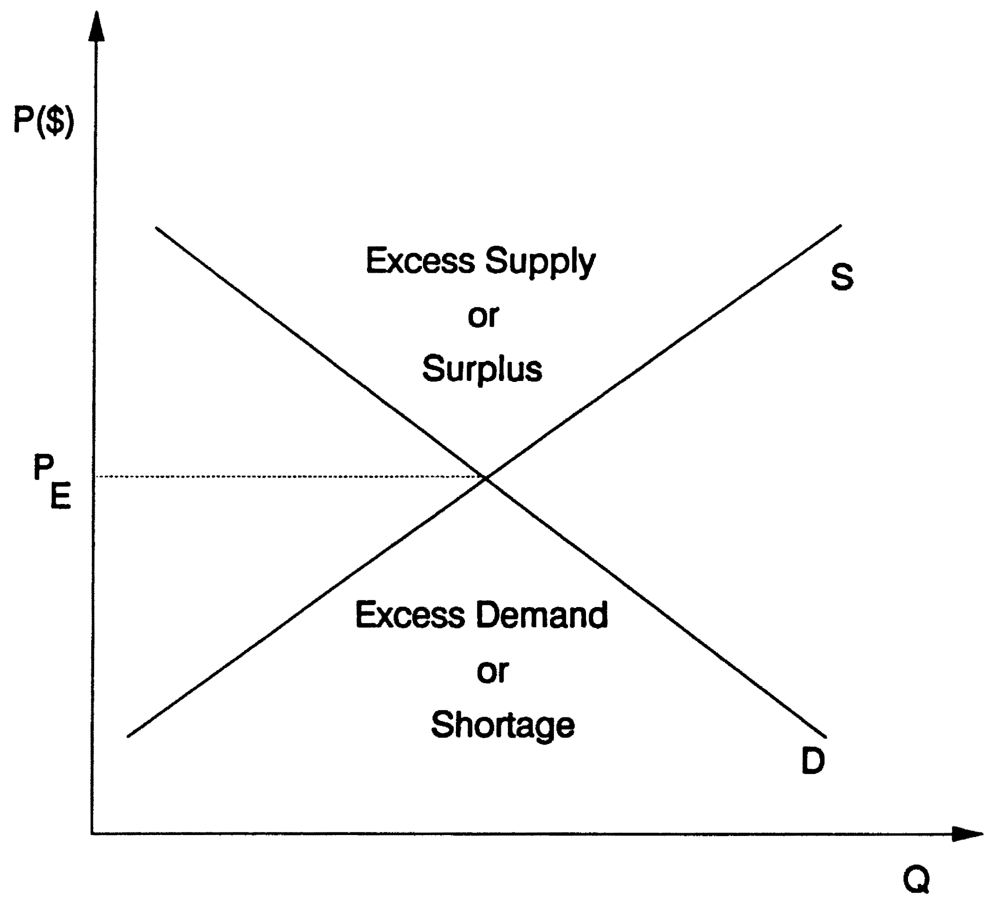


Figure 13. Demand and Supply Equilibrium

opportunity cost. Therefore, through comparative advantage resources are more efficiently used between nations, and consumers can obtain more goods and services than would otherwise be supplied domestically and at a lower cost (Houck, 1986).

Graphical Analysis of Trade

Previously, the world price was identified as a factor determining whether goods are imported or exported. This section describes how the world price is created, or the price transmission between countries. In Figure 14 exists a two-nation trading model with no barriers to trade. Nation A is a net exporter while nation B is a net importer. Without trade producers would receive P_A^1 and supply Q_A^1 in nation A. In nation B, producers would receive P_B^1 and supply Q_B^1 to domestic consumers. The excess supply function (ES) is the horizontal difference between S_A and D_A representing the quantity supplied for export by nation A. The function ED in Figure 14 is the horizontal difference between S_B and D_B and measures the amount demanded for import by nation B. The world price (P_W) is created by the intersection of the excess demand (ED) and excess supply (ES) functions (McCalla and Josling, 1985).

