The Mexican Live Cattle Import Market

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by

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Abstract

Mexico is the most important market for United States live cattle among the developing countries. In 1989 and 1990 Mexico was singly responsible for the entire live cattle export market in Latin America. The main purpose of this study was to investigate the economic forces that influence Mexico's import demand for live cattle and sorghum. To achieve these objectives, a simultaneous model consisting of four equations was formulated. Mexican import demand for cattle from the United States was hypothesized to vary with respect to: 1) import price of cattle; 2) per capita income; 3) foreign exchange reserves and 4) number of cattle imported from countries other than the United States. The Mexican import demand for sorghum relates the quantity demanded to the import price of sorghum, sorghum production in Mexico and the production of cattle in Mexico. The statistical model was simultaneously estimated using both two-stage least squares and ordinary least squares. The estimated coefficients for most of the variables were consistent with a priori expectations. The results indicated that Mexican cattle imports from the rest of the world (other than the United States) could reduce the import demand for United States cattle. The results also indicated that an increase in cattle production in Mexico could substantially increase the import demand for United States sorghum.

An Overview of the Mexican Economy and Trade Policy

The Mexican economy has made remarkable economic achievements since World War II, with few parallels in the developing world. From 1950 to 1980, the Mexican economy grew at an average annual rate of 6.63 percent (Table 1). The Mexican population of 86 million (mid-1990) makes it the tenth most populous country in the world (Table 2). It has a Gross National Product (GNP) per capita of about United States $2,164 (1985) which is high compared to other Latin American countries (Table 3).

There are a number of factors that underlie the economic achievements of Mexico: (a) the presence of a variety of natural resources on which to build a development effort; (b) the far-reaching role played by government policies and strategies adopted and implemented; massive investment in infrastructure, and through the establishment of state and public enterprise; (c) the vigorous response of both domestic and foreign private enterprise to development opportunities and incentives which attracted huge foreign loans and investments which may be attributable to its linkage to the United States economy.

The shortcomings of the Mexican economy and its farm sector are the result of the underlying structure of the economy, the society and the political regime that Mexico has uniquely developed over 75 years since the revolution. Economic development in Mexico can be classified into periods, some of which coincide with presidential terms. The period of concern in this study is 1970 to 1990, but events occurring in earlier periods are discussed as they affect the current performance of the country and the trade policies adopted.

The United States involvement in World War II presented Mexico with unparalleled opportunities for economic takeoff. The principle objective of Mexico's policy was to provide economic support for industrial development via an import substitution strategy. The elements were an overvalued exchange rate, tariffs, import licenses and price controls which later became part of Mexico's development process.

To further trade liberalization, the Presidents of the United States (Bush) and Mexico (Salinas de Gotari) and the Prime Minister of Canada (Mulroney) announced their intention to begin negotiations on a North American Free Trade Agreement (NAFTA) on February 5, 1991. NAFTA has since been signed and is ready for submission to Congress. If approved by the Clinton administration NAFTA would go into effect January of 1994. Such an agreement will be the world's largest and could serve as a powerful counterweight to the rapidly rising trading blocks of the European Community (EC) and Asian Pacific Economic Cooperation (APEC). The main objective of the NAFTA agreement is to promote economic growth through expanded trade and investment with the minimization or elimination of trade barriers. NAFTA may be a catalyst for economic growth and development in all three countries. The combined trade flow among the members reached $237 billion in 1990

Table 1. Gross Domestic Product Growth Rates and Deviations from the Long-Run Trend (Percentages).

	Average Annual Growth Rates							Mean Average	Standard
	1950-60	1959-69	1970-75	1975-80	1980-85	1950-80	1950-85	Dev.[1]	Dev.[2]
Argentina	2.57	4.39	3.18	2.07	-1.18	3.62	3.09	2.59	3.38
Brazil	7.19	5.20	10.17	6.47	1.14	7.32	6.93	2.85	3.36
Colombia	4.61	4.86	5.97	5.60	1.94	5.17	5.00	1.69	1.96
Korea	4.96	7.70	9.22	8.03	7.28	7.56	7.56	2.74	3.40
Mexico	6.19	7.28	6.88	6.74	0.83	6.63	6.36	2.01	2.49
Venezuela	8.29	5.78	4.98	3.33	-1.73	6.05	5.26	3.32	4.11

Source: Villanueva 1988, p.28

[1] Sum $\frac{[Abs\ (X\{i\} - X)]}{n}$

[2] Sqrt $\frac{(X\{i\} - X)^\wedge 2}{n}$

Table 2. The Ten Most Populous Countries in the World.

Country	Population (Millions) Midyear Estimates 1989	1990	Rank
Republic of China	1,122.40	—	1
India	811.82	827.05	2
United States	247.35	249.97	3
Indonesia	179.14	179.30*	4
Brazil	147.40	150.37	5
Japan	123.12	123.54	6
Nigeria	113.76	117:51	7
Pakistan	108.68	112.05	8
Bangladesh	106.51	—	9
Mexico	84.49	86.15	10

Source: International Financial Statistics 1991.

* In 1990 for Indonesia there is a break in the comparability of population data. The 1990 population figure does not form a consistent series with those for earlier years.

Table 3. Mexican Gross National Product Per Capita, 1970-1990.

Year	GNP[1]	Exchange Rate	Population in Millions	GNP Per Capita U.S. $
1970	438,700	12.5	50.69	692
1971	483,500	12.5	52.45	738
1972	557,300	12.5	54.27	755
1973	680,900	12.5	56.16	814
1974	884,700	12.5	58.12	1,015
1975	1,082,100	12.5	60.15	1,439
1976	1,342,000	15.4	61.98	1,406
1977	11,806	22.6	63.81	8,187
1978	2,285	22.8	65.66	1,526
1979	2,990	22.8	67.52	1,942
1980	4,159	23.0	69.66	2,596
1981	5,674	24.5	71.39	3,246
1982	8,908	56.4	73.02	2,163
1983	16,100	120.1	74.67	1,795
1984	27,061	167.8	76.31	2,113
1985	43,337	256.9	77.94	2,164
1986	74,983	611.8	79.57	1,540
1987	183,636	1,378.2	81.26	1,640
1988	—	2,273.1	82.82	—
1989	—	2,461.5	84.49	—
1990	—	2,812.6	86.15	—

Source: Derived from IFS, 1991.

[1] Millions of Pesos per U.S. Dollar through 1976 and billions of Pesos per U.S. Dollar from 1977.

Table 4. North American Trading Partners: A Profile.

	United States		Canada		Mexico	
	1989	1990	1989	1990	1989	1990
Population (Millions)	248.8	251.4	26.6	26.7	84.5	86.0
GDP (U.S.$ Billions)		5,513.8	550.3	581.2e*	201.4	233.6
Unemployment	5.3%	5.5%	7.5%	8.1%	18.0%	18.0%
Inflation	4.8%	5.4%	5.0%	4.8%	19.7%	29.9%
Average Exchange Rate (1 U.S. $=units foreign currency)			1.18	1.17	2,453.0	2,801.0
Minimum Wage (U.S.$)	3.35/hr	3.80/hr	3.36/hr	3.42/hr	4.13/day	4.28/day
U.S. Exports to (U.S.$ Billions)			78.8	83.9	24.9	28.4
U.S. Imports from (U.S.$ Billions)			87.9	91.4	27.2	30.8
U.S. Foreign Direct Investment to Partner Country (U.S.$ Billions)			63.0	71.0	7.1	n/a
Partner Country Direct Investment in United States (U.S.$ Billions)			30.0	33.0	1.0	n/a

*e = Estimated

Source: U.S. Department of Commerce, Offices of Canada and Mexico.

(Wallace 1991, p. 3). Table 4 shows the profile of North American trading partners.

The breakdown of the Uruguay round of the multilateral GATT talks seems to have sparked the proposed Free Trade Agreement (FTA) between the United States and Mexico. Such a bilateral FTA with Mexico seemed a sensible alternative policy to pursue for goods to flow north and south across the border free of duties. However, there are some costs with NAFTA as outlined by Becker (1991) and Barkema (1992) (See Table 5). According to Melton (1991, p. 12) U.S. exports to Mexico increased 14 percent in 1990 and 20 percent in 1989. U.S. imports from Mexico increased by 11 percent to $30.2 billion in 1990 (See Figure 1). In addition the U.S. trade deficit with Mexico has been declining since 1987 and was $1.8 billion in 1990 (Melton 1991, p. 12).

Mexican Trade Policy

The evolution of trade policies in Mexico bear upon several characteristics of the Mexican economy. Its proximity to one of the world's largest markets, the United States, restricts the degree to which Mexico's economic policies can create significant differences between domestic and foreign prices and real interest rates. Large differences in these instruments would lead to smuggling, capital outflows and movement of labor. On the other hand, such proximity gives Mexico a comparative advantage in penetrating United States markets at a relatively low distribution cost (transportation, delivery time, packaging) compared to other developing countries. Mexico's proximity to the U.S. allows the former to adjust quickly to significant changes in rates of return and prices that are occurring in the latter country.

