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AN ECONOMIC ANALYSIS OF THE MEXICAN DAIRY
SECTOR AND PROSPECTS FOR U.S. DAIRY EXPORTS

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M.S. degree in AGRICULTURAL ECONOMICS

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AN ECONOMIC ANALYSIS OF THE MEXICAN DAIRY SECTOR AND PROSPECTS FOR U.S. DAIRY EXPORTS

By

Miguel Angel Ramirez

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ABSTRACT

AN ECONOMIC ANALYSIS OF THE MEXICAN DAIRY SECTOR AND PROSPECTS FOR U.S. DAIRY EXPORTS

By

Miguel Angel Ramirez

Mexican dairy product demanded outgrew domestic quantity supplied during the 1990's and the deficit has been filled with imports from the U.S., Europe, Oceania and South America. NAFTA enabled the U.S. to become the main dairy supplier to the Mexican market, but competition from other countries and Mexico itself has raised several questions about the prospects for U.S. exporters. Milk supply in Mexico was modeled using an aggregate profit function, the results suggest that milk supply is very own-price inelastic and sensitive to feed and capital cost. An assessment of dairy demand was performed considering income and population growth. Demand forecasts suggest that Mexico will have a milk deficit ranging from 4.06 to 6.10 million metric tons of milk equivalents in 2003 and 2011 respectively. Mexican dairy import behavior during the 1990's was analyzed by estimating a Source Differentiated Almost Ideal Demand System and a marginal share analysis, the results suggest that Mexican importers differentiate dairy products by source of origin and U.S. will continue to be the main dairy supplier to Mexico. This is especially for cheese and other dairy products, as the U.S. faces no import tariffs for all dairy products, but milk powder, which faces a quota scheduled to disappear in 2008. Oceania, especially New Zealand, could potentially become the second largest supplier to the Mexican dairy market.

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CHAPTER 1

INTRODUCTION

Introduction

Mexico has been the largest foreign destination of U.S. dairy products since 1990. Sales of U.S. dairy products to Mexico in 2002 reached $250 million according to the U.S. Dairy Export Council (USDEC). In the ten years since the North America Free Trade Agreement (NAFTA) was implemented, tariff rates for all U.S. dairy exports to Mexico, with the exception of milk powder, were lowered to zero, endowing U.S. exporters with a competitive advantage in this market[1]. However, despite this advantage, U.S. companies continue to face fierce competition from the European Union, because of high subsidies, and New Zealand, because of low cost of production.

The U.S. dairy industry has several questions regarding domestic production, consumption, and export prospects in the Mexican market. These questions can be answered with a better understanding of dairy supply and demand in Mexico. To answer these questions, this study examines the Mexican dairy industry and provides an outlook of the prospects for U.S. exports to Mexico, compared to other world-class competitors.

Background

Many policies created in the mid 1980's were aimed at opening the economy and have changed the structure and performance of the Mexican dairy sector. In 1986, Mexico's accession to the General Agreement on Tariffs and Trade (GATT) was a major step towards liberalization of the agricultural sector. Prior to 1989 and as a anti-

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[1]The milk powder tariff will be lowered to zero in 2008. Currently, there is a non-tariff quota of 40,000 MT allocated to U.S. Imports exceeding the quota are subjected to a 139% tariff. Under the NAFTA guidelines the U.S. will be the only country capable of exporting non-tariff milk powder to Mexico in 2008.

inflationary policy, milk price was fixed by the government and not allowed to rise despite increasing production costs. In order to encourage domestic milk production, the fixed price policy was removed in 1989, and as a result milk production increased from roughly 5,280 million liters in 1989 to 6,176 million liters in 1992 (a 16.96% increase).

The North American Trade Free Agreement (NAFTA) in 1992 was the culmination of the liberalization of the government-controlled agricultural sector in Mexico. Mexico's accession to the Organization for Economic Development (OECD) in 1994 required a further reduction in government involvement in the dairy sector. In 1995, the National Dairy Program was implemented and resulted on further price liberalization, technological modernization, and implementation of imported milk powder quotas.

These changes in policy contributed to an evolving dairy market, and especially liberalized import requirements. As a result, annual milk production growth has averaged 5.38% during the 1990's and in 2001, Mexico produced 9,500 million liters. However, dairy production has failed to keep up with dairy consumption, which has grown 4% per year during this period, because of population and income increases. Despite a smaller growth in the consumption than in supply rate, consumption has been bigger than supply during the period of study, creating a milk deficit This milk deficit has been covered with imports, which represent around 20% of the total dairy consumption.[2]

The United States has been the major supplier to Mexico, because of proximity and trade preferences brought about by NAFTA. However, the Mexican market has

[2] Imports have ranged from 15.61% in 1991 to 31.93% of total dairy consumption in 1990. The total consumption covered with imports averaged 20% for the period 1990-2001.

attracted other exporters such as the European Union, New Zealand and several South American countries. The Mexican dairy sector itself has evolved and some companies and dairy producers can produce milk efficiently in terms of quality and cost. As a result of these evolution in the sector, the U.S. Dairy Export Council reports that the product mix exported to Mexico has changed in the 1990's and in fact, around 85% of the U.S. sales to Mexico are unsubsidized products such as cheese, whey and ice cream, while milk powder imports have decreased.

Research Objectives

The primary goal of this research is to understand Mexican dairy production and consumption, thus prospects for U.S. dairy exporters. To accomplish this objective three analyses are performed:

1. *To understand Mexico's milk supply response for the period 1990 to 2001.* An econometric model of Mexico's milk output supply and inputs demand is estimated for the dairy sector in Mexico. This model focuses on understanding total milk production, allowing a better assessment of the long-term prospects for increased milk production and self-sufficiency.
2. *To estimate import demand elasticities for different exporters to Mexico in a way that accounts for differences in preferences for products from different sources of origin.* This encompasses an analysis of the dairy import demand in Mexico during the period 1990-2002 by estimating a Restricted Source Differentiated Almost Ideal Demand System (RSDAIDS).
3. *To analyze the prospects of U.S. exporters of dairy products to Mexico vis-à-vis other exporters.* By estimating forecasts based on models developed in 1 and 2, an

analysis of the prospects for U.S. exporters to satisfy the import demand for dairy products in Mexico is performed.

Study Outline

This thesis is organized as follows. Chapter two deals with an analysis of the structure and conduct of the dairy sector in Mexico providing a historical background and information for the economic modeling efforts that follow. Chapter three presents the theoretical framework and estimation of a supply response model for the Mexican dairy sector following the work of Blayney and Mittelhammer (1990). Chapter four presents the analysis of the dairy import demand in Mexico by estimating a Source Differentiated Almost Ideal Demand System following the work of Yang and Koo (1994). Chapter five analyzes prospects for U.S. exporters drawing upon the results obtained from economic modeling and some opinions from specialists in Mexico. Finally, chapter six provides a summary of the results obtained and the conclusions of this research.

CHAPTER TWO

THE MEXICAN DAIRY SECTOR

Introduction

In 2001, Mexico's economy was the ninth largest economy in the world with a GDP of $617,820 million USD. This number ranks Mexico as an upper-middle income country. Agriculture and related activities represented approximately 9% of the total GDP in 1990. However, by 2001, it represented only 3.75% of the total GDP, as the country's economy has rapidly moved towards industry (27.5% of GDP) and services (68.8% of GDP) (Central Bank of Mexico).

The objective of this chapter is to provide background information on the characteristics of Mexico's dairy sector, which lays the groundwork for the economic analysis that follows.

The first cattle in Mexico were introduced in the 16th century by Spanish settlers. The introduction of dairy cattle in Mexico was aimed to supply the urban settlements with milk and beef in the New World and the operations were located in close proximities to cities. By the beginning of the 1900's, some improved breeds were brought into Mexico along with immigration into the western highlands giving rise to today's second biggest milk production area in Jalisco State (Cervantes et al., 2001; Garcia Hernandez, 1996).

In 1938, the Compañia Nacional de Subsistencias Populares (CONASUPO), translated as National Company of Subsistence Commodities, was founded. CONASUPO's goals were to increase farmer income and to provide dairy products to consumers at low cost (Garcia Hernandez, 1998). CONASUPO operated several sub-agencies that performed various marketing functions, such as storage, transportation, raw product assembly, wholesale and retail services. Among all the sub-agencies operated by CONASUPO, the most important was Leche Industrializada CONASUPO, LICONSA (Industrialized CONASUPO Milk). This agency was charged to dehydrate milk and support rural production and consumption. Among its most important roles was to guarantee a minimum farm-gate price to producers, which sold to it, acting many times as the buyer of last resort (Garcia Hernandez, 1998; Nicholson, 1995).

The dairy sector did not suffer radical transformation until the 1950's. Mexico followed what is known as the "import substitution" development strategy, relying heavily on trade barriers to promote industrial development and relying more on the domestic rather than on the export market. This policy entailed a heavy dose of governmental regulation and accelerated the urbanization rate in Mexico but did not stress agriculture development. The growing urban population demanded more animal products than Mexican agriculture could produce with existing technologies and structure, leading to increasing food imports (Barham et al., 1994, Garcia Hernandez, 1996).

By the beginning of the 1980's, increased revenues from the oil operations together with increased government spending on social programs and agricultural subsidies led to a lack of sustained growth and high inflation. The fall in oil prices in the mid 1980's along with a high external debt terminated the agricultural subsidy programs (Hallberg, 1992; Cranney, 1992).

The Mexican government, struggling to maintain producer incentives while providing food to consumers at low prices, introduced a series of retail price controls on basic food commodities administered by government agencies. Favored urban consumers and retail price controls reduced producer incentives to expand dairy herds and milk production. (Nicholson, 1995; Hallberg, 1992). As a result, milk production declined, leading to increasing dairy imports.

As the government budgetary pressures derived from the fall of oil prices, and as an anti-inflationary policy, policy-makers decided to import dairy products to meet the demand rather than increasing prices paid to milk producers. This decision was based on the availability of low cost dairy imports, resulting from heavy subsidies in industrialized countries, which had accumulated large stocks of dairy products offered for sale in international markets at low prices (Cranney, 1992).

CONASUPO was in charge of procuring dairy imports, mainly skimmed milk powder (SMP) for LICONSA, which in turn reconstituted imported SMP and distributed the reconstituted milk through its own outlets, concentrated in rural areas. The SMP not employed by LICONSA social programs was auctioned to private industry at prices above the world price, because it worked as a monopoly extracting quasi-rents (Nicholson, 1995). CONASUPO was the single largest buyer of skimmed milk powder (SMP) in the world, its imports in the 1980's represented between 15% and 21% of the world SMP supply (Garcia Hernandez, 1998). In 1986, Mexico's accession to GATT (General Agreement on Tariffs and Trade) decreased CONASUPO'S role as dairy imports monopoly and several LICONSA facilities were sold to the private sector. This accession also required to transform import licenses into tariffs.

The scheme of retail-controlled prices, aimed at providing accessible prices for consumers in urban areas, was changed to a policy known as "concerted prices" in 1988, which meant that consumer prices served as "base" prices, and the other prices in the system were determined based on traditional or "reasonable" margins negotiated by producers, processors, retailers and government in a regional basis. This policy change contributed to milk supply rebound of 10% annually in both 1990 and 1991.[1]

Mexico's accession to the OECD (Organization for Economic Development) in 1994 required increased market access and competition that further decreased CONASUPO's role. As a result, the "concerted prices" scheme remained in effect until 1995 when price controls for all dairy products, except fluid milk because it was considered a basic food requirement, were liberalized only in specific states and then nationwide in 1998. In the same year, corruption scandals led to the total disappearance of CONASUPO. LICONSA continued and was transferred to the ministry of Social Welfare and Development (SEDESOL) with responsibility to produce reconstituted milk for lower-income people, but no longer regulating SMP imports (Garcia Hernandez, 1998; Nicholson, 1995).

Government Programs for the Dairy Sector

In order to increase milk production, some specific programs were developed by the Mexican government. The Milk Productivity Program was started in 1995 and specifically designed to support the specialized dairies. This program subsidized the acquisition of equipment and physical infrastructure, but has been very controversial,

[1] Milk production increased from roughly 5,280 million liters to 5,812 million liters from 1989 to 1990. In 1991, it increased to 6,176 million liters.

because small dairy producers argue they have never been considered in the support programs aimed for the largest dairies operating under cooperative structures.

The Grazing Establishment program was designed to support the free-range dairy operations in need of pasture-based forage. This program subsidizes the acquisition of fences, pumping equipment, wells, and pasture seed.

The Better Cattle Program was aimed to increase the milk and beef yield. It encourages the acquisition of improved breed animals, mainly imported from the U.S. and Canada, and artificial insemination technology to promote genetic improvement in dairy cattle (SAGARPA, 2001; Rabobank, 2000).

Production Systems

Diversity characterizes the production systems in Mexico. This section describes the different systems in Mexico. Milk production in Mexico has been steadily increasing (figure 2.1) but has been unable to keep up with the demand, so imports have had to complement that deficit. Despite of the relative large total volume of milk produced, the relative productivity per cow is low as compared to other countries (table 2.1).

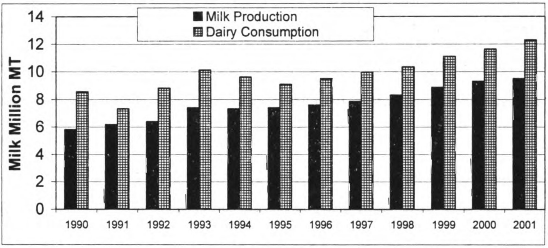
This low productivity can be understood in terms of the diversity that describes the milk production in Mexico, where there exists a wide dispersion between the smallest and biggest operations ranging from one or two cows to herds of 3000 or 5000 cows. In 2000, there were around 1.5 million dairy operations with an average of 16 cows per farm. For comparison purposes only, the U.S. dairy farm had on average 100 cows per farm and the European Union had 25 cows per farm for the same year. (Rabobank, 2000).

Table 2.1 Average Annual Production per Cow (milk tons/cow/year)

Country	*1998*	*1999*	*2000*	*2001*	*2002*
United States	**7.80**	**8.06**	**8.26**	**8.23**	**8.43**
Canada	6.82	6.92	7.15	7.43	7.50
European Union	5.38	5.50	5.57	5.62	5.67
Australia	4.72	4.87	5.15	4.76	4.83
Argentina	3.78	4.12	4.00	3.88	3.57
Poland	3.58	3.48	3.58	3.80	3.87
New Zealand	3.56	3.37	3.67	3.70	3.71
Russian Federation	2.28	2.37	2.47	2.64	2.70
Others	1.99	2.09	2.15	2.26	2.32
Mexico	**1.27**	**1.32**	**1.37**	**1.40**	**1.41**
India	1.01	1.01	1.01	1.01	1.01

Source: United States Department of Agriculture (USDA-FAS).

Figure 2.1 Total Milk Production and Consumption in Mexico



Source: SAGARPA

Explaining the diversity of production requires an understanding of the diverse climates in Mexico. Figure 2.2 shows the different climates where milk production takes place. Approximately two-thirds of the country is arid or semi-arid. There are three clearly differentiated production systems: the specialized, semi-specialized and dual-purpose systems (table 2.3).

The specialized system

Commercial or corporate farms have been increasing in size over the last 20 years. The average of cows per farm is often between 120 and 400, but some of them have thousands of cows. Their contribution to the total milk production is generally estimated to range from 50-61% (SAGARPA, 2001; Barham et al., 1994; Rabobank, 2000; Hernandez and Del Valle, 2000).

These farms have the highest yields per animal (5 to 10 tons of milk) and are largely located in the Northern arid and semi-arid parts of the country. Dobson and Procter (2002) state that the shift in production location toward the Northern part of the country "may appear less than dramatic" and that it has been accelerated in recent years. However, these shifts, like the one experienced in the U.S. from the East and Upper Midwest to the West do not occur rapidly. In Mexico, this process started in the 1950's, when Northern Mexico gave up cotton production and utilized the existing irrigation infrastructure to produce inputs for milk production.

These farms are often organized as cooperatives and vertical integrated. The dairy herd is mainly Holstein confinement operations with state-of-the-art technology and production comparable to farms in California and Arizona. These farms feed their animals with concentrates and have specialized labor (SAGARPA, 2001; Rabobank, 2000).

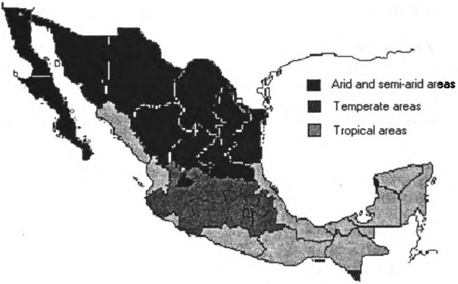
The semi-specialized system

The semi-specialized farms tend to be in semi-confinement and free range grazing. Traditionally, this system is family-owned and operated with an average herd of five to 40 cows per farm and most are Holstein, Brown Swiss or crossbreeds. They produce 25% of the total milk in Mexico (Rabobank, 2000). Their milk is marketed mostly through near-by processing companies and heavily relies on the many times under-compensated family labor. Most of the milking is performed by hand and many farms do not have cooling tanks. The primary problems associated with this system are difficulties for the milk marketing process, low quality and lack of specialized infrastructure. Although, the degree of technology varies from farm to farm, these operations are located in the temperate and semi-arid areas of the country, because of grazing areas and favorable weather (FIRA, 2001).

