THE IMPACT OF THE NORTH AMERICAN FREE TRADE AGREEMENT ON THE U.S. FEEDER CATTLE MARKET

By

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CHAPTER I

INTRODUCTION

With the advent of the North American Free Trade Agreement (NAFTA), policymakers and special interest groups in Canada, Mexico and the U.S. are interested in determining the potential effects, both domestically and internationally, for their constituents. The U.S. agriculture industry is particularly interested, as Canada and Mexico are important markets for U.S. farm products. Conversely, the U.S. also imports many agricultural products, including livestock from both Mexico and Canada.

The livestock sector of U.S. agriculture has traditionally experienced highly variable returns. Prices for livestock products fluctuate due to changes in consumer demand, costs of production, and available supply. Increased livestock imports will increase supply in the U.S. driving prices downward.

Mexican cattle exports to the United States have grown sharply since 1980 (Figure 1). Because Mexico's cow-calf

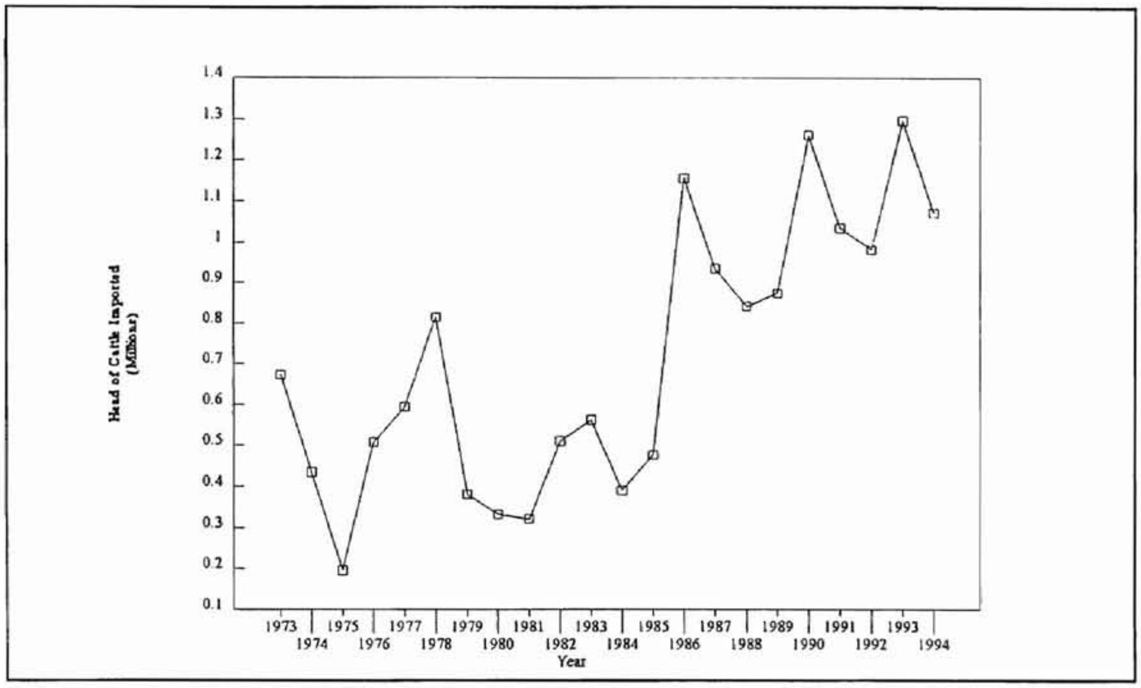

Figure 1. Total Annual Cattle Imports from Mexico.

producers are providing southwestern cattle feeders with a low-cost factor of production, the growth in the number of cattle imported annually from Mexico is expected to continue. Foreign cattle sales, which accounts for 92% of Mexico's livestock exports, could increase when NAFTA goes into effect (USMEF).

The purpose of NAFTA is the gradual elimination of all trade barriers between the U.S., Mexico, and Canada. Mexico has maintained an export quota and/or tariff on feeder cattle exports since 1966. These trade barriers effectively limit the number of animals that may be exported. The removal of the barriers will allow Mexican producers to export cattle freely.

Does Mexico have the capacity to produce feeder cattle in large numbers? Estimates of Mexico's maximum annual production of exportable feeder cattle range from 1.4 to 2.33 million (CAIE; SARH; Rosson, Davis, Segarra, and Angel). From 1987 to 1991, the production of calves in the U.S. averaged 39.8 million (USITC). Given the above estimates, Mexico's maximum production is 3.5 - 5.8% of the current U.S. production.

Will increased feeder cattle imports from Mexico significantly lower U.S. prices? Recent studies (Rosson, et. al.) have indicated that the importation of live feeder cattle from Mexico into the U.S. could conceivably have a large downward impact on the price of feeder cattle. While greatly benefiting U.S. cattle feeders in the southwest, the downward change is of concern to cow-calf producers in the U.S.

Figure 2 illustrates both the potential direct and indirect impacts of NAFTA on feeder cattle exportation. Line **ED** represents the U.S. excess demand (U.S. demand less U.S. supply) for feeder cattle. Line **ES** is Mexico's excess supply (Mexican supply less Mexican demand) of feeder cattle before NAFTA. **P** is the preNAFTA equilibrium price, which occurs at the intersection of **ED** and **ES**. At price **P**, U.S.

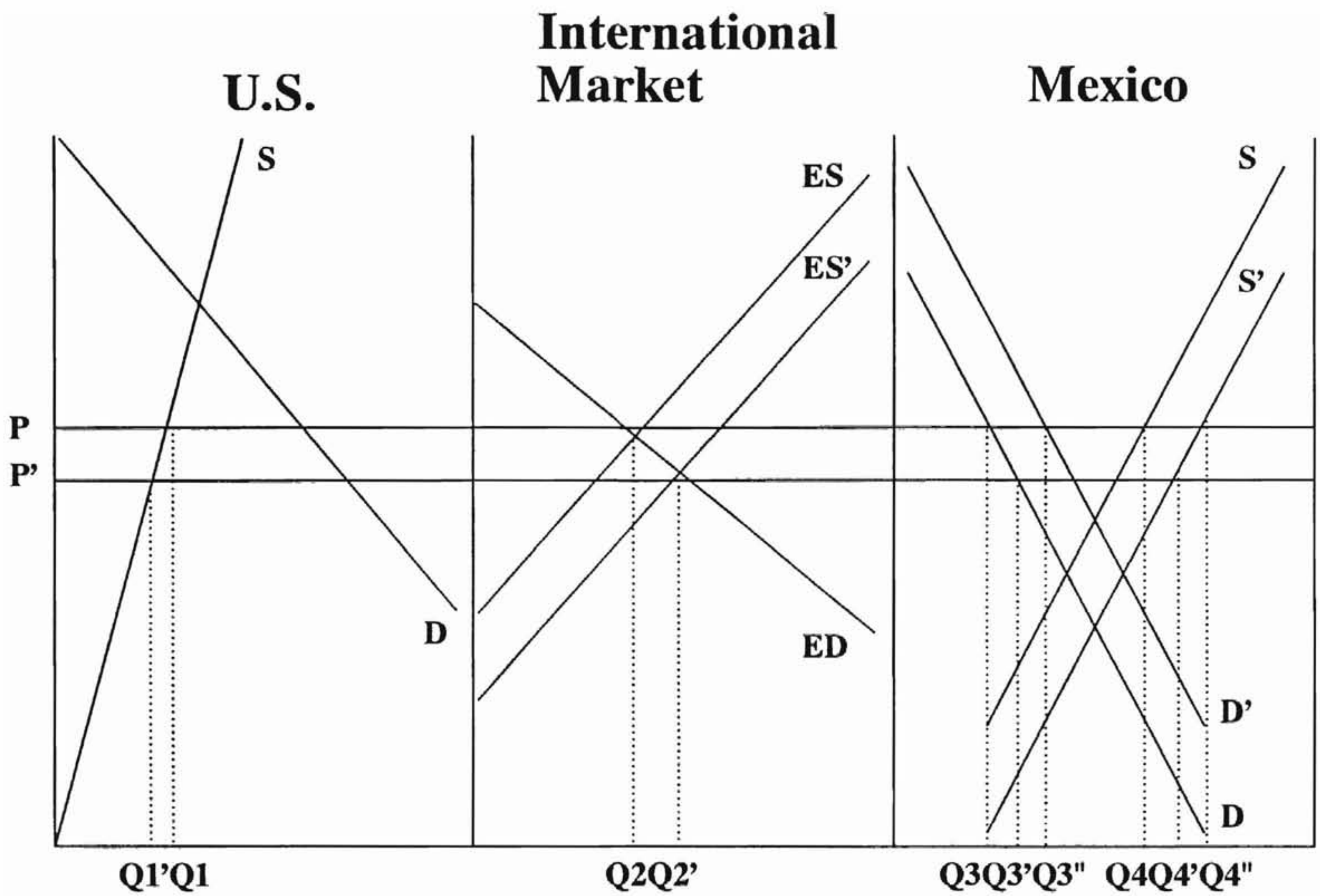

Figure 2. Potential Impact of NAFTA on the U.S. and Mexican Feeder Cattle Market

cow/calf producers supply **Q1** number of cattle, while Mexican producers supply **Q4**. **Q3** is the number of feeder cattle demanded in Mexico, given price **P**. **Q2** represents the number of feeder cattle exported to the U.S., and is equal to **Q4** minus **Q3**.

The direct expected result of NAFTA is a decrease in the costs of exporting feeder cattle, effectively increasing the available supply of feeder cattle from Mexico for exportation. This results in an outward shift of Mexico's supply curve from **S** to **S'**. Mexico's excess supply curve also shifts, from **ES** to **ES'**, and the equilibrium price decreases to **P'**. In addition, U.S. production decreases to **Q1'**, while Mexican production increases to **Q4'**, and imports increase to **Q2'**.

The indirect, longer-run expected impact of NAFTA is an increase in the per capita income of Mexican consumers, and a greater demand for beef. The increased demand for beef leads to an upward shift in the demand for feeder cattle within Mexico, from **D** to **D'**. Mexico's excess supply curve shifts up. In this example, Mexico's excess supply curve returns to the original **ES** position. Feeder cattle price increases, imports to the U.S. shrink, and U.S. production increases. In Mexico, the number of feeder cattle produced rises, after both supply and demand have shifted, and is found at the intersection of **P** and **S'**, or **Q4"**. However, the increase in production is offset by Mexico's larger domestic demand, represented by **Q3"**.