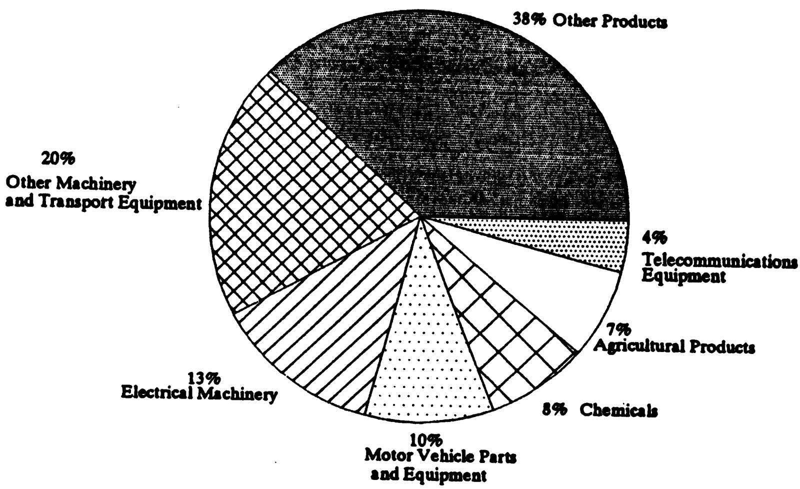
Since Mexico is a small country in the global market, the government is concerned with its economic independence and the limits of its policy options. The Mexican government's plan to achieve economic independence has been exerted through the use of instruments typical of the government sector, plus the creation of public enterprises that control the production and distribution of many basic industrial inputs such as oil, communication, electricity and irrigation systems. The government achieved this by issuing regulations, decrees and legislation. The economic policies that support industrialization are implemented directly through budget allocations and indirectly through an incentive system. As is common with most import substitution strategies of development, the incentive system includes trade restrictions, tariffs, subsidies, tax breaks, preferential credit programs, industrial regulations, sector programs, and pricing and marketing controls. In Mexico, trade policies are interwoven with domestic price controls and marketing arrangements.

Table 5. Balancing the Books on U.S.-Mexican Free Trade

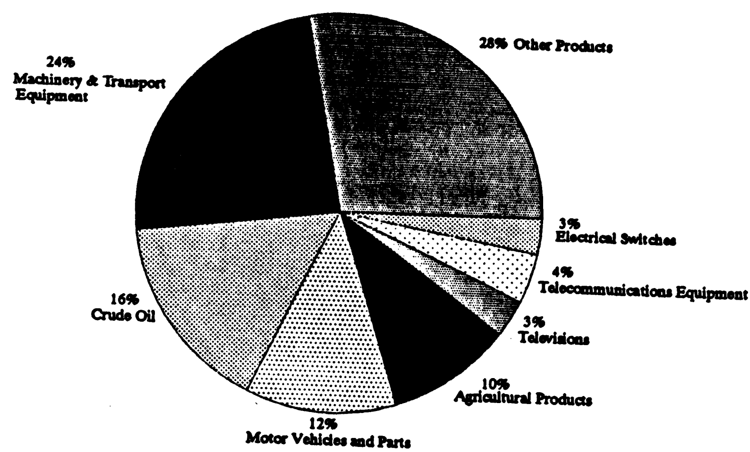
Benefits	
Mexico	***United States***
Better access to U.S. and Canadian markets	Preferential access to growing market
Improved technology and management skills	Increased competitive abilities will stimulate skilled job growth
Lower costs to the consumer	Lower costs to the consumer
Economic growth, lower unemployment and stable higher wages translate into political stablility	National security strengthened by having a secure neighbor to the south
Reduced corruption	Decresed dependence on Middle Eastern sources of crude oil
More government revenues available to combat drug, emigration, pollution, and human rights problems	Improved economic conditions in Mexico translate into a lessened burden on the U.S. to control illegal immigration and drug traffic
	Resumption of Mexican investment and tourism flows into the United States
	Magnet for foreign investment, especially from Hong Kong and other Asian sources
	Easy access to cheap, high-quality labor counters Asian cost advantages
	Relaxation of restrictions of foreign ownership of Mexican businesses, property and stocks
Costs	
Inefficient, protected industries will suffer	Asian producers may sidestep quotas by entering U.S. market through "southern" door
Opposition from leftist economic nationalists who fear being swallowed by the Yanqui economy	Job loss and downward pressure on wages in labor-intensive, low-tech sectors (apparel, textiles, automobiles, agriculture, fishing)
Painful social dislocations associated with transition from traditional to modern culture	Retraining to upgrade job skills
Threat of increased environmental contamination OEM	Smaller suppliers may not be able to follow their customers south
Uneven distribution of new wealth and lifestyle changes that lag expectations may stir discontent	Stronger competition in capital markets—industrial redevelopment, tourism and agricultural projects

Source: Becker (1991)

U.S. Exports to Mexico 1990



U.S. Imports from Mexico 1990



Source: United States Department of Commerce, Office of Mexico

Figure 1. United States Exports To and Imports From Mexico, 1990

The major trade policy instruments utilized in Mexico are:
(1) the significance of government enterprise.
(2) import and export policies.
(3) vertical integration in industry.
(4) price controls.

The Significance of Government Enterprise

The establishment or acquisition of enterprises by the government is common in Mexico as in most developing countries. These enterprises allow the government to subsidize private enterprise through low prices of electricity, petroleum products, gas and transportation. Domestic producers are given preferences even though they have operational inefficiencies. The subsidization of public goods and services as well as the nationalization and control of private enterprise has greatly distorted the economy. However, these measures gained public support, particularly the nationalization of the oil companies, due to the unpopular practices of foreign companies in their acquisition of farmland with oil reserves.

Import and Export Policies

Though nations as well as individuals gain from the specialization and economies of size that follow trade, Mexico, like other countries, imposed protectionist policies for domestic producers and consumers. Mexico has employed technical instruments such as import and export tariffs, permits, licenses and production quotas to prevent imports of products competitive with domestic production. Though the government aims to establish self sufficiency in such basic foodstuffs as corn, beans, wheat, etc., it has acknowledged the need to import necessary goods until domestic production is sufficient. Thus low tariff rates are given to imports necessary for the development of the country. The entrance of nonnecessary (nonbasic) commodities, products competitive with those produced in Mexico, or products considered luxury items are restricted by elevated rates. Table 6 shows the percentage of production that requires import permits in protected sectors, and Table 7 shows the protected sectors and products. It is not unusual to have ad valorem rates exceeding 50 percent on nonbasic goods and 100 percent on luxury items. Tables 8 and 9 list agricultural commodities which require an import permit and the percentage of ad valorem import tariff required by Mexico. It should be noted that live cattle is not included in this list.

The application of import licenses by the government is common and is based on the belief that imports are inelastic. The assumption of inelasticity is due to the assumption that imported goods have superior quality.

Table 6. Percent of Production That Requires Import Permits in Significantly Protected Sectors (1986 Production Weights).

	May 1988
Agtriculture	63.0
Cattle	17.5
Fish and Hunting	63.3
Crude Petroleum	100.0
Meat	23.5
Coffee	99.7
Sugar	90.0
Vegetable Oils	57.0
Tobacco	100.0
Petroleum Derivitives	87.2
Pharmaceuticals	12.0
Automobiles	100.0

Source: Calculation by Alanis-Garza (1991)

Table 7. Percentage of Import Permits in Mexico (1986 Production Weights)

	April 1980	May 1988
Primary Sector	94.44	42.52
Mining[1]	70.10	57.00
Manufacturers	54.42	12.75
Food, Beverages, and Tobacco[2]	53.82	27.06
Textiles, Apparel, and Leather	87.10	0.52
Lumber	76.70	0.00
Paper and Printing	31.25	0.34
Chemicals, Petroleum, Der., Rubber and Plastics[3]	48.07	10.94
Non-Metallic Minerals	29.20	2.17
Basic Metals	49.04	0.00
Metallic Production, Machinery and Equipment[4]	52.86	17.52
Other Manufacturers	51.80	0.00
TOTAL	64.00	23.20

Source: Alanis-Garza, Mario (1991).

[1] The 1988 percent includes only petroleum.
[2] The 1988 percent mostly represents coffee, sugar, tobacco, and vegetable oils.
[3] The 1988 percent largely represents petroleum derivatives and jpharmaceutical products.
[4] The 1988 percent mostly represents automobiles and auto parts.

Table 8. January 1 - October 31, 1990 List of Agricultural Commodities Subject to Import Permits (Mexican FreeTrade Zones are not Included).