Dual-Purpose system

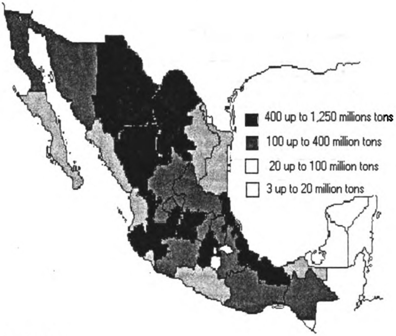
These operations are oriented primarily towards beef production and milk is a complementary part of their income. These farms are primarily located in the Mexican tropics and produce approximately 25% of the total milk in Mexico, but their participation is steadily decreasing. The herds are small, an average of 20 animals and most of the times are crossed-breeds of Zebu-Holstein. These cows are fed with native and improved pastures, which make the quality and production of milk very seasonal. The milk is marketed directly to the consumer and consumed raw most of the time. The milk is also utilized to produce artisan cheese varieties. These farms have the lowest production cost, but lack appropriate management and infrastructure to improve their quality (FIRA, 2001; Hallberg, 1992; SAGARPA, 2001; Hernandez & Del Valle, 2000).

Figure 2.2 Mexico Climatic Variation of Zones



Source: SAGARPA (2001)

Figure 2.3 Geographic Distribution of Mexico's Milk Production



Source: SAGARPA

The opinions and expectations about the growth in milk production in Mexico are almost as diverse as the production systems. This differentiation in production and technologies can explain the low average productivity per cow in Mexico. However, there is a consensus about the potential expansion of milk production in the specialized system. A summary of the main characteristics of the production systems is displayed in table 2.2.

Milk production is concentrated mainly in the Northern states that allegedly lack the resource endowments, such as water and grain to produce milk. However, technology has enabled those areas to produce milk and has given them comparative advantages in terms of physical infrastructure (Garcia Hernandez et al, 1999; FIRA, 2001; Dobson and Proctor, 2002). Figure 2.3 displays the different milk producing regions in Mexico.

Table 2.2. Main Characteristics of Mexican Dairy Producing Systems

Characteristics	***Specialized***	***Semi-specialized***	***Dual Purpose***
Location	North and North Central regions	North and Central regions	Southern and Southeastern regions
Climate	Arid and semi-arid	Semi-arid and temperate	Tropical
Cows/Herd (Avg)	120-400	40	20
%Total herd	14%	23%	63%
Breeds	Holstein	Holstein and/or Brown Swiss and some crossing with Zebu	Zebu crossed with Holstein and Swiss
Yield per cow	5 to 10 tons	2 to 4 tons	0.54 to 0.75 tons
% Of Total Production	Approx. 50%	25%	25%

* These values vary by source and year, so they are only approximates.
**Source: Rabobank (2000), FIRA (2001), SAGARPA (2001)

A description of the production systems would be incomplete without including some estimates of the production costs. Due to the wide variety of production systems, there is no singular estimate that precisely identifies the cost of producing milk. An accurate picture of the cost of production would be based on regional differences, different levels of technology and size. However, this information is not available and surveys of production costs are not common in Mexico (Cranney, 1992; Barham, 1994).

Furthermore, the few estimates that are available are likely biased toward the commercial farms in Northern Mexico, which do not necessarily represent the majority of the operations. Previous studies (Cranney (1992); Hallberg (1992) and Nicholson (1995)) report estimates of production costs for the beginning of the 1990's.

Table 2.3 describes the cost structure per pound of milk produced. The conclusion is that feed costs represent approximately 70% of the production costs for milk in Mexico. This is the same value reported by Cranney (1992) and Nicholson (1995).

Table 2.4 describes some production costs for specialized, semi-specialized and dual-purpose dairy farms in Mexico based on a survey carried out in 1998 by the Bank of Mexico Agribusiness Research Branch (FIRA).

Following the discussion about the production systems in Mexico, the next section describes the Mexican dairy marketing sector.

Table 2.3. Variable cost structure per milk lb.

Input	*Percentage*
Grains and concentrates	54
Forage	15
Labor and Cleaning operations	3
Financial cost	10
Other Expenses	18

*Estimates for the specialized and semi-specialized systems
Source: FIRA, 2001.

Table 2.4. Estimates of Milk Production Cost, 1998

	Specialized		*Traditional*		*Dual Purpose*	
Variable	*Total*	*Top 25%*	*Total*	*Top 25%*	*Total*	*Top 25%*
Size and Investment						
Capacity (# cows)	400	400	20	19	55	58
Herd size of milking cows	252	312	11	11	-	-
Herd size capacity ratio	0.63	0.78	0.55	0.55	-	-
Total Investment per dairy cow (USD)	2809	3178	1544	2324	2297	1978
Production						
Milk per cow (lb)	15604.31	15992.33	7689.72	8496.62	1157.4	1298.5
Beef per cow (lb)	-	-	-	-	315.26	482.81
Economic variables						
Income per milk lb (USD)	0.1532	0.1532	0.1313	0.1681	0.1104	0.1072
Income per beef lb (USD)	-	-	-	-	0.55	0.52
Operation costs per lb (USD)	0.1090	0.0932	0.0918	0.0945	149*	101.2
Financial costs per lb (USD)	0.007	0.008	0.0104	0.010	47.1*	36.3*
Labor units per cow/year**	18	14	11.1	21.5	1.04	4.29
Family labor units	1.16	0.59	35.5	43.6	3.45	5.5
Profitability per cow (USD)	686.6	957.5	303.5	624.3	133.1	249.4
Returns to capital (%)	15	22	13	23	6	11
Qualitative Variables						
% Farms receive technical assistance	80	83	24	38	-	-
% Farms produce all of the forage inputs	41	50	42	50	-	-
% Farms integrated into commercialization operations	39	42	0	0	-	-

* Operation and financial costs in a per cow basis (yearly average number of cows in the herd)
**Labor units consist of 8 hours journeys
Source: Bank of Mexico Agribusiness Development Branch (2001)

Dairy marketing in Mexico

The dairy industry in Mexico is the third most important activity in Mexico's food sector. In 1999, it generated $4,300 million USD, roughly 13% of the Food Processing and Manufacturing GDP and employed around 50,000 workers (INEGI Manufacturing Census, 1999).

There are two marketing channels in Mexico. The formal channel that involves the large dairy cooperatives, the dairy processing industry, and LICONSA, is similar to the U.S. dairy channels. The informal channel encompasses a vast number of small artisanal cheese producers and dairy processors. Figure 2.4, provides insight of how milk flows from the producer to the consumer and its estimated volumes.

As contrasted with the U.S., much of the fluid raw milk (referred as "leche bronca" in Spanish) in Mexico is marketed through the informal channel. Different sources are concordant that approximately 30% of the milk is marketed in this way happening more often the tropics. The rest of the milk goes to the processing industry.

Formal Channel

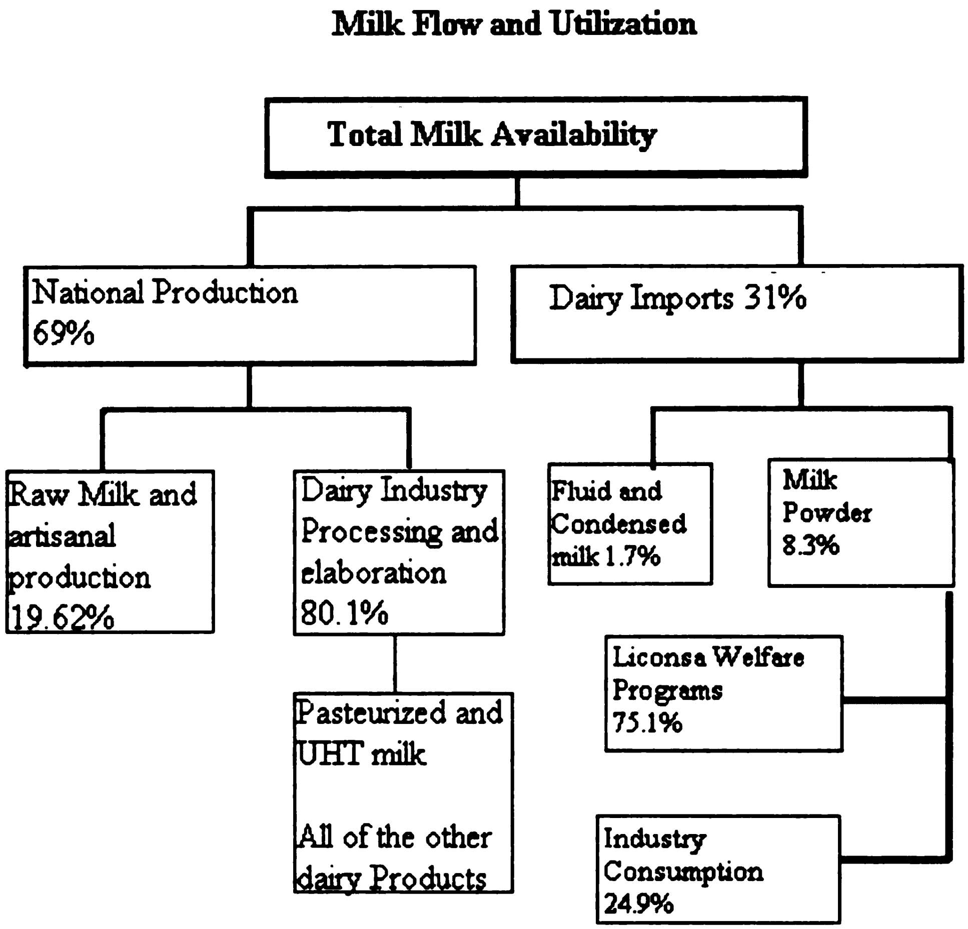
The marketing process begins with the shipment of raw milk to a processing facility. In the specialized system, there are formal agreements for the recollection of milk in refrigerated tanker trucks. One interesting feature of this collection system is that large cooperatives often ship farm milk long distances to the processing facilities. Sometimes these distances are up to 1,000 miles from the farms in Northern Mexico to facilities outside Mexico City or Acapulco in the Pacific Coast. The final products are marketed by the cooperatives as their own brands, in a similar manner to the big cooperatives in the U.S.

Dairy farmers that are not members of the cooperatives usually have short-term arrangements with local and small dairy companies. The degree of technology varies accordingly to the size of the producer and the size of the processor in terms of cooling equipment and distribution. Farm milk is usually collected in milk cans or plastic containers, either by the farmer or an entrepreneur and delivered to the collection centers. Once in the collection center, the milk is weighted, filtered, chilled and often tested for fat and density[2] until a tanker truck transports the milk to a central processing facility. Nestle and other large companies that acquire milk from the semi-specialized system have been installing more cooling tanks in the farms they have procured since 1994, the investment is done by the company and the farmers in different ways, for instance many times the processors set up the cooling tank for several farms and farmers receive a discounted price for their milk during an agreed time period to pay for the tank.

As indicated in figure 2.4, approximately 80% of the total milk goes to private industry. However, LICONSA takes approximately 10-12% of the national production and the processing industry processes only 68% (Rabobank, 2000; FIRA, 2001). This quantity of milk is a considerable increase compared to the 58% of the milk processed by the industry in 1994. According to the Agribusiness Research Branch (FIRA), LICONSA's and the informal channel participation are expected to decrease and leave more room to the processing industry, which often, has problems of idle capacity (Hernandez & Del Valle, 2000). Table 2.5 displays the different flows and uses of the milk processed by the industry in Mexico.

[2] So much has been argued about milk adulteration with water in Mexico. It used to be a common practice, but most of the collection centers perform tests on density. Moreover, in the past, milk was paid in terms of volume and not quality, since the price of the milk was controlled. Today, milk is paid more on a quality basis with a premium if milk is cooled on-farm.

Figure 2.4. Estimated Flow and Use of Milk in Mexico in 1998



*Source: SAGARPA, 2001; Rabobank, 2000.
**The percentages vary depending on the source, the values are only estimates

Table 2.5. Milk Uses in the Processing Industry in 1998

Product	*% Of Industry Milk*	*Value (million dollars)*
Fluid milk	42%	1,788
Powder milk	15%	616.9
Cheese	11%	470.6
Yogurt	11%	453.4
Cream (Sour and others)	3%	131.5
Others	18%	771.6

*Source: INEGI Manufacturing census 1998.

One characteristic of the formal channel is the degree of concentration, for instance the largest 17 companies in Mexico purchased around 50% of the total milk production and had 75% of the total dairy sales in 1999, suggesting that regional concentration and market power might be even greater in a regional basis. The fluid milk pasteurizing companies are the most important in Mexico employing 42% of the milk in the industry and generating 1,788 million dollars in sales (FIRA, 2001).

These companies are organized in different business structures including completely integrated cooperatives, multinational companies such as Nestle, Dannon, Parmalat, Kraft Foods and New Zealand Dairy products, independent processing companies with farmer contracts, smaller-scale cooperatives and government companies such as LICONSA. In general, these companies market around 70% of the pasteurized milk in Mexico. Table 2.6, displays these companies and their respective market shares. The two biggest firms, Lala and Alpura are cooperatives completely integrated from production to retailing.

Table 2.6. Leading Pasteurized Milk Firms in Mexico

Company	*Market share percentage*
LALA	26
Alpura	15
Zaragoza	9
Sello Rojo	9
Boreal	6
San Marcos	6
Otros	29

Source: FIRA 2001.

In terms of other manufactured dairy products, the structure is more fragmented. In the case of cheese, there are around 1,300 firms producing cheese, but most of them are small and artisanal ones. Large companies such as Nestle, some domestic companies and Kraft Foods supply the biggest part of the production. These companies together supply around 65% of cheese production. Three firms, namely Dannon, Sigma Alimentos and Nestle supplied 60% of the total production of yogurt (INEGI, 1998; FIRA, 2001).

This skewed distribution of the industry suggests that the Mexican dairy industry is an oligopsony with few firms leading the whole sector. Hernandez & Del Valle (2000) agree that the Mexican dairy industry is an oligopsony with a skewed technological distribution favoring the biggest firms and many times excluding the production sector. Table 2.7 shows the biggest dairy firms operating in Mexico. Nestle continues to be the largest dairy company in Mexico and U.S. firms such as Kraft have not reached yet the sales magnitudes to be considered among the major players in the Mexican dairy sector.

Table 2.7. The largest Mexican Dairy Companies

Company	*1998 Sales (US millions)*	*Ownership structure*
Nestle Mexico	$1,650	Multinational (Switzerland)
Grupo Lala	$778	Cooperative
Grupo Alpura	$486	Cooperative
Grupo Zaragoza	$250	Private family-owned
Lechera Guadalajara	$171	Private family-owned
Grupo Chilchota	$169	Private family-owned
Sigma Alimentos	$120	Private public
Gilsa	$115	Cooperative
Parmalat México	$80	Multinational (Italy)
Dannon	$70	Multinational (France)
New Zealand Dairy Board**	$45	Multinational

*Source: Rabobank (2000)
**The New Zealand Dairy Board changed its name to Fonterra in 2000

Informal Channel

The "informal" channel is characterized by the large number of intermediaries. These "entrepreneurs" sell milk in the nearby towns or to small-scale processing plants, where it is transformed into fresh cheese or other dairy products. The technology of this informal channel is rudimentary as is the milk quality. The milk marketed through this channel comes mostly from the dual-purpose farms and it is common in the tropics and small towns.