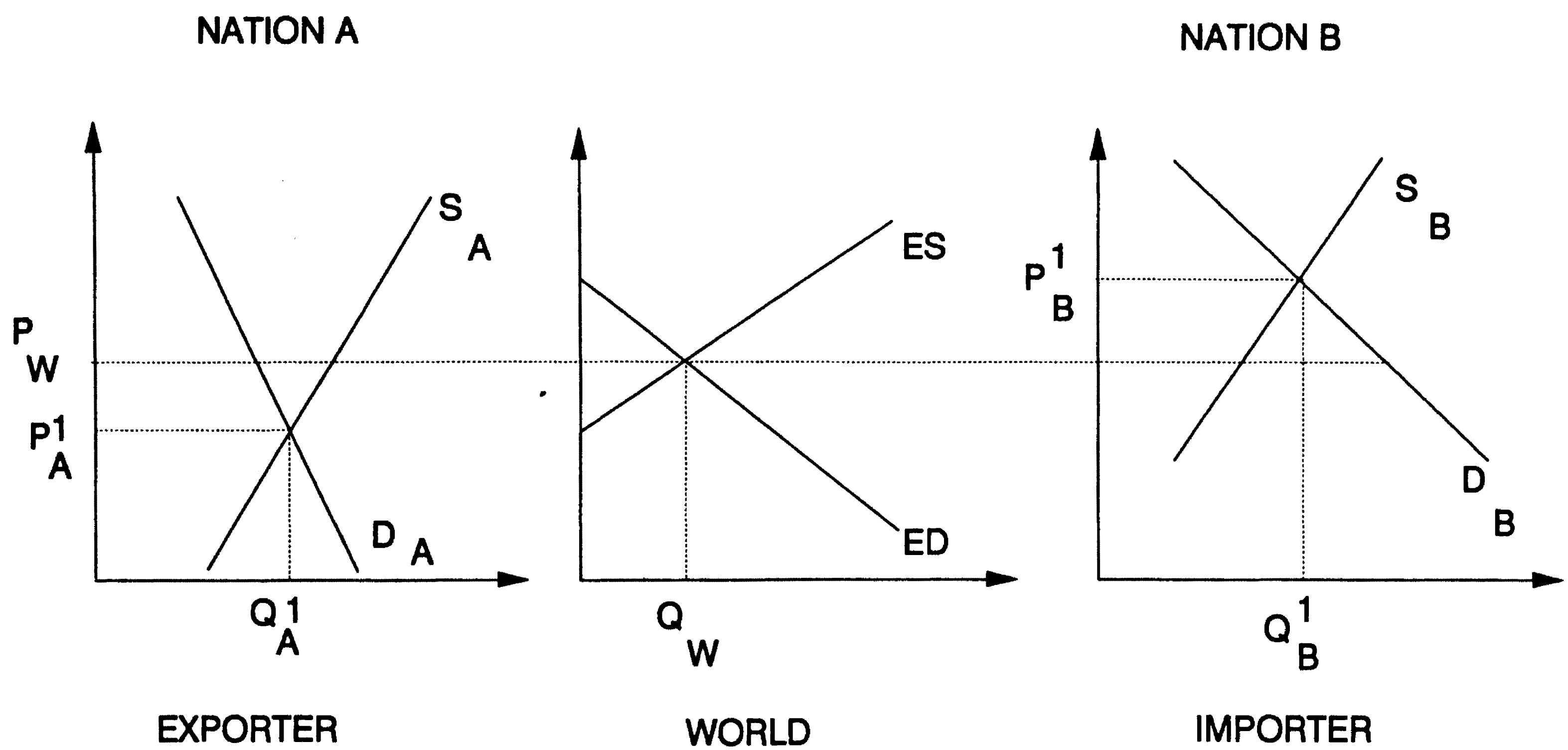


Figure 14. Two Nation Trade Model

Impact of a Decrease in Supply
on World Trade

Changes in the domestic market will be transmitted to the world market through shifts in the ES and ED functions. In Figure 15 lower production of pork in nation A reduces domestic supply and shifts the domestic supply curve to the left from S_A to S_A^1. This results in upward shift in the excess supply curve from ES to ES^1 and a new world price is created at P_W^1. Any shift in the domestic supply and demand functions will change the position of the excess demand and supply function and lead to a new international price and quantity traded.

Impact of a Import Tariff on World Trade

Trade policies can also shift the ES and ED functions. In Figure 16 the importing country (Mexico) has applied an ad valorem tariff on all pork imports. The import tariff reduces the effective import demand by shifting the ED curve to the left to ED'. The quantity imported is reduced from Q_B to Q_B'. The impact of the import tariff is a higher domestic price in the importing country and a lower domestic price in the exporting country.

Trade Elasticities

The prior discussion on price elasticities focused on the domestic market, but it is important to know how