The implication of this scenario is that NAFTA could increase, decrease, or have no effect on the U.S. price of feeder cattle. The magnitude of any change in price is dependent on the relative shifts in Mexico's feeder cattle demand and supply.

Estimating the changes in Mexico's market that arise from NAFTA requires producer prices and quantities for both Mexico and the U.S. Information on the expected change in Mexico's per capita income, and the income elasticity for beef is also needed. Unfortunately, much of this data is unavailable. However, by examining the historical impact of Mexico's feeder cattle exports on U.S. prices, and assessing the possible changes in the quantity of cattle exported as a result of NAFTA, it is possible to measure the potential outcome of NAFTA on U.S. feeder cattle prices.

The general objective of this study is to evaluate the potential effect of free trade with Mexico on the U.S. feeder cattle market.

Specifically this study will: (1) provide a qualitative description of the Mexican feeder cattle industry; (2) estimate the historical impact of Mexican feeder cattle imports on U.S. feeder cattle prices, and (3) evaluate the potential effects of NAFTA on U.S. feeder cattle prices.

CHAPTER II

MEXICAN BEEF CATTLE INDUSTRY

General

Mexico is the third largest Latin American country. Roughly triangular in shape, it consists of 756,066 square miles (or almost 484 million acres) of widely varied terrain, with elevations ranging from sea level to over 10,000 feet. Mexico's climate is also highly diversified, being determined primarily by elevation, latitude and relative position to major air masses. In addition, vegetation in Mexico covers a broad varietal spectrum.

Mexico's largest landform is the Mexican Plateau (Figure 3), running along the center of the country, southward from the U.S. border to the Isthmus of Tehuantepec. Divided by three mountain ranges, which make up the transverse Sierras, the plateau has 2 regions. The Northern Mesa is dry and sparsely populated, while the Central Mesa has many lakes and is densely populated. The entire plateau is enclosed by the mountains of the Sierra Madre ranges on the east, west and south. Coastal plains separate the mountains from the sea on both the east and west.

Figure 3. Physiographic Regions of Mexico.

At the southernmost point of Mexico, the Sierra Madre del Sur and the Sierra Madre Oriental join together, leading into the Isthmus of Tehuantepec, the Chiapas highlands and the limestone platform of the Yucatan Peninsula.

Approximately 307.8 million acres (63%) of Mexico's total land area is used for livestock production. Of this, 172.9 million is brush, 54.3 million is natural pastures, 19.8 million is improved pastures, and 60.8 million is converted forest or other (Arce-Diaz).

Cattle operations in Mexico may be beef, dairy or dual purpose, and are Mexico's primary livestock activity. However, as in the U.S., regional production is based on geoclimatic factors, and available markets. Mexico has three distinct geoclimatic regions (Figure 4): arid or semiarid, temperate, and tropical. Tropical areas can be further divided into wet or dry.

Arid or Semi-arid

The arid and semi-arid region is located in the north of Mexico, and includes the states of Baja California Norte, most of Baja California Sur, Chihuahua, Coahuila, Durango, Nuevo Leon, San Luis Potosi, the north half of Sinaloa, Sonora and Zacatecas. Average rainfall is between 7.9 and 31.5 inches annually, although in the far northwest of Sonora, it can be as low as 2 inches per year. The rainy

Figure 4. Climatic Regions of Mexico

season is limited to the summer and early fall months. Temperatures range, depending on elevation, from cool to cold in the winter, to long hot summers.

The important cattle-producing states in this area are Chihuahua, Coahuila, Durango, Sinaloa, Sonora and Nuevo Leon. Large parts of Chihuahua, Coahuila, and Durango are located on the Northern Mesa of the Mexican Plateau. The soils in this area are arid, low in humus, and may be alkaline. However, they are often quite fertile with irrigation resulting in extensive production of corn, oats, sorghum, alfalfa, oilseeds, cotton and other horticultural crops.

Vegetation in unimproved areas is mainly desert scrub, although this becomes semi-arid grassland to the south and west as elevations and precipitation increase. The carrying capacity is low, as shown by the estimated range coefficient for Chihuahua of 51 acres per animal unit (Bredahl, Burst and Warnken). Supplemental feeding is not required during the late summer months and early fall (rainy season), but it is likely to be needed throughout the rest of the year.

The remainder of Chihuahua and Durango lies on the Sierra Madre Occidental range, while Coahuila is similarly located across the north end of the Sierra Madre Oriental. These mountain regions are covered by highland forests of conifers and oaks.

Sonora, Sinaloa and Nuevo Leon are coastal plains, with their inland borders rising up into the Sierra Madres. Their soils are mostly fertile arid soils in the north, changing to laterite and alluvial soils further south. Northern vegetation changes from desert scrub to grasslands further south. Because of soil fertility, and the availability of water for irrigation (with the exception of northwestern Sonora), farming is extensive in these states, producing a wide variety of fruits and vegetables, in addition to alfalfa, corn, oats and oilseeds.

Due to the region's proximity to the U.S., short growing season, inadequate for fattening (although extensive) grasslands, the primary cattle enterprise is feeder cattle production. A large segment of steers produced from this region are exported to the U.S. Consequently, many European or predominantly European cattle are found here, mainly Charolais, Hereford, and Angus. Some Brahman-derived breeds such as Beef Master and Santa Gertrudis, along with the Brahman, are also common (SARH).

In addition, the region also provides Zebu (Brahman, Indo-Brazil, Sardo Negro, Gyr, and Nelore) breeding stock, as well as commercial feeder cattle to producers in Veracruz, San Luis Potosi and Hidalgo for domestic consumption (Bredahl, et. al.).

Beef production is found over approximately 70% of the northern arid/semi-arid area, with stocking rates varying from 39.5 to 136 acres per animal unit. Calving rates range from 45 to 55%. Meat production has been estimated to be 4.5 lbs per acre. Because of the region's proclivity for breeding, the percentage of cows within the herd is higher than the national and other regional averages (Arce-Diaz).

Overgrazing, as well as prolonged droughts have been the principal production problems in this territory. Other problems involve: lack of water and forage in general, short growing season for forages, sparse population, lack of infrastructure, and frosts in the higher elevations (CAIE).

Temperate

The temperate region is located in the central part of Mexico and consists of the central area of Chiapas; the Federal District; Guanajuato; the southern two-thirds of Hidalgo; the northern halves of Jalisco, Michoacan, and Oaxaca; Mexico; Pueblo; Queretaro, and Tlaxcala. It is the most densely populated area in the country. Nearly 25% of the total population of Mexico live in or around Mexico City, which is located in the Federal District.

This area is characterized by high, steep mountains with broad, flat valleys (Bredahl, et. al.). Soils include lacustrine soils, originated from ancient dry lake beds, and soils derived from volcanic debris. It is very fertile, and farming is widespread. Because of the altitude, warm, sunny days and cool nights are standard year round. Rainfall occurs throughout the year, but the quantity of precipitation increases in the summer. The amount of rain received varies throughout the region, but is generally more than 24 inches per year, removing the need for irrigation. The production of food and forage crops occur mainly on the more level valley floors. While some crop production does occur on the slopes, the more frequent use is for cattle grazing (Bredahl, et. al.).

With the large increases in population density from high birth rates and rural immigration, competition for agricultural land is great. This competition is generated by both increased food demand and space for housing. The result has been to drive cattle producers to more confined production systems, favoring dairy, rather than beef production.

The most important states for commercial cattle in this region are Jalisco, Mexico, Michoacan, Queretaro, and Puebla. Livestock inhabit 18.3 million acres of the temperate region. Of these, 55% are found in Jalisco and Michoacan (Arce-Diaz). Both dairy and beef enterprises rely on crop production for forage. Similar to areas in the midwestern U.S., particularly Oklahoma, cattle are grazed during the winter months on grain crops planted in the fall. After harvest they graze on crop residues. The rest of the year, cattle may require supplemental feeding (Bredahl, et. al.).

Cattle production in the central temperate region has remained stable. Calving rates are approximately 50 to 51% (Arce-Diaz). While this area does contain commercial cattle operations, it is dominated by the dairy industry, unlike the other regions of the country. In addition, the commercial cattle produced in this region are for domestic consumption. Because of the confined production systems; higher demand for better quality meat from higher incomes, and easy access to feeds and forage, the common meat-type animal found here is predominantly European with some Brahman. The breeds of cattle frequently used are Angus, Hereford, Charolais, Brahman, Indo-Brazil, and Guzerat (SARH).

Production problems observed here are: lack of protein and mineral supplements; scarcity of forages in periods of low water, and frosts in the higher elevations (CAIE).

Tropical

The dry tropical region is found along the Pacific coastal plains, the Sierra Madre del Sur mountains, the northern Gulf coastal plains, and the northern coast of the Yucatan peninsula. The states included in this region are: the southernmost tip of Baja California Sur; the southern portion of Chiapas; Colima; the southern half of Jalisco, Michoacan, and Oaxaca, the northern tip of Hidalgo; Guerrero; Morelos; Nayarit; a small southern area of San Luis Potosi; the south half of Sinaloa; Tamaulipas; the north half of Veracruz; and the northern coast of Yucatan (Bredahl, et. al.). Rainfall in this area is typically heavy in the summer but relatively light throughout the rest of the year. The amount of rainfall varies within the region, and can be as much as 141 inches per year. The terrain is highly mountainous, in general, with the coastal plains along the northern Gulf of Mexico and the Pacific being the exception. Temperatures depend primarily on elevation, decreasing as elevation rises. Vegetation varies from north to south. Going southward, the vegetation starts as dry steppe, changing to grasslands, and then tropical deciduous and semideciduous forests. Soil types include rendzina and alluvial, with some arid soils in northern Tamaulipas and Yucatan. Laterite soils are often found in nonalluvial areas of the coastal plains.