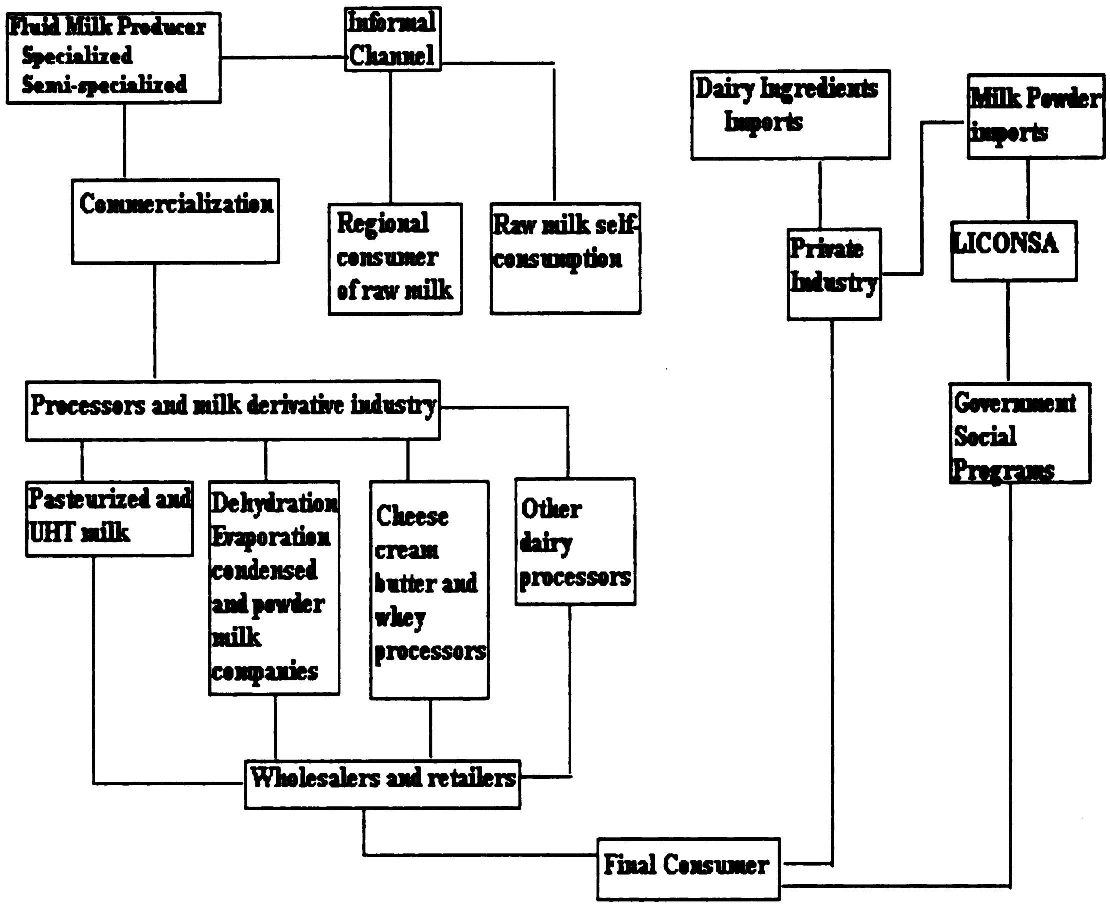
Final Distribution of Milk and Dairy Products

The last part of the marketing chain is also of interest. The largest companies have their own distribution systems at a national level, providing them direct delivery and negotiation power with the retailers. It is important to mention that none of the Mexican cooperatives have national presence; their presence is rather regional. Central wholesale markets and trading firms continue to play a key role in the distribution of dairy products (USDEC, 2000).

At the retail level, significant differences exist depending on the type of product. According to the U.S. Dairy Export Council (USDEC), large retail chains account for only 25% of overall food sale, wholesale markets represent 25% and small regional retailers including mom and pop stores represent 40%. Food service companies handle the remaining 10%. However, given the perishable nature of the dairy products, their distribution is made mainly through small retailers and supermarkets[3]. Small retailers remain the most important distribution points for fluid milk, while 80% of processed dairy products are distributed through modern retail chains (USDEC, 2000; Rabobank, 2000). Figure 2.5 summarizes the previous discussion on milk marketing in Mexico.

[3] Fluid milk distribution through retailers was heavily supported by the government to better enforce the price control policy previously described.

Figure 2.5. Milk Marketing Channels



* Source: Adapted from Rabobank (2000) and USDEC (2001)

Dairy Consumption in Mexico

This section describes the consumption patterns in Mexico and it is strongly linked to the milk marketing and production sections previously described. This section is aimed to give an insight into the dairy consumption patterns in Mexico. The dairy market in Mexico is not uniform. On one hand, there is milk that is basically bought by medium and high-income consumers and there is strong competition among local and international brands. On the other hand, the social programs provide milk to the poorer strata of the society and subsidize its price. This difference is caused by the different production systems, which in turn determine differences in quality and price structure (Garcia Hernandez, 1998; Nicholson, 1995). Mexico is a vast country, with varied climates and huge differences that influence consumer preferences. Figure 2.6, shows the main milk consuming regions in Mexico. These differences are explained in terms of demographic, per capita income and distribution, urbanization rate and age distribution factors.

The areas where most milk is consumed in Mexico are, not surprisingly, the ones that exhibit the fastest population growth and have the highest income levels located in Central and Northern Mexico (2000 Mexican Census). These results are consistent with previous estimations done by Gould & Kim (1998) and Nicholson (1995) who mentioned that the consumption of milk in those areas is a combination of a young, rapidly growing population and increasing urbanization.[4] Sixty five percent of the total dairy production is consumed in or around Mexico City, Mexico's largest city (USDA, 2001).

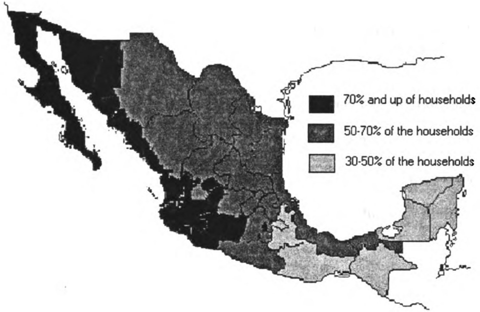
An estimated 30% of the milk in Mexico, mainly from the semi-specialized and dual-purpose systems, is consumed raw. This is perhaps one of the most important consumption patterns in Mexico. Some consumers reportedly regard this raw milk as higher quality than processed milk. What accounts for the high consumption of raw milk in Mexico? Nicholson (1995) suggests this phenomenon is in part a result from the restrictive price control policies of the 1980's. He states these controls provided incentives for farmers and entrepreneurs to market their product themselves to achieve a higher price rather than selling it to the intermediaries or processors.

---

[4] According to the National Institute of Geography, Informatics and Statistics (INEGI) approximately 80% of Mexico's population lives in an urban area.

In the same way, milk processing was more focused on those products that were not controlled at the retail level, offering very few options on fluid milk availability to consumers. Quality of the pasteurized milk and the milk provided under the social programs was regarded as low quality,[5] rooting the belief that milk purchased at the farm gate was "real and fresh." In other areas of Mexico, the lack of processing and cooling infrastructure derived the consumption of raw milk as well. Although, the price controls no longer exist, it seems that consumer habits persisted.

Figure 2.6. Geographic Distribution of Dairy Household Consumption



*Source: Done by the author with estimates from the INEGI 2000 and 1994 Household Income and Expenditure National Survey.
**The percentages represent the % of households buying dairy products.

[5] This quality perception has also implications in the way import products are regarded and their success into the Mexican market despite being higher-priced than their domestic counterparts. For further discussion, see the chapter on imports demand.

The milk and dairy products quality have increased in recent years. However, price controls created a mix of processing technologies nearly as diverse as production technologies used on farms. These technologies were characterized by the degree of substitutability of the dairy and in many cases non-dairy ingredients such as vegetable fat for butterfat. This created a functionality-based market for dairy ingredients such as caseins, whey powder, butter fat and other imported dairy dry ingredients that are still important today. To cite an example, what is called "imitation" cheese in the U.S., those cheeses made of milk powder or milk proteins recombined with other ingredients such as whey powder and vegetable fat, are very popular in Mexico. It is estimated that approximately 75% of the Mexican cheeses is "imitation". This is legal in Mexico, as long as it is labeled as "analog" cheese.

Considering this information, what factors generate the consumption of dairy products? Dairy consumption in Mexico entails the final demand by consumers and industrial demand (within and outside the dairy industry[6]). Determining the apparent consumption (as a proxy for final consumption) of dairy products in Mexico is a key step to understand the prospects for Mexico future dairy demand. Table 2.7 displays the apparent consumption of different dairy products. Milk consumption is the sum of milk production and all dairy imports, expressed in total solids milk equivalents, following the approach of Barham et al. (1994) and the conversion factors from Selinsky et al. (1992).

The numbers in table 2.8 reveal some interesting facts. First, domestic production has failed to outdo the total consumption, despite its increase. Second, the role of imports to meet the final demand for dairy has been somewhat constant over the years, regardless

[6] Some dairy ingredients have uses in other industrial applications. However, the quantities consumed in other industries are very small in comparison to those consumed by the dairy industry.

of the increase in production. The nature of the dairy consumption in Mexico requires an insight into the dairy purchasing expenditures. It is not a secret that income distribution is very uneven in Mexico. Nicholson (1995) reported that in 1992 an estimated 65% of the entire dairy was consumed by 40% of the population with the highest incomes. Rabobank (2000) estimated that in 1999, 30% of the population consumed 50% of the total dairy products. This unequal distribution of the income has two important implications for the final demand for dairy products.

Table 2.8. Dairy Apparent Consumption

Year	*Domestic Milk Production (millions of tons)*	*All Dairy Imports** (millions of tons)*	*Total Dairy Apparent Consumption (millions of tons)*	*% Of the consumption supplied with domestic production*	*% Of the consumption supplied with imported products*
1990	5.81	2.73	8.54	68.07%	31.93%
1991	6.18	1.14	7.32	84.39%	15.61%
1992	6.38	2.45	8.83	72.25%	27.75%
1993	7.40	2.73	10.13	73.09%	26.91%
1994	7.32	2.29	9.61	76.17%	23.83%
1995	7.40	1.69	9.09	81.41%	18.59%
1996	7.59	1.91	9.50	79.86%	20.14%
1997	7.85	2.12	9.97	78.72%	21.28%
1998	8.32	2.02	10.34	80.45%	19.55%
1999	8.88	2.22	11.09	80.01%	19.99%
2000	9.31	2.31	11.62	80.12%	19.88%
2001	9.50	2.78	12.28	77.37%	22.63%

*Source: Calculations made by the author with data from the Bank of Mexico, SAGARPA and USDA.
**It considers fluid milk, milk powder, whey, cheese, yogurt, ice cream, condensed and evaporate milk and dairy desserts.

First, low-income persons still consume dairy from subsidized social programs, mainly imported milk powder. So, as long as the social programs remain, there will be demand for fluid milk, even at the lowest income level that will be met with skimmed milk powder imports and with domestic production[7]. Second, demand for other domestic and imported dairy foods will increase as income increases in Mexico. Considering the current marketing and production systems, it is expected that part of the final dairy demand will be in part supplied by imports.[8] To corroborate the validity of these implications, data from the 2000 Household Income and Expenditure National Survey are shown in table 2.9 and 2.10.

Table 2.9. Distribution of Consumer Expenditures in Dairy Products in 2000

Product	*Expenditure (percentage)*
Fluid Milk	70
Cheese	11
Cream	4
Butter	1
Other	14

*Source: Calculations made by the author with INEGI'S data.

The results in table 2.9 suggest that fluid milk accounts for the biggest expenditure in the dairy category. Table 2.10 suggests that the expenditures in dairy products increased in average 50% from the 1992 levels. The budget shares remained constant or with the exception of a decrease at the highest income levels, and an increase at the lowest income levels. These results suggest that as income increases in Mexico, dairy products consumption will increase but at different rates depending on the income level. Not surprisingly, Nicholson (1995) suggested that the biggest increase in consumption would come from the lower income strata.

[7] Recently, LICONSA announced that some of its facilities would be procuring only domestic fresh milk for the social programs.
[8] The discussion on marketing systems suggests that even if all the milk needed to meet the final demand, not all of it could be marketed to the final consumers due to the lack of contracts between producers and processors.

Table 2.10. Weekly Household Expenditures on Dairy Products, by Income Decile

Income Decile	I	II	III	IV	V	VI	VII	VIII	IX	X
1992										
Total Expenditure ($USD/Household	11.45	18.84	30.87	34.94	44.94	50.23	56.23	68.74	82.42	104.19
Total Budget Share (%)	4.22	4.12	4.82	4.53	4.74	4.63	4.34	4.15	3.75	2.33
2000										
Total Expenditure ($USD/Household	28.76	37.83	45.16	49.40	58.81	60.83	73.13	84.48	93.26	128.64
Total Budget Share (%)	8.29	4.67	4.99	4.85	4.79	4.57	4.37	4.14	3.52	1.95

*Source: Calculations made by the author with data from INEGI 1992 and 2000 Household Income and Expenditures National Survey

**Lowest income decile= I

Summary

This chapter provided an insight on the Mexican dairy sector and the necessary background for the economic modeling efforts developed in the following chapters. It identified differences in production, marketing and consumption of dairy products in Mexico considering factors such as geographical distribution, urban growth, income, and consumer preferences. Different policies affecting the dairy sector, and their effects on the dairy sector were described. Regarding the marketing sector, it is characterized by an oligopolistic structure, where a reduced number of companies (17) concentrate more than 75% of the industry sales. Consumer preferences are shifting towards a more value-added trend bringing about consolidation within the industry and many times unequal power distribution along the marketing chain.

CHAPTER THREE

ECONOMETRIC MODEL OF MEXICO'S AGGREGATE MILK SUPPLY AND INPUT DEMAND

Introduction

The Mexican dairy sector is characterized by a diversity of production and marketing systems. This diversity has characterized the behavior of milk production as "uneven" (Nicholson, 1995). The yearly rate of growth for the period 1980-1990 was on average –1.27% while for the period 1990-2001 the growth rate averaged 5.38%[1]. Several authors have argued that the growth of production was the result of "price liberalization" starting in 1989 (Nicholson, 1991; Cranney, 1992; Hallberg, 1992). Prior to 1989, as an anti-inflation policy, milk retail prices were fixed and not allowed to rise, placing a ceiling on the price paid to producers (Hallberg, 1992). These policies created a lack of price incentive to expand milk production and domestic production shortfalls led to increasing dairy imports.

An aggregate econometric supply response model was estimated for the dairy sector in Mexico. This model was aimed at understanding the relations and effects on total milk production with respect to milk price and key production inputs. Technology is a crucial element of long-term shifts in agricultural supply. It follows that improvements in technology should be an important factor in determining the level of milk production in Mexico.

[1] Calculations done by the author with data from the Secretariat of Agriculture and Natural Resources (SAGARPA)

Theoretical considerations

Following the approach of Blayney and Mittelhammer (1990), an aggregate profit function was defined for a given output, input prices and aggregate production relation. Farmers are assumed to maximize the present value of income over an infinite horizon with respect to inputs utilized to produce milk. The farm objective is first to maximize short-run profits with respect to variable inputs and then maximize the present value of long-run profits (Thijsen, 1992). According to Blayney and Mittlehammer (1990), the aggregate profit function must characterize the problem of maximizing the aggregate profit that can be generated by distributing production of output across industry firms. This can be represented as:

$$(1)\ \pi(P,w)=\max_{q_1 \cdots q_m} P\sum_{j=1}^{m} q_j - \sum_{j=1}^{m} c_j(w,q_j),$$

where P is the output price, w is the vector of input prices, q_j is the output of the jth firm, and c_j (w, q_j) is the cost function of the jth firm. The optimality conditions for (1) require that each firm maximize its own profit at prices (P, w). The optimal output distribution across the firms is represented by the collection of continuously differentiable firm-level supply functions $q_j=q_j$ (P, w), j=1, m. Substitution of the output supply functions into (1) yields:

$$(2)\ \pi(P,w)=\sum_{j=1}^{m}[Pq_j(P,w)-C_j(w,q_j(P,w))]=\sum_{j=1}^{m}\pi_j(P,w).$$

Thus, the aggregate profit function can be represented as the sum of the individual firm-level profit functions (Blayney and Mittelhammer, 1990).

By Hotelling's Lemma, differentiating the profit function with respect to output price yields the supply function. Similarly, the negative partial derivative of the profit function with respect to an input price yields the input demands:

$$(3.1)\frac{\partial \pi(P,w)}{\partial P} = Q(P,w).$$

$$(3.2) - \sum_j \frac{\partial \pi_j(P,w)}{\partial w_i} = \sum_j x_{ij}(P,w) = X_i(P,w),\ i = 1,..n,$$

where Q (P, w) is the aggregate milk supply, x_{ij} (P, w) is demand for input i by firm j, and X_i is aggregate input demand.

Functional Form

Since theory does not suggest a specific functional form, applied economists are faced with the important task of selecting a functional form for the aggregate profit function. Resulting problems can be reduced by specifying a flexible functional form, which can be viewed as (usually second-order) approximations to a general functional form. Following the work of Blayney and Mittelhammer (1990), the Box-Cox form was selected for this study.