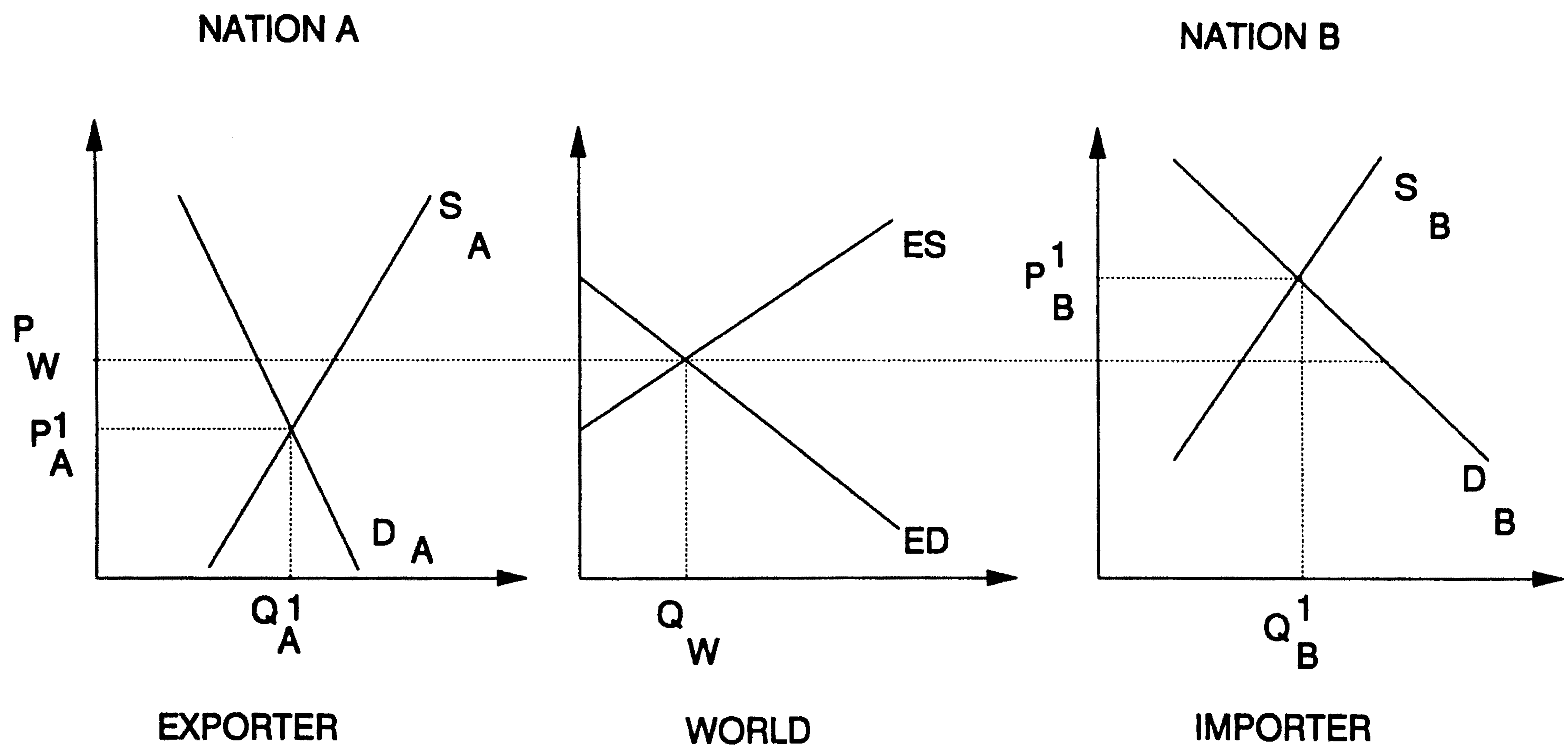


Figure 15. Effect of a Decrease in Supply on the World Market

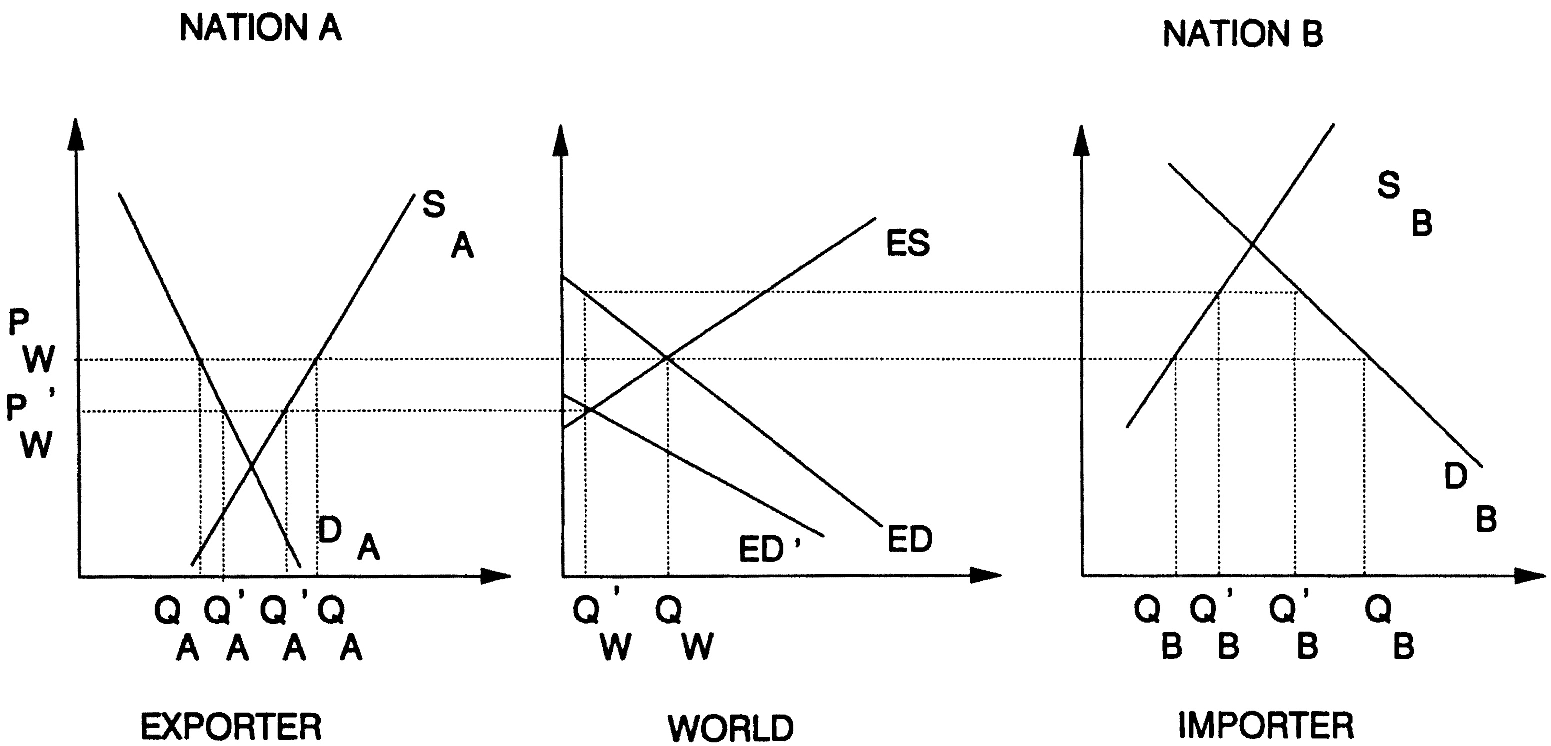


Figure 16. Effect of an Import Tariff on International Trade

responsive the entire market is to changes in price. Consider the following relationship,

$$S_A - D_A = X_A = M_B = D_B - S_B \qquad (3.17)$$

If nation A is a net exporter and nation B is a net importer, then (assuming two countries) for the market to be in equilibrium the exports in nation A (X_A) must equal imports in nation B (M_B). Trade elasticities measure how responsive the quantity exported and imported is to changes in price.

$$E_{X_A}, P = \frac{dX_A}{dP} * \frac{P}{X_A} \qquad E_{M_B}, P = \frac{dM_B}{dP} * \frac{P}{M_B} \qquad (3.18)$$

Where $E_{XA,P}$ is the elasticity of exports of nation A with respect to price, and $E_{MB,P}$ is the elasticity of imports of nation B with respect to price. To obtain trade elasticities weights must be assigned to the domestic supply and demand elasticities. The weights are ratios of supply and demand in each country to the quantity traded.

$$E_{X_A}, P = E_{S_A}, P * \left(\frac{S_A}{X_A}\right) - E_{D_A}, P * \left(\frac{D_A}{X_A}\right) \qquad (3.19)$$

$$E_{M_B}, P = E_{D_B}, P * \left(\frac{D_B}{M_B}\right) - E_{S_B}, P * \left(\frac{S_B}{M_B}\right) \qquad (3.20)$$

E_{SA} and E_{DA} are the elasticities of supply and demand for nation A. To obtain weighted trade elasticities, the weights (S_A/X_A) and (D_A/X_A) are applied to the elasticities of supply and demand. The same procedure was applied to nation B.

Since the excess demand and excess supply curves are always more elastic than the domestic markets, the absolute value of the price elasticities for the ES and ED functions are larger since they are a weighted sum of all countries supply and demand functions. Thus, the more trading countries in the market, the higher the expected elasticities of the ES and ED functions (McCalla and Josling, 1985).

Import Demand Theory

The theory of import demand originates from consumer demand theory where a consumer will attempt to allocate income among different commodities to gain the maximum utility. Thus, the quantity of imports purchased is dependent upon income, the price of imports, and the price of other goods. By this definition import demand may be written as:

$$M = \frac{V_M}{P_M} = f(P_M, P_Y, Y) \tag{3.21}$$

Where M is the quantity of imports, V_M is the value of imports, P_M is the price of imports, P_Y is the price of other goods and Y is domestic income.