Tariff No. (Heading/Subheading)	Article Description	Jan. 1-Oct. 31, 1990 Import Permit	Ad Valorem Import Tariff Percent
0105.11	Chickens ("Gallus Domesticus")		
0105.11.01	Day old chicks, which do not need feeding during transport	Yes	10
0207	Meat and edible offal, of the poultry for heading 0105, fresh, chilled or frozen:		
0207.10	Poultry not cut in pieces, fresh or chilled:		
0207.10.01	Poultry not cut in pieces, fresh or chilled	Yes	10
0207.21	Chickens		
0207.21.01	Chickens	Yes	10
0207.22	Turkeys		
0207.22.01	Turkeys	Yes	10
0207.39	Other		
0207.39.01	Of chickens, except livers	Yes	10
	Poultry cuts and offal other than livers, frozen		
0207.41	Of chickens		
0207.41.01	Of chickens	Yes	10
0207.42	Of turkeys		
0207.42.01	Of turkeys	Yes	10
0207.42	Of turkeys		
0207.42.01	Of turkeys	Yes	10
0207.43	Of Ducks, Geese, or Guineas		
0207.43.01	Of Ducks, Geese, or Guineas	Yes[1]	10
0209.00.01	Pig fat free of lean meat and poultry fat (not rendered), fresh, chilled, frozen, salted, in brine, dried, or smoked	Yes	10
0402	Milk and cream, concentrated or containing added sugar or other sweetening matter:		
0402.10	In powder, granules or other solid forms, of a fat content, by weight, not exceeding 1.5 percent		
0402.10.01	Milk powder	Yes	0
	In powder, granules or other solid forms, of a fat content, by weight, exceeding 1.5 percent		
0402.21	Not containing added sugar or other sweetening matter		
0402.21.01	Milk powder	Yes	0
0402.91	Not containing added sugar or other sweetening matter		
0402.91.01	Evaporated milk	Yes	10

Table 8 (continued)

0406	Cheese and curd		
0406.10	Fresh cheese (including whey cheese), not fermented, and curd		
0406.10.01	Fresh cheese (including whey cheese), not fermented, and curd	Yes	20
0406.30	Processed (process) cheese, not grated or powdered:		
0406.30.01	Founded cheese, except grated or in powder, containing no more than 30 percent of fat in weight and fat in dry extract weight more than 40 percent, weighing, together with immediate container more than 1kg.	Yes	20
0406.30.99	Other	Yes	20
0406.90	Other		
0406.90.03	Soft cheese of the colonia type, of a degree of humidity of 35.5 to 37.7 percent, containing fron 3.2 to 3.3 percent of ash, from 29 to 30.8 percent of fat, from 25 to 27.5 percent of proteins from 1.3 to 2.7 percent of chlorides and from 0.8 to 0.9 percent acidity expressed as lactic acid	Yes	20
0406.90.99	Other	Yes	20
0407	Birds' eggs, in shell, fresh, preserved or cooked		
0407.00	Birds' eggs, in shell, fresh, preserved or cooked		
0407.00.01	Eggs, fresh	Yes	10
0701	Potatoes fresh or chilled:		
0701.90	Other		
0707.90.99	Other	Yes	10
1501	Lard, other pig fat and poultry fat, rendered, whether or not pressed or solvent extracted		
1501.00.01	Lard, other pig fat and poultry fat, rendered, whether or not pressed or solvent extracted	Yes	10
1516	Animal or vegetable fats and oils and their fractions, partly or wholly hydrogenated, interesterified, reesterified or elaidenized, whether or not refined, but not further prepared		
1516.10.01	Animal fats and oils and their fractions	Yes[1]	20

Source: Mexican Import Tariff, as of November 6, 1990.

[1] These are new categories included inthe November 1, 1990 list of agricultural commodities subject to import permit requirements.

Table 9. November 1, 1990 List of Agricultural Commodities Subject to Import Permits and Tariffs in Mexican Free Trade Zones.

Tariff No. (Heading/Subheading)	Article Description	Effective November 1, 1990 Import Permit	Ad Valorem Import Tariff Percent
0105.11	Chickens ("Gallus Domesticus")		
0105.11.01	Day old chicks which do not need feeding during transport	Yes	0
0207	Meat and edible offal, of the poultry for heading 0105, fresh, chilled ot frozen:		
0207.10	Poultry not cut into pieces, fresh or chilled:		
0207.10.01	Poultry not cut into pieces, fresh or chilled	Yes	10
0207.21	Chickens		
0207.21.01	Chickens	Yes	10
0207.22	Turkeys		
0207.22.01	Turkeys	Yes	10
0207.23	Ducks, Geese, and Guineas		
0207.23.01	Ducks, Geese, and Guineas	Yes[1]	10
0207.39	Other		
0207.39.01	Of chickens, except livers	Yes	0
0207.39.99	Other		
	Poultry cuts oand offal other than livers, frozen		
0207.41	Of chickens		
0207.41.01	Of chickens	Yes	10
0207.42	Of turkeys		
0207.42.01	Of turkeys	Yes	10
0207.43	Of Ducks, Geese, or Guineas		
0207.43.01	Of Ducks, Geese, or Guineas	Yes[1]	10
0402	Milk and cream, concentrated or containing added sugar or other sweetening matter:		
0402.10	In powder, granules or other solid forms, of a fat content, by weight, not exceeding 1.5 percent		
0402.10.01	Milk powder	Yes	0
	In a powder, granules or other solid forms, of a fat content, by weight, exceeding 1.5 percent		

Table 9 (continued)

0402.21	Not containing added sugar or other sweetening matter		
0402.21.01	Milk powder	Yes	0
0402.91	Not containing added sugar or other sweetening matter		
0402.91.01	Evaporated milk	Yes	10
1501	Lard; other pig fat and poultry fat, rendered, whether or not pressed or solvent extracted		
1501.00.01	Lard; other pig fat and poultry fat, rendered, whether or not poessed or solvent extracted	Yes	10
1516	Animals fats and oils and their fractions		
1516.10.01	Animals fats and oils and their fractions	Yes[1]	5

Source: Mexican Import Tariff, as of November 6, 1990.

1 These are new categories included in the November 1, 1990 list of agricultural commodities subject to import permit requirements.

NOTE: Imports of all these categories to the free trade zones require an import permit, and generally do not pay import duties. These areas encompass the states of Baja,Caligfornia; Baja, California Sur; Quintana Roo, Northwest Sonora; and the "Frontera Norte and Frontera Sur" or border regions. The area within 22 kilometers of the Mexico-U.S. border and the Mexico-Guatemala border in the Mexican States of Sonora, Chihuahua, Nuevo Leon, Coahuila, Tamaulipas, and Chiapas is included in the Free-Zones.

Until recently, CONASUPO had monopsonistic power in selling many agricultural commodities which lead to imperfect competition in factor markets. Licenses for all nonbasic agricultural and livestock imports can now be filed with SECOFIN. SECOFIN, in consultation with CONASUPO, determined the import quantity of basic products. In the case of livestock and its products SECOFIN requests that the opinion of the Undersecretary of Livestock, the Mexican National Cattlemen's Confederation, the Directorate General of Livestock, and the Directorate General of Animal Sanitation be provided.

Vertical Industrial Integration

The advanced stage of import substitution has resulted in the vertical integration of industries in Mexico. The Government objective apparently was to subsidize domestic producers of intermediate goods. Industries were given tax exempt status and received additional protection through the Law of New and Necessary Industries.

Price Controls

Other nontariff barriers used in Mexico include official pricing, anti-dumping and countervailing duties. In Mexico, the Ministry of Industry and Trade sets and enforces maximum prices while CONASUPO has set minimum prices for most agricultural products. Over the years, the primary objective of CONASUPO switched from guaranteeing a minimum income to farmers protecting the purchasing power of individual workers. CONASUPO is currently being dismantled as part of Mexico's privatization program.

The "official" price system (different from the actual market price) is used to calculate ad valorem taxes and duties. Official prices are usually higher than actual invoice prices. Invoice prices are only accepted in Mexico if they are higher than "official" prices.

In the quest for industrialization through import substitution, the result has been the neglect of the agricultural sector. For all nonbasic agricultural and livestock products, import licenses are required.

As a member of the Latin American Integration Association (LAIA), Mexico grants preferential duty rates on specified imports from member countries. Though Mexico has sometimes waived the official valuation or licensing requirements to member countries, this has not improved its trade relationship with these member countries.

As a member of GATT since 1986, Mexico's protectionist activities are subject to the disciplines required by the international institution. Many items are now being exempted from protectionism. The Mexican government has begun to liberalize import and export barriers and thus facilitate bilateral trade with the U.S. and other trading partners. However, the official valuation system is maintained on imports of goods which are produced in Mexico, goods exempt from import permits, licensing and luxury goods produced in foreign countries. Table 7 shows a significant decline in import permits between 1980 and 1988. However, a transitional period is expected before the full benefits of liberalization can be realized.

Cattle Production in Mexico

About 70 million hectares and 500,000 persons are engaged in raising stock in Mexico. Cattle production is the main activity of the livestock industry (see Table 10). In 1990, total cattle production was 28 million head, an 8 percent decline from the previous year. However, Mexico's cattle industry experienced an average 3.4 percent annual growth rate from 1970 until 1983 (see Table 11). In 1983 the number of cattle peaked at 37.5 million head before declining to 31.5 in 1985 and 28.2 million in 1990. Fluctuations in herd size may be directly affected by: (1) natural limitations such as geography, water, diseases and vagaries in the weather which cause high death losses for cattle; (2)

Table 10. Livestock Population in Mexico, Thousands of Head.

Kind/Year	*1980*	*1984*	*1985*	*1986*	*1987*
Cattle	27,742	30,479	31,489	31,123*	31,156*
Sheep	6,484	6,120	6,373	5,699	5,926
Pigs	16,895	19,393	18,579	18,397	18,722
Horses	6,205	6,134	6,135*	6,140*	6,150*
Asses	3,221	3,182	3,183*	3,183*	3,183*
Mules	3,129	3,130	3,130*	3,130*	3,130*

Source: 1987 Statistical Yearbook, Thirty-Sixth Issue, United Nations (1990).

* = Unofficial figure.

Table 11. Total Domestic Production of Live Cattle in Mexico, 1970-1990.