According to Genc and Bairam (1998, p. 55), the Box-Cox form is popular because it allows unrestricted substitution among inputs and satisfies the homogeneity restrictions imposed by economic theory. The Box-Cox form requires a non-linear transformation of the dependent variable (Y) in a functional relationship: $Y^{(\lambda)} = F(X)$, where Y is the vector of original observations of the dependent variable transformed by the parameter λ, and X is a matrix of independent variables. There are two popular forms of the Box-Cox transformation (Genc and Bairam):

$$(4a)\ Y^{(\lambda)} = \frac{F(X)-1}{\lambda}, \lambda \neq 0;$$

$$(4b)\ \ln Y, \lambda = 0.$$

A generalized Box-Cox transformation of the dual profit function was specified as (Blayney, 1988):

$$(5)\ \frac{\pi(P,w)^{\Theta}-1}{\Theta}=h(\frac{P^{\lambda}-1}{\lambda},\frac{w^{\lambda}-1}{\lambda}),$$

for $\lambda \neq 0$ and $\Theta \neq 0$. The parameters Θ and λ are the transformation parameters and h denotes a general functional relationship. By defining a vector of transformed prices Z and a form for h (Z) that includes all of the own price and cross price relationships in the following manner:

$$(6)\ h(Z)=(\frac{P^{\lambda}-1}{\lambda},\frac{w^{\lambda}-1}{\lambda}),$$

the following equation is obtained (Blayney):

$$(7)\ \begin{aligned}&\pi(P,w)=[1+\Theta h(Z)]^{1/\Theta}\\ &h(Z)=a_o+a'Z+0.5Z'AZ,\end{aligned}$$

where a_0 is a constant, a' and A the row vector and a symmetric matrix of price effect parameters denoted by:

$$(8)\ \begin{aligned}&a'=(a_p,a_w)\\ &A=\begin{bmatrix}a_{pp} & a_{pw}\\ a_{wp} & a_{ww}\end{bmatrix},\end{aligned}$$

where the subscripts P and w denote output price and input price respectively. Economic theory requires a profit function to be homogenous of degree one (Genc and Bahram, 1998), by substituting equation (6) into (7), one obtains:

$$(9)\ \begin{aligned}&\pi(P,W)=(1+\Theta[a_0+a_p(\frac{P^{\lambda}-1}{\lambda})+a_w(\frac{W^{\lambda}-1}{\lambda})+\\ &1/2a_{pp}(\frac{P^{\lambda}-1}{\lambda})^2+1/2a_{ww}(\frac{W^{\lambda}-1}{\lambda})^2+a_{pw}(\frac{P^{\lambda}-1}{\lambda})(\frac{W^{\lambda}-1}{\lambda})])^{1/\Theta}.\end{aligned}$$

By assuming λ>0, and imposing the following restrictions:

$$\begin{aligned}&1+\Theta_{a_0}=\Theta/\lambda\,(a_P+a_W)\\ (10)\quad &a_P=1/2\lambda\,(a_{PP}+a_{PW})\\ &a_W=1/2\lambda\,(a_{WW}+a_{WP})\\ &a_{PW}=-1/2\,(a_{PP}+a_{WW})\end{aligned}$$

One can obtain the homogeneous function (Blayney):

$$(11)\ \pi(P,W)=[\Theta(\frac{1}{2\lambda^2 a_{PP}}P^{2\lambda}+\frac{1}{\lambda^2}a_{WP}P^{\lambda}W^{\lambda}+\frac{1}{2\lambda^2 a_{WW}}W^{2\lambda})]^{1/\Theta}.$$

Multiplying both P and w by a positive constant k results in:

$$\begin{aligned}&(kP,KW)=[\Theta(\frac{1}{2\lambda^2 a_{PP}}(kP)^{2\lambda}+\frac{1}{\lambda^2}a_{WP}(kP)^{\lambda}(kW)^{\lambda}\\ (12)\quad &+\frac{1}{2\lambda^2}a_{WW}(kW)^{2\lambda})]^{1/\Theta}=k^{2\lambda/\Theta}\pi(P,W),\end{aligned}$$

which implies that the degree of homogeneity is 2λ/Θ. Homogeneity of degree one requires that 2λ=Θ and results in (Blayney):

$$(13)\ \pi(P,w)=(\frac{1}{\lambda}(Z'AZ))^{1/2\lambda}.$$

Equation (13) represents the Box-Cox specification under the homogeneity condition.

Following the work of Blayney and Mittelhammer, an aggregate profit function with a technology parameterization, which maintains the homogeneity condition, was specified in the following generalized Box-Cox form:

$$(14)\ \pi(P,w,t)=[\lambda^{-1}(Z'AZ)]^{1/2\lambda}e^{[g(P,W,t)]},$$

where t is the technological variable (a trend variable starting in 1988=1 and ending in 2001=14). A form g (P, W, t) that accommodates the notion of technological change is given by:

(15) $g(P,W,t) = t(\Gamma + \sum_j \gamma_j \ln(R_j))$,

where R_j is either the price of the output or the price of an input.

The parameters of the aggregate profit function are the functional parameter λ, the neutral technology measure τ, the vector of biased technology effects γ, and A, an N x N symmetric matrix of parameters associated with own- and cross-price relationships.

Linear homogeneity of the aggregate profit function is imposed by:

(16) $\sum_{j=1}^{N} \gamma_j = 0$,

where γ_j's are the elements of gamma. The profit function was not estimated directly. Instead, Hotteling's lemma was applied, which resulted in a system of equations representing aggregate output (milk) supply and the aggregate input demands (Blayney, 1990. p. 865-866).

$$
\begin{aligned}
&Q = (\lambda^{-1}(Z'AZ))^{1/2\lambda} e^{t(\tau+\gamma'R)}(\frac{\tau\gamma_1}{P}) + \\
&e^{t(\tau+\gamma'R)}(\lambda^{-1}(Z'AZ))^{(1/2\lambda)-1}\lambda^{-1}(a_{11}P^{2\lambda-1} + \sum_{j=2}^{N} a_{1j}P^{\lambda-1}w_{j-1}^{\lambda}),
\end{aligned}
\tag{17}
$$

$$
\begin{aligned}
&X_i = -[(\lambda^{-1}(Z'AZ))^{1/2\lambda} e^{t(\tau+\gamma'R)}(\frac{t\gamma_{i+1}}{w_i}) + \\
&e^{t(\tau+\gamma'R)}(\lambda^{-1} \cdot (a_{i+1,i+1}w_i^{2\lambda} + a_{i,i+1}w_i^{\lambda-1}p^{\lambda} + \sum_{j\neq i} a_{i+1,j+1}w_j^{\lambda-1}w_i^{\lambda})].
\end{aligned}
$$

The a_{ij}'s denote cross-price parameters. Algebraic manipulation of the above equations allows the level of profit,π to be substituted into (17) and the matrix A to be removed from the expressions. In particular, the supply and input demand equation can be transformed into:

$$(18)\ Q = \pi(\frac{\tau\gamma_1}{P}) + \pi^{1-2\lambda} e^{2\lambda t(\tau+\gamma' R)} \cdot (a_{11} P^{2\lambda-1} + \sum_{j=2}^{N} a_{1j} P^{\lambda-1} w_{j-1}^{\lambda}),$$

$$X_i = \pi(\frac{\tau\gamma_1}{P}) + \pi^{1-2\lambda} e^{2\lambda t(\tau+\gamma' R)} \cdot (a_{i+1,i+1} w_i^{2\lambda} + a_{i,i+1} w_i^{\lambda-1} p^{\lambda}$$
$$+ \sum_{j \neq i} a_{i+1,j+1} w_j^{\lambda-1} w_i^{\lambda}).$$

These are the forms that are estimated and the results are reported below.

Data Definition and Sources

Data quality and availability on the Mexican dairy sector are major problems when estimating a supply response function for the sector. As the years have passed by, more data on the dairy sector have become available. This model incorporates the best and most complete information available to date.

Annual data were available for the period 1988 to 2001, a total of 14 observations. This period of study is important to analyze, because it includes the implementation of the milk price liberalization in 1989, the 1993 North America Free Trade Agreement (NAFTA), as well as the economic and financial crisis of 1995.

The price of milk was defined as the national average of price paid for 1,000 liters of milk in 32 Mexican States collected from the Secretariat of Agriculture and Natural Resources (SAGARPA). The quantity of milk was defined as the aggregate milk production in 32 Mexican States collected by SAGARPA, defined in thousand millions of liters.

The feed price and quantity variables deserve special attention. Two feeds were considered, concentrates and forage. Actual feed quantities were expressed in millions of tons and collected from the General Cattle Coordination Branch of SAGARPA.[2] The feed price was defined as the average of concentrates and forage weighted by their respective quantities. Concentrate prices was defined as FOB Gulf Ports corn and oilseed paste prices reported by the U.S. Department of Agriculture, because most of the grains and feeds in Mexico were imported from the U.S. The forage price was represented by the price paid for a metric ton of hay in Northern Mexico reported by SAGARPA.

The cow price was the price of dairy replacement cows imported into Mexico as reported by the Food and Agriculture Organization (FAO). The dairy herd population is expressed in millions of head and collected from the SAGARPA.

The price of capital was defined as the commercial lending interest rate reported by the Central Bank of Mexico. The proxy for quantity of capital was the amount of milk machines imported into Mexico as reported by the FAO. This variable is a proxy given the lack of data on capital investments such as buildings, parlors, cooling tanks or others in Mexican dairy farms.

The price of labor was defined as the minimum wage hourly remuneration reported by the Labor Secretariat in Mexico and the U.S. Department of Labor. The quantity of labor in Mexico's dairy farms was estimated from the Mexican Census Department (INEGI), the Labor Secretariat and the SAGARPA, defined as millions of hours per year. This estimate included paid labor hired for dairy operations, but did not include the owner and unpaid (underpaid) family labor devoted to the farm. This labor estimate is the only estimate for Mexican dairy farms.

---

[2] Over the period considered the average ration consisted of 40% concentrates (35% grains and 5% oilseeds) and 60% forage.

The equations in (18) require substituting for a profit proxy. There have been very few studies of the cost of production and management of Mexican dairy farms (Nicholson, 1995; Cranney, 1992; Barham, 1994; FIRA, 1998). All of the existing studies are biased towards the largest farms in the Northern part of the country and there are no studies or time series data on small-scale farms available. Furthermore, dairy farming profits are not positive in every period in Mexico or anywhere else, but the specification of the equations to be estimated in (18) require the profit proxy to be positive and greater than zero, so that the Box-Cox form does not yield imaginary or zero values that can cause numerical problems in the estimation.[3] To overcome these problems, a study performed by the Agricultural and Food Policy Center in Texas A&M University was used. This study titled "Mexican Representative Dairy Farms 1998 Economic Outlook" describes the profitability, measured as the difference between the total cash receipts and the total cash expenses of different dairy farms in Central and Northern Mexico for the period 1988-1998 and makes projections up to 2002.

According to Ochoa et al. (1998), the following assumptions were made for the profit estimation:

- All farms surveyed are of moderate scale to be representative of full-time commercial farming operations in the study area.
- Herd size was held constant for all farms over the 1997-2002 planning horizon.
- All prices were converted to U.S. dollars.
- Minimum family living withdrawals for family dairies were assumed at a base rate ranging from 17 to 34 percent of gross receipts accordingly to the panel suggestions.

[3] The term $\Pi^{2\lambda-1}$ yields imaginary numbers if π is negative and $2\lambda-1<1$, so the function does not allow for negative values of the estimated profit.

- Managerial costs were used instead of family living expenses for the corporate farms. These costs were assumed to be 5 percent of gross receipts. This cost represents the amount of money either paid to a professional manager or the amount of money extracted from the operation by the owners/shareholders.
- Family employment was not included in the analyses.
- The farms are subject to federal and state taxes as a sole proprietor or corporations, according to Mexico's income tax provisions.

Table 3.1 summarizes variables and definitions of the data utilized for this model.

Table 3.1 Variables and Definitions

Variable	*Represents*	*Scaling*	*Mean*	*Min*	*Max*	*Standard Deviation*
P	Milk Price	Average price paid in $USD to the farmers for 1,000 lts in the 32 Mexican States	382.654	233.681	950.0000	180.1189
W_{FEED}	Feed Price	Weighted Average of grain, oilseed and hay prices expressed in $USD/ton	95.3916	78.8630	116.7505	10.8078
W_{COW}	Cow Price	Price per head of replacement calves expressed in $USD/cow	731.720	461.363	1003.594	140.9883
$W_{CAPITAL}$	Interest Rate	Percentage commercial banks interest rate in Mexico	27.4497	10.1200	67.6367	15.9437
W_{LABOR}	Labor cost	Minimum wage Hourly remuneration in Mexico expressed in $USD/hr	1.8536	1.2500	2.4600	0.3781
Beef	Beef Price	Average carcass price of 32 Mexican States in $USD	2462.19	1275.39	3377.65	621.9823
Q	Milk Quantity	Aggregate milk production in the 32 Mexican States expressed in thousand millions of liters	7.3580	5.2795	9.5013	1.3421
X_{FEED}	Feed Quantity	Total estimation of the fed quantities of grain, oilseed and hay expressed in millions of tons	7.8773	5.8556	10.2196	1.3106

Table 3.1 Continued.

Variable	*Represents*	*Scaling*	*Mean*	*Min*	*Max*	*Standard Deviation*
X_{COW}	Dairy Herd	Aggregate dairy herd of milk producing cows in Mexico expressed in millions of heads	6.4015	5.5858	6.8019	0.3437
$X_{CAPITAL}$	Capital Stock	Total value of milk machines imported into Mexico expressed in millions of US dollars	10.5103	4.0990	21.0460	5.6759
X_{LABOR}	Total Labor	Estimated quantity of hired labor in Mexico's dairy farms expressed in millions of hours	532.403	336.909	755.2196	113.27
π	Profit	Total Cash Receipts-Total Cash Expenses expressed in $USD/cow	984.180	262.740	3345.03	801.1549

Estimation and Results

The estimation of the highly non-linear model (18) presented challenges. There are only 14 observations (from 1988-2001) and 22 parameters. Following the approach of Blayney and Mittelhammer (1992) a two-step procedure was used to estimate the system.

In the first step, the profit term was proxied with a value obtained from an OLS regression on the milk, inputs and beef prices, because the profit function is endogenously determined with prices (Blayney and Mittelhammer).

Since the equations are contemporaneous, disturbances across the equations are unlikely to be independent. The preferred technique for estimation of (18) would be a non-linear 3SLS. However, the existence of 22 parameters and 14 observations rules out the use of standard non-linear 3SLS.

A set of instrumental variables was constructed from the set of six squared prices (milk, feed, cow, capital, labor and beef) and the technology dummy variable T (1988=1, 2001=14) and used in the estimation of the variance-covariance structure generated by 3SLS. There must be as many instruments as parameters, in this case 22. In order to gain an extra degree of freedom, the homogeneity condition stated in (16) was used resulting in 12 parameters per equation.

In the second step, the variance-covariance structured generated in the first step was imposed in a non-linear Seemingly Unrelated Regressions (NSUR). NSUR is "a second best" approach since the dimensionality of the parameter space and the data space is still problematic (Blayney, 1990. p. 117). There are effectively 13 time series with 14 observations to estimate the parameters of the system. Based on this procedure, a "baseline" set of estimated system parameters is shown in table 3.2. This model was subjected to a series of tests to estimate a restricted model.

A series of hypothesis tests were focused on the functional form parameter λ and the elements of the A matrix (own- and cross-price parameters). Specific values of the functional form parameters are indicative of the applicability of common functional forms to the data. Two values of λ are notable; 0 and different from zero to discriminate between the translog form and the general form used in the baseline projections.[4] Given the non-linear nature of the model, the Wald Statistic was used to test the null hypothesis of λ=0. This test is asymptotically valid for the non-linear systems. The Wald statistic was 90.64, which support the functional Box-Cox general form of the model and rejects the translog functional form.

[4] See eq. (4)

Table 3. 2. Supply Response Parameter Estimates

Parameter	*Definition*	*Estimate*	*STD Error*	*T-Statistic*	*P-value*
τ	Neutral Technology measure	-0.1055	0.0612	-1.7237	0.085
γ_1	Technology parameter associated with milk price	0.0256	0.0257	0.9960	0.319
γ_2	Technology parameter associated with feed price	0.0236	0.0213	1.1119	0.266
γ_3	Technology parameter associated with cow price	-0.0205	0.0162	-1.2592	0.208
γ_4	Technology parameter associated with capital price	**-0.0128**	0.0054	-0.2353	0.019
λ	Functional form parameter	**0.5392**	0.0566	9.5205	0.000
A_{11}	Milk own-price parameter	2.3383	8.4063	0.2781	0.781
A_{12}	Cross-price parameter of milk with respect to feed	1.4148	7.0154	0.2016	0.840
A_{13}	Cross-price parameter of milk with respect to cows	2.8842	4.0394	0.7140	0.475
A_{14}	Cross-price parameter of milk with respect to capital	2.4698	4.5320	0.5449	0.586
A_{15}	Cross-price parameter of milk with respect to labor	**32.3894**	11.485	2.8199	0.005
A_{22}	Feed own-price parameter	-18.0052	59.291	-0.3036	0.761
A_{23}	Cross-price parameter of feed with respect to cows	0.2524	4.5032	0.0560	0.955
A_{24}	Cross-price parameter of feed with respect to capital	-1.1539	11.762	-0.0981	0.922
A_{25}	Cross-price parameter of feed with respect to labor	0.4898	5.6137	0.0872	0.930
A_{33}	Cow own-price parameter	-12.5683	7.7190	-1.6282	0.103
A_{34}	Cross-price parameter of cow with respect to capital	-0.1236	1.2411	-0.0996	0.921
A_{35}	Cross-price parameter of cow with respect to labor	0.1596	0.5611	0.2845	0.776
A_{44}	Capital own-price parameter	-35.5371	32.307	-1.0999	0.271
A_{45}	Cross-price parameter of capital with respect to labor	4.4676	4.9275	0.9066	0.365
A_{55}	Labor own-price parameter	-1581.31	922.0500	-1.7150	0.086

*Bolded values represent significance at the 5% level.