Perfect Substitutes

Import demand functions have been categorized into perfect substitutes and imperfect substitutes. Under perfect substitutes both imported and domestic goods are assumed to be homogenous, and import demand is the difference between domestic demand and supply.

$$Mi = D_i(P_i, P_1..n, Y, ods) - S_i(P_s, r_1..r_n, oss) \qquad (3.22)$$

Where M is the quantity of imports of good i, D is the domestic demand for good i, P_i is the price of good i in the importing country, P_1 represents the prices of complements and substitutes, Y is consumers income, and ods are other demand shifting variables. On the supply side, S_i denotes domestic supply, P_s is the supply price of good i, r_1 are input prices, and oss are other supply shifting variables (Gardiner and Carter, 1988).

Under perfect substitutability with no barriers to trade, the import price is assumed equal to the domestic supply price.

Both P_i and P_s are equal to the world price P_{Wi}. By substituting the world price for P_i and P_s, equation 3.22 can be rewritten as:

$$M_i = D_i(P_{W_i}, P_1..n, Y, ods) - S_i(P_{W_i}, r_1..r_n, oss) \qquad (3.23)$$

Therefore, import demand under perfect substitutability can be stated as:

$$M_i = M_i(P_{W_i}, P_1..n, Y, ods, r_1..rn, oss) \qquad (3.24)$$

Imperfect Substitutes

With imperfect substitutes, imports and domestic goods are not homogenous, and domestic supply will only influence imports through domestic prices. If the domestic supply of product i is assumed to be zero in the importing country, then import demand is a function of:

$$M_i = M_i(P_{W_i}, P_{D_i}, P_1..n, Y, ods) \qquad (3.25)$$

Where M_i is the quantity of imports of good i, P_{Wi} is the world price of imports of good i, P_{Di} is the domestic price of good i, P_1 are the prices of domestic substitutes and complements, Y represents income, and ods are other demand shifting variables. Under imperfect substitutes, changes in demand in the importing region will cause a shift in the excess demand function. Although, a change in domestic supply of the importing region will not directly cause a shift in the excess demand function since the goods are not perfect substitutes.

Chapter Summary

In this chapter, it was explained how basic consumer demand and production interact to determine prices at the domestic and world levels. The understanding of price, income, and trade elasticities was particularly important since one of the main objectives of this study is to gain elasticities which will aid in explaining imports of pork in Mexico. The theory behind import demand functions was covered, and will be used as a foundation to explain the import demand model and methodology in the following chapter.

CHAPTER IV

DATA AND METHODOLOGY

The theory chapter and literature review have provided a foundation on which to build a model that explains (provides reliable estimates) the relationship of the import demand for pork in Mexico. This chapter discusses specification of the import demand model and choosing between functional forms. Sections are also included on multicollinearity and first-order autocorrelation. The actual data used to estimate the models is listed at the conclusion of this chapter.

Model Specification

In searching for the best specification of the import demand model, there is no verification that a model is correctly specified. The specification must be made upon what is perceived to be the main forces determining the demand for imports. Economic theory is the main foundation determining which variables to include. If economic theory cannot support the use of certain variables, they should not be included in the set of potential independent variables. This eliminates the need to include an independent variable just because it explains a significant amount of the variation in the dependent variable (Kennedy, 1990).

In the previous chapter, economic theory identified the quantity of imports purchased by a consumer as dependent upon income the price of imports and the prices of other goods. Under perfect substitutability the demand for imports was the difference between domestic demand and supply. Therefore, by assuming that the world price is equal to the domestic supply price, the import demand for pork in Mexico may be stated as:

$$M_P = M_P\,(P_{WP}, P_1..n, Y, ods, r_1..r_n, oss) \qquad (4.1)$$

Where M_P is the imports of pork, P_{WP} is the world price of imported pork, $P_1..n$ are prices of substitutes and complements, Y is domestic consumers income, ods are other demand shifting variables, $r_1..r_n$ are input prices, and oss are other supply shifting variables. Under this scenario, both supply and demand might be estimated simultaneously to determine the demand for imports. In this analysis a reduced form of the above equation is used where:

$$M_P = M_P(P_{WP}, P_1..n, Y, ods, S_P) \qquad (4.2)$$

S_P is the production of pork in Mexico. By assuming that supply equals production and is given, simultaneity can be avoided since there is no interaction between supply and demand.

Linear Functional Form

The classical linear regression model (CLRM) states that the dependent variable should be a linear function of a specific set of independent variables and a disturbance term. Thus, for this estimation the equation is written as:

$$NPCIP_t = \beta_0 - \beta_1 RWPP_t + \beta_2 RWPB_t - \beta_3 RWPOT_t + \beta_4 PCGNP_t - \beta_5 PCPROD_t + \beta_6 D1 + U_t \qquad (4.3)$$

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

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

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 and calculated by:

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

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.

$RWPB_t$ = Real wholesale price of imported beef in Mexico in U.S. dollars per metric ton and calculated as:

$$RWPB_t = \left(\frac{PIB_t}{IPI_t}\right)(100) \qquad (4.6)$$

Where PIB is the nominal wholesale price of imported beef in Mexico in dollars per metric ton deflated by Mexico's import price index. $RWPOT_t$ = Real wholesale price of imported potatoes in Mexico in U.S. dollars per metric ton and calculated by:

$$RWPOT_t = \left(\frac{PIPOT_t}{IPI_t}\right)\ (100) \qquad (4.7)$$

Where PIPOT is the nominal price of imported potatoes in Mexico in U.S. dollars per metric ton deflated by the Mexican import price index.

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

$$PCGNP_t = \frac{\left(\frac{GNP_t}{POP_t}\right)}{CPI_t} \qquad (4.8)$$

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.

$$PCPROD_t = \left(\frac{PRO_t}{POP_t}\right)\ (1000) \qquad (4.9)$$

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 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. RWPOT 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 in 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.