Year	Production in Millions of Head	Annual Percentage Change
1970	24.9	5.3
1971	25.1	1.0
1972	25.8	2.8
1973	27.1	4.7
1974	27.6	2.0
1975	27.9	1.0
1976	28.4	1.8
1977	28.9	2.0
1978	29.3	1.4
1979	29.9	2.0
1980	31.1	3.9
1981[F]	31.8	2.2
1982	36.8	15.9
1983	37.5	1.9
1984[F]	37.5	-0.1
1985	31.5	-16.0
1986*	31.1	-1.2
1987*	31.2	0.1
1988*	31.2	0.1
1989*	30.9	-1.0
1990*	28.2	-8.7

Source: Derived from FAO Production Yearbook, Various Issues.

F =FAO estimates.

* = Unofficial figure.

infrastructure limitations; (3) market forces such as devaluation of the Peso and recession which dampen the demand for meat. In this type of analysis, the cattle cycle can be a strong determinant of supply.

The Agrarian Reform Code, which permits ranchers to own only as much land as needed to support 500 head of cattle, and the small area devoted to the cultivation of artificial pastures have been some of the historical causes of low cattle productivity in Mexico. Table 12 shows the major cattle producing regions and their holding capacities.

Cattle Consumption and Distribution

The derived demand for live cattle in Mexico depends on national production, since the volume of imports is very small and consists mainly of breeding cattle. Although there has been a marked improvement in total cattle supplies or production, this has been just sufficient to meet the increasing demand of recent years.

The Mexican Government has become increasingly concerned about the ability of the beef cattle industry to supply the domestic market with sufficient quantities of beef at a reasonable price (Roberts 1986, p. 34). Table 13 reveals a gradual decline in cattle (beef) consumption since 1985 reaching its lowest level in 1990. Consumption levels are highest in large towns where higher incomes and better distribution facilities encourage effective demand. Consumption levels in rural areas are even lower, reaching as low as 15 kilograms a year.

U.S. - Mexico Trade in Live Cattle

World demand for United States live cattle can be divided into two categories: (1) demand by developed countries (accounting for 40 percent of the total live cattle demanded in 1990) and (2) developing countries demand (which utilized 59 percent in 1990). As revealed in Table 14 Latin America is the most important developing country market. Annual United States exports have consisted largely of breeding cattle. Tables 15 and 16 show that exports of U.S. beef breeding cattle to Mexico for January to September 1990 totaled 12,396 head which is down from 38,598 head in 1989. The value of exports in 1990 was $11.7 million. For the period shown Mexico is the leading export market for both beef and dairy breeding cattle. However, exports of breeding cattle to Mexico were about 20 percent lower in 1990 than in 1989 by volume because shipments of breeding heifers under the fiscal year 88 GSM-102 program were delayed until 1989 and no FY' 90 funds were allocated.

Mexico exports cattle on the hoof, most of which are shipped to U.S. feedlot operators. In 1990, an agreement was reached between the U.S. customs service, USDA and the Mexican government to allow feeder lambs and feeder cattle to enter the U.S. in bond for feeding and ultimate

Table 12. Mexico: Pasture Area and Carrying Capacity for Livestock, By States.

Regions	Thousands of Hectares	Carrying Capacity[a]
North:		
Coahuila	8,282	18-50
Chihuahua	14,555	5-50
Durango	5,729	8-50
Nueva Leon	2,586	6-15
S. L. Potosi	2,698	1-15
Tamulipas	1,670	1-15
Zacatecas	3,899	6-10
Gulf of Mexico:		
Campeche	692	1-5
Quintana Roo	119	8-15
Tabasco	727	1-5
Vera Cruz	1,856	1-5
Yucatan	347	8-15
North Pacific:		
Baja, California	1,752	8-50
Nayarit	926	5-10
Sinaloa	1,443	5-10
Sonora	7,189	15-25
South Pacific:		
olima	208	4-10
Chiapas	1,404	1-5
Guerrero	2,205	5-10
Oaxaca	1,420	3-10
Central:		
Aguascalientes	268	5-10
Distrito Federal	13	5-15
Guanajuanto	892	5-15
Hidalgo	474	1-15
Jalisco	2,470	4-10
Mexico	446	5-15
Michoaoan	1,621	2-10
Morelos	7	6-15
Puebla	802	6-15
Querotaro	418	6-15
Tlaxcala	78	1-15
TOTAL	67,376	——

Source: Livestock in Latin America Status: Problems and Prospects, United Nations, New York, 1962
[a] Hectares required per head of heavy cattle.

Table 13. Estimated Cattle Consumption in Mexico, 1970-1990 (1,000 Heads).

Year	Production[a]	Exports[b]	(pp.45) Imports[c]	Consumption[d] Estimate
1970	24,876	5.727	13.688	24,884
1971	25,124	7.159	17.317	25,141
1972	25,827	11.695	22.522	25,838
1973	27,045	20.106	33.837	27,059
1974	27,583	23.325	42.303	27,602
1975	27,863	226.177	40.101	27,677
1976	28,376	470.459	91.970	27,998
1977	28,935	535.244	28.529*	28,428
1978	29,333	982.191	34.267	28,385
1979	29,920	466.379*	32.400*	29,486
1980	31,094	380.000*	21.000*	30,735
1981	31,784[F]	381.000*	79.387	31,482
1982	36,834	510.600*	73.993	36,398
1983	37,522	561.000*	2.395	36,963
1984	37,500[F]	378.000	143.144	37,265
1985	31,849	528.000	128.382	31,089
1986	31,123*	980.920	65.000	30,027
1987	31,158*	1,022.322	38.648	30,174
1988	31,200*	806.724	236.156	30,629
1989	30,900*	835.767	104.545	30,169
1990	28,200*	1,350.000*	67.631	26,918

Source: Derived from FAO Production and Trade Yearbooks.

F = FAO estimates.

* = Unofficial Figure.

[d] = a + c - b = d.

Table 14. Global Exports of Live Cattle and Calves From the U.S. in 1989 and 1990.

Region	1989	Percent Share	1990	Percent Share
World	169,140	100	119,914	100
Developed Countries	30,598	18	48,092	40
Less Developed Countries	138,522	82	71,218	59
Latin America	134,248	79	69,219	58
Mexico	124,937	74	62,226	54

Source: Derived from USDA - FATUS, various issues.

Table 15. United States Exports of Live Cattle.

Commodity and Destination Country	Quantity (In Head) 1988 Jan-Sep	1989 Jan-Sep	1990 Jan-Sep	1990 Sep	Value (In Thousands of Dollars) 1988 Jan-Sep	1989 Jan-Sep	1990 Jan-Sep	1990 Sep
Beef Cattle Breedin Bull (No.)								
Mexico	13,111	9,032	3,351	97	13,015	6,756	3,297	112
Canada	209	417	544	32	279	261	646	27
Australia	0	14	240	0	0	70	462	0
Thailand	110	88	118	31	302	76	195	119
Other EC-12	0	44	0	0	0	30	0	0
Others	1,520	414	390	246	2,213	1,027	319	168
TOTAL	14,950	10,009	4,643	406	15,809	8,220	4,919	426
Beef Cattle Breeding Female (No.)								
Mexico	4,238	25,590	5,138	227	4,231	11,712	4,208	216
Japan	157	542	571	283	315	1,104	873	471
Brazil	117	0	1,064	0	226	0	653	0
Thailand	412	738	127	0	747	1,091	491	0
Other EC-12	0	0	0	0	0	0	0	0
Others	1,477	1,719	853	30	2,029	1,621	599	12
TOTAL	6,401	28,589	7,753	540	2,029	1,621	599	12

Table 15 (continued)

Dairy Cattle Breeding Bull (No.)								
Mexico	1,660	2,921	1,772	383	1,838	2,733	2,117	522
Brazil	10	36	448	16	34	130	736	88
Korea, Repulic of	29	0	656	0	60	0	492	0
Saudi Arabia	0	0	35	0	0	0	148	0
Other EC-12	0	82	0	0	0	82	0	0
Others	2,937	912	171	64	5,891	1,026	339	137
TOTAL	4,636	3,951	3,082	463	7,823	3,971	3,832	747
Dairy Cattle Breeding Female (No.)								
Mexico	5,424	16,163	20,550	1,255	5,513	14,047	23,716	1,529
Brazil	128	704	1,688	469	263	1,122	3,543	634
Japan	1,243	1,088	751	161	1,992	1,415	1,153	265
Other EC-12	507	860	376	0	500	951	557	0
Others	21,255	6,453	1,387	46	21,145	7,457	1,708	97
TOTAL	28,557	25,268	24,752	1,931	29,413	24,992	30,677	2,525
Other Cattle (No.)								
Canada	10,058	9,871	18,417	2,178	4,504	4,320	7,341	872
Mexico	138,324	53,698	16,291	1,604	63,065	23,626	7,129	1,043
Japan	5,070	2,973	1,476	0	4,071	1,189	687	0
Other EC-12	0	238	436	56	0	108	175	23
TOTAL	153,731	66,989	45,418	3,838	71,751	29,388	16,319	1,938

Source: United States Department of Agriculture, Dairy, Livestock, and Poultry Division, FAS, Commodity and Marketing.