The wet tropical area is located at the southern end of Mexico and includes the states of Campeche; the northern part of Chiapas; Quintana Roo; Tabasco; the southern half of Veracruz, and all of Yucatan except the northern coast. Rainfall in this area is year round, and may be over 200 inches annually in some places. Temperatures decrease with elevation. Along the Gulf coast soil drains poorly in the lowland areas, and there are many lakes, swamps and marshes. Tropical rain forest is found on the better drained land along with savanna and palm savanna. Mangrove forests rim the rivers and lakes. In the Yucatan peninsula, tropical rain forest covers the southern portion while deciduous and semideciduous forest are found in the north, where it is drier. The terrain in this area is mainly lowlands, with the exception of northern Chiapas.

Both regions produce many agricultural products, such as corn, coffee, citrus and sugar cane. In the dryer climates, they also produce milo, while in the wetter climates, rice may be found (Bredahl, et. al.).

The important cattle producing states include Veracruz, Chiapas, Tabasco and Tamaulipas. The principal market for cattle produced in this region is for domestic consumption. Carrying capacity is high in many areas, with stocking rates at 2.5 acres per animal unit (Arce-Diaz). Pastures are often improved by introduced species (SARH). Because of the quantity of good forage available, feeder cattle produced in the northern regions for domestic use are sent to the tropics for fattening on pasture. There are also many purebred operations.

In the wet tropics, dual purpose (milk and beef) livestock enterprises are common. This is due, in part, to traditional values of self sufficiency, as many ranches are small, and limited infrastructure exists in this region.

The cattle typically used are Brown Swiss or Holstein crossed on the Zebu breeds, and are milked during the year (Arce-Diaz; Bredahl, et. al.).

The beef cattle are Zebu, or Zebu crossed on European breeds, mainly Simmental and Charolais. The Zebu's ability to withstand insects, hot weather, and diseases account for their strong influence in the tropical area (SARH).

Production problems include mineral deficiencies in the forage caused by soil leeching, in areas of high rainfall; pronounced seasonality in the availability of introduced pastures; extensive pastures without infrastructure such as roads and water supplies; and accented scarcity of forages in periods of low rainfall (CAIE, SARH).

Production Systems

Table I summarizes the general characteristics of Mexico's beef production systems, including herd productivity, feeding, sanitation, technological implementation, breeds of cattle, marketing, producer organization, and geographic locations. Production systems are classified by the level of resource use, and the type of activity.

Intensive cattle operations provide greater production efficiency, but require better management skills and knowledge of modern technologies. Traditional, extensive beef enterprises are more commonly found (SARH). As extensive operations are often isolated, Mexico's lack of infrastructure, as well as an overall ignorance of technologies, discourage a more intensive use of resources.

Further, cattle are evaluated and selected mainly on aspects of type and conformation, rather than carcass quality and yield (SARH). Choosing animals based only on type and conformation slows down the genetic process leading to the production of a more efficient animal.

Mexico's traditional beef production process is characterized by a long biological lag. From inception to slaughter can take up to 40 months: nine months of gestation, a year before weaning, 6-12 months for growing, and then 14-18 months of fattening on grass and grain (CAIE, SARH). In addition, the extensive nature of the majority of the production systems, and the low diffusion of technology leads to long calving intervals. According to SARH, in systems with little or no technology, calving intervals average 620 days.

Government Policies

Land Tenure

One of the purposes of Mexico's civil war of 1910 was to redistribute land holdings in a more equitable, and food secure fashion. Prior to the revolution, cattle were used as a way of storing wealth and holding onto land. This encouraged the development of larger herds in order to increase both wealth and ranch size, while keeping crop production down. At the same time, the proportion of the Mexican population that could afford to eat animal-derived

TABLE I

CHARACTERISTICS OF MEXICAN BEEF PRODUCTION SYSTEMS.

Type of Beef Enterprise	Average Herd Productivity	
INTENSIVE		
Fattening	Initial wt. Final wt. Age at slaughter Dressing percent Capacity	660 lbs. 880 lbs. 2 years 56% 200-500 hd.
Purebred cow/calf	Herd size	200-350 hd.
EXTENSIVE		
Commercial cow/calf	Weaning wt.	330 lbs.
Stocker	Initial wt. Final wt. Duration Herd size	330-400 lbs. 600-750 lbs. 6-10 months 50-200 hd.
Fattening	Initial wt. Final wt. Duration Dressing percent	400-460 lbs. 900 lbs. 18 months 52%
SEMI-INTENSIVE		
Dual Purpose	Produce meat and milk Strong seasonality Capacity Milk production Lactation period Weaning wt. Weaning age	 35-50 hd. Approximately 3 qts/day/head 60-180 days 400-440 lbs 12 months

TABLE I (Continued)

Type of Beef Enterprise	Feed and Nutrition	Sanitation	Technical Level of Enterprise
INTENSIVE			
Fattening	Balanced rations; Forages with vitamin, mineral and protein supplementation	High	High Use total confinement
Purebred cow/calf	Balanced rations; Forages with vitamin, mineral and protein supplementation	High	High Use artificial insemination
EXTENSIVE			
Commercial cow/calf	Pasture, grain stubble and agricultural byproducts	Low	Low
Stocker	Improved summer pasture, grain stubble and supplements	Low	Low
Fattening	Pastures with introduced grasses. Supplementation occurs only in some herds	Low	Medium
SEMI-INTENSIVE			
Dual Purpose	Pastures with cultivated grasses, and natural summer pastures. Supplementation occurs only in some herds	Low	Medium Partial milking Deficient management skills

TABLE I (Continued)

Type of Beef Enterprise	Breeds Used	Marketing
INTENSIVE		
Fattening	European, mainly, or crossed with Brahman	Local domestic markets and large cities
Purebred cow/calf	Purebred Brahman, Brown Swiss, and Simmental	Inadequate because of high prices and many intermediaries
EXTENSIVE		
Commercial cow/calf	European breeds crossed with Zebu breeds	Export to the U.S., or fatten in the tropics
Stocker	European breeds crossed with Zebu breeds Marked Holstein influence in the center region	Local consumers, and supermarkets in large cities
Fattening	Brahman crossed with Brown Swiss, other Zebu breeds, and some Simmental	Domestic markets, and supermarkets in large cities
SEMI-INTENSIVE		
Dual Purpose	Brahman crossed with Brown Swiss, other Zebu breeds, and some Simmental	Calves are sold for fattening

TABLE I (Continued)

Type of Beef Enterprise	Level of Producer Organization	Geographic Location
INTENSIVE		
Fattening	High	Arid and semiarid north; states bordering the U.S.
Purebred cow/calf	High	Dry and humid tropics; Tamaulipas, Veracruz, Tabasco, Chiapas Campeche and Yucatan
EXTENSIVE		
Commercial cow/calf	Low Frequently, not a member of any organization	Arid and semiarid north; temperate and mountainous central region
Stocker	Low Frequently, not a member of any organization	Arid and semiarid north; temperate and mountainous central region
Fattening	Medium	Dry and humid tropics
SEMI-INTENSIVE		
Dual Purpose	Medium	Dry and humid tropics

Source: SARH

protein was growing smaller, creating the need to import staple commodities so that Mexico could feed itself.

After the revolution, large land holdings were parceled out, under the Land Tenure Law, to landless peasants for crop production forming the *ejido* system. The *ejido system* is one in which the land is owned by the people of Mexico, while the right to use the land is owned by the low-income farmer. In addition, there were constraints placed on the farmer's rights, ironically, as an attempt to protect small farmers. For example, *ejido* distributions could not be sold or rented but they could be inherited. In addition, no farmer could control more than 100 hectares (approximately 250 acres) of irrigated land for row crops. The limit was increased to 200 hectares (almost 500 acres) of irrigated land for orchards. Ranchers were confined to the amount of land capable of sustaining 500 animal units, and livestock producers could not grow forages or crops, without the risk of their land being reclassified and expropriated (Bolling and Valdes, Bredahl et. al.). Furthermore, Article 27 of the 1926 Organic Law forbid farms to be owned, run, or acquired by corporations (Bolling and Valdes).

Pasture improvements, while encouraged by the government, were actually discouraged by government policy. As technology became available for better range management, carrying capacities would be increased, reducing the amount of land necessary for the support of livestock. If the land was found capable of sustaining more than 500 animal units, then the excess could be given to someone else (Bredahl, et. al.). Although benefiting society, this would result in a loss to the producer of the capital improvements made upon the expropriated land.

In 1971, the Federal Agrarian Reform Law, designed to clarify legislative vagueness over land usage declared that the size of a small livestock property (500 animal units or less) would be based on geoclimatic factors on a case by case basis, leading to the development of range coefficient estimations for expressing forage capacity in every zone of the country. By comparing the actual number of cattle supported to the "ideal" number of cattle (determined by the range coefficients), the majority of Mexican states were severely over-utilized (Bredahl, et. al.).

In an effort to increase cattle production and land use efficiency, the Agricultural Development Law was passed in 1981, allowing livestock producers to grow forages without danger of expropriation (Bredahl, et. al.).

With the installation of President Miguel de la Madrid's administration in 1982, Mexico's economic character began to change. Producer subsidies were reduced, or eliminated. Mexico joined GATT, forcing the gradual removal of explicit trade barriers. Subsequent administrations have continued the policy of "economic realism" started by President de la Madrid (Engels and Segarra).

In February 1992, legislation was passed allowing *ejido* land to be sold or rented. In addition, farmers may join together and incorporate their operations, provided that the corporation is made up of no more than 25 members (similar to a U. S. Subchapter S farming business), and permitting the enterprise to operate upon up to 2500 irrigated hectares (nearly 6200 acres). Land corporations may own 25,000 hectares (61.8 thousand acres) (Bolling and Valdes).

Despite the changes, the outcome of the *ejido* system was to create substantial numbers of small subsistence farms. Representing almost half of the total land area of Mexico, approximately 75% of the total crop production area is made up of *ejido* land (USDA, 1992). According to Rosson, et. al., two-thirds of Mexico's productive land, in 1991, was still comprised of plots of less than 5 hectares (about 25 acres), mostly used to grow corn, rice or beans. However, cattle producers have traditionally represented a wealthier class of agriculturalist. As a result, according to data collected in 1981 (Schiavo) over a sample of 43,500 cattlemen, the percentage of total *ejido* cattle land was only 28.5% of all cattle land, while approximately 50% of the total number of cattle producers were *ejidos* (Arce -Diaz).