Multicollinearity

When two or more of the explanatory variables are highly correlated multicollinearity may be present. Although with multicollinearity the estimates will remain unbiased, the consequence is the variances of the parameter estimates of the correlated variables are quite large. In order to verify if multicollinearity is a problem, the Klein test is used where each independent variable is regressed on the remaining regressors to obtain an R^2_i (where i refers to the dependent variable X(i) of the auxiliary regressions). If the R^2_i of a auxiliary regression is higher than the R^2 of the original model, then multicollinearity is considered a problem (Brito, 1991). Multicollinearity can sometimes be corrected by transforming the functional relationship, or by dropping one of the highly collinear variables.

Dummy Variable

In this study, zero imports of pork in Mexico were reported in 1978 and 1979. A zero dependent variable may lead to inaccurate estimates if a trade policy or other constraint caused imports to be zero, therefore; a dummy variable is used as a proxy by assuming the value of 1 in years when imports were zero. To account for the increase in size of the R^2 by including this variable, the adjusted R^2 is used which accounts for the change in degrees freedom.

Linear Elasticities

Previously, the model was assumed to be linear in the parameters, (i.e. the regression model results in constant slope values for all observations), but the elasticities can vary across observations. With a linear functional form, the elasticities are calculated at the point of the means of each of the independent variables. Such as the model Y = f(x), the elasticity at the means of y with respect to x is calculated as:

$$\mathrm{E}_{yx} = \frac{d(y)}{d(x)} \cdot \frac{\bar{x}}{\bar{y}} \qquad (4.10)$$

Log-linear Functional Form

The log-linear functional form implies that the elasticities, rather than slopes are constant. In the previous example, y = f(x), the elasticity of y with respect to x is calculated by taking the natural log of both sides of the function:

$$E_{yx}=\frac{d(\ln y)}{d(\ln x)} \tag{4.11}$$

Therefore, by taking the natural log of both sides of equation (4.3), the equation is linear in the parameters. The coefficients are now the elasticities and remain constant over all observations. Thus, the log-linear equation is.[1]

$$\begin{aligned} lnPCIP_t &= \beta_0 - \beta_1 lnRWPP_t + \beta_2 lnRWPB_t + \beta_3 \ln RWPOT_t \\ &+ \beta_4 lnPCGNP_t - \beta_5 lnPCPROD_t + \beta_6 D1 + U_t \end{aligned} \tag{4.12}$$

Ordinary Least Squares (OLS)

Both equations (4.3) and (4.12) were estimated using ordinary least squares (OLS). OLS was chosen since it finds the values for the ß's minimizing the sum of the squared residuals and accordingly maximizes the R^2. Most methods of choosing among estimators are based upon the Classical Linear Regression Model (CLRM) which consists of five

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[1]Explanation on the derivation of constant elasticities is summarized from Chiang (1984). The terms log-linear and log-log can be used interchangeably, both imply a logarithmic transformation of the dependent and independent variables.

assumptions concerning the generation of the data. Under the framework of CLRM, OLS has several desirable characteristics including: low computational cost, it minimizes the sum of the squared residuals, it has the highest R^2, and it is the best linear unbiased estimator (BLUE) (Kennedy, 1990).

Specification Error

Specification error can take the form of omitting a variable that should have been included or including a variable that should have been omitted from the model. If a variable is omitted that should be included, the result is often estimates that are both biased and inconsistent. If a variable is included that should have been omitted, there is a loss of degrees of freedom, and thus a loss of efficiency. No biasness or inconsistency results from including an incorrect variable.

Comparing the results of misspecification, there is a tradeoff of biasness or efficiency. If there is a large number of observations, often the loss of degrees freedom will be less severe. If the number of observations is small, loss of efficiency in the parameter estimates may be significant (Kennedy, 1990).

The encompassing principle is often used in attempting to find the correct specification where the model chosen should be able to provide better results based upon alternative models. Determining the correct specification is performed by beginning with a general unrestricted model and simplifying the model based upon certain specification tests.

In most cases, it can be determined whether a variable or group of variables should be included by performing a t or F test to determine whether the coefficient is significantly different from zero. With the null hypothesis, the variables omitted are equal to zero, if the null hypothesis is correct then dropping the variables will have little effect on the explanatory power of the equation, and ESS_R (error sum of squares of the restricted model) will be only slightly higher than the ESS_{UR} (error sum of squares in the unrestricted model).

Functional Form

Although theoretically there is strong evidence in determining which variables to include in a import demand equation, there is little guidance as to which functional form is the most appropriate. The choice of the functional forms being linear and log-linear. Boylan, Cuddy, and O'Muircheartaigh (1979), Khan and Ross (1976), Magne and Goodwin (1990), and Salas (1991) 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.[2]

[2]The log-linear functional form is used interchangeably with log-log, both imply a logarithmic transformation of the dependent and independent variables.

This procedure applies a group of power transformations to the variables. In this model, the price of imported pork would be transformed as follows:

$$RWPP^{(\lambda)} = \frac{RWPP^{\lambda}-1}{\lambda} \quad \lambda=0 \tag{4.13}$$

$$\ln RWPP \qquad \lambda=0 \tag{4.14}$$

When $\lambda=1$, $RWPP^{(\lambda)} = RWPP-1$; when $\lambda=0$, $RWPP^{(\lambda)}=\ln RWPP$. Therefore, when $\lambda=0$, the model is the same as in log-linear form. When $\lambda=1$ the model is the same as the linear form.[3]

Likelihood Ratio Test

By applying the Box-Cox transformation, the likelihood ratio test can determine if the functional forms are statistically the same. The value of the log of the likelihood function when $\lambda=0$, the unrestricted model is compared with the value of the likelihood function when $\lambda=1$, the restricted model. The likelihood ratio test is computed as

$$-2\,[LF_R - LF_{UR}] = LR \tag{4.15}$$

The value of LF_R is obtained from maximizing the value of the likelihood function when $\lambda=1$, the linear function. The value of LF_{UR} is obtained from maximizing the value of the likelihood function when $\lambda=0$, the log-linear function.

[3]Explanations of the Box-Cox transformation and the Likelihood Ratio Test are from Judge (1988) and Pindyck and Rubinfeld (1991).