Table 16. Mexico's Share of United States Live Cattle Exports

Commodity and Destination Country	Percentage Share Jan.-Sept. 1989 (1)	Percentage Share Jan.-Sept. 1990 (2)
Beef Cattle Breeding Bulls		
Mexico	90.2	72.2
Canada	4.2	11.7
Thailand	0.9	2.5
Australia	0.1	5.2
Beef Cattle Breeding Females		
Mexico	89.5	66.3
Thailand	2.6	1.6
Brazil	0.0	13.7
Japan	1.9	7.4
Dairy Cattle Breeding Bulls		
Mexico	73.9	57.5
EC-12	2.1	0.0
Korea, Republic of	0.9	14.5
Dairy Cattle Breeding Females		
Mexico	64.0	83.0
Japan	4.3	3.0
Brazil	2.8	6.8
EC-12	3.4	1.5
Other Cattle		
Canada	14.7	40.6
Mexico	80.2	35.9
Japan	4.4	3.2
EC-12	0.4	1.0

return to Mexico. Upon return to Mexico, the Mexican government will waive all animal inspection requirements (USDA FAS Circular Series FDLP5-90 June 1990, p. 4).

Corn is a staple food item as well as feed in Mexico. Corn production in Mexico is highly affected by weather. Mexico has been a net corn importer since 1973 (Kim 1986, p. 9). Corn in livestock feed has accounted for about 20 percent of total corn consumption since the late seventies. Virtually all feed corn is imported (Roberts 1986, p. 37). By allowing Mexican feeder cattle into the U.S. for feeding, the amount of corn (feed) imported from the U.S. may decline.

It is the general belief that trading patterns of developing countries differ from those of industrialized or developed economies. An empirical analysis is necessary to determine the extent of such differences. As evident from the preceding section, Mexico, a developing country, is a major market for United States live cattle. Changes in the volume of meat exports may be somewhat dependent on trade in live cattle. The study of the behavior of Mexican imports is important in response to factors such as differing domestic and foreign inflation rates, exchange rate changes, and changes in the levels of tariffs and other trade barriers. The purpose of this study is to improve the understanding of the factors affecting Mexican import demand for United States live cattle by estimating an import demand function.

The empirical objective of this study is to construct and estimate an econometric model for Mexican live cattle imports in which the major factors affecting import demand can be determined and quantitatively evaluated.

A knowledge of price and income elasticities provides the means for testing economic theories, forecasting trade flows and analyzing the effects of government policies. Salas (1982), Thursby and Thursby (1988), and Arnade and Dixit (1989) emphasized the selection of an appropriate model, functional form, and the choice of variables. Since the problem of specification is yet to be fully resolved, Gardiner and Carter (1988, p.4) proposed that the appropriate model depends on the following factors:

(1) The models purpose - hypothesis testing, structural analysis, forecasting, or policy analysis;
(2) The nature of the commodity under investigation - Is the commodity homogeneous so there exist close or perfect substitutes or is the commodity sufficiently differentiated so there are no perfect substitutes?;
(3) The type of market that the commodity is traded in - competitive or imperfectly competitive; and
(4) The desired degree of regional disaggregation.

Among many authors, Goldstein and Khan (1978), and Haynes and Stone (1983) stressed a general model across a wide variety of commodities and countries. The single commodity models examine the inclusion of and the significance of specific commodity variables such as prices, income, foreign exchange reserves and exchange rate changes.

Various techniques of estimating trade elasticities and the associated problems of specification error, identification, simultaneous equation bias, aggregation, and the measurement of cyclical and secular effects were addressed by such authors as Khan and Ross (1974), Mutti (1977), and Pheup (1981).

The presence of such problems causes single-equation OLS estimated parameters to be biased and inconsistent. The problem of aggregation and simultaneous equation bias was addressed by Orcutt (1950), Binkly and McKinzie (1981), Leamer and Stern (1970), and Khan (1975).

Binkly and McKinzie utilized a Monte Carlo analysis to combat the problem of simultaneous equation bias. Roe, Shane and Vo (1986) address the problem of heteroskedasticity in OLS estimates with a Generalized Least Square (GLS) procedure.

The disaggregation of imports by commodity and country in empirical analysis has made simultaneous equation bias soluble. As presented in the foregoing studies, individual commodity/country studies have drawn a lot of interest because of policy implications.

The effect of government policies which insulate producers and consumers from international price transmission was addressed by Abbot (1979), Kim (1986), and Pick (1990). According to Kim, the degree of price insulation varies among countries and across commodities depending upon the objective of government price policies. Kim employed the Canonical Regression Instrumental Variable (CRIV) approach in estimating the quantitative effects of pricing policies. The influence of government intervention on import price elasticity was also addressed by Roe, Shane and Vo (1986). The authors moved away from the traditional excess demand approach and they used both cross-section and time series data to estimate the specified government choice function and the implied import demand model.

The prospects, costs and benefits of trade liberalization were addressed by Carter (1988), Leo and Tower (1988), Kim and Lin (1990). Kim and Lin employed the modified Armington model using PSE and CSE to quantify the degree of government protection, by country and by commodity.

The theoretical framework of the import demand model is based on the concept of excess supply and excess demand. A country produces a certain commodity (cattle) in excess of the domestic requirement for consumption. At a given price there exists an excess supply that moves to the world market. On the other hand, another country's production of the same commodity is less than their total requirement for consumption or there is no domestic production. At a given price excess demand exists. Thus the countries with excess demand satisfy their requirement by importing from the countries with excess supply at an equilibrium price, where excess demand equals excess supply.

In an attempt to enhance prices and incomes, domestic policies often infringe on other nations interconnected through trade. The impacts of government intervention and price transmission on world markets can be classified as: 1.) the effect on the world price level (which depends on the relationship between domestic and international prices) and 2.) the consequences for world price stability (which depends on the extent to which domestic price is fixed by policy or is allowed to react to the changes in the world price level).

Policy makers use various intervention instruments such as direct transfer payments to producers, subsidies to increase demand, subsidies on inputs, and a government commitment to buy all commodities at a price above the prevailing free-trade price. The most cost-effective means of increasing producers incomes in most importing countries is to restrict imports on the domestic market. The prevailing trade policy tools available are 1.) tariffs, 2.) variable subsidy levies, 3.) price fixing in domestic markets and 4.) quantitative restrictions on imports.

The economic impacts of these policy options may be classified as macroeconomic effects i.e. the effects on the balance of trade and the microeconomic effects which are the effects on allocation of resources, pattern of consumption and welfare effects.

Except for crude petroleum, most imports and exports developed for the Mexican economy are regarded as imperfect substitutes. Primary goods are not homogeneous disaggregated products. Modelling the demand for live cattle in this research assumes imperfect substitution.

The economic structure underlying the demand for live cattle arose from the demand for their final products such as finished beef (table cuts), milk and other products such as hides and offals. Because of the derived demand for cattle, demand analysis requires that the production process of the user industry be incorporated into the model. As a result, live cattle is treated as an input (Beattie and Taylor, p. 112).

The production of beef involves two major groups of livestock farmers: cow-calf operators who maintain beef cow herds and raise calves, and feedlot operators who purchase feeder cattle and calves at varying weights and feed them to the desired slaughter weight and conditions for sale as fed beef.

Assume a rational stock farmer who is free to vary the levels of both cost and output. The farmer employs inputs to the level where the profit is maximized (or cost is minimized). Suppose the firm sell its output Q at constant price P employing two inputs X1 and X2 at constant unit factor prices Γ1 and Γ2, respectively. The firms production process is given by the following production function

$$Q = f(X_1, X_2) \qquad [1]$$

Assuming technical efficiency and possible optimum output level obtainable by combining the two factors, mathematically, the firm maximizes its total revenue (PQ) minus total cost ($c = \Gamma_1X_1 + \Gamma_2X_2 + b$)

yielding the following profit function

$$\pi = Pf(X_1, X_2) - \Gamma_1X_1 - \Gamma_2X_2 - b \qquad [2]$$

By setting first order conditions for profit maximization equal to zero, equation 2 yields.

$$Pf_1(X_1, X_2) - \Gamma_1 = 0 \qquad [3a]$$

$$Pf_2(X_1, X_2) - \Gamma_2 = 0 \qquad [3b]$$

Equations [3a] and [3b] indicate that the firm employs inputs 1 and 2 up to the point where the value marginal product is equal to the cost of purchasing additional units of factors. However, a second-order condition is required to confirm maximum profit. The condition that the principal minors of the unbordered Hessian determinant alternate in sign is satisfied by the following equation (Beattie and Taylor, p. 112).

$$\frac{\partial^2\pi}{\partial X_1^2} = Pf_{11} < 0$$

$$\frac{\partial^2\pi}{\partial X_2^2} = Pf_{22} < 0 \qquad [4]$$

The above condition indicates that profit is decreasing with further application of either input 1 or 2.

$$\begin{vmatrix} \dfrac{\partial^2\pi}{\partial X_1^2} & \dfrac{\partial^2\pi}{\partial X_1 \partial X_2} \\ \dfrac{\partial^2\pi}{\partial X_2 X_1} & \dfrac{\partial^2\pi}{\partial X_2^2} \end{vmatrix} > 0 \qquad [5]$$

Equation 5 evaluated at the values of X_1 and X_2 confirms that profit is declining with further application of both inputs. For price $P > 0$, the above condition requires that the marginal products of both X_1 and X_2 be declining.