Price Controls

To ensure that livestock products are affordable to lower-income consumers, price ceilings remain in place, and exist throughout the marketing process. Although, prices are held down at artificial levels, in general, beef is too high-priced for low-income groups, and is regulated because it is a price leader for other animal-derived protein sources, such as pork (Engels and Segarra).

Price ceilings, if lower than production costs, require supply policies to guarantee adequate domestic supplies. Producer input subsidies, along with subsidized credit, exist to aid livestock producers. Although, in the case of cattle, Mexico's primary supply policy has been its border quotas and tariffs.

Export Quotas and Tariffs

Until 1988, export quotas aided the Mexican government in maintaining a cattle inventory, and a supply of beef for domestic consumption. Quotas were based on domestic demand and supply conditions, along with the climatic situation in northern Mexico. Quota amounts were directly correlated with domestic supply. However, if the weather was severe in the northern states, then quotas would be increased because of forage scarcity. Qualitative standards were also included in export quotas. For example, according to Bredahl, et. al., for the 1980/1981 quota, only male, castrated animals, less than 18 months of age, and weighing greater than or equal to 160 kilograms, could be exported.

Prior to September 1985, Mexico also employed an export tariff of 20% ad valorem with a minimum of $60.00 per head, along with the export quota. The tariff was removed in September of 1985, leaving only the export quota to control the quantity of exports.

In 1988, the Mexican government switched to tariff only border controls. The initial tariff was 20% ad valorem with a minimum of $60.00 per head, for the first 500,000 head of cattle. Over 500,000 head, the tariff increased to 25%. In September 1989, the tariff was reduced to 10% ad valorem with a $30/head minimum. In September 1990, the tariff decreased again, to 5%, and then to 1.67% ad valorem in 1991. As of September 1992, the tariff has been eliminated (USDA, 1992).

Import Tariffs

The U.S. does have an import tariff on feeder cattle, to help offset the administrative costs of inspection. The U.S. tariff of $0.01/pound of live animal weight has not changed in the last twenty years.

Feeder Cattle Exportation

The number of feeder cattle exported to the United States reflects the government policies, weather conditions, and the relative price of feeder cattle between the U.S. and Mexico. The study published by SARH concludes that Mexico's export quota from 1962 to 1988 had very little effect on the number of cattle exported. Annual exports averaged 80.6% of the authorized quota. In addition, there were only five years in which exports equalled or slightly exceeded the authorized quota. SARH also shows that while rainfall amounts may have some impact, the relative price of feeder cattle is a stronger explanatory variable for the behavior of feeder cattle exports. SARH did not address the consequences of Mexico's export tariff, however, because the tariff was removed at the time of the study.

Marketing

Almost all feeder cattle exports are sold prior to entering the U.S. They may be marketed by either a broker or the owner. Direct marketing by owners seems to be increasing (Peel).

Cattle are classified into four grades: No. 1, 2, 3, and Plain (Peel). No. 1 refers to cattle made up of European breeds, or Zebu crosses that are more than one-half

European. A No. 2 is an animal that is one-half or more Zebu. No. 3 cattle contain all Zebu breeding (SARH). SARH estimates that approximately 40% of exports to the U.S. are No. 1, 30% are No. 2, and 30% are No. 3 or Plain.

Traditionally, most of the animals are of the lower grades, but this is changing as Mexican producers are becoming more knowledgeable about the U.S. feeder market (Peel). The change is evidenced in part by the shift in weight distribution of exported feeder cattle. In the 1970s and early '80s, mainly lighter weight steers were exported, weighing 275-440 lbs. However, the distribution began to change in the middle 80's as higher numbers of feeder cattle weighing more than 440 lbs. began to be exported.

Mexican feeder steers are exported shortly after weaning, and usually weigh between 300-600 lbs. (CAIE, SARH). Figure 5 displays the distinct seasonal pattern of feeder cattle exports. Due to the seasonality of the north region of Mexico, and the large number of feeder cattle produced there, the largest export activity of feeder cattle occurs from October to January, when temperatures drop and precipitation is low (Bredahl, et. al.). From January to October monthly exports decrease, often to very low numbers.

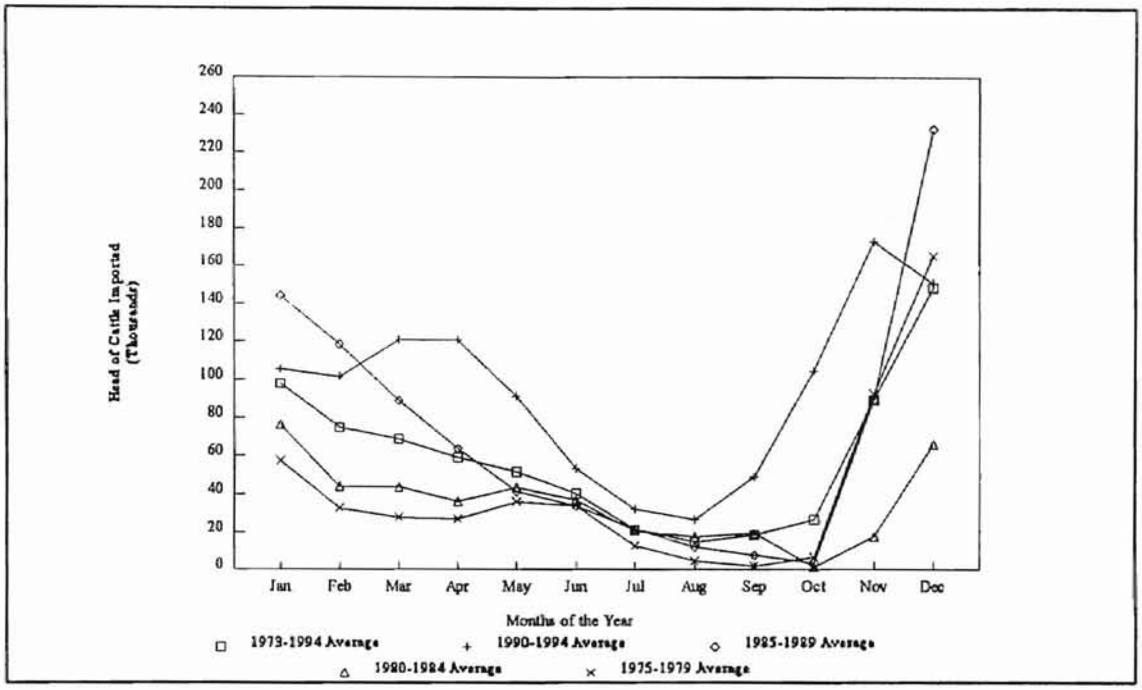

Figure 5. Average Monthly Mexican Feeder Cattle Imports.

Health Regulations

Feeder cattle being imported into the U.S. are detained and inspected at the entry port in order to ensure that federal regulations are met. The regulations are found in Title 9 of the Code of Federal Regulations (CFR).

The cattle must be accompanied by a certificate from a salaried veterinarian of the Mexican government stating that:

1.) the cattle were inspected immediately before shipping and showed no evidence of any communicable disease;

2.) the cattle have all tested negatively for tuberculosis not more than 60 days prior to their arrival at the port;

3.) the cattle have not been exposed to tuberculosis or other communicable diseases in the preceding 60 days, as far as it can be determined, and

4.) if shipped by train or truck, the cattle were loaded into clean and sanitized cars or trucks for direct transportation to the entry port.

In addition, the certificate must list the date and place of inspection, the date and place of the tuberculin test, the name of the herd owner, the name of the consignor and consignee, and an individual description of each animal including breed, sex, age and tattoo or eartag number (CFR).

The feeder cattle are also accompanied by a certificate from the importer or his/her agent expressing that the cattle have not been trailed through an area infested with fever ticks while moving towards the port of entry (CFR).

The owner of the cattle must complete an application for inspecting and dipping. By signing the application, they agree to waive all claims against the U.S. government for damage or loss to the cattle as a result of dipping for the removal of parasites (CFR).

Each animal must have the letter "M" branded with a hot iron on the right jaw.

Because of Brucellosis concerns, only castrated males or spayed females may be imported.

The cattle are inspected for the above items, as well as evidence of parasites and physical soundness. After inspection, each animal is dipped, and if no parasites are found, the steers are placed into "clean" facilities to wait for transportation in disinfected, sealed trucks across the border (Peel).

Lots containing steers that are not free of parasites must be quarantined for 10 days, on minimal feed, and then re-inspected. If they are clean at that time, they will be allowed to cross the border (CFR).

Estimation of Maximum Capacity

Data on the livestock sector in Mexico is generally unavailable, due mainly to government policy objectives. In addition, much of the existing data is collected by private organizations or small government units, with a regional emphasis. As a result, historical, national livestock production and inventory data is often absent or inaccurate.

As part of the objective to evaluate the potential effects of NAFTA on U.S. feeder cattle prices, one goal of this comprehensive description of the Mexican cattle industry is to estimate the maximum number of feeder cattle, that could potentially be exported into the U.S. by Mexico. It is not possible to perform a precise estimation because of the data limitations described above. In addition, while carrying capacities for each region have been calculated by the Mexican government, the total acreage being used for livestock in the southern, tropical region is a subject of wide disagreement with estimates varying from approximately 30 to 123 million acres (Arce-Diaz).

Previous Estimates

An estimated maximum of 2.33 million head of feeder cattle was calculated by Eduardo Segarra (Rosson, et. al.; Engels and Segarra; WLMIP). His estimation was based on an upper bound for Mexico's herd size of 37 million head of cattle. He assumed a 70% calf crop out of 16.65 million cows (45% of total herd). In addition, because of disease problems, only steers are currently imported into the U.S., and of these steers, he assumed that 60% would not meet U.S. standards.

In another study (SARH), based on data from various sources, the maximum number of cattle available for export to the U.S. was estimated at 5% of total herd size. Using 37 million for total herd size, yields 1.85 million head of feeder cattle available for export. Further analysis by SARH indicated that if levels of domestic consumption was at its historical low, relative prices remained constant, and the weather was favorable, then only 1.2 million head of feeder cattle would be used for export, of the 1.85 million available.