Statistics displayed in table 3.2 were used to select parameters for parameter exclusion tests and to estimate a more concise restricted model. A series of nested hypothesis tests were undertaken. Again, the Wald Statistic was calculated. Table 3.3 displays the results for the hypothesis testing of the own and cross-price parameters.

Table 3.3 Hypothesis Tests of Own- and Cross-price Parameters

Hypothesis	*Wald Statistic*	*P-value*
Ho: $a_{25}=a_{35}=a_{45}=0$	0.263620	0.60764
Ho: $a_{25}=a_{35}=a_{45}=a_{23}=0$	0.155846	0.69301
Ho: $a_{25}=a_{35}=a_{45}=a_{23}=a_{24}=0$	0.147330	0.70110
Ho: $a_{25}=a_{35}=a_{45}=a_{23}=a_{24}=a_{22}=0$	0.064302	0.79982
Ho: $a_{25}=a_{35}=a_{45}=a_{23}=a_{24}=a_{22}=a_{34}=0$	0.066752	0.79613
Ho: $a_{25}=a_{35}=a_{45}=a_{23}=a_{24}=a_{22}=a_{34}=a_{44}=0$	0.697822	0.40352

Given the set of restrictions tested above, a new estimate of the variance-covariance that imposed the restrictions was estimated. This new estimation followed the two-step procedure described above. Table 3.4 shows the results of the restricted model.

Table 3.4. Parameter Estimates from the Restricted Model.

Parameter	*Estimate*	*STD Error*	*T-statistic*	*P-value*
τ	**-0.1381**	0.0430	-3.2126	0.0010
λ	**0.5314**	0.0297	17.8639	0.0000
γ_1	-0.0014	0.0164	-0.0868	0.9310
γ_2	**0.0395**	0.0148	2.6637	0.0080
γ_3	-0.0016	0.0125	-0.1286	0.8980
γ_4	**-0.0160**	0.0042	-3.7913	0.0000
γ_5^*	-0.0204			
A_{11}	**3.7210**	1.6881	2.2042	0.0280
A_{12}	-0.5587	1.4690	-0.3803	0.7040
A_{13}	0.4385	0.8431	0.5201	0.6030
A_{14}	-0.8645	0.5440	-1.5891	0.1120
A_{15}	**19.7259**	6.3004	3.1309	0.0020
A_{25}	-0.9734	0.6767	-1.4385	0.1500
A_{33}	**-4.6282**	0.9748	-4.7479	0.0000
A_{55}	**-830.5820**	356.1260	-2.3323	0.0200

*Parameter recovered by homogeneity. No statistics available

Most of the parameters shown in table 3.4 are significant at the 5% level. The R-squared values for the different equations are displayed in table 3.5 and range from 0.4852 to 0.6819. This model was aimed at estimating supply elasticities, so this model was aimed at determining long-term factors of production relations.

Table 3.5 Restricted Model Equation Results

Equation	*Std Error*	*R-squared*	*Durbin-Watson*
Milk Quantity (Q)	2.16359	0.6819	0.0860
Feed Quantity (X_{Feed})	5.33101	0.6039	0.2289
Cows Number (X_{Cow})	1.21890	0.6089	0.1932
Capital ($X_{Capital}$)	4.58381	0.4852	1.1231
Labor (X_{Labor})	77.5956	0.5010	2.0241

The parameter estimates obtained in the previous section were used to calculate own- and cross-price elasticities of output supply and input demand.

Elasticities measure the relative response of one variable to a change in another variable in a unitless manner. Economic theory dictates that own price elasticity of the supply is positive and the own-price demand elasticities of inputs are negative.

Following the approach of Blayney and Mittelhammer (1990), the technological rates of change were also calculated. These measure how much of the increase in output or input demand was derived from improved technology. Technological rates of change do not measure how much the output changed during the study period. Rather they are estimates of the impact of technology in the production of milk and in the demand for the variable inputs. Table 3.6 displays the elasticities matrix at the mean value of the data points.

Table 3.6. Own- and Cross-price Elasticities Matrix

	Price					
	Milk	Feed	Cow	Capital	Labor	Technology Rates*
Quantity						
Milk	0.0775	-0.2206	-0.0491	-0.1201	0.3123	0.4869
Feed	0.0070	-1.1316	-0.0144	-0.1439	1.2829	0.5575
Cow	0.0459	0.2923	-0.0845	-0.1184	-0.1353	0.5361
Capital	0.1944	0.0157	-0.0048	-0.6319	0.4266	0.2563
Labor	0.3065	0.2770	-0.0112	-0.4936	-0.0760	0.4957

*Measured as $\dot{Q}/Q$ or $\dot{X}_i / X_i$

The first row in the table displays the price elasticities of output supply and the technological rate of change for milk output. The first column displays input demand elasticities with respect to milk price. The milk own- price elasticity result suggests that milk supply is very inelastic. Given the nature of the data, this is an estimate for the medium- or long-term. This value seems to be consistent with other estimates for Mexico. Fonseca (1991) calculated 0.07 elasticity for the period 1980-1988, and 0.094 for 1970-1979 using an ARIMA model based on milk prices. Cranney (1992) reported a 0.46 short-run and 1.08 long run for the period 1960-1990. For comparative purposes only, Chavas and Klemme (1986) estimated the U.S. supply elasticity value of 2.46 for a 10-year period considering 1980 as the baseline. Thijsen (1992) estimated the Dutch milk supply elasticity values ranging from 0.01-0.27 for the short- and long-run respectively. Another factor to be taken into consideration is the fact that the results will vary due to methodological differences. Moreover, regional supply elasticities in Mexico are expected to be different, the estimate of this study is an aggregate estimate for the whole country of Mexico. Data to estimate a disaggregate model for the different regions in Mexico was not available.

The elasticity of milk supply with respect to the input prices was expected to be negative. The results confirmed this relationship with the exception of labor price. The milk supply is the most sensitive to feed price (-0.2206), which reinforces what already has been discussed about the Mexican dairy policy and the need for a greater availability for high-quality and cheaper grains in Mexico.[5] A recent study by the Agribusiness Development Branch of the Central Bank of Mexico (FIRA) found that only 41% of the largest corporate farms produced their own forage (hay), but were dependent on the external purchases of grain as compared with 42% of the smaller family-owned semi-confinement operations.

The results suggest that milk supply response is somewhat sensitive to the capital cost (-0.1201). The FIRA (1998) study found that the average debt/asset ratio of the corporate large farms in Northern Mexico was 12% and the financial costs represented around 6% of the total costs. For the smaller semi-confinement dairy operations, the same study found that their average debt/asset ratio was 15% and the financial cost represented around 11% of the total costs.

The supply elasticity with respect to the cow price was the smallest in magnitude (-0.0491) and the results suggest that this may be due to both adjustments of production per cow and adjustments in the size of the dairy herd (Chavas & Klemme, 1986). It is expected that an increase in the price of the imported replacement calves has an effect on replacement decisions, which in turn determines productivity and milk output.

The supply elasticity with respect to labor is of a considerable magnitude (0.3123) and is the only positive value. Economic theory suggests that an increase in the price of

[5] Most of the studies agree that feed, mainly grains and concentrates, represents up to 70% of the milk production costs in Mexico.

an input is expected to initiate a decrease in the supply of the output being produced. This elasticity estimate contradicts theory and could represent an anomaly in the data. The labor statistic utilized for this study hides the effect of family labor employed, since it only considers hired labor. The effect of an excluded variable makes the estimators biased and inconsistent, because the variance is incorrectly estimated and it is likely to give misleading conclusions about the statistical significance of the parameters in question. This could be true for this case since family labor must be highly correlated with hired labor, so the bias due to the exclusion of family labor does not disappear. Family labor is important in Mexico's small double-purpose and small semi-specialized farms. According to the survey of the Agribusiness Development Branch (FIRA, 2001), family labor constitutes 76.18% and 76.83% of the total labor employed in the semi-confinement and dual-purpose operations respectively. These results suggest that the labor statistics utilized for this study do not reflect the actual situation of labor in Mexican dairy farms. Data on family labor employed in Mexican dairy farms was not available.

The first column of table 3.7, excluding the first entry, displays the calculated milk price effects on the aggregate demand for the production inputs. Milk price effects were the greatest for capital (0.1944) and labor (0.3065). This might reflect decisions to improve quality of milk and get price premiums by employing milking machines in the case of capital. In the case of labor, it might reflect the willingness to hire more specialized labor as an incentive to improve quality and get a price premium. For instance, the FIRA study indicates that 80% and 24% of the specialized farms and family operations respectively hire specialized labor such as veterinarians and dairy technicians.

SAGARPA (1999), FIRA (2001), Hallberg (1992) and McDonald (2000) emphasized the importance of investing in milking machines and technical assistance to increase milk supply and its quality. However, the definition of labor masks any possible increase in owner-operator labor as described above.

Technological Effects

Following the work of Blayney and Mittelhammer, the technological rates were calculated as:

(12) $(\partial Q / \partial T)/Q$ or $(\partial X_i/\partial T)/X_i$

These values are aggregate estimates of how technology influenced milk supply and input demands. The rates of technological change (table 3.6) suggest that 48.69% of the yearly increase in milk production resulted from technology advancement. Regarding the input factors, the values suggest that technology advancement increased input demand by 55.75% for feed, 53.61% for cows, 25.63% for capital and 49.57% for labor respectively.

The functional form allowed calculating parameters of interest from the technological viewpoint, τ and a set of γ's. τ captured the neutral technological change and the set of gammas captured non-neutral technological changes. The simultaneous estimation of the technology parameters with λ and the A matrix captured interactions between technological changes and production responses implied by the aggregate profit functional form (Blayney, 1988. p 149). These parameters were used to estimate technology effects on aggregate profit, namely the proportional rate of change in profitability due to technological effects. Recall that the functional form was defined as:

$$\pi(P,w,t) = (\lambda^{-1}(Z'AZ))^{1/2\lambda} e^{[t(\tau+\gamma' R)]}$$

By defining the logarithmic form of the aggregate profit, it can be shown that the technology term is linear in parameters τ andγ.

(12) $\ln \pi(P, w, t) = 1/2\lambda \ln(\lambda^{-1}(Z' AZ)) + t(\tau + \gamma' R)$

By partially differentiating (12) with respect to t, the technology variable, the following equation was obtained:

(13) $$\frac{\partial \ln \pi(P, w, t)}{\partial t} = \frac{1}{\dot{\pi}} * \frac{\partial \dot{\pi}}{\partial t} = \frac{\dot{\pi}}{\pi} = t + \gamma' R$$

The proportional rate of change in aggregate profit with respect to technological change described by (13) includes both a neutral and non-neutral component. If τ=0, all effects are due to non-neutral change if γ' is non-zero. If τ is non-zero and γ' is zero, then all technological effects are due to neutral changes. Finally if both τ and γ' are zero, there are no technological effects at all (Blayney, 1988. p 150).

Most of the technological parameters displayed in table 3.4 are significant at the 1% level, excepting the ones for milk price and cow price. The negative sign of the τ parameter suggests that technological advances have negatively influenced the profitability of the Mexican dairy sector. Technology plays a cost-reducing role, but in an aggregate way it also reduces revenue by shifting outwards the supply curve when technology is adopted in the industry and the demand is inelastic. This is a relatively short period of study, so these results must be carefully scrutinized. Technology advancement is unevenly distributed in Mexico and it is likely biased toward the largest operations in the Northern part of the country. It makes more sense to analyze these results in the context that these dairy operations are located in the arid Northern part of the country. Arguably, technology has been adapted by most farms in these areas to produce milk in a more efficient way, expanding production and reducing farm revenues (Garcia Hernandez et al. 2001. p 363).

The implications of the signs attached to the estimates of γ were more difficult to assess. The sign indicated the direction and the proportional rate of change in the aggregate profit under ceteris paribus conditions. The prices of the output and the inputs actually determine the proportional rate of change in aggregate profit.

The positive sign associated with the feed price, indicates that changes in this price, *ceteris paribus*, led to changes in the rate of change in aggregate profit in the same direction. The parameters associated with milk, cow, capital and labor price indicate that changes in these prices (under *ceteris paribus* conditions) impart a negative effect on the rate of change in aggregate profit, suggesting that the positive effect of technological advance from feed on aggregate profit was smaller than the overall technological advance effect. These results suggest that technology advancement comes at a cost in Mexico, but the price signals have not been enough to discourage milk production, mainly attributable to the largest confinement dairy operations in the Northern part of the country.

Summary

An aggregate profit function with a technological parameterization was estimated to assess the response of Mexico's dairy sector to changes in prices and technology during the 1988-2001 period of study. The theory and implications of this model were discussed and contrasted with previous studies. The milk supply elasticity value estimated was 0.007, which suggests that milk production is very inelastic. The sign and magnitude of the results suggest that milk supply is sensitive to changes in feed (-0.2206) and capital (-0.1201) prices. Milk supply response to labor price was found to be positive

(0.3123), suggesting that the labor estimate could be biased due to the exclusion of family labor employed in farms. The results suggest that technological advancement has been a considerable factor in the increasing quantity of milk production, but this has come along with a negative effect on the aggregate revenues of dairy farms in Mexico. However, these price signals have not been strong enough to discourage milk production. These results require careful interpretation given the diversity of milk production systems found in Mexico. The lack of disaggregate data on the different systems deters further analysis on the supply response, which would be expected to be different for every production system given underlying differences in technology.

CHAPTER FOUR

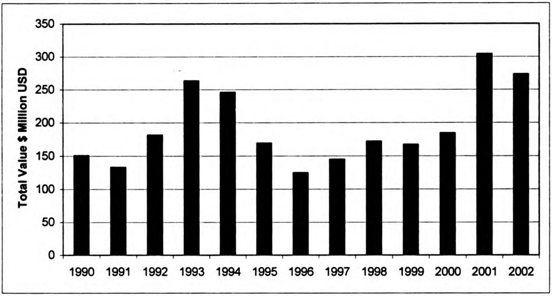
AN ECONOMETRIC MODEL OF THE MEXICAN DAIRY IMPORTS

Introduction

Mexico is a milk-deficit country. Despite a yearly average growth rate in milk production of 5.38% during the period 1990 to 2001, the country has still imported approximately 2.20 million tons per year to meet the final demand for dairy products, or approximately 20% of domestic consumption. LICONSA, Mexico's social services agency, imports approximately 110,000 tons of milk powder yearly to distribute to low-income consumers (USDEC, 2002).

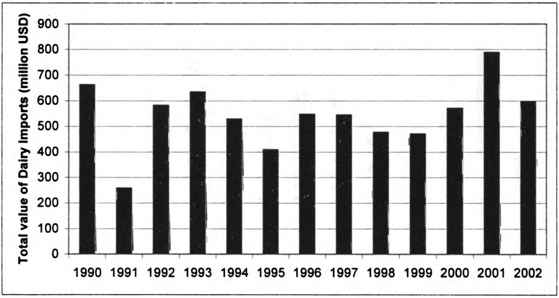
Mexico has long been the largest U.S. dairy customer. Sales to Mexico in 2002 totaled $250 million (USDEC, 2002). Figure 4.1 displays these values. However, the pattern of the imports into Mexico has been variable. Figure 4.2 displays imports of dairy products into Mexico for the period 1990-2002. During the first half of the 1990's, imports were not constant, peaking in 1990, drastically falling in 1995 due to the financial crisis and steadily increasing from 1998 to 2001.

Fig. 4.1. Total Value of U.S. Exports to Mexico



Source: U.S. Department of Agriculture
*These values are the total exports to Mexico rather than the USDEC member companies' sales to Mexico. USDEC channels 85% of the exports to Mexico.

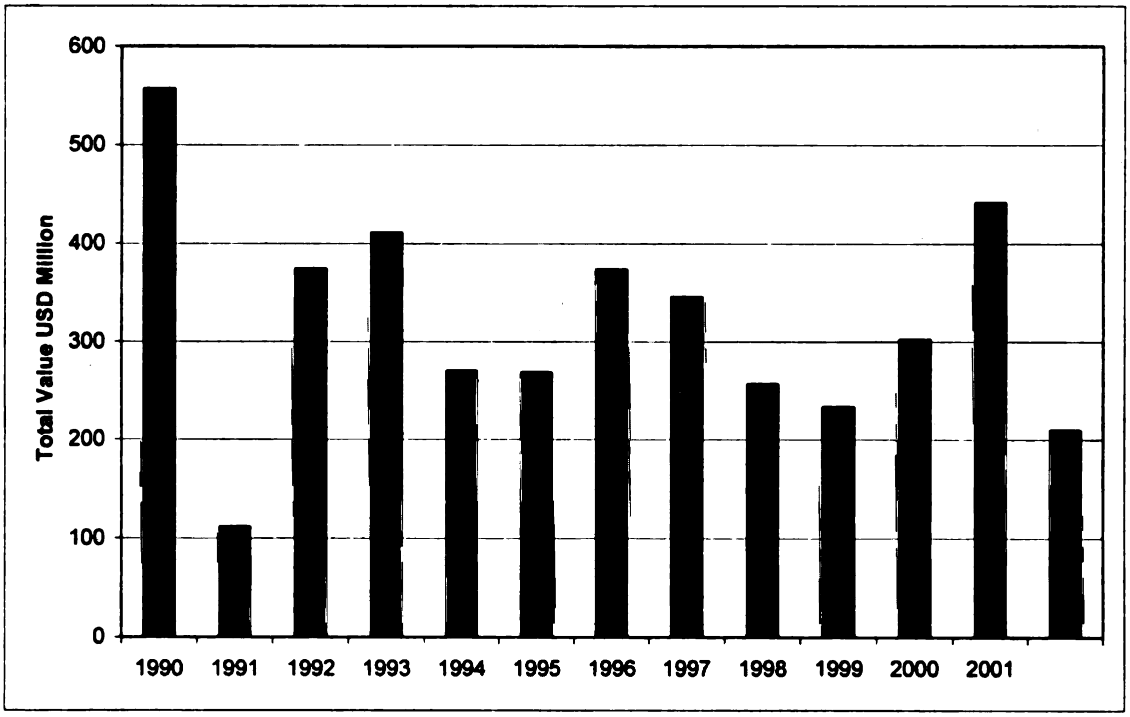
Figure 4.2. Total Value of Mexico Dairy Imports



Source: U.S. Department of Agriculture and SAGARPA.