LR is asymptotically distributed as a χ^2 with degrees freedom equal to the number of restrictions. If the LR value is greater than the critical value, the null hypothesis can be rejected that the two functional forms are the same. The model accepted is the one which provides the best results.

Least Squares Approach

A least squares approach can also be used to determine which functional form is the most appropriate. By normalizing the Y variables both the linear and log-linear functions can be compared directly assuming the errors are distributed normally. Thus, the form with the highest R^2 or the smallest error sum of squares will give the most appropriate functional form. When the data is normalized both the least-squares and likelihood ratio test should yield the same results (Pindycke and Rubinfeld, 1991).

First-Order Autocorrelation

First-order autocorrelation is present when the error term in one time period is correlated with the error term in another time period. Thus, the total effect of a random error is not immediate, but experienced in future periods. Autocorrelation is often present in time series analysis either because of correlation in the error term or because of the relationship over time in the total effects of omitted variables. Although autocorrelation will not lead to biased or inconsistent parameter estimates, it can lead to downward-biased standard errors and result in parameter estimates more accurate than they actually are. Therefore, autocorrelation can lead to incorrect statistical tests.

Durbin Watson Test

The Durbin Watson Test is used to test for first-order autocorrelation with the hypothesis of no first-order autocorrelation is present ($\rho=0$), against the alternative that ($\rho\neq 0$). In ordinary least squares a Durbin Watson test statistic is computed based upon the residuals by:

$$DW=\frac{\sum_{n=2}^{T}(\hat{U}_t-\hat{U}_{t-1})^2}{\sum_{t=1}^{T}\hat{U}_t^2} \tag{4.16}$$

U_t is the residual resulting from the OLS regressions. The hypothesis is accepted if the calculated value of DW is smaller than the tabular value or $DW < DW_L$ (lower limit), the hypothesis is rejected if $DW > DW_U$ (upper limit), and the test is inconclusive if $DW_L < DW < DW_U$.

Cochrane-Orcutt Procedure

The Cochrane-Orcutt Procedure is used to correct for first-order autocorrelation by transforming the original equation to obtain new estimates of the original disturbances. By regressing OLS residuals on themselves lagged one period provides a better estimate of ρ. With the transformed equation, the corrected parameter estimates are used and new residuals are obtained.

Time Period of this Study

The time period of this estimation is from 1973 to 1990. In time series analysis, problems often are encountered if the period of estimation is too short. This period has been chosen so the number of observations is large enough that the loss of degrees of freedom will not be severe. These specific years were chosen since the U.S. switched from a fixed to a floating currency in 1973, and 1990 represents the most current data available.

Data Sources

The data used in this analysis appears in Table VI. The quantity and price of imported pork were obtained from the United Nations Calendar Year Trade Data. Per-capita GNP was obtained from the Socio-economic Time Series Access Retrieval System (STARS) database of the World Bank. The import prices for potatoes and beef and the domestic production of pork in Mexico were also obtained from 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

TABLE VI

DATA

YEAR	NPCIP MT	RWPP $/MT	RWPB $/MT	RWPOT $/MT	PCPROD MT	PCGNP $
1973	0.0004	1681.49	1062.49	242.93	0.0110	2404.09
1974	0.0032	3089.21	1915.71	334.77	0.0120	2580.64
1975	0.0812	1191.68	1916.02	277.31	0.0131	2875.26
1976	0.2896	1049.64	1096.48	386.71	0.0143	2994.01
1977	0.2818	866.83	686.54	165.58	0.0154	2795.49
1978	0.0000	893.79	2336.08	183.28	0.0162	2752.61
1979	0.0000	892.72	884.00	197.27	0.0170	2852.61
1980	0.6886	854.64	2468.32	160.13	0.0178	3200.00
1981	0.9426	1064.76	2756.75	345.95	0.0181	3754.70
1982	0.7322	1091.80	2311.47	305.86	0.0185	3321.55
1983	0.5312	758.32	2375.61	140.40	0.0197	2614.15
1984	0.8087	1069.76	2632.11	208.63	0.0189	2330.42
1985	1.2182	1077.82	2758.91	212.82	0.0165	2304.43
1986	0.8370	746.22	2760.24	187.46	0.0120	1960.58
1987	0.4496	481.88	1623.13	174.28	0.0112	1770.00
1988	0.7600	1140.16	2101.25	191.11	0.0103	1682.69
1989	0.6628	1267.64	1875.43	132.02	0.0085	1825.68
1990	0.3430	1639.81	2173.91	102.77	0.0084	2145.45

Sources: United Nations and the World Bank years when 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 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.

Chapter Summary

This chapter has explained the procedures set forth in the following chapter. The first stage is specification of the model, with economic theory as the foundation for which variables to include. A Klein test will be performed to detect for multicollinearity in the data. In choosing between the linear and log-linear functional forms, a Box-Cox procedure is used to perform a likelihood ratio test which allows the data to determine which form is the most appropriate. The equations are estimated using ordinary least squares (OLS) because of the desirable qualities it has compared to other estimators. The test for specification error begins with an unrestricted model and uses t and F tests to determine whether the variables should be omitted from the model. The Durbin Watson statistic will be used to detect for first-order autocorrelation, if present. The Cochrane-Orcutt procedure will be used to correct for autocorrelation. The empirical results of the models are presented in the succeeding chapter.

CHAPTER V

EMPIRICAL RESULTS

Equations 4.3 and 4.12 (Chapter IV) were estimated with ordinary least squares (OLS) using time series data from 1973 to 1990. The empirical results are presented in both linear and log-linear form. The estimates of the linear model are presented in Table VII beginning with an unrestricted model and restraining the model based on the significance of the coefficients. The estimates of the log-linear model are presented in Table IX. In this study, the Durbin Watson test was used to detect for first order autocorrelation, and the Klein test was used to detect for multicollinearity in the data set. A likelihood ratio test was performed to determine whether the functional forms are statistically the same. The results of each procedure are presented below.