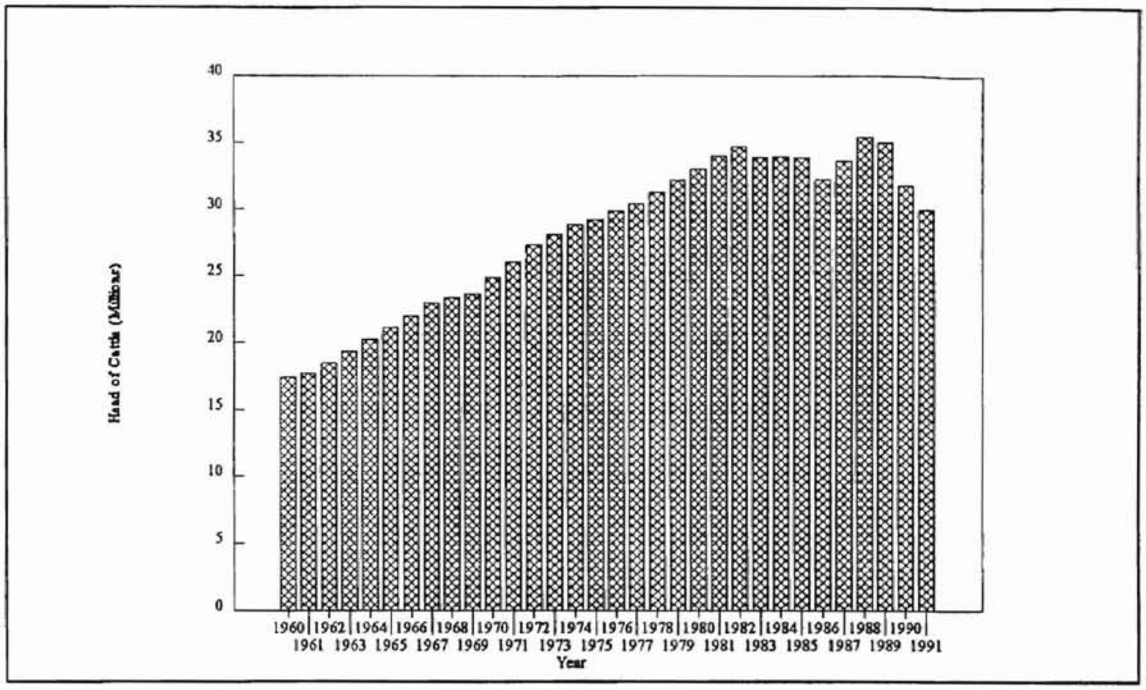

Figure 6. Mexico's Total Cow Herd Inventory.

CAIE estimated that the maximum carrying capacity for Northern Mexico was 8 million head of cattle. Of these, only 4 million were commercial cows, producing 2.8 million calves with a 70% calving rate. Since only steers can be exported, the maximum number of cattle available for export is 1.4 million (50% of 2.8 million).

Factors Affecting Potential Supply

According to data provided by the USDA's PS&D database (Webb and Gudmunds), Mexico's total cow herd inventory has remained between 30-35.4 million from 1977 to 1991 (Figure

6). Since 1989, it has begun to decrease gradually, reaching 30 million in 1991. The potential supply of feeder cattle available for export depends mainly on the maximum number of commercial cows which can be supported in Mexico. Some other factors include changes in breed composition, increased technology, changes in the health regulations, and a higher domestic demand for beef.

Due to its proximity to the border, the northern arid/semiarid region is likely to remain the primary source of feeder cattle exports to the U.S. The cattle industry in this area is well-established, commanding a large percent of the region's total land area. Acreage required per animal unit is relatively high, and overgrazing is a problem. The cow herd in this region is not likely to expand much. Any increase in feeder cattle supply will come mostly from better use of technology and advancing management skills.

The temperate region is the most densely populated area, creating the necessity for more confined beef systems. Many of these operations already make use of increased technology and management. Additionally, it is often more profitable to produce milk rather than beef in this area (CAIE). The commercial cow herd has limited potential for growth in this region. Further, most feeder cattle produced in this area are consumed domestically because of the high transportation costs, although some are exported to the U.S.

The tropical region contains the least developed sector of Mexico's beef cattle industry. As such, it has the greatest potential for cow herd expansion. However, because of the insects, weather and diseases, it is necessary to maintain a high percentage of Zebu blood in the breeding programs. Feeder cattle produced in the tropical region would have the highest transportation costs, and receive the lowest price from producers (Peel, SAIE). Therefore, they are unlikely to be exported.

Significant changes in breed composition (i.e. more European breeding) would increase the proportion of animals suitable for export to the U.S. Current estimates of the percentage of steers that meet U.S. standards range from 40 -50% (CAIE, Segarra). Changes in breed composition would be most likely to occur in Northern Mexico for two reasons. First, Mexican producers receive a higher price in U.S. markets for more European blood in their cattle. And second, European breeds are at a distinct disadvantage because of climate and insects in Southern Mexico.

Increased technology and better management skills would aid in improving fertility and feed efficiency, and decreasing calving intervals and calf mortality. Current estimates of calving rates are 45-55% in Mexico (Bredahl, et. al., SAIE), while in the U.S. calf crop percents are about 85-90% (Ensminger) because of better technology and management. CAIE and Segarra estimate that calf crop percents could be raised to 70% with greater implementation of technology and increased management skills. Higher calving rates could significantly increase the potential supply of feeder cattle available for export.

Currently, breedable cattle are not allowed entry into the U.S. from Mexico because of Brucellosis. Unless the Mexican government is willing to undertake a strong control and eradication program for Brucellosis, comparable to the one initiated by the U.S. in 1934 (Ensminger), the health regulations are unlikely to change. While the ability to export heifers would dramatically raise the number of animals available for export, the cost of initiating the eradication program would be high as it would require the slaughter of many cattle. The institution of such a strong control program would be politically unattractive for the Mexican government.

One of the anticipated results of NAFTA is a higher per-capita income, increasing the demand for better quality protein sources, such as beef. Currently, the price of beef is controlled in Mexico. Furthermore, Mexico must import beef to meet domestic demand. Unless the Mexican government allows price controls to be lifted, an increased domestic demand will result in more beef imports, rather than fewer cattle exports, given a constant relative price of feeder cattle.

The removal of the tariff will lower the cost of exporting cattle, providing an incentive to export for some operations that were previously indifferent between selling to the U.S. or domestic markets. However, transportation costs and breed composition must also be considered. Those operations located in the tropical region are the most affected by transportation costs and breed composition, although it is the area with the greatest potential for industry growth. This implies that greater cattle supplies in Southern Mexico will be used mainly for domestic demand rather than for feeder cattle exports.

Estimation

Using the SARH and Segarra's estimate for the maximum national cow herd size of 37 million, and given that approximately 30% of the cow herd is found in Northern Mexico, the maximum number of cows that could be found in Northern Mexico is 11.1 million. If calf crop percent was increased to 70% and calf mortality decreased to 5% because of greater use of technology and better management, then the total calf crop would be 7.4 million in Northern Mexico. Assuming that 50% of the calves are steers, the potential supply would be 3.7 million. Significant changes in breed composition could increase the percent of acceptable steers to 80%, resulting in 2.95 million steers available for export.

The estimation presents a greatest-possible scenario, as it is based on an assumption that the entire cow herd of Northern Mexico is made up of commercial cows. However, the estimation also makes the assumption that no cattle are exported from Southern Mexico. The implications of the two assumptions have offsetting effects. Realistically, the consequences of the first assumption should more than offset the effects of the second, conceivably causing the estimate to be overstated. Unfortunately, because of data limitations it is not possible to be more precise at this time.

CHAPTER III

LITERATURE REVIEW AND METHODOLOGY

Previous Research

While many studies model the domestic demand for feeder cattle in the U.S. (Buccola, Brester and Marsh, Cockerham and Peel, Davis et. al., Marsh, etc.), only Davis, et. al., and Cockerham and Peel examine the feeder cattle trade relationships. Both of these studies look exclusively at the trade between Mexico and the U. S., without considering the supply of feeder cattle coming into the U.S. from Canada.

Davis, Rosson, Angel, and Capps determine the U.S. price impacts of feeder cattle from Mexico. Using a complete demand system for meats and three stage least squares, and quarterly data this study derives price flexibilities for feeder steers. As heifers are not allowed across the U.S.-Mexico border for health reasons, only steer price effects are considered. The results of this study show that the import supply of feeders does have a downward impact.

Cockerham and Peel also determine the price impacts of Mexican feeder cattle on U.S. steer prices. However, price flexibilities were directly estimated from an inverse derived demand framework, using monthly data. Both studies found comparable price flexibilities and a downward impact.

Buccola examines the supply and demand factors for feeder cattle on feeder cattle price differentials. He found that future slaughter cattle prices, feed prices, soil moisture conditions, and the speed at which cattle inventory changes affect average feeder prices and the rates at which feeder cattle prices change with weights.

Brester and Marsh develop a complete demand system for the U.S. beef industry, including the effect of feeder cattle supply and demand. They conclude that corn displays short-term behavior similar to feeder cattle prices, and the expected effect of changes in feed cost can only be adjusted by increasing or decreasing the cow herd base. They also found that ultimately the consumer drives the price structure in the U.S. beef industry.

Marsh (1985) considers the price differences between feeder calves and feeder steers. He hypothesizes that these price differences are chiefly a function of cost of gain, seasonality, and the expected slaughter cattle price. He also suggests that demand for feeder cattle by feedlots can be greatly influenced by expected fed cattle and expected corn prices.

Theory

In accordance with demand theory, demand functions are generally specified at the retail market/consumer level, as the consumers' desires for final products determine the shape and position of the demand function. Consumers' ordinary (Marshallian) demand functions are often described as a schedule of quantities of a commodity that consumers are willing to purchase given a specific set of own prices, *ceterus paribus*. Quantities demanded by the consumer are a function of own price, prices of substitutes and complements, consumer income, population, and consumer tastes and expectations. Demand for a commodity at this level is referred to as primary demand.