This aggregate picture of total imports does not reveal much about the nature and origin of the imports. Figure 4.3 and 4.4 display a more detailed description of imports by product. The products selected for this study include skim milk powder, cheese, butter, fluid milk, whey, ice cream and yogurt. These products encompass the entire dairy category as defined by the Harmonized Tariff Schedule (HTS)[1] and reflect the interests of the exporters. Skim milk powder has always been the most important import in terms of value and quantity. Imports of milk powder have shown considerable variability, depending on the quota allotment, domestic availability and world prices, peaking in 1990 and drastically falling in 1991 (Figure 4.3). Other dairy products have been increasing steadily since 1995 and cheese has been the most important product followed by other dairy that includes ice cream and yogurt (Figure 4.4)

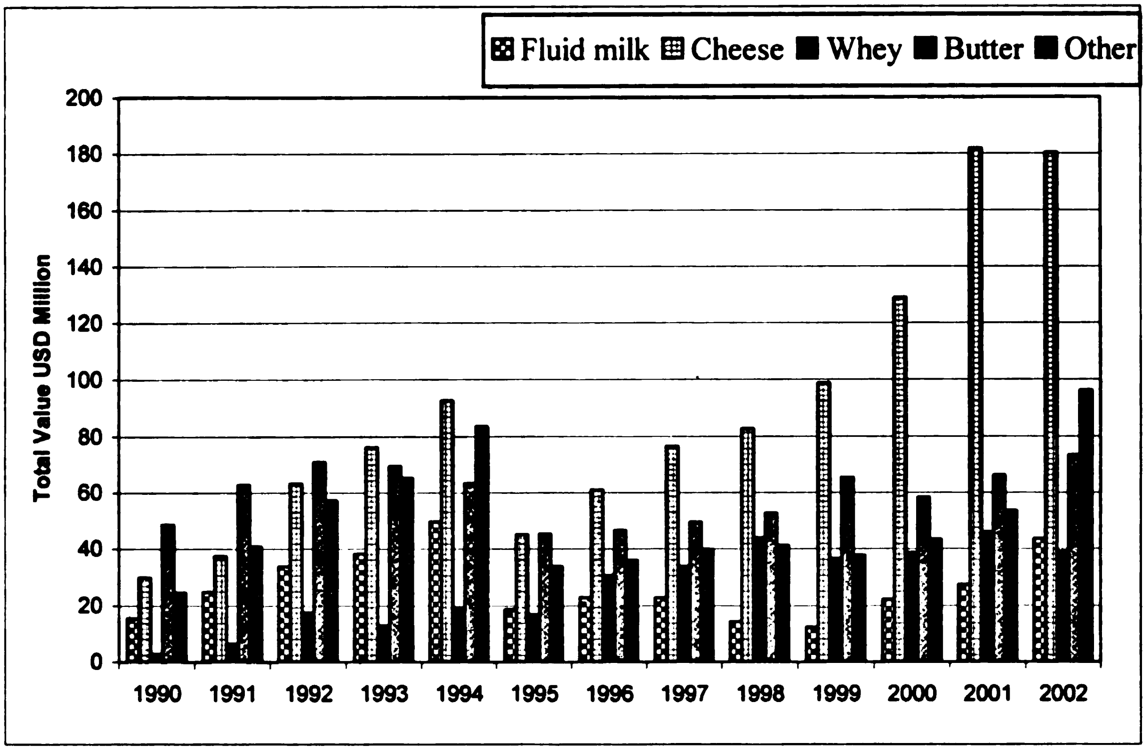
Figure 4.3. Milk Powder Imports



Source: Mexican Secretariat of Economy

[1] This schedule describes dairy products under chapter four of the Harmonized Tariff Schedule and includes these products excepting ice cream that is included under chapter 18.

Figure 4.4. Dairy Imports by Category



Source: Mexican Secretariat of Economy
*The category other includes ice cream and yogurt

Table 4.1 shows the changes in import market share for the main exporters to Mexico for all dairy products. It is clear that the U.S. has faced competition from the other major suppliers of dairy to Mexico, especially the European Union. Oceania has kept a somewhat constant share of the market and competition from other countries, especially those in South America such as Argentina and Uruguay, has been increasing. These changes in import shares are shown in figure 4.5. Countries export different goods based on their comparative advantages.

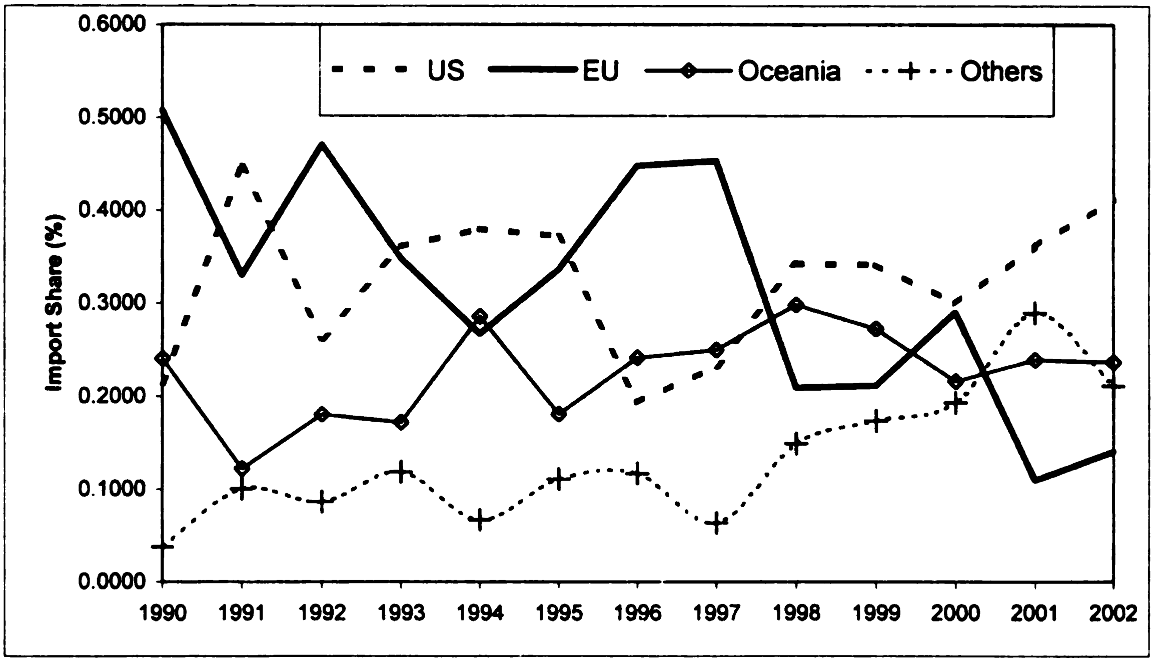
Table 4.2 shows the relative advantages in terms of products exported. The U.S. has the largest share in cheese, fluid milk, whey and other dairy. European countries have the largest share in milk powder and Oceania has the largest share in butter. It is important to note that all these shares are based on value of imports.

Table 4.1. All dairy shares of main dairy exporters to Mexico

Year	*US*	*EU*	*Oceania*	*Others*
1990	0.2141	0.5077	0.2403	0.0378
1991	0.4476	0.3300	0.1221	0.1003
1992	0.2620	0.4708	0.1806	0.0866
1993	0.3610	0.3482	0.1721	0.1187
1994	0.3802	0.2669	0.2860	0.0669
1995	0.3722	0.3361	0.1808	0.1109
1996	0.1932	0.4483	0.2415	0.1170
1997	0.2327	0.4535	0.2501	0.0637
1998	0.3426	0.2095	0.2987	0.1492
1999	0.3419	0.2115	0.2727	0.1738
2000	0.3000	0.2903	0.2163	0.1934
2001	0.3613	0.1095	0.2395	0.2897
2002	0.4117	0.1403	0.2368	0.2112

Source: Calculations made by the author with data from the Mexican Secretariat of Economy

Figure 4.5. Import Shares of main dairy exporters to Mexico



Source: Mexican Secretariat of Economy

Table 4.2. Main Exporters to Mexico Shares by Product

	Fluid Milk	*Cheese*	*Skim Milk Powder*	*Whey*	*Butter*	*Other Dairy**
US	91.2198%	30.8438%	24.9312%	69.8711%	18.7517%	76.2357%
EU	0.4661%	26.6696%	36.4942%	13.7870%	29.9286%	19.4722%
Oceania	0.3780%	21.5815%	23.8565%	2.3839%	47.9408%	0.0000%
Other	7.9360%	20.9051%	14.7181%	13.9580%	3.3789%	4.2921%

Source: Calculations made by the author with data from the Mexican Secretariat of Economy
*Includes ice cream and yogurt.

Previous studies on the prospects for U.S. exporters have focused on different perspectives. Cranney (1992) estimated a general equilibrium model for the supply-demand of milk in Mexico. Nicholson (1995) estimated a spatial equilibrium model for the dairy sector. Bradford et al. (1994), and Procter and Dobson (2002) made projections and built scenarios based on "baseline" projections. The Food and Agriculture Organization (FAO) has estimates for the demand of different commodities based on "baseline" period projections. These studies did not consider the differentiation of products and origins and how distinct dairy products may have interactions due to their use as ingredients for manufacturing other dairy products.

The objectives of this chapter are: (1) to analyze dairy import demand in Mexico during the period 1990-2002, (2) to assess the import behavior and determine the demand elasticities for different imported dairy products, differentiating source of origin to account for differences in preferences, and (3) to evaluate the prospects for U.S. exporters vis-à-vis with other exporters. This is done by estimating a Restricted Source Differentiated Almost Ideal Demand System (RSDAIDS) of Mexican dairy imports.

Model

This research utilizes an Almost Ideal Demand System (AIDS) (Deaton and Muellbauer, 1980). The AIDS model allows unbiased estimation of cross-price elasticities across different commodity categories as contrasted with a single equation form that does not consider that the expenditure is shared among different categories of the same commodity and that different categories have interactions related to the expenditure function, thus biasing the estimations.

Empirical applications of the AIDS model to import demand typically assume either product aggregation, under which the demand system does not differentiate products by source[2] or block separability among goods, which allows the model to consist only of share equations for a good from different origins, and does not account for different perceptions in quality and other preferences. An AIDS model based on only one product from different origins, in this case dairy or milk, assumes aggregation over products that is possible only if all prices move together by the same proportion, which does not necessarily hold true in international trade (Yang and Koo, 1994; Alston et al., 1990). This aggregation ignores the fact that Mexican importers may perceive U.S. dairy products differently from European or Australian products, meaning that preferences are based on block-wise dependence. Thus the marginal utility of consuming U.S. cheese would not be affected by the consumption of European cheese, which does not hold true (Seale et al., 2002). Ignoring block separability among goods in dairy imports would be counter-intuitive. This would allow modeling the demand for milk independently of the demand for cheese, which would not represent the different interactions between the

[2] This means that they assume perfect substitutability from different sources. Even though, perfect substitutability does not necessarily imply perfect substitution.

different dairy products and may bias elasticity estimates (Yang and Koo). This discussion suggests that source differentiation is important in import demand analysis.

The starting point for the AIDS model is a general second-order approximation to any arbitrary direct or indirect expenditure given a utility function which by Shephard's lemma yields the budget share as a function of prices and utility (Deaton and Muellbauer, 1980). Based on these considerations, the model specified by Yang and Koo assumes that utility is a function of price and source of origin in the following way:

$$(1)\ w_{ih} = \alpha_{ih} + \sum_{j}\sum_{k}\gamma_{ihjk}\ln(P_{jk}) + \beta_{ih}\ln(\frac{E}{P*}),$$

where w is the import share of a given product; the subscripts *i* and *j* denote goods (i, j = 1..N) and h and k denote sources of origin, P represents price of the commodity in question; E is the expenditure, represented by the per capita private consumption rather than a general income per capita, and P* represents an index of prices similar to the Consumer Price Index, but based only on the commodities in question; ln (P*) is:

$$(2)\ \ln(P*) = \alpha_0 + \sum_{i}\sum_{h}\gamma_{ih}\ln(P_{ih}) + \frac{1}{2}\sum_{i}\sum_{h}\sum_{j}\sum_{k}\gamma_{ihjk}\ln(P_{ih})\ln(P_{jk}),$$

where α, β and γ are parameters. Since the price index ln (P*) in equation (2) is non-linear and is difficult to estimate, Stone's index is used as a linear approximation (Deaton and Muellbauer, 1980). Stone's index is defined by:

$$(3)\ \ln(P*) = \sum_{i}\sum_{h} w_{ih}\ln(P_{ih}).$$

To avoid problems of simultaneity in the expenditure share w_{ih}, which is also the dependent variable in equation (1), the average share was used as indicated by Yang and Koo. The Source Differentiated Almost Ideal Demand System (SDAIDS) model in equation (2) is data intensive and may suffer from issues related to degrees of freedom shortages. Following the approach of Yang and Koo, the following assumptions were followed to reduce the number of parameters:

(4) $\gamma_{ihjk} = \gamma_{ihj} \forall k \in j \neq i$.

This assumption is called block substitutability and means that cross-price effects of commodity *i* from origin *h* are the same for all commodities *j* regardless of their origin. In terms of this research, it implies that Mexican demand for U.S. cheese exhibits the same cross-price response to milk powder from Europe or milk powder from Oceania.

Substituting equation (4) into (2) allows rewriting the model as:

(5) $$w_{ih} = \alpha_{ih} + \sum_{k} \gamma_{ihk} \ln(P_{ik}) + \sum_{j \neq i} \gamma_{ihj} \ln(P_j) + \beta_{ih} \ln(\frac{E}{P*}),$$

where γ_{ihk} is a cross-price response parameter for the same good for different origins, and the parameter γ_{ihj} is the block substitutability cross-price parameter.

In this case the commodity is all dairy and the categories are cheese, milk powder and other dairy products. The advantage of the model in (5) is that it requires less parameters, M + (N - 1) + 2 parameters, where M is the number of origin countries and N is the number of commodities. This is important given data constraints.

Marshallian price elasticities are given by:

(6) $$\begin{aligned} \varepsilon_{ihih} &= -1 + \frac{\gamma_{ihh}}{w_{ih}} - \beta_{ih}, \\ \varepsilon_{ihik} &= \frac{\gamma_{ihk}}{w_{ih}} - \beta_{ih}(\frac{w_k}{w_{ih}}), \\ \varepsilon_{ihj} &= \frac{\gamma_{ihj}}{\gamma_{ih}} - \beta_{ih}(\frac{w_j}{w_{ih}}), \\ \eta_{ih} &= 1 + \frac{\beta_{ih}}{w_{ih}}. \end{aligned}$$

The general demand assumptions include:

(7) adding-up: $\sum_i \sum_h \alpha_{ih} = 1; \sum_h \gamma_{ihk} = 0; \sum_i \sum_h \gamma_{ihj} = 0; \sum_i \sum_h \beta_{ih} = 0,$

(8) homogeneity: $\sum_k \gamma_{ihk} + \sum_{j \neq i} \gamma_{ihj} = 0$, and

(9) symmetry: $\gamma_{ihk} = \gamma_{ikh}$.

Finally, this model does not consider domestic products (Yang and Koo and Alston et al.). Domestic production is not precluded as an import, thus it is not possible to construct budget shares using import data with domestic prices. This is especially true when imports have different marketing channels from their domestic counterparts, which is the case in Mexico. This study assumes separability between domestic and import products (Winters, 1984).

Data

Data from the Mexican Secretariat of Economy on import monetary values and quantities for fluid milk, cheese, milk powder, whey, butter, ice cream and yogurt were utilized. Fluid milk, whey, butter, ice cream and yogurt were grouped to save degrees of freedom and classified as other dairy products. These statistics were reported on a yearly basis and were separated by source of origin. The sources of origin were defined as: The United States, European Union, Oceania (including Australia and New Zealand), and Other Countries. This latter category of countries included all the small players engaged in dairy trade with Mexico (e.g., India, Costa Rica, Argentina, Poland and Uruguay). With this information, it was possible to derive the import shares from the respective sources of origin.