Linear Model Results

Model 1 represents the original unrestricted model where net per-capita imports of pork in Mexico (NPCIP) is dependent upon the real wholesale price of imported pork (RWPP), the real wholesale price of imported beef (RWPB), the real wholesale price of imported potatoes (RWPOT),

TABLE VII

ESTIMATED RESULTS OF LINEAR MODELS

MODEL	CONST	RWPP	RWPB	D1	PCGNP	PCPROD	RWPOT	DW	R^2	ADJ R^2	DF
1	.1986	-.234*	.2986**	-.476**	-.158	21.15	.514	2.13	.74	.60	11
	(0.559)	(-1.87)	(3.081)	(-2.42)	(-.894)	(0.8)	(0.51)				
2	.1904	-.212*	.2932**	-.5**	-.112	20.61		2.25	.73	.62	12
	(0.555)	(-1.86)	(3.14)	(-2.7)	(-0.76)	(0.8)					
3	.2495	-.254**	.322**	-.473**	-.246			2.36	.72	.63	13
	(0.756)	(-2.54)	(3.79)	(-2.63)	(-0.25)						
4	.1895	-.254**	.32**	-0.48**				2.33	.72	.65	14
	(0.863)	(-2.63)	(3.92)	(-2.8)							

Const = Constant
RWPP = Real wholesale price of imported pork
RWPB = Real wholesale price of imported beef
D1 = Dummy variable
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

per-capita GNP (PCGNP), per capita pork production (PCPROD), and a dummy variable (D1). The R^2 indicated that 74 percent of the total variation in import demand for pork in Mexico is explained by model 1. The Durbin Watson statistic of 2.13 showed no signs of first order autocorrelation.

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.

Detection of Multicollinearity

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. Table VIII presents the $R^2{}_i$ for each auxiliary regressions. In each run, the R^{2i} was lower than the R^2 of the original model

TABLE VIII

RESULTS OF AUXILIARY REGRESSIONS
FOR DETECTION OF MULTICOLLINEARITY

Regressor X_i	R^2_i
RWPP	.327
RWPB	.205
RWPOT	.478
PCPROD	.652
PCGNP	.670
D1	.177

(.74) indicating multicollinearity was not a problem in the data.

Based upon the t-statistic in model 1, the null hypothesis could not be rejected that the estimated coefficient for RWPOT is significantly different from zero. The exclusion of RWPOT in model 2 resulted in no significant changes in the results indicating the price of potatoes did little in explaining the variation in imports of pork. Again, the estimated coefficients for PCGNP and PCPROD did not have the expected signs, and were insignificant at the 10 percent level.

The insignificance of the per-capita production variable in models 1 and 2 led to the premise that domestic supply has very little effect on the level of imports. The null hypothesis could not be rejected that the estimated coefficient for PCPROD is statistically different from zero. With this restriction in linear model 3, all the coefficients had the correct sign and were significant at the 5 percent level, except for PCGNP which carried a theoretically unexpected sign, but was also insignificant. The adjusted R^2, and the coefficients for the RWPP, RWPB, and PCGNP did not change notably when compared to the results of the original unrestricted model.

Although income is theoretically an important variable to include in import demand studies, it could not be rejected that the estimated coefficient for PCGNP was statistically different from zero. As presented in model 4, the elimination of PCGNP produced estimates that were all statistically significant at 5 percent or better as indicated by the t-statistics. Again, the results changed only slightly from the original unrestricted model.

Summary of Linear Results

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 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 IX. 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. First order autocorrelation will not affect the unbiasedness or consistency of the estimates, but the standard errors will be smaller than the actual standard errors (Pindyck and Rubinfeld, 1991)

In model 1 the adjusted R^2 of .86 denoted the independent variables explained 86 percent of the variation in pork imports. All of the variables except LPCPROD had signs consistent with economic theory. Although, 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.

With 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

TABLE IX

ESTIMATED RESULTS OF LOG-LINEAR MODELS

MODEL	CONST	LRWPP	LRWPB	D1	LPCGNP	LPCPROD	LRWPOT	DW	R^2	ADJ R^2	DF
1	5.238	-3.07**	1.91*	-12.75**	.946	.315	-1.05	1.47	.91	.86	11
	(.156)	(-2.26)	(1.79)	(-9.2)	(.297)	(.114)	(-.73)				
2	2.015	-3.16**	1.956*	-12.73**	1.21		-1.02	1.49	.90	.87	12
	(.117)	(-2.98)	(2.04)	(-9.72)	(.57)		(-.748)				
3	4.27	-3.36**	2.01*	-12.55**	.349			1.23	.90	.87	13
	(.256)	(-3.33)	(2.13)	(-9.92)	(.199)						
4	6.91	-3.34**	1.998*	-12.51**				1.23	.90	.88	14
	(.702)	(-3.45)	(2.20)	(-10.4)							

Const = Constant
LRWPP = Log of wholesale price of imported pork
LRWPB = Log of wholesale price of imported beef
D1 = Dummy variable
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

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[1]. The positive sign of the estimated coefficient for LPCGNP symbolized 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 1 percent increase in the price potatoes would lead to a 1.02 percent decrease in the quantity of pork imported (ceteris parabis).

The restriction that per-capita production has no effect on the level of imports in model 2 resulted in a slight change from the original unrestricted model. Each coefficient had signs consistent with economic theory. As indicated by the t-statistics, the parameter estimates for LRWPP, LRPB, and D1 were significant at 10 percent or better. The coefficient for LPCGNP decreased from 1.21 to

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[1]Elastic refers to a price elasticity greater than one.

.3 with the elimination of LRWPOT in log model 3. The adjusted R^2 remained at .87. LRWPP, LRPB, and D1 were again significant at 10 percent or better and had signs consistent with economic theory. Excluding LPCGNP in model 4, resulted in all the coefficients significant at 10 percent or better.

Summary of Log-Linear Results

Overall there was very 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.

Preferred Specification

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 imported 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).

Although, economic theory implies the demand for a good is dependent upon both prices and income, therefore; model 3 is also preferred since it includes per-capita GNP (PCGNP) as a measure of income.

Functional Form

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 empirical results of the Box-Cox transformation of the linear and log-linear functional forms of model 3 are presented in Table X. The results are in linear form when lambda is equal to 1, and log-linear form when lambda is equal to 0.