Consumer demand for any given commodity is interrelated with their demand for *n* other commodities, as constrained by their income. In order to capture all of consumers' willingness to purchase goods, and the interactions between substitutes and complements, primary demand functions must be estimated for all commodities that a consumer purchases. This involves specifying a direct or indirect utility function, which may not be possible, and deriving all the necessary demand functions.

Another method of estimating demand for a given commodity is to directly specify the demand equation, creating an incomplete demand model. The obvious advantage of this approach is simplicity. In addition, incomplete demand systems permit a more ecumenical genre of functional forms than complete demand models, while still fulfilling the conditions for integrability of demand systems (LaFrance and Hanemenn, LaFrance). Direct (incomplete) estimation is used for this study.

Demand functions for inputs that are used in the final product sold to consumers may be obtained from the consumers' primary demand. Input demand is called derived demand, and "differs from primary demand by the amount of marketing and processing charges per unit of product" (Tomek and Robinson, p.26). The retail-level price of a commodity contains information on the costs of producing, processing, transporting, storing, and a return to capital for each service. Derived demands can be found by subtracting the appropriate marketing margin from the primary demand.

From the consumer demand for beef, the quantity demanded for slaughter cattle, feeder cattle, feed grains, pasture, and other inputs used in producing beef can be derived. By subtracting the cost of slaughter, transportation, and other marketing services, along with a return to capital from the price of beef, the demand schedule for slaughter cattle will be obtained. Demand for feeder cattle can then be found by extracting feeding and marketing costs, and a return to capital from the price of slaughter cattle.

The neoclassical paradigm states that in a perfectly competitive market, there are many buyers, many sellers, perfect information, and a homogeneous product. Buyers and sellers react at once to exogenous price changes, adjusting their behaviors appropriately. In the short run, the quantity supplied will be based on the current market price, which reflects consumer demand, and a market equilibrium will be achieved. For manufactured goods, where producers can change the level of production almost instantaneously, this implication would seem to hold.

In agriculture, the quantity supplied by producers reveals the current market price at the time of planting or breeding, as well as farmers' price expectations for the future. In addition, agriculture is subject to natural disasters of all shapes and sizes, which affect production yields. The result is a supply fixity in the short run, as farmers cannot adjust their production, once the process is begun. Therefore, the assumption of predetermined prices, upon which consumer demand is based, is inappropriate. Instead, prices are found to be a function of quantities supplied, creating an inverse demand framework.

Inverse demand functions are especially relevant to agricultural market level studies (Dahlgren), as opposed to individual consumer level studies. Due to the biological nature of the commodity, "particularly for demands based on monthly or quarterly data" (Marsh, 1991, p. 384), quantities produced are assumed fixed in the short run (Houck; Marsh 1985; Wohlgenant and Mullen). For example, cow-calf producers require 2 years to change production levels in response to price. As demand for both slaughter and feeder cattle are found at the market level, rather than the consumer level, using inverse demand functions is appropriate for this study.

Aggregate consumer inverse demand functions depict the prices consumers are willing to pay for a commodity given a specific set of quantities supplied of that commodity, *ceterus paribus*. Prices are a function of quantities of a commodity, quantities of substitutes and complements, consumer income, population, and consumer tastes and expectations. In an incomplete, derived demand structure, price of a commodity becomes a function of quantity supplied of the commodity, quantity supplied of substitutes and complements, and quantity demanded of the finished product. Quantity demanded of the finished product is assumed to implicitly contain information about income, consumer preferences, and consumer level substitutes and complements. The ramification of this assumption is that the "absolute values of the coefficients may be smaller than those estimated in complete systems since they do not fully reflect behavioral feedback" (Marsh, 1991, p. 389) from substitutes and complements.

From the preceding theoretical framework, prices of feeder cattle can be hypothesized to be a function of quantities of feed, as well as slaughter and feeder cattle inventories. However, because demand for feeder cattle is derived from demand for slaughter cattle, and demand for slaughter cattle is inverse, the price of slaughter cattle is substituted for the quantity.

Total feeder cattle supplies are the summation of those produced domestically, and those imported from other

TABLE II
U.S. IMPORTS FROM MEXICO AND CANADA: LIVE CATTLE WEIGHING 90 KG OR MORE BUT LESS THAN 320 KG EACH.

Quantity (1,000 head)							
Source	1987	1988	1989	1990	1991	Ave	%
Mexico	916	829	856	1,252	1,030	976.6	92
Canada	14	37	61	158	157	85.4	8
Total	930	866	917	1,410	1,187	1,062	100

Source: USITC

countries. The U.S. imports feeder cattle from two countries, Mexico and Canada. Historically, Canadian live cattle imports consist primarily of slaughter and breeding cattle. Only a small percentage of Canadian imports weigh less than 700 lbs. (USITC). Table 2 shows that from 1987 to 1991, comparable feeder cattle imports from Canada accounted for only 8% of total feeder cattle imports. Feeder cattle supplies from Mexico made up the remaining 92%. For the purposes of this research, Canadian feeder cattle imports are assumed to be such a small percentage of total imports, as to be insignificant. The effect of this assumption is that the true values of the coefficients may be more than those estimated.

Import (or excess) demand is a function of both supply and demand factors. Assuming global equilibrium conditions and import availability, excess demand represents the difference between domestic consumption and domestic supply.

For feeder cattle, domestic supply is a function of herd size, production costs, and seasonality which is generally caused by biological lags. Domestic quantity demanded, on the other hand is a function of the price of U.S. feeder cattle, price of imported feeder cattle, expected slaughter cattle price, seasonality, and consumer income, tastes and preferences. The price of the imported feeder cattle is made up of two components: the exporting country's price and the cost of any existing trade barriers. For simplicity, domestic feeder cattle supply is equal to the number of cattle on feed.

After differencing domestic demand and supply, the quantity of Mexican feeder cattle imported is a function of the price of U.S. feeder cattle, the price of Mexican feeder cattle, cattle on feed inventory, government trade policies, expected slaughter price, seasonality and consumer tastes and preferences.

Endogenous variables are jointly determined variables. They "have outcome values determined through the joint interaction with other variables within the system" (Judge, Hill, Griffiths, Lutkepohl, and Lee, p. 601). The U.S. price of feeder cattle and the quantity of Mexican imports are endogenous. The U.S. price of feeder cattle is a function of the quantity of imports, and the quantity of imports is a function of the U.S. price. Their values are resolved simultaneously.

If the causal relationship between the two variables is statistically significant, the estimation of one without also estimating the other will result in biased, inconsistent estimates. A modified Wu-Hausman test will be performed to test for significant endogeneity.

While the price of slaughter cattle is a function of the price of feeder cattle, slaughter price reflects lagged feeder cattle prices, rather than current. This is due to the time lag between purchase as a feeder steer and sale as a slaughter steer. Therefore, endogeneity between feeder and slaughter cattle prices is not an issue.

Model

This study presents an econometric analysis of monthly price Flexibilities to examine the historical impact of imported feeder cattle on U.S. feeder cattle prices. In an incomplete, inverse demand framework, feeder cattle price is hypothesized to be a function of demand for slaughter cattle, cost of feed, seasonality, and quantities of domestic and imported feeder cattle.

The model is specified as:

$$P_{feeders} = f(P_{slaughter}, MI/Fed, P_{corn}, P_{soybean\ meal}, P_{hay}, D_i)$$

where

$P_{feeders}$	=	Price of no. 1 medium frame steers per cwt @ 300-400 lbs., 400-500 lbs. and 500-600 lbs. respectively, Oklahoma City;
$P_{slaughter}$	=	Average price of select-choice slaughter steers per cwt, Texas Panhandle and Western Oklahoma feedlots;
MI	=	U.S. imports of live cattle and calves from Mexico;
Fed	=	Cattle on feed in seven western states;
$P_{soybean\ meal}$	=	Price of 44% protein soybean meal per ton, Decatur;
P_{corn}	=	Price of no. 2 yellow corn per bu, St. Louis;
P_{hay}	=	Average price received by farmers, and
D_i	=	Monthly dummy variables, i = February to December.

Mexican imports arrive in the U.S., primarily through Texas ports of entry, although some also enter into California and Arizona. Due to the cost of transporting cattle, imports from Mexico are assumed to be marketed in the Southwest. Oklahoma City is the largest feeder cattle market in the Southwest. For this study, Oklahoma City prices are used to represent the nation. Any price change in Oklahoma City prices, as a result of imports from Mexico, is assumed to be reflected in all U.S. prices. However, by using Oklahoma City prices, instead of a national average, the estimated price flexibilities with respect to import quantities may be higher than the true national flexibilities.

Given that the demand for feeder cattle is derived from the demand for slaughter cattle, the price of slaughter cattle was included in the model, and is assumed to implicitly contain information about income, consumer preferences, beef substitutes and complements. The ramification of this assumption is that the coefficients' absolute true value may be smaller than those estimated in complete systems since they do not capture all the behavioral interactions between substitutes and complements (Marsh).

Prices of corn, soybean meal, and hay are included to represent cost of feed.

Currently, only feeder steers and spayed heifers are allowed into the U.S. because of brucellosis and tuberculosis concerns (CFR, Rosson, Davis, Segarra and Angel). As spaying a heifer is costly, quantities of imported cattle from Mexico are assumed consist of only feeder steers. In addition, because of Mexican topography and agricultural practices, imported feeder steers are assumed to weigh between 300 and 600 lbs. The implication of these assumptions is that the true absolute value of the coefficients may be smaller, since the supply variable would be less.

Data

Monthly prices of U.S. feeder steers are collected from the USDA's *Agricultural Marketing Services Livestock Quotations*. Slaughter steer prices are collected from Oklahoma Department of Agriculture's *Oklahoma Market Report*. Corn, hay, and soybean meal monthly prices are obtained from USDA's *Feeds Situation and Outlook Report* and *Oil Crop Situation and Outlook Report*. Western States Extension Services' *Livestock Marketing Information Project* provided monthly quantities of cattle imported to the U.S. from Mexico. The number of cattle on feed in seven Western states is also collected from the *Livestock Marketing*

Information Project, as well as the USDA's *Livestock and Meat Statistics*.