Export prices from the U.S. were obtained from the U.S. Department of Agriculture. Export prices for the European Union and Oceania were obtained from the FAO Statistics Database. For Oceania, the price selected was a weighted average of the prices of New Zealand and Australia based on their proportional share of exports.

Data for the other countries deserves special attention. Some of these countries are eventual exporters and some of them do not have a stable presence. The only "other" countries that were relatively constant throughout the period of study were Argentina, Uruguay and Poland. The export prices for these countries were obtained from the FAO Statistics Database and a proxy price was based on weighted average of exports to Mexico.

Dollar export values were divided by their corresponding quantities reported by the USDA and FAO to obtain a proxy Free on Board Price (FOB) Mexico without tariffs. This approach allows reporting the prices that exporters actually charged importers accounting for export subsidies and transportation costs (Yang and Koo).

Prices were adjusted by Mexican import tariffs to better reflect the actual price in Mexico. Two different tariff schedules were applied to the prices, one for the United States specified under the North American Free Trade Agreement[3] (NAFTA) that considers the phasing out of tariffs in a 10-year period, and another tariff schedule for all the other countries[4]. Table 4.3 displays the tariff schedules for dairy imports into Mexico. Another factor that was considered when getting the prices was the prevailing milk powder quota. Under WTO and GATT guidelines, there is an 80,000 metric tons

[3] This schedule is only valid for the United States under the NAFTA guidelines. Canada excluded its dairy sector from the NAFTA negotiations.
[4] Even though a Free Trade Agreement with the European Union was signed in 2000, the dairy category was excluded from the negotiation because of the high level of subsidies endeavored by the European Union.

duty free quota for all the WTO countries exporting milk powder to Mexico. Quantities that surpass the quota are subject to a 139% tariff. For the U.S., under NAFTA guidelines[5], there is a quota of 40,000 metric tons of milk powder independent from the WTO quota, subject to the same tariff for exceeding quantities, and scheduled to be phased out over a 15-year period ending in 2008. Every year, the quota increases by 3%. The tariffs phased out by 24% over the first six years of the agreement and the remainder of the over-quota tariff will be eliminated linearly over the remaining time period ending in 2008. These considerations were taken into account when calculating the import prices of milk powder by source country. Data on private consumption was obtained from the Central Bank of Mexico (Banxico).

Table 4.3. Tariff Schedules

Product	*WTO countries Tariff*	*NAFTA Tariff in 1993*	*NAFTA Tariff in 2003**
Fluid milk	10%	10%	0%
Yogurt	20%	20%	0%
Whey	10%	10%	0%
Butter	20%	20%	0%
Cheese	20%	20%	0%
Ice cream	20%	20%	0%

Source: Mexican Secretariat of Economy
*These values consider that NAFTA started in 1993 and the tariffs were phased out linearly over a 10 years period ending in 2003.

Estimation and Results

Data were available from 1990 through 2002, a total of 13 annual observations. Since the objective of the research is to estimate demand responsiveness to prices and expenditure. In order to assess future demand and prospects for U.S. exporters, one system for cheese, milk powder, and other dairy products was estimated. This system

[5] These guidelines under NAFTA started in 1993. Before that date, the U.S. was subject to the same WTO schedule.

had four equations for every good and a total of six parameters per equation. The last equation for other dairy products from other countries, was dropped to avoid singularity. The expenditure function (import monetary value) was constructed as a linear function of national private consumption and the Stone Index (Yang and Koo). This system was estimated by a Seemingly Unrelated Regression (SUR) technique.

Table 4.4 displays the results for the parameters estimated from the models. As can be seen, most of the parameter estimates are significant at the 10% level. These parameters are used to calculate the own- and cross-price elasticities estimates.

Table 4.4. Estimated Results from the RSDAIDS model

Product	*Source of Origin*	*Parameter*	*Estimate*	*t-statistic*	*P-value*	*Definition*
Cheese	United States	α_{USCH}	-1.12335	-6.57564	.000	Equation Intercept
(CH)	U.S.	γ_{USUSCH}	-0.02151	-3.07206	.002	Own-price parameter
		γ_{USEUCH}	0.035077	4.51943	.000	Cross-price parameter with respect to cheese from the EU
		γ_{USAUCH}	-0.04708	-4.9649	.000	Cross-price parameter with respect to cheese from Oceania
		γ_{USCHM}	0.021849	2.17205	.030	Cross-price parameter with respect to milk powder from all the origins
		β_{USCH}	0.061499	6.71686	.000	Expenditure parameter
Cheese	European Union	α_{EUCH}	-0.41046	-3.41587	.001	Equation Intercept
(CH)	EU	γ_{EUEUCH}	-0.08317	-5.43641	.000	Own-price parameter
		γ_{EUAUCH}	0.068397	4.35393	.000	Cross-price parameter with respect to cheese from Oceania
Cheese	European Union	γ_{EUMCH}	-7.35E-03	-0.94907	.343	Cross-price parameter with respect to milk powder from all the origins
		β_{EUCH}	0.024092	3.74967	.000	Expenditure parameter

Table 4.4. Continued.

Product	*Source of Origin*	*Parameter*	*Estimate*	*t-statistic*	*P-value*	*Definition*
Cheese (CH)	Oceania (AU)	α_{AUCH}	-0.60359	-3.87239	.000	Equation Intercept
		γ_{AUAUCH}	-0.02592	-1.15029	.250	Own-price parameter
		γ_{AUMCH}	9.63E-03	0.807647	.419	Cross-price parameter with respect to milk powder from all the origins
		β_{AUCH}	0.033906	4.06426	.000	Expenditure parameter
Cheese (CH)	Other Countries (OT)	α_{OTCH}	-1.09905	-7.20796	.000	Equation Intercept
		γ_{OTMCH}	-0.02458	-2.69642	.007	Cross-price parameter with respect to milk powder from all the origins
		β_{OTCH}	0.060914	7.45436	.000	Expenditure parameter
Milk Powder (MP)	U.S.	α_{USMP}	1.14738	1.65813	.097	Equation Intercept
		γ_{USUSMP}	0.196103	5.61716	.000	Own-price parameter
		γ_{USEUMP}	-0.12957	-3.88514	.000	Cross-price parameter with respect to milk powder from EU
		γ_{USAUMP}	-0.1322	-7.41825	.000	Cross-price parameter with respect to milk powder from Oceania
		γ_{USMPCH}	0.198821	2.53025	.011	Cross-price parameter with respect to cheese from all the origins
		β_{EUMP}	-0.06386	-1.6594	.097	Expenditure parameter
Milk Powder (MP)	European Union (EU)	α_{EUMP}	5.91046	4.25439	.000	Equation Intercept
		γ_{EUEUMP}	0.11604	2.07928	.038	Own-price parameter
		γ_{EUAUMP}	-0.02228	-0.85833	.391	Cross-price parameter with respect to milk powder from Oceania
		γ_{EUMPCH}	-0.01663	-0.13333	.894	Cross-price parameter with respect to cheese from all the origins
		β_{EUMP}	-0.30153	-3.97889	.000	Expenditure parameter

Table 4.4. Continued.

Product	*Source of Origin*	*Parameter*	*Estimate*	*t-statistic*	*P-value*	*Definition*
Milk Powder (MP)	Oceania (AU)	α_{AUMP}	-1.15778	-1.99056	.047	Equation Intercept
		γ_{AUAUMP}	0.471351	12.7905	.000	Own-price parameter
		γ_{AUMPCH}	-0.23881	-4.1993	.000	Cross-price parameter with respect to cheese from all origins
Milk Powder	Oceania	β_{AUMP}	0.080846	2.54425	.011	Expenditure parameter
Milk Powder (MP)	Other Countries (OT)	α_{OTMP}	-0.46006	-0.76892	.442	Equation Intercept
		γ_{OTMPCH}	0.014123	0.209093	.834	Cross-price parameter with respect to cheese from all origins
		β_{OTUMP}	0.02594	0.789325	.430	Expenditure parameter
Other Dairy (OD)	U.S.	α_{USOD}	-2.33706	-3.32598	.001	Equation Intercept
		γ_{USUSOD}	-0.28036	-21.9694	.000	Own-price parameter
		γ_{USEUOD}	0.113161	11.3723	.000	Cross-price parameter with respect to other dairy from EU
		γ_{USAUOD}	0.106043	10.4813	.000	Cross-price parameter with respect to other dairy from Oceania
		γ_{USODCH}	0.058803	2.07584	.038	Cross-price parameter with respect to cheese from all the origins
		β_{USOD}	0.12507	3.34926	.001	Expenditure parameter
Other Dairy	European Union (EU)	α_{EUOD}	0.662094	1.81831	.069	Equation Intercept
		γ_{EUEUOD}	-0.0366	-3.18211	.001	Own-price parameter
		γ_{EUAUOD}	-0.05903	-5.32063	.000	Cross-price parameter with respect to other dairy from Oceania
		γ_{EUODCH}	7.31E-03	0.306796	.759	Cross-price parameter with respect to cheese from all the origins
		β_{EUOD}	-0.0294	-1.52391	.128	Expenditure parameter
Other Dairy	Oceania (AU)	α_{AUOD}	0.502852	1.94356	.052	Equation Intercept
		γ_{AUAUOD}	-0.011	-0.82503	.409	Own-price parameter
		γ_{AUODCH}	-0.01586	-0.85275	.394	Cross-price parameter with respect to cheese from all the origins
		β_{AUOD}	-0.02155	-1.5763	.115	Expenditure parameter

Table 4.5. Summary Statistics

Equation	R^2	*Std. Error of regression*
Cheese U.S.	0.7915	0.0101
Cheese EU	0.8212	0.06456E-2
Cheese Oceania	0.7282	0.84412E-2
Cheese Other Countries	0.7898	0.9239E-3
Milk Powder U.S.	0.3468	0.0358
Milk Powder EU	0.6641	0.0779
Milk Powder Oceania	0.3931	0.0333
Milk Powder Other Countries	0.5386	0.0328
Other Dairy U.S.	0.5592	0.0417
Other Dairy EU	0.0330	0.0213
Other Dairy Oceania	0.3388	0.0149

Table 4.5 displays the different R^2 values and standard errors for the equations; these values seem reasonable for an equation system, ranging from 0.03 to 0.82. Hicksian elasticities were calculated to better assess the net relationships between the products from different origins. These values are reported in table 4.6. Values for Marshallian elasticities are reported in table 4.7 for comparison purposes. The significance of the elasticities was tested following the approach of Chalfant (1987) by calculating the standard errors (SE), as a function of the average share (w_i) and the β_I parameter from the regressions, and testing their significance with the Wald statistic:

(10) $SE(\varepsilon) = (1/w_i)SE(\beta_i)$.

Income elasticities were easier to compare among different studies. Cranney (1992) reported own-price elasticity for farm-gate milk of –0.15. Tanyeri-Abur and Rosson (1996) reported import demand for fluid milk and cheese income elasticities estimates of 4.863 and 1.998 respectively by using a linear demand curve. Gould and Kim (1998) estimated own-price elasticities for cheese (-0.182), total dairy (-0.010) and butter (-1.30) by using a Tobit model built on household consumption surveys.

Nicholson (1995) reported estimates for expenditure elasticities at the mean level based on household surveys for fluid milk (1.01), milk powder (0.32), fresh cheese (0.62), and butter (1.18).[6] The results for expenditure elasticities based on this model, suggest that expenditure elasticities for dairy products show large variations depending on the origin.[7]

Implications

Given the disaggregated nature of the estimates, a description of different products is performed to better understand the results and interactions of the products.

With respect to the demand for cheese, all own-price elasticities are elastic. Demand for U.S. cheese is the least sensitive to its own price (-1.4090), followed by cheese from Other Countries (-1.4827), and cheese from Oceania (-1.7545). European cheese is the most sensitive to its own price (-3.1013), arguably because Europe exports specialty cheeses that are luxuries and are very sensitive to their own-price. In terms of the expenditure elasticity, if total expenditure on dairy products were to rise, *ceteris paribus*, cheese demand from Other Countries would increase the most (2.7690), followed by cheese from the U.S. (2.3044), and Oceania (2.0301). European cheese would be the least favored (1.6200). Cross-price elasticities reveal competitive relations among products. Two goods are said to be (net) complements if the price of one rises, the quantity consumed of the other will fall, holding expenditure constant. Two goods are (net) substitutes if the price of one increases, more of the other good will be demanded if expenditure is held constant.

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[6] Both Nicholson (1995) and Gould & Kim based their estimations on the Household Income and Expenditure National Survey done by the National Institute of Statistics and Informatics (INEGI).
[7] Yang and Koo (1994) and Alston et al. (1990) arrived to the same conclusion with studies on beef and grain demand, so source differentiation is important when evaluating imports demand.

Table 4.6. Hicksian Elasticities of Mexican Dairy Import Demand using the Restricted SDAIDS Model

	Cheese				Milk Powder				Other Dairy			
Price	United States	European Union	Oceania	Other Countries	United States	European Union	Oceania	Other Countries	United States	European Union	Oceania	Other Countries
U.S. Cheese	**-1.4090**	**0.9364**	**-1.4122**	**0.9851**								
Cheese	**0.8020**	**-3.1013**	**2.1047**	**-0.5632**								
Oceania Cheese	**-0.9330**	**1.8027**	**-1.7545**	**0.1709**								
Cheese	**0.7745**	**-0.4810**	**0.1713**	**-1.4827**								
U.S. Milk Powder					**0.6671**	**-0.5080**	**-0.8792**	0.9099				
European Union Milk Powder					**-0.8456**	-0.2465	-0.0926	0.4940				
Oceania Milk Powder					**-0.9090**	-0.0064	**2.7387**	-4.0400				
Other Countries Milk Powder					**0.6178**	**0.1882**	**-2.2619**	1.8641				
U.S. Other Dairy									**-2.1987**	**2.8676**	**3.6968**	2.5952
European Union Other Dairy									**0.8641**	**-1.8361**	**-1.9344**	-0.7257
Oceania Other Dairy									**0.8360**	**-1.3824**	**-1.3376**	-1.5102
Other Countries Other Dairy									0.6160	-0.3916	-1.1784	-1.3003
Cheese from all the Origins					**1.7015**	0.0515	**-1.7114**	0.2345	0.5232	0.2958	-0.4113	-1.3558
Milk Powder from all the Origins	-0.1468	**-0.4679**	-0.2083	**-1.5933**					**-0.3120**	0.2256	0.9355	1.2886
Other Dairy from all the Origins	**-0.7402**	0.0689	-0.5302	0.2863	**-1.3494**	0.4042	**1.8566**	-0.1786				
Expenditure	**2.3044**	**1.6200**	**2.0301**	**2.7690**	0.4986	-0.3970	**1.6188**	1.3356	**1.6241**	0.2948	0.2797	1.1737

*Bolded values indicate significance at the 5% level.

Table 4.7. Marshallian Elasticities of Mexican Dairy Import Demand using the Restricted SDAIDS Model

	Cheese				Milk Powder				Other Dairy			
Price	United States	European Union	Oceania	Other Countries	United States	European Union	Oceania	Other Countries	United States	European Union	Oceania	Other Countries
U.S. Cheese	**-1.5176**	**0.8735**	**-1.4790**	**0.8898**								
European Union Cheese	**0.6933**	**-3.1643**	**2.0379**	**-0.6585**								
Oceania Cheese	**-1.0416**	**1.7398**	**-1.8213**	**0.0755**								
Other Countries Cheese	**0.6659**	**-0.5440**	**0.1044**	**-1.5781**								
U.S. Milk Powder					**0.6036**	**-0.4224**	**-1.0907**	**0.8067**				
European Union Milk Powder					**-0.9091**	-0.1609	-0.3041	**0.3907**				
Oceania Milk Powder					**-0.9725**	0.0793	**2.5272**	**-4.1432**				
Other Countries Milk Powder					**0.5543**	**0.2739**	**-2.4734**	**1.7609**				
U.S. Other Dairy									**-2.5242**	**2.8553**	**3.6884**	2.5676
European Union Other Dairy									**0.5387**	**-1.8484**	**-1.9428**	-0.7533
Oceania Other Dairy									**0.5105**	**-1.3947**	**-1.3460**	-1.5378
Other Countries Other Dairy									0.2905	-0.4039	-1.1868	-1.3279
Cheese from all the Origins					**1.6380**	0.1372	**-1.9229**	0.1312	0.1977	0.2835	-0.4197	-1.3834
Milk Powder from all the Origins	-0.2555	**-0.5309**	-0.2751	**-1.6886**					**-0.6374**	0.2133	0.9272	1.2610
Other Dairy from all the Origins	**-0.8489**	0.0059	-0.5970	0.1909	**-1.4129**	0.4899	**1.6452**	-0.2819				
Expenditure	**2.3044**	**1.6200**	**2.0301**	**2.7690**	0.4986	-0.3970	**1.6188**	**1.3356**	**1.6241**	0.2948	0.2797	1.1737

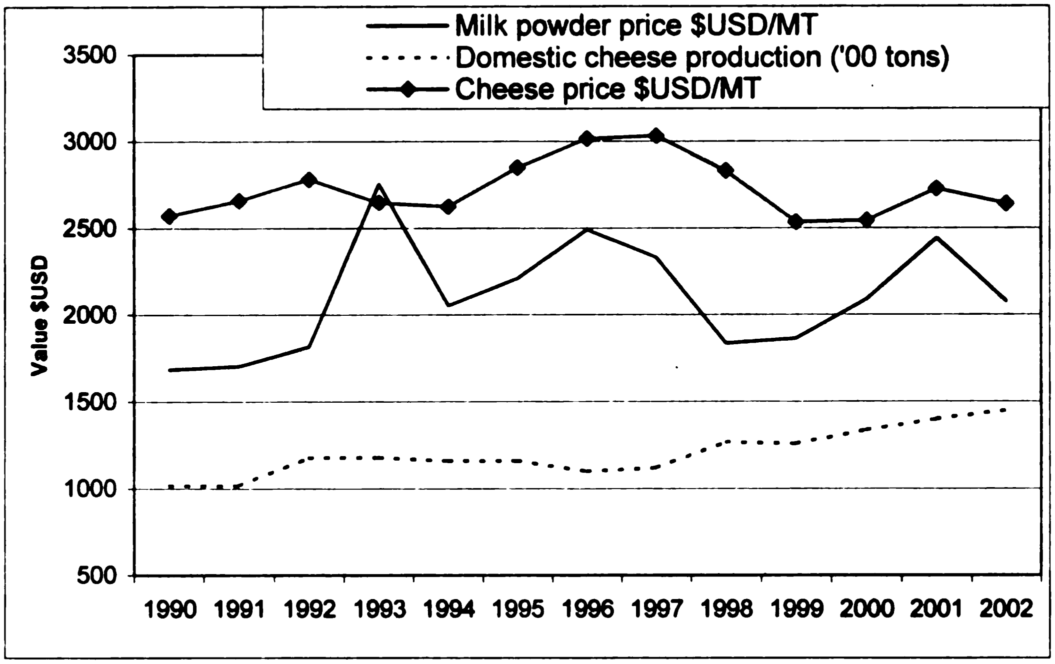
*Bolded values indicate significance at the 5% level.