The results of the maximum likelihood estimation were a likelihood ratio (LR) value of 33.99. Thus at the 5 percent level of significance, the null hypothesis was rejected that the two functional forms are statistically the same. Based upon the signs, size, and statistical significance of the coefficients, the log-linear estimates, are considered superior compared with linear estimates, which supports the work of Khan and Ross (1977), and Boylan, Cuddy, and O'Muircheartaigh (1979). Since trade elasticities are one of the primary objectives of this study, the log-linear functional form is also preferred since the coefficients are the elasticities.

TABLE X

RESULTS OF THE BOX-COX TRANSFORMATION

VARIABLES	LAMBDA = 1	LAMBDA = 0
CONSTANT	.249 (.755)	-1.08 (-.512)
RWPP	-.253 (-2.53)	-.242 (-3.79)
RWPB	.322 (3.79)	.129 (2.38)
PCGNP	-.24 (-.25)	-.30 (-.49)
D1	-.47 (-2.63)	-12.56 (-10.96)
R^2	.71	.92
ADJ R^2	.63	.89
LF	4.06	21.06

LF = Log of the likelihood function
The function is linear when lambda = 1
The function is log-linear when lambda = 0

Rationale of the Results

The following is a subjective explanation of the empirical results obtained. In both the linear and log-linear models, the estimated coefficients for per-capita GNP, per-capita production, and the price of potatoes, were insignificant at the 10 percent level. The insignificance of per-capita production indicates domestic supply has not influenced the amount of pork imported in Mexico. By comparing production with the quantity of pork imported, pork production peaked in 1983 (Figure 7) and remained high in 1984 and 1985 which was nearly the same time when pork imports were at a maximum (Figure 1). Thus, domestic pork production has remained relatively low and has not been a significant factor in the quantity of pork imported in Mexico.

Since consumers in Mexico spend a proportionately large share of total income on food, income was expected to be a important influence on demand for imported pork. The empirical results indicated per-capita GNP did not significantly affect the demand for imported pork. In Figure 6, per-capita GNP exhibited a downward trend between 1981 and 1989 which corresponds to years with growing pork imports. This partially explains the insignificance of the coefficient as pork imports in Mexico were increasing, even though there was a decline in the real income of Mexican consumers.

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 found. 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 to meet the requirements to join 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). Therefore, the cause for zero pork imports in 1978 and 1979 was not determined.

Chapter Summary

Both linear and log-linear forms of the import demand equation were estimated using ordinary least squares. Estimation of the models revealed the price of imported potatoes, per-capita production, and per-capita GNP were never statistically significant in both the linear and log-linear runs. Although in each model, the statistically significant coefficients carried the expected signs.

The likelihood ratio test revealed that the two functional forms were not statistically the same at the 5 percent level. The log-linear functional form was chosen based upon the signs, significance, and size of the estimated coefficients, and since obtaining price and income elasticities is one of the primary objectives of this study.

The empirical results indicate the net per-capita import demand for pork in Mexico is significantly influenced by the price of imported pork (own price) and the price of imported beef (price of substitute). As reflected by the coefficients of log-linear model 3, a 1 percent increase (decrease) in the real wholesale price of imported pork (RWPP) would lead to a decrease (increase) in the quantity of pork imported by 3.36 percent (ceteris parabis). A 1 percent increase (decrease) in the real wholesale price of imported beef (RWPB) would lead to an increase (decrease) in the quantity of pork imported pork by 2.01 percent (ceteris parabis). Thus, the demand for imported pork in Mexico is very price elastic with respect to its own price and the price of imported beef.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Mexico has been a highly unstable market for imported pork as imports have ranged from 0 to over 90 thousand metric tons between 1973 and 1990. The U.S. has on average supplied 96 percent of all pork imports in Mexico during this period. With such a volatile market for U.S. exports, research is needed to determine the underlying factors influencing the import demand for pork in Mexico. The specific objectives of this study were to: provide an overview of the Mexican economy and pork industry; review the literature and economic theory of import demand; and to specify and estimate a model which explains the relationship between the import demand for pork in Mexico and income, population, the prices of pork, prices of other goods, and domestic supply.

Summary of Empirical Results

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 significantly determined by the price of imported pork (own price) and the price of imported beef (price of substitute). It was also determined the demand for imported pork in Mexico is elastic with respect to its own price and the price of imported beef. The estimated coefficients for the price of imported potatoes, per-capita production and per-capita GNP were never statistically significant in both the linear and log-linear runs. 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.

Factors Influencing Pork Demand

Mexico is experiencing rapid population growth averaging over 2 percent annually, and is expected to reach 95 million by 1995. In addition, the growing number of foreign tourists is expected to reach 10 million annually by 1994. Together over 100 million people will either visit Mexico or reside there by 1995. Of this population, approximately 95 percent are current or potential consumers of pork in their regular diet. In 1990 an average of 9.3 kilograms of pork was consumed annually per person. High inflation has resulted in a decline in the real income of Mexican consumers, and limited the quantity of pork and other meats purchased. In 1990, the Mexican economy began to show signs of improvement as inflation has fallen resulting in a increase in consumers real income. As inflation falls and incomes rise, pork consumption in Mexico is expected to increase from 9.3 kilograms per-capita to 13.6 kilograms by the year 2001 (Lee, 1992). Total consumption of pork is estimated to increase from 144,000 metric tons in 1990, to 170,000 metric tons by 1995. These results support the work of Mellor (1989) who concluded the demand for food in developing countries is accelerated by: population growth rates, high elasticities of expenditures for food, and income growth.

Potential Impacts of NAFTA

The potential for increased trade between the United States and Mexico largely depends on trade policy. Both countries are realizing the impact protectionist policies have on domestic and foreign markets. 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 the near future. In 1990 the U.S. share of imports fell from 97 to 72 percent as 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 and with lower production costs. NAFTA will enable more feed grains to be imported, thus allowing pork producers in Mexico to obtain lower cost feedgrains which should increase domestic production. Although, the gains in production are not expected to keep pace with the growing demand of the expanding population.

Limitations of this Study

Certain limitations of this study should be considered before inferring about 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 these two years, 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.

Suggestions for Future Research

As the Mexican economy expands and real incomes increase, this analysis should be re-estimated to determine if income and production become significant factors determining the import demand of pork in Mexico. In the future if NAFTA is approved research is needed on the impact of NAFTA on Mexican pork imports. 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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