Price data is deflated using the producer price index (1992=100) for all foods, as reported in the USDA's *Agricultural Outlook*. Although the prices of corn, soybean meal, hay, feeder cattle and slaughter cattle are captured in this index, they are assumed to represent a very small share. This index is chosen over an index of prices received by farmers because the prices of the commodities used in this model make up a much larger share of the prices received index.

All variables are observed monthly from January 1973 to September 1992. Observations in which there are no monthly exports are excluded.

Method of Estimation

The three inverse demand equations are estimated jointly as a nonlinear, incomplete demand system using maximum likelihood. It is necessary to estimate them nonlinearly since they demonstrate significant second degree autocorrelation. They are estimated as a system, based on the assumption that the three U.S. feeder cattle price series are determined simultaneously in the Oklahoma market. Further, by estimating the equations as a system, the impact of Mexican imports is spread across the three price series, which reflects actual market conditions.

Due to multicollinearity problems between quantities of imported cattle and the number of cattle on feed, these two variables are expressed as a ratio.

All price and quantity data are transformed into logs. The estimation is also performed with untransformed data, but the model does not converge.

Wu-Hausman Test

A modified Wu-Hausman test is performed to check for simultaneity between the quantity imported and the price of feeder cattle (Godfrey). This test is implemented by using an artificial regression in which the quantity imported is replaced by the residuals from a two-stage least squares estimation of import quantity. Under the null hypothesis of no simultaneity, the coefficient on the residuals will be zero.

The two-stage least squares estimation of import quantity requires excluded exogenous variables, and is, in essence, a supply equation. For the purposes of this study, the quantity of feeder cattle imported is a function of the relative price of feeder cattle, a tariff variable, a dummy variable for the Mexican quota, lagged herd size, and monthly seasonal dummy variables. The import supply equation is

$$MI = f(RP_{feeders}, Tar, D_{MexQ}, Herd, D_i)$$

where

MI	=	U.S. imports of live cattle and calves from Mexico;
$RP_{feeders}$	=	Relative price of 450 lb. feeder steers;
Tar	=	U.S. and Mexico's tariffs on live cattle and calves exported from Mexico, in pesos;
D_{MexQ}	=	Dummy variable for Mexico's export quota on live cattle and calves to the U.S., equals 1 if quota enforced, 0 otherwise;
Herd	=	Cow herd size, lagged 12 months, and
D_i	=	Monthly dummy variables, i = February to December.

The relative price of feeder cattle is the ratio of the deflated U.S. feeder cattle price to a deflated Mexican producer price, on a per-head basis. The deflated Mexican producer price is calculated by multiplying a Mexican producer price index (1992=100) by the 1992 Mexican import unit value. The 1992 Mexican unit value is assumed to be the price of 450 lb. steers. The previously deflated 400-500 lb. U.S. price series is multiplied by 4.5 to determine the U.S. per-head price.

The tariff variable is the summation of both the Mexican and American tariffs. Since the tariff values are given in nominal U.S. dollars, they are multiplied by a relative exchange rate and deflated using the Mexican producer price index, in an attempt to capture the actual cost of the tariff to Mexican producers. The relative exchange rate used is: Pesos per SDR ÷ Dollars per SDR. SDR is the standard denomination used by the International Monetary Fund for reporting exchange rates. The tariff is deflated using the Mexican producer price index (1992=100).

Herd size is interpolated from annual cow herd estimates. As Mexican exports are assumed to be 1 year of age, herd size is lagged by 12 months to reflect the biological cycle.

Except for herd size, all variables are observed monthly from January 1973 to September 1992. Herd size is observed monthly from January 1972 to September 1991. Observations in which there are no monthly exports are excluded.

The instrumental variable used in the two-stage least squares estimation was lagged relative price.

The International Monetary Fund's *International Financial Statistics* provides the Mexican producer price index and the exchange rates. The 1992 unit value for imported Mexican feeder cattle is obtained from USDA's *Foreign Agricultural Trade Statistics*. Mexico's cow inventory is acquired from the USDA's *PS&D* database and *Production, Supply and Demand Outlook*. The U.S. and Mexican tariffs are provided in a publication by USMEF.

CHAPTER V

RESULTS

The parameter estimates of the import supply equation utilized in the Wu-Hausman test are given in Table III. The t-ratios of the endogeneity test variables are 1.21, 1.53, and 1.39 for the 300-400 lb., 400-500 lb. and 500-600 lb. demand equations, respectively. As a statistically significant t-ratio with a 90% degree of confidence is greater than or equal to 1.645, no statistically significant endogeneity is demonstrated.

The results of the empirical demand analysis are shown in Table IV. With the exception of soybean meal and hay, the signs of the estimated price flexibilities and statistical significance of the economic variables in the feeder price equations were consistent with expectations, assuming *ceterus paribus* conditions.

For all weight groups, slaughter steer prices display high statistical significance, and positively affect the price of feeder cattle. If the price of slaughter steers goes up, indicating a higher demand for slaughter steers, the price of feeder steers also rises, denoting a corresponding increase in the demand for feeder steers. Furthermore, the t-ratio increases as feeder weights increase, implying that as a feeder steer approaches the slaughter weight, its value relies more on the price of slaughter steers.

The import variable coefficient is negative in all three equations. The t-ratios are -1.55, -1.92, and -1.87 for 300-400, 400-500, and 500-600 lb. steers respectively. Imports have a greater impact on the price of 400-500 and 500-600 lb. steers, implying that most border-crossing feeder cattle are in this weight range.

The price of corn is highly significant, and has a negative effect on the price of feeders. This is indicative that as the price of corn (the principal feed ingredient) increases, the demand for feeder steers decreases.

While soybean meal is the typical source of protein for feeder calves, the sign on the coefficient for soybean meal is positive. The positive correlation is unexpected. One potential cause is that soybean meal is a small part of the feeder cattle diet, relative to some other livestock species. An increase in the price of soybean meal will drive up the price of the alternative livestock product more than the price of feeder cattle. This could cause a substitution effect of feeder cattle for the alternative livestock. Another explanation is that soybean meal can also be a protein substitute for beef at the retail market level. The t-ratio indicates that this coefficient is statistically significant.

The coefficient of the hay variable is negative in the 300-400 and the 400-500 lb. price equation. However, in all weight classes, it has a very small t-ratio. This result was surprising as hay is a major feed component for cattle at all stages of the beef process. One rationality for this result is that many beef producers provide their own forage, rather than purchasing it.

The seasonal variables for February through April are all statistically significant, and positive for all weight classes. The 300-400 lb. and 400-500 lb. price equations are also positive and significant for May. Demand for light weight feeder calves is typically higher in the early months of the year, as backgrounders are purchasing calves for stocker operations to be sold to feedlots in the fall, at heavier weights. The dummy variable for August in the 300-400 lb. price equation is also positively significant. A possible reason is the source of the price series. In Oklahoma, stocker cattle are often wintered on wheat pasture. Farmers may be purchasing cattle at this weight range for use on their wheat.

The October dummy variable for 500-600 lb. steers is negative and statistically significant. This variable is a reflection of the supply-side seasonality in 500-600 lb. steers. October is a customary time for cow-calf producers to sell their spring calves who often weigh between 500-600 lbs.

The constants are all positive and highly significant. There may be other variables affecting the price of feeder cattle that have not been explicitly defined, and therefore are captured in the constant.

The first order autocorrelation coefficients have t -ratios of 14.10, 14.38, and 16.62 for 300-400, 400-500, and 500-600 lb. steers respectively. This is an indication of extremely strong positive autocorrelation. The second order coefficients are also very statistically significant with t -ratios of 5.64, 5.56, and 3.82. The demand system was estimated with third order autocorrelation coefficients, but these coefficients had rather small, statistically insignificant t-ratios.

TABLE III

PARAMETER ESTIMATES, STANDARD ERRORS, T-RATIOS, AND R-SQUARE FOR WU-HAUSMAN IMPORT SUPPLY EQUATION.

Monthly Import Quantity

Variable Name	Param Estim	Stand Error	T-ratio
$RP_{feeders}$	42.1240	19.7100	2.137
Tar	-0.0773	0.0240	-3.225
D_{MexQ}	-21035.0000	8726.0000	-2.411
Herd	4.2785	2.9910	1.431
D_{feb}	-24611.0000	13660.0000	-1.801
D_{mar}	-33921.0000	13670.0000	-2.482
D_{apr}	-44373.0000	13680.0000	-3.245
D_{may}	-45434.0000	13830.0000	-3.285
D_{jun}	-56900.0000	13650.0000	-4.167
D_{jul}	-73905.0000	13830.0000	-5.344
D_{aug}	-83104.0000	13660.0000	-6.084
D_{sep}	-81255.0000	14230.0000	-5.709
D_{oct}	-83347.0000	14030.0000	-5.941
D_{nov}	-19179.0000	13820.0000	-1.387
D_{dec}	53517.0000	13820.0000	3.872
Const	81422.0000	38810.0000	2.098

R-Square	0.5036
Adj R-Square	0.4688

TABLE IV

PRICE FLEXIBILITIES, STANDARD ERRORS, AND T-RATIOS.