By simultaneously solving equations 3a and 3b for X_1 and X_2, producer input demand is obtained. Assuming there is perfect competition in both input markets and that other factors of production are fixed under the assumption of perfect competition in both factor markets, then factor demands are given by (Beattie and Taylor, p. 113).

$$X_1{}^* = X_1{}^* (\Gamma_1, \Gamma_2, P) \qquad [6]$$

$$X_2{}^* = X_2{}^* (\Gamma_1, \Gamma_2, P) \qquad [7]$$

where $X_1{}^*$ and $X_2{}^*$ are the profit maximizing levels of inputs. By summing the individual demand function of the ith firm, for the jth input, the long-run aggregate demand function for n number of firms becomes

$$\sum X_{ij} = \sum_{i=1}^{n} D_{ij}(P, \Gamma_1, \Gamma_2), \; i=1, 2 \qquad [8]$$

By applying the same analogy, the aggregate demand for cattle is presented as

DDC = f(PB, PS, PO, PT)

where

DDC = quantity of live cattle needed in the production of beef and other cattle products.
PB = average unit of price of cattle paid by stock farmers.
PS = unit price of feed paid by farmers.
PO = unit price of all other remaining inputs paid by farmers.
PT = unit price of beef received by farmers.

The demand for cattle consists of total demand and import demand. Total demand is defined as domestic production plus net imports. The most important factors causing changes in total demand of cattle may be the wholesale prices of the different types of cattle (feeder, slaughter, fed and nonfed). Import demand for cattle is influenced by the quantity of cattle available from the domestic market. Imports are specified as a function of the wholesale prices of cattle and feed.

Since the majority of cattle imported into Mexico are for breeding purposes (assume fed cattle) feed grain demand and imports are also included in the model. The growth of Mexico's economy is bringing with it larger demand for high-value foods, in particular livestock products; which in turn is stimulating larger imports of grain sorghum (Celma, 1991, p. 10).

Based on the above discussions and considering the general characteristics of the Mexican market for cattle, the relevant variables and relationships are specified in a model consisting of two demand equations for cattle and two demand equations for feedgrains. In addition, four equations reflecting the simultaneous nature between observed data and prices are included. The preliminary model is specified below. Because of the complexity and simultaneous relationship among the variables, symbols are employed.

1. Mexico's total demand for cattle $Y_1 = f(Y_2, X_1, X_2)$
2. Wholesale price of cattle in Mexico $Y_2 = f(Y_1, Y_4)$
3. Mexico's import demand for cattle $Y_3 = f(Y_2, Y_4, X_3, X_4, X_5)$
4. Import price of cattle $Y_4 = f(Y_3, Y_1)$
5. Total demand for feedgrains $Y_5 = f(Y_6, X_6, X_7)$

6. Wholesale/producer price of feedgrains $Y_6 = f(Y_5, X_8)$
7. Mexico's import demand for feedgrains $Y_7 = f(Y_5, Y_8, X_6, X_7)$
8. Import price of feedgrains $Y_8 = f(Y_6, Y_7)$

The model consists of eight equations with eight endogeneous variables (the system is complete). The model also contains variables which influence the endogeneous variables. Their values are not explained by the model nor labeled as predetermined. Classification of the variables into endogenous and exogenous is judgmental and generally depends on the nature and extent of the system being studied, data availability and the purpose for which the model is being developed (Johnston, 1984, p. 498-516).

In this analysis, the classification into endogenous and exogenous variables is based on economic theory and a priori knowledge of the livestock market in Mexico. As a result, the variables Y_1, Y_2, Y_3, Y_4, Y_5, Y_6, Y_7, and Y_8 are judged to be endogenous in the sense that these variables influence the cattle market and in turn are measurably influenced by it. This implies that their values are determined simultaneously with the model. On the contrary, the exogenous variables X_1, X_2, X_3, X_4, X_5, X_6, X_7 and X_8 are not directly influenced by the cattle market. Their values are given and the outcome of the model is conditional on those given values (Johnston 1984, p. 7). For the purpose of estimation the model is statistically formulated. It is assumed that the functional form of the equations are linear in the coefficients of both the endogenous and exogenous variables. It is also assumed that each relation contains an error or a disturbance term resulting from incomplete specification and/or measurement errors (Johnston 1984, p. 15-16). In addition, the following general linear model assumptions are maintained:

1. The error terms are normally distributed with $E(U) = 0$
2. The covariance matrix of the errors in a behavioral equation is the same for all t, $E(U_t U_t^1) = \Sigma$; for t = 1, 2,...t
3. The disturbances are pair wise uncorrelated $E(U_t U_{t+s}) = 0$ for $S \neq 0$
4. The predetermined variables are uncorrelated with the disturbances $E(X^1U) = 0$
5. The coefficient matrix of the endogenous variables is non-singular.

Under these assumptions the statistical model is specified as follows:

1. $Y_{1t} = a_1 - b_{12}Y_{2t} + c_{11}X_{1t} - c_{12}X_{2t} + U_{it}$
2. $Y_{2t} = a_2 - b_{21}Y_{1t} - b_{24}Y_{4t} + U_{2t}$
3. $Y_{3t} = a_3 - b_{32}Y_{2t} - b_{34}Y_{4t} - c_{33}X_{3t} + c_{34}X_{4t} + C_{35}X_{5t} + U_{3t}$
4. $Y_{4t} = a_4 - b_{43}Y_{3t} - b_{41}Y_{1t} + U_{4t}$
5. $Y_{5t} = a_5 - b_{56}Y_{6t} + C_{56}X_{6t} + C_{57}X_{7t} + U_{5t}$
6. $Y_{6t} = a_6 - b_{65}Y_{5t} + C_{68}X_{8t} + U_{6t}$
7. $Y_{7t} = a_7 + b_{75}Y_{5t} - b_{78}Y_{8t} + C_{76}X_{6t} - C_{77}X_{7t} + U_{7t}$
8. $Y_{8t} = a_8 - b_{86}Y_{6t} - b_{87}Y_{7t} + U_{8t}$

where

U = the disturbance term.

t refers to the time period with t = 1, 2, 3,. . . . 21.

a's represent the constant term.

b's are the coefficients of the endogenous variables (Y's).

C's are the coefficients of the exogenous variables (X's).

The sign before each coefficient in each equation corresponds to the expected relationship between the dependent and the corresponding explanatory variable. As an illustration, the expected relationship between the import demand for feedgrains and the import price of feedgrains is negative. Therefore, b_{78} is negative. On the other hand b_{76} is positive since an increase in the population of livestock is expected to increase the import demand for feedgrains.

The problem of data availability will dictate some necessary modifications in the theoretical model. The structural equations need to be identified before embarking on modification and estimation.[1]

Specification of the Model

The appropriate explanatory variables to be introduced into a regression model has been the topic of discussion by many authors. According to Koutsoyiannis (1977), it is clear that the number of variables to be included in the model depends on the nature of the phenomenon being studied and the purpose of the research. The most important variables are generally included. However, the non-inclusion of some variables might lead to misspecification and cause structural bias. Therefore, care and good judgement is necessary in selecting the set of explanatory variables. On the basis of economic theory and a priori knowledge, a preliminary model consisting of eight equations was developed for Mexico's demand. The strong linkage between the data and model specification hindered the estimation of the eight equations. According to Johnston (1984, p. 499) model specification will have strong implications for the data required and, conversely, data limitations may constrain the feasible specification.

Consequently, the preliminary model is specified into import demand for cattle and import demand for feedgrain-sorghum as follows:

Behavioral Equations

$$Y_{1t} = a_1 - b_{12}Y_{2t} + C_{12}X_{2t} + C_{13}X_{3t} - C_{14}X_{4t} + U_{1t} \quad [1]$$

$$Y_{2t} = a_2 + b_{23}Y_{3t} + C_{21}X_{1t} + U_{2t} \quad [2]$$

$$Y_{4t} = a_3 - b_{35}Y_{5t} + C_{31}X_{1t} - C_{35}X_{5t} + C_{36}X_{6t} + U_{3t} \quad [3]$$

$$Y_{5t} = a_4 + b_{46}Y_{6t} + C_{41}X_{1t} + U_{4t} \quad [4]$$

[1]For detailed discussion of identification problem, see Johnston 1984, p. 450.

Identity Equations

$$Y_{1t} = Y_{3t}$$

$$Y_{4t} = Y_{6t}$$

$$X_{7t} = Y_{4t} + X_5$$

$$X_{7t} = X_{8t} \qquad \text{(Equilibrium S = D)}$$

and the variables are defined as follows

Endogenous Variables

Y_{1t} = import demand for live cattle from the United States (1,000 heads).

Y_{2t} = import unit value of cattle in United States dollars.

$Y_{3t} = Y_{1t}$

Y_{4t} = Mexico's import demand for sorghum, (1,000 metric tons).

Y_{5t} = import unit value of sorghum in United States dollars.

Exogenous Variables

X_{1t} = real wholesale price index of sorghum (1985 = 100), United States dollars.

X_{2t} = per capita income, United States dollars.

X_{3t} = foreign exchange reserves in millions of United States dollars.

X_{4t} = Mexico's import of live cattle from countries other than the United States (rest of the world)[2]

X_{5t} = production of sorghum in Mexico (1,000 metric tons, all figures before 1970 include millet in sorghum production).

X_{6t} = production of cattle in Mexico (1,000 head).

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[2] The approach of separating import demand into demand from the United States (as an endogeneous variable) and including the demand from the rest of the world an exogeneous variable was employed by Saremi (1984) in analyzing Mexican import demand for United States pesticides.

X_{7t} = total consumption of sorghum (1,000 metric tons).

X_{8t} = total supply of sorghum (1,000 metric tons).

U_t = random disturbance.

t = year.

After modification the model contains eight equations: four behavioral equations and four identity equations. The number of exogenous variables is 6 (X_1, X_2, X_3, X_4, X_5 and X_6,) $X_7 = X_8$ which indicate a supply and demand equilibrium. This simultaneous approach was employed by Elsheikh (1976) in analyzing the import demand for oilseeds and oilseed products in the European Economic Community.

Estimation Technique

Two-stage least squares is utilized for the estimation of the model. The first stage is to take the least square regression of the endogenous variables which are used as explanatory variables on all the predetermined variables (X_{is}) in the complete model. The purpose of this stage is to purge the equations of any stochastic element. Any correlation between the endogenous variables and the disturbance terms of the structural equations is eliminated.

In the second stage, the original values of the endogenous variables are replaced by their estimated values, thereby allowing each equation to represent the dependent variable as a function of the relevant exogenous variables and the predicted values of the endogenous variables (Johnston 1984, p. 472-483).

The two-stage least squares method was employed under the assumption that the functional forms of the equations are linear in their coefficients of both the endogenous and the exogenous variables plus the usual assumptions for least squares applications already outlined in Chapter III.

Equations 1 and 2 were estimated by two-stage least squares using the Syslin, Statistical Analysis Systems (SAS), computer package. The results exhibit very low levels of significance for some of the independent variables. These problems were in part due to intercorrelation between the exogenous variables which violates one of the classical linear regression assumptions. Although there was no perfect multicollinearity, the fact that most of the variables were not significantly different from zero indicates the existence of multicollinearity (Johnston 1984, p. 239).

Coping With Multicollinearity

Various authors have used different approaches to cope with the problem of multicollinearity. One approach is to alleviate time-series multicollinearity by using estimates from cross-sectional studies. Another approach is to use cross-section survey data in a time-series observation (Johnston 1984, p. 250; Kennedy 1985, p. 150). Yet another approach is to transform the available data to first differences so that instead of estimating

$$Y_{4t} = a_4 - b_{46}Y_{6t} + C_{41}X_{1t} + C_{45}X_{5t} + U_{4t}$$

the following is estimated by the least squares method.

$$Y_{4t} - Y_{4,t-1} = b_{46}(Y_{6t} - Y_{6,t-1}) + C_{41}(X_{1t} - X_{1,t-1}) + C_{45}(X_{5t} - X_{5,t-1}) + (U_{1t} - U_{1,t-1})$$

Although this approach reduces multicollinearity, it introduces auto correlation in the disturbance terms and consequently large variances (Johnston 1984, p. 250).

None of these approaches were possible because time-series data on the relevant variables and for the period before 1970 were limited and inconsistent. Independent studies that could provide more information on the coefficients of some of the variables and specifically on the research topic in Mexico were not available. Thus the alternatives were limited. According to Mutti (1977, p. 73) "among the several competing theoretical models none will be applicable in all situations." A particular model gains its usefulness by simplifying reality and allowing the researcher to concentrate on a few critical variables. Thus some of the variables were dropped from the model using the Bunch-Map approach. This approach involves regressing the dependent variable on each of the explanatory variables, and then choose those variables that statistically yield significant coefficients, low standard errors and higher R^2.

Data and Time Period

This study utilizes secondary data from several selected sources. Because of the disparities between U.S. export statistics and Mexican import statistics, only U.S. data sources were used.

The basic data consists of the observations of quantity of imports of cattle and sorghum and their associated import unit values. The period covered is from 1970 to 1990 using annual calendar series data. Data before 1970 were either in value only or under a different classification.[3]

Mexico's import quantities and values of cattle and sorghum from the United States were obtained from United States Department of Agriculture, Economic Research Service, Foreign Agricultural Trade of the United States (FATUS) Washington, DC. According to Celma (1991, p. 10) Mexico imports corn mainly for food which goes primarily into the manufacture of tortillas. Sorghum is the major component of feed grains imports. Since the Food and Agriculture Organization Trade Yearbook did not report the import/export demand for sorghum, it can be assumed

[3]Instead of sorghum only, the data included millet.

that Mexico obtains all its imports of sorghum from the United States. Mexico's total import quantities and values of cattle were obtained from the United Nations, Food and Agriculture Organization (FAO) Trade Yearbook. To obtain Mexico's imports from countries other than the United States, the import figures from FATUS were subtracted from FAO figures.

Import unit value was used to account for the exchange rate differences between the United States and Mexico. To obtain the unit prices, the value of imports was divided by the quantity of imports. The data for Mexico's cattle and sorghum production were obtained from the FAO production yearbook. The wholesale price was used as a proxy for the producer price of sorghum. This was also obtained from FAO production yearbook.

Gross National Product (GNP) was used as a proxy for the national income of Mexico. The figures were obtained from the United Nations International Monetary Fund (IMF), International Financial Statistics (IFS). The GNP was divided by the population to obtain per capita income. Foreign exchange reserve figures were also obtained from IFS.

This study is organized around the working hypotheses that information on the responsiveness of the quantity demanded to changes in income and price will be useful to policy makers in formulating Mexican domestic and agricultural trade policy. The specific hypotheses to be tested is that cattle and sorghum imported from the United States respond to changes in income and their respective prices.

Empirical Results

In general, ordinary least squares (OLS) estimates of a simultaneous equation model yields biased and inconsistent estimates because of the correlation of some independent (right-hand side) variables with the error term. This violates one of the basic classical assumptions for the application of ordinary least squares. On the other hand, the sampling distributions of the two-stage least squares (2SLS) estimates are unknown for finite sample sizes.

Consequently, the confidence limits for the estimated coefficients cannot be constructed. The traditional significance tests are not appropriate for OLS and 2SLS estimates of a simultaneous model (see the central limit theorem and asymptotic properties of a sample size, Kennedy p. 30; Johnston 1984, p. 268). Thus, in this analysis, evaluation of the coefficients of multiple determination, R2, which indicates the goodness of fit and the standard error (SE) of estimated coefficients are employed. The SE is in parentheses beneath the estimates. The coefficients are judged to be significantly different from zero if their absolute value exceed their standard errors. The symbol * indicates that the corresponding variable is significantly different from zero at the five percent level of confidence. For comparison, the results of both formulations (2SLS and OLS) are presented.

Equation 1: Import Demand for Live Cattle

2SLS:

$$Y_1 = 35.242 - \underset{(0.105)}{0.019Y_2} + \underset{(0.02)}{0.007X_2} + \underset{(0.003)}{0.003X_3} - \underset{(0.0003)}{0.0004X_4}*$$

$R^2 = 0.174SE = 5.755$

OLS:

$$Y_1 = 45.213 - \underset{(0.062)}{0.049Y_2} + \underset{(0.015)}{0.011X_2} + \underset{(0.003)}{0.003X_3} - \underset{(0.0002)}{0.0003X_4}*$$

$R^2 = 0.205SE = 5.730$

Comparing the results of both methods of estimation, the signs of the parameter estimates are in accordance with a priori expectations. The size of the residual mean square (33.117 for 2SLS and 32.827 for OLS) and the results are slightly higher for OLS estimates. The estimated coefficient for the import price of cattle is not significantly different from zero. A possible explanation for this can be the problem of identification. There may be other significant factors that determine the demand for cattle imports which were not represented in the simple model described here. The ideal cattle model is much more complicated, including the demand for feeder cattle, slaughter cattle, inventory and other aspects of the cattle market which were not represented in the study. Lack of data availability makes further investigation difficult at this time. Thus a specification error may have been introduced resulting in a low R^2.

Mexico's imports of cattle from countries other than the United States is significantly different from zero in both formulations. This indicates some mutual dependency between the quantity of cattle imported from the United States and imports from other countries.

The estimated coefficient for foreign exchange reserves is the same under both methods. It has the correct sign but is not significant. In modeling import demand for corn in Mexico, Kim (1986) had a similar result. A possible explanation for imports being insensitive to changes in foreign exchange was attributable to the high priority the Mexican government places on basic staple food imports.

In the OLS results, the explanatory variables specified in the equation account for 21 percent of the total variability in the quantity of live cattle imported into Mexico.

Equation 2: Import Unit Price of Cattle

2SLS:

$$Y_2 = 709.286 + \underset{(2.366)}{1.194Y_3} - \underset{(2.728)}{9.752X_1}*$$

$R^2 = 0.463SE = 12.230$

OLS:

$$Y_2 = 765.285 - 0.385Y_3 - 9.306X_1{}^*$$
$$\qquad\qquad (1.073) \quad (2.491)$$

$R^2 = 0.494SE = 11.891$

In accordance with priori expectation, the import price of cattle, Y_2 and the total quantity imported, Y_3 exhibit a positive relationship in the 2SLS method. In the OLS method, it exhibits a negative relationship which is contrary to the economic expectation that imports of cattle exerts downward pressure on the price of cattle. The coefficient for the wholesale price of sorghum, X_1 has a negative sign in both cases. An explanation for this effect might be that the wholesale price of sorghum was used as a proxy for the producer price of feed while sorghum is only one component (though a dominant one) of the several types of feed grains imported to Mexico. As a result, a specification error might have been introduced resulting in the inconsistent sign of X_1. However, the coefficient on the wholesale price of sorghum is significant in both methods of estimation. The two explanatory variables Y_3 and X_1, account for 49 percent of the total variation in the import price of cattle, using the OLS method.