Feeder Steers 300-400 lbs

Variable Name	Price Flex	Stand Error	T-ratio
P_{slghtr}	0.4359	0.0703	6.2001
MI/Fed	-0.0036	0.0023	-1.5539
P_{corn}	-0.1930	0.0652	-2.9575
P_{SBM}	0.0912	0.0423	2.1593
P_{hay}	-0.0610	0.0899	-0.6788
D_{feb}	0.0421	0.0120	3.4967
D_{mar}	0.0672	0.0138	4.8675
D_{apr}	0.0733	0.0163	4.5052
D_{may}	0.0579	0.0190	3.0546
D_{jun}	0.0282	0.0178	1.5857
D_{jul}	0.0045	0.0182	0.2460
D_{aug}	0.0438	0.0184	2.3804
D_{sep}	0.0103	0.0187	0.5530
D_{oct}	-0.0220	0.0182	-1.2097
D_{nov}	-0.0033	0.0140	-0.2338
D_{dec}	-0.0019	0.0119	-0.1560
Constant	2.6568	0.5300	5.0127
Rho1	0.6813	0.0483	14.1040
Rho2	0.2634	0.0467	5.6416

TABLE IV (Continued)

Feeder Steers 400-500 lbs

Variable Name	Price Flex	Stand Error	T-ratio
P_{slghtr}	0.4477	0.0639	7.0089
MI/Fed	-0.0041	0.0021	-1.9293
P_{corn}	-0.1594	0.0595	-2.6795
P_{SBM}	0.0669	0.0388	1.7258
P_{hay}	-0.0067	0.0822	-0.0821
D_{feb}	0.0399	0.0110	3.6373
D_{mar}	0.0504	0.0126	4.0031
D_{apr}	0.0631	0.0149	4.2372
D_{may}	0.0335	0.0174	1.9279
D_{jun}	0.0099	0.0163	0.6078
D_{jul}	-0.0052	0.0166	-0.3124
D_{aug}	0.0174	0.0169	1.0313
D_{sep}	0.0004	0.0170	0.0214
D_{oct}	-0.0250	0.0166	-1.5045
D_{nov}	-0.0074	0.0128	-0.5803
D_{dec}	0.0128	0.0109	0.0118
Constant	2.4162	0.4826	5.0062
Rho1	0.6831	0.0475	14.3750
Rho2	0.2533	0.0456	5.5583

TABLE IV (Continued)

Feeder Steers 500-600 lbs

Variable Name	Price Flex	Stand Error	T-ratio
P_{slghtr}	0.4639	0.0540	8.5904
MI/Fed	-0.0033	0.0018	-1.8706
P_{corn}	-0.1818	0.0503	-3.6170
P_{SBM}	0.0629	0.03316	1.8974
P_{hay}	0.0305	0.0691	0.4416
D_{feb}	0.0312	0.0088	3.5267
D_{mar}	0.0420	0.0108	3.8829
D_{apr}	0.0450	0.0127	3.5314
D_{may}	0.0096	0.0147	0.6511
D_{jun}	0.0058	0.0139	0.4184
D_{jul}	0.0021	0.0142	0.1479
D_{aug}	0.0151	0.0143	1.0560
D_{sep}	-0.0053	0.0145	-0.3657
D_{oct}	-0.0286	0.0141	-2.0249
D_{nov}	-0.0077	0.0108	-0.7122
D_{dec}	-0.0028	0.0088	-0.3184
Constant	1.6150	0.4085	5.2953
Rho1	0.7632	0.0459	16.6220
Rho2	0.1702	0.0445	3.8227

CHAPTER V

SUMMARY AND CONCLUSIONS

U.S. feeder cattle producers, particularly those in the southwest, are concerned about the effects of NAFTA on U.S. feeder cattle prices. This study describes the Mexican cattle industry, estimates the historical impact of imported Mexican feeder cattle, and evaluates the potential effect of NAFTA.

Mexico's cattle industry is broken up into three geoclimatic regions. The primary source of feeder cattle for importation is the arid/semi-arid north. The feeder cattle are mostly produced in traditional, extensive pasture systems, using European, American and Zebu breeds.

The cattle are exported to the U.S. shortly after weaning, and tend be lighter weight than their American counterparts. Further, the importation process causes substantial shrinkage. These two factors enable the imported cattle to make considerable gains upon placement in a U.S. feedlot.

During the period of this study, Mexico eliminated their export quota, and began phasing out their export tariff. The two stage least squares estimator of the supply of imported feeder cattle indicates that the quota is statistically significant, contrary to SARH conclusions. However, the quota was abolished in 1988. NAFTA, scheduled to be initiated in 1994, resulted in the elimination of border tariffs for feeder cattle in September 1992. This study is concerned only with the removal of the tariffs.

The tariff variable found in the supply equation used for the Wu-Hausman test is negative and significant. However, the coefficient, which represents the change in quantity exported to the U.S. as a result of a 1 peso change in the tariff, is only -0.0773. The average real (1992=100) tariff from October 1991 to September 1992, for Mexican producers, was 30,288 pesos per head. The monthly average impact of the tariff, during this period, on the number of head exported to the U.S. was 2,341 head. The existence of the tariff from October 1991 to September 1992 resulted in a reduction of imports of approximately 28,000 head.

Similarly, using the average real (1992=100) tariff level from January 1988 to September 1992 of 59,314 pesos per head, results in a monthly reduction in cattle exports of 4,585 head, or 55,020 head annually.

The price flexibility calculated in Table IV for import quantities (MI/Fed) depicts the percent change in price from a 1% change in the ratio of imports to cattle on feed. The price flexibility is easier to interpret if it is based on quantities of imports. Feeder cattle imports are a very small percentage of the cattle on feed. From 1973 to 1992, monthly Mexican imports averaged 0.7% of the cattle on feed in seven western states. A 1% change in the ratio represents an approximate 1000 head increase (or decrease) in the quantity of feeder cattle imported.

Table V describes the economic impacts, at average price values, of imported cattle in dollars per hundred weight and dollars per head. Dollars per head is based on feeder steer weights of 350, 450, and 550 lbs.

If the imported feeder cattle to cattle on feed ratio increased by 1% (i.e. the number of imports increased by approximately 1000), the decrease in price would be $0.36, $0.42, and $0.29 per hundred weight for 300-400, 400-500, and 500-600 lb. steers respectively, using the average 1973-1992 real (1992=100) price. In the same situation, but using an average 1988-1992 (1992=100) real price, the decreases are $0.42, $0.44, and $0.32 per hundred weight. The larger impacts reflect higher average real prices and increased quantities of imported feeder cattle, for the period January 1988 to September 1992 .

Assuming that the elimination of the export tariff results in an increase in monthly feeder cattle imports of 4,585 head, using the average real 1988-1992 prices, the direct economic impact of NAFTA is small. On a hundred weight basis, the decrease in price is approximately $0.02

for all three weight classes. Per head, the price declines $0.08, $0.11 and $0.10 respectively, for 300-400, 400-500 and 500-600 lb. steers.

Estimated historical maximum impacts are calculated using the largest number of monthly imports and average real prices from January 1973 to September 1992. The estimated historical maximum price decreases for any one month are $1.85, $1.98 and $1.48 per hundred weight for 300-400, 400-500, and 500-600 lb.

Using the average monthly distribution of imports and average real prices from 1973 to 1992, and assuming the maximum annual number of steers cattle available for export equals 2.95 million (calculated in Chapter II), results in a monthly maximum of 663,415 head of feeder cattle exported from Mexico. Under this greatest-possible scenario, the economic maximum monthly impact would be substantial. Real prices would decline by $3.99, $4.28 and $3.19 per hundred weight for 300-400, 400-500, and 500-600 lb. steers respectively. This translates into a loss of $13.98, $19.26, and $17.55 per head assuming steers weigh 350, 450, and 550 respectively. However, this maximum would occur only in December which is not a traditional time for U.S. cattle producers to sell light-weight feeder steers.

Table V also shows the economic impact of an additional 100,000 head. For feeder steers weighing 300-400 lbs., price is reduced by $0.66/cwt or $2.30/head. Price declines

$0.70/cwt or $3.16/head for steers weighing 400-500 lbs. The price of 500-600 lb. steers decreases $0.52/cwt or $2.88/head. From January 1973 to September 1992, approximately 7% of monthly feeder cattle imports fell into this range.

These results differ notably from the results of Rosson, Davis, Segarra, and Angel. There are several possible explanations, including model specifications and data differences. Rosson, et. al. used a macroeconomic model designed to estimate the effects of policy changes on the economy as a whole. Their price data was from the Texas region which is more heavily impacted by Mexican imports than Oklahoma, and they used quarterly observations.

Several limitations exist in this analysis. First, the supply equation used to calculate the effect of the tariff on the number of cattle imported has a low R-square (0.5036). One possible reason is measurement error in the calculation of a Mexican price for feeder cattle. Mexico's prices had to be proxied as actual prices were unavailable. Consequently, the actual effect of the removal of the tariff may be greater than 4,585 head per month.

The second limitation is the lack of an ideal supply variable for the demand system. Monthly quantities of feeder calves outside of feedlots, as well as total cattle on feed in all 50 states, are not available for the period examined in this study. This could cause the coefficients for imported cattle, to be overstated.

Finally, impacts measured at Oklahoma City are assumed to be representative of the overall national impact of imported feeder cattle on U.S. prices. Actual coefficients may be smaller. Furthermore, regional economic impacts are likely to be greater in areas closer to the border.

Historically, the impact of imported Mexican feeder cattle on U.S. prices has been negative and statistically significant. However, on average, the real dollar impact has been relatively small, reducing light weight feeder steer prices by $2 per head or less.

Potentially, in the long-run, NAFTA could have a large impact on the price of feeder cattle, under a greatest-possible scenario. Nonetheless, this analysis indicates that the elimination of trade barriers for Mexican feeder cattle has an almost negligible effect.

It is important to note that these impacts are based on seasonal monthly prices. U.S. producers can develop strategies to market their cattle during months when export supplies are typically low. This will reduce the overall effect of exports on individual producers.

TABLE V

ECONOMIC IMPACTS OF FEEDER CATTLE IMPORTS FROM MEXICO.

Import Level	300-400 lbs.	
	$/cwt	$/head
1973 - 1992 avg.	-0.36	-1.26
1988 - 1992 avg.	-0.42	-1.49
4,585 head*	-0.02	-0.08
Maximum (historical)	-1.85	-6.46
Maximum (greatest-possible)	-3.99	-13.98
100,000 head	-0.66	-2.30
	400-500 lbs.	
	$/cwt	$/head
1973 - 1992 avg.	-0.42	-1.49
1988 - 1992 avg.	-0.44	-1.98
4,585 head*	-0.02	-0.11
Maximum (historical)	-1.98	-8.90
Maximum (greatest-possible)	-4.28	-19.26
100,000 head	-0.70	-3.16
	500-600 lbs.	
	$/cwt	$/head
1973 - 1992 avg.	-0.29	-1.58
1988 - 1992 avg.	-0.32	-1.78
4,585 head*	-0.02	-0.10
Maximum (historical)	-1.48	-8.11
Maximum (greatest-possible)	-3.19	-17.55
100,000 head	-0.52	-2.88

* *The impacts of an additional 4,585 head are based on average number of cattle imported and average real (1992=100) price for 1988 - 1992.*

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