Equation 3: Total Import Demand for Sorghum

2SLS:

$$Y_4 = - 4307.069 + 15.816Y_5{}^* + 0.005X_5 + 0.121X_6{}^*$$
$$\qquad\qquad (7.563) \quad (0.143) \quad (0.054)$$

$R^2 = 0.744 \quad SE = 23.50$

OLS:

$$Y_4 = - 4428.369 + 11.480Y_5{}^* + 0.037X_5 + 0.135X_6{}^*$$
$$\qquad\qquad (6.193) \quad (0.137) \quad (0.051)$$

$R^2 = 0.745 \qquad SE = 23.30$

The import price of sorghum, Y_5, and the total quantity imported, Y_4, exhibit a positive relationship which is contrary to the theoretical expectation. A possible explanation for this could be an identification problem in the sense that the true demand schedule cannot be determined from the current observation, that is, given a sample of the jointly observed values of Y_4, and Y_5, the structural equation is compatible with both a demand and supply relation. As a result, the price-quantity relationship could be positive or negative. In estimating Mexican import demand for United States pesticides, Saremi (1984) also obtained a positive coefficient for the import price of pesticides which the author attributed to the effect of multicollinearity.

The importance of sorghum production, X5, is questionable since its estimated coefficient is smaller that its corresponding standard error. Contrary to a priori expectations, the quantity of sorghum imported has a positive relationship to the domestic production of sorghum.

The explanatory variables in this equation account for 74 percent of the variability in Mexico's total imports of sorghum.

Equation 4: Import Price of Sorghum

2SLS:

$$Y_5 = 10.919 + \underset{(0.006)}{0.019Y_6^*} + \underset{(0.611)}{1.047X_1^*} + \underset{(0.006)}{0.014X_5^*}$$

$R^2 = 0.674$ SE = 4.37

OLS:

$$Y_5 = 10.919 + \underset{(0.006)}{0.019Y_6^*} + \underset{(0.611)}{1.047X_1^*} + \underset{(0.006)}{0.014X_5^*}$$

$R^2 = 0.674$ SE = 4.37

The estimated coefficients in this equation are all significantly different from zero. The results in both methods are identical.

By economic theory, the quantity of sorghum imported, Y_6, and its price, Y_5, should have a negative relationship. The inconsistency here may have risen from the larger demand for high value food, in particular livestock products in Mexico which in turn is stimulating the use of high energy diets for cattle and other livestock (Celma 1991, p.10). Such demand might have overridden any negative relationship between the import price of cattle and the quantity of cattle imported into Mexico. Another possible explanation could be the presence explanation of an identification problem in the equation.

On the whole, the explanatory variables included in the model account for 67 percent of the variation in Mexico's import price of sorghum.

Elasticities of Import Demand for Cattle

The price elasticity of demand is defined as the degree of responsiveness of the quantity demanded of a commodity to changes in its price. By economic theory, a direct price elasticity is assumed to be negative since an inverse relationship exists between the quantity demanded and the price paid. The results of equation one above confirm the inverse relationship since a negative sign preceded the price coefficient. This and other elasticities discussed below are computed from the estimated coefficients and the averages of the relevant variables for the eight-year period 1980-1987, using the following arc elasticity formula.

$$\frac{dY_1}{dY_2} \bullet \frac{\left(\sum Y_{2i},...n)/n\right)}{\left(\sum Y_{1i},...n)/n\right)}$$

which implies that the elasticity of Y1 with respect to changes in Y2 is:

$$\frac{\text{Proportionate change in } Y_1}{\text{Proportionate change in } Y_2}$$

The price elasticity of import demand for cattle is -0.366. This indicates that, ceteris paribus, a one percent increase in the Mexican import price of cattle will result in a 0.366 percent decrease in the quantity of cattle imported. Such a low figure indicates an inelastic demand for cattle imports and suggests that other demand shifting factors such as changes in population, technology, efficiency of the feedlot industry and technical know-how of stock farming exert more influence on the quantity of cattle imported to Mexico. The effect of price changes on the quantity of imported cattle is minimal.

The income elasticity of cattle imports is positive as expected. A one percent increase in per capita income increases imports of cattle by 0.397 percent, ceteris paribus. Such a low figure for a developing country is contrary to economic theory. It suggests that cattle imports are not very responsive to changes in income, which is contrary to the economic expectation for a developing country whose per capita consumption level for cattle (beef) is far from the saturation level. However, it should be noted that the calculation of an income elasticity is based on a coefficient whose standard error is greater than that of the estimated coefficient.

Elasticity of Import Demand for Sorghum

To measure the responsiveness of the quantity of sorghum imported to changes in the import price of sorghum, the arc elasticity formula described above was also employed.

Accordingly, the price elasticity of sorghum of 1.086 indicate high responsiveness. However such responsiveness is questionable because it is preceded by a positive sign. In the analysis of import demand for oilseeds and oilseeds products in the European Economic Community, Elsheikh (1976) got a similar positive result but with lower value.

Conclusion

Latin America is the most important market for United States live cattle among the developing countries. In 1989 and 1990, Mexico was singly responsible for the entire U.S. live cattle export market in Latin America.

The central purpose of this study was to investigate the economic forces that influence Mexico's import demand for live cattle. Yearly data for the period 1970-1990 were used. An economic model was developed to reflect the major aspects of the Mexican cattle market and its complementary demand for sorghum.

The model consists of eight behavioral equations which incorporate a set of endogenous and exogenous variables and reflect the complementary relationship between cattle and sorghum (the principal component of Mexico's feed). Because of data limitations the preliminary specification was not estimated. The model was then replaced by a four equation model consisting of Mexican import demand for cattle, import demand for sorghum and their respective prices.

The Mexican import demand for cattle from the United States was hypothesized to vary with respect to: 1) import price of cattle; 2) per capita income; 3) foreign exchange reserves; and 4) number of cattle imported from countries other than the United States.

Under the assumption of a linear relationship, the statistical model was estimated using two-stage least squares. The model was also estimated using ordinary least squares.

The import demand for United States sorghum relates the quantity demanded to the import price of sorghum, sorghum production in Mexico, and the production of cattle in Mexico. The statistical model was also estimated using both two-stage least squares and ordinary least squares.

Despite the many shortcomings arising from data, the results capture the relevant economic forces that affect Mexican import demand for United States cattle and sorghum. The estimated coefficients for most of the variables are consistent with a priori expectations. The results indicate that Mexican cattle imports from the rest of the world (other than United States) could reduce the import demand for United States cattle. The results also indicate that an increase in cattle production in Mexico could substantially increase the import demand for United States sorghum.

Limitations and the Need for Further Research

This study suffered from a number of limitations. Among them is data unavailability for Mexico. This constrained the construction of a more representative model that takes into account all the relevant factors of the cattle sector in Mexico. More detailed, reliable data including inventory, domestic demand for cattle, feeder and slaughter cattle, the wholesale-retail beef market, feeding rates, and a feed conversion ratio for each category will enable researchers to formulate a more disaggregated model and make meaningful projections.

Since the sample size was dictated by the availability of data, a longer series of data could improve the results obtained by the regression. The problem of multicollinearity encountered would have been overcome if related cross-section data were available to combine with time series data. Thus another avenue for research is to generate cross-sectional data and conduct budget studies applicable to the cattle sector in Mexico.

Another drawback of the model is that static rather than dynamic assumptions were upheld. The inclusion of a lagged dependent variable as an additional explanatory variable in the structural equation would have increased the predictive power of R2 in addition to giving a coefficient of adjustment which expresses the relationship between the short run and long run elasticities. However, the inclusion of lagged variables was not implemented in this research because of data problems. Since the life cycle of cattle is about 5 years, the inclusion of lagged dependent variables would have reduced the number of observations in the model.

Economic models for future research on the Mexican cattle sector should reflect the joint-input aspects of cattle and feed grains for the production of finished beef; the multiple market outlets for cattle-feeder cattle, slaughter cattle and the wholesale-retail beef market; and imports or net imports of cattle from countries other than the United States as an endogenous variable.

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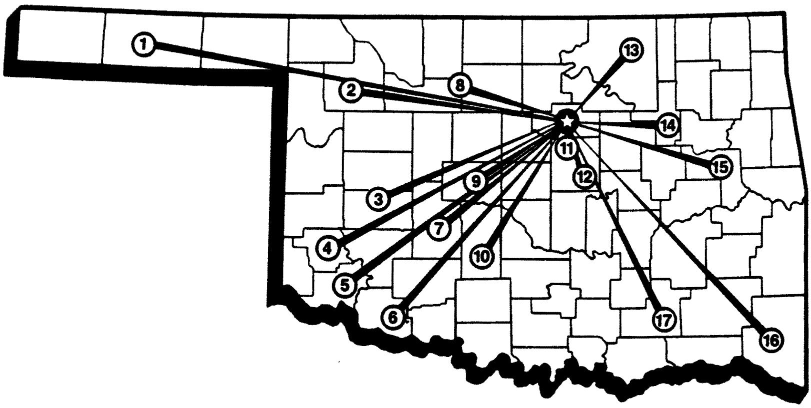

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