In this sense U.S. cheese exhibits substitutability with cheese from Europe (0.8020) and cheese from Other Countries (0.7745). Cheese from Oceania is a complement for U.S. cheese (-0.9339). In other words, as U.S. cheese price increases, *ceteris paribus*, more cheese from Europe and from Other Countries, and less cheese from Oceania is demanded.

The complementarity and substitutability relations are not symmetric. U.S. cheese is less sensitive to Oceania prices (-0.9339) than Oceania cheese to U.S. prices (-1.4122). The results suggest that milk powder and Other Dairy are complements for cheese by the predominance of negative signs in the cross-product elasticities, but their estimates are very inelastic. For instance, a 1% increase in U.S. cheese price, would bring about a 0.1468% decrease in milk powder demand.

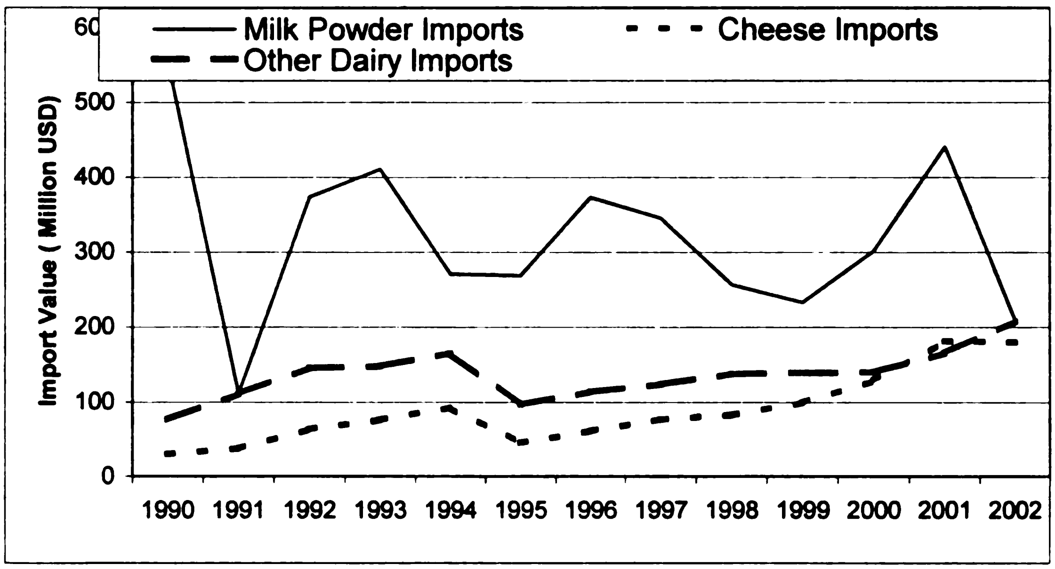
Regarding the demand for milk powder, the own-price elasticity estimates for the U.S., Oceania and Other Countries are positive and significant at the five percent level, while the own-price elasticity for European milk powder is negative and not significant. The significance of the estimates requires some explaining on the reason why these values could be positive. One argument is the fact that milk powder principal use in Mexico is for social programs. Indeed, Liconsa, Mexico's social agency processes an estimate of 70 to 75% of the total imports of milk powder and distributes them to low-income people (Garcia Hernandez, 1996; Rabobank, 2000). Garcia Hernandez (1996) argued that the Mexican government is obliged to buy milk powder in order to accomplish the social goals. By regressing milk powder imports on domestic production and milk powder world prices, Hernandez found that the coefficients for domestic production and world prices were insignificant. Other reason to be considered is the fact that milk powder can be a substitute for domestic and imported dairy products, as confirmed by the elasticity estimates, i.e., if prices for cheese and other dairy go up, *ceteris paribus*, the demand for milk powder increases. In general, milk powder prices move with other prices (fig 4.6), so if milk powder prices were to rise, prices for other products such as cheese would increase, and importing more milk powder to produce some of them domestically would be cheaper than importing the finished products. According to Fernandez (personal communication), imported milk powder is utilized in manufacturing cheese and other dairy products in Mexico, around 75% of the cheese manufactured in Mexico is analog cheese (cheese made with milk powder or other dry dairy ingredients). This argument is weakly supported by the correlation coefficient between the milk powder price from all the origins and the domestic cheese production (0.2003), as milk prices rise, domestic cheese production rises too (Fig. 4.7). The same result is valid for cheese and other dairy products (Fig. 4.7) as denoted by the correlation coefficient between milk powder imports and other dairy imports (-0.2795). Thus, the social programs and the role as a substitute for manufacturing other dairy products, could be arguments for explaining the anomaly of these milk powder own-price elasticity estimates. The limited amount of observations is also a possible cause of the anomaly.

Fig. 4.6. Relation between Milk Powder Prices and Mexican Cheese Production



Source: USDA and INEGI.

Fig. 4.7. Relation between Milk Powder, Cheese and Other Dairy Imports



Source: Mexican Secretariat of Economy

Traditionally, the European Union and the U.S. have been the main suppliers of milk powder to Mexico through subsidizing programs such as the Common Agriculture

Policy (CAP) and the Dairy Export Incentive Program (DEIP) in the case of the European Union and the U.S. respectively. This long-term relationship with these countries and the continuous need for milk powder are reflected in the inelastic estimates for the U.S. (0.6671) and Europe (-0.2465). However, the elasticities for milk powder from Oceania (2.7387) and Other Countries (1.8641) are highly elastic, which could be explained by the fact that these countries do not always have milk surpluses to convert into milk powder and LICONSA's supplier diversification policy that encourages procuring milk powder from alternative sources.

The results for expenditure elasticities suggest that milk powder from the European Union is regarded as an inferior good (-0.3970). U.S. milk powder exhibits an inelastic expenditure elasticity (0.4986) as compared to milk powder from Other Countries (1.3356) and Oceania (1.6188). The preponderance of negative signs among the different sources of origin suggests strong complementarity among the sources of origin, because milk powder international prices tend to move together.

U.S. milk powder exhibits complementarity to milk powder from Oceania (-1.0272) and from Europe (-0.3589), but substitutability with respect to milk powder from Other Countries. The positive value of the cross-product elasticities suggests that milk powder is a substitute for imported cheese and other dairy products.

In terms of the demand for other dairy products, the own-price elasticities suggest that the demand for these products is highly price elastic. Own-price elasticity estimate for Other Countries is the least sensitive to its own price (-1.3003), followed by Oceania (-1.3376) and the European Union (-1.8361) and the U.S. (-2.1987). In terms of cross-price elasticities, the results suggest that the U.S. exhibits strong substitutability with other sources of origin. Competition is strong among the other sources, as suggested by the preponderance of negative signs. In terms of expenditure elasticities, the U.S. would benefit the most from an increase in expenditure (1.6241), followed by Other Countries (1.1737), EU (0.2948), and Oceania (0.2747). Regarding the cross-product elasticities, milk powder and cheese can be either complements or substitutes depending on the source of origin in question.

Summary

This chapter described the demand for Mexican dairy imports over the period 1990-2002. The theoretical background suggests that source of origin is important to avoid aggregation and substitution bias, so a Restricted Source Differentiated Almost Ideal Systems (RSAIDS) was estimated. These results seem to be consistent with previous estimates based on household surveys and represent an improvement in the way dairy import demand has traditionally been approached and modeled in Mexico. The results suggest that block substitutability does not necessarily imply that products from different sources are perfect substitutes, thus it is important to differentiate the source of origin when modeling imports demand. The results are consistent with previous studies suggesting that competition among different exporters is strong and that importers behavior is driven by both prices and perceptions. This analysis provides insights on how Mexican importers perceive differences in dairy imports and can be used to evaluate the prospects for U.S. exporters vis-à-vis other exporters under different scenarios.

CHAPTER FIVE

IMPLICATIONS FOR U.S. EXPORTERS

Introduction

One motivation to do this study was to determine whether self-sufficiency in milk production could be achieved in Mexico. Several studies (Barham et al., 1994; Nicholson, 1995) have suggested the possibility of self-sufficiency in milk production based on observations of the past performance of the sector. Indeed, Mexico is self-sufficient in pasteurized fluid milk, for the medium-, high-income consumers, but not yet in the entire dairy sector, including those people that cannot afford milk at market prices and need the government subsidies. A description of these factors and the results from the economic models specified for this research are explored to assess the prospects for U.S. exporters.

Prospects for increased milk production

In 2001, Mexico produced nine million tones of milk, but total imports have yearly averaged around two million tones and domestic production has covered on average 78% of the total demand (table 5.1).

In 1994, Bradford et al. forecasted a milk deficit ranging from 1.488 to 3.762 million tons for 1997, using the average deficit for 1989 to 1992 as a base period. It was further assumed that the totality of the deficit would be covered by U.S. exports and ignored price effects could be derived from NAFTA tariff preferences. Bradford concluded that the most likely scenario would be a medium growth in production (5-7%

annual growth) and high consumption growth (4%)[1]. This prediction proved remarkably accurate as the annual growth of milk production in Mexico has been in average 5% and the growth in demand 4% respectively (table 5.1). This growth in production has not been enough to satisfy the deficit. With these numbers in mind, what are the prospects for increased milk production to meet the consumption of dairy in Mexico?

Table 5.1. Mexico's Dairy Sector Statistics, 1990-2001.

Year	*Production (million tons)*	*Imports (million tons)*	*Total consumption (million tons)*	*% Consumption covered with domestic production*	*% Consumption covered with imports*	*Ratio Imports/Domestic Production*
1990	5.81	2.73	8.54	68.07	31.93	0.47
1991	6.18	1.14	7.32	84.39	15.61	0.19
1992	6.38	2.45	8.83	72.25	27.75	0.38
1993	7.40	2.73	10.13	73.09	26.91	0.37
1994	7.32	2.29	9.61	76.17	23.83	0.31
1995	7.40	1.69	9.09	81.41	18.59	0.23
1996	7.59	1.91	9.50	79.86	20.14	0.25
1997	7.85	2.12	9.97	78.72	21.28	0.27
1998	8.32	2.02	10.34	80.45	19.55	0.24
1999	8.88	2.22	11.09	80.01	19.99	0.25
2000	9.31	2.31	11.62	80.12	19.88	0.25
2001	9.50	2.78	12.28	77.37	22.63	0.29

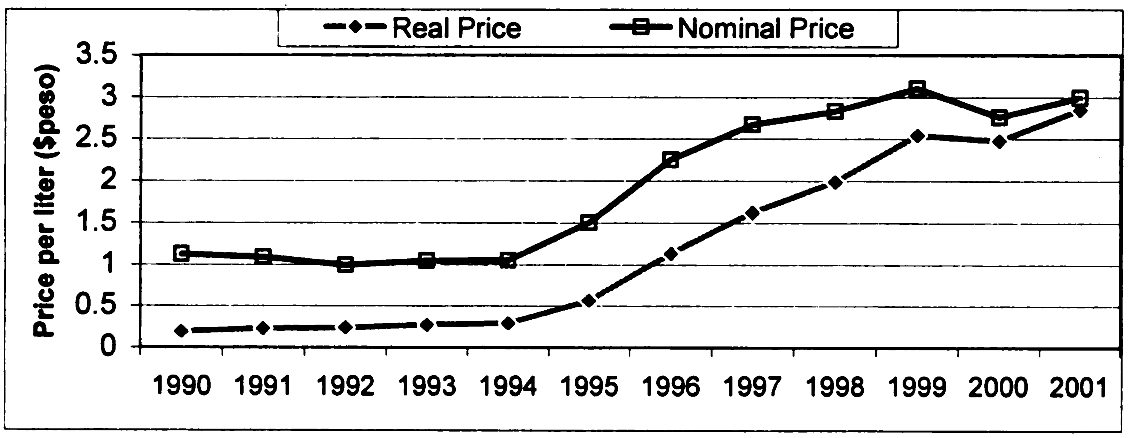
Source: Calculations done by the author with data from the SAGARPA and the USDA.

The prospects for self-sufficiency in milk production are not good. Milk nominal and real prices have been increasing since the price liberalization was allowed in 1995 (Fig 5.1). Dobson and Proctor (2002) mentioned that with increasing prices processors and LICONSA have an incentive to buy dairy products at lower subsidized world prices. If world prices remain below the domestic price, they effectively place a ceiling on domestic production. This free trade policy backed up by NAFTA has been criticized by

[1] This growth is due to 2% from population and 2% of NAFTA induced income effects.

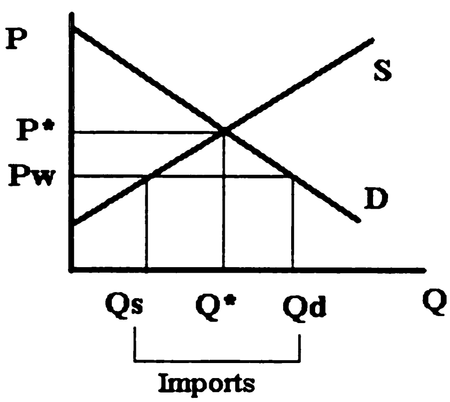
dairy farmers in Mexico, arguing that the Mexican government has forced them to produce for the same price as highly subsidized nations such as the European Union (McDonald, 2000; Hernandez & Del Valle, 2000). Figure 5.2, illustrates graphically this situation: P* represents the domestic milk price in Mexico, Pw represents the world price, a subsidized price. It is clear that Mexican producers have a ceiling on the price they can produce and the incentive to import dairy ingredients from abroad exists for processors and the government itself (Cranney, 1992). Only by lowering costs can farmers increase supply in this situation.

Figure 5.1. Nominal and Real Milk Price ($peso/liter)



Source: SAGARPA

Figure 5.2. Model of Mexican Dairy Market



In terms of cost of production, feed represents approximately 70% of the production costs in Mexico. Dobson and Proctor argued that Mexican farmers have benefited from relatively low prices for grains imported from the U.S. Further, the elasticity estimate for milk supply with respect to feed price was –0.2206, which means that one percent increase in feed price, holding the other factors constant, results in a decrease of 0.2206% in milk production. The own-price elasticity estimate for feed was –1.1316. These estimates suggest that Mexico will likely continue to depend on feed imports.

The model estimated in chapter four was used to forecast milk production in Mexico. This model considered prices for milk and four inputs as exogenous. Individual price forecasts for milk and input prices were estimated using data available modeled as Autoregressive Integrated Moving Average (ARIMA) processes. The estimates were plugged into the original model and milk production was forecasted (Table 5.4).

The time horizon of the predictions is 2011, ten years ahead from the last observation used for the model. The forecast is for milk production to grow by 33.55% over the ten year period for an annual average growth rate of 3.36%.

Prospects for Dairy Consumption

The main factors driving dairy consumption in Mexico are income and population (table 5.2). Per capita income in Mexico has been increasing, but the rate of growth has been variable and even decreased following the 1995 peso devaluation. Even at the lowest income level, demand for dairy products exists, either due to increases in income or to the effects from the social programs. Evidence based on data from the Household Income and Expenditure National Survey carried out in Mexico, revealed that the weekly budget share on dairy expenditures at the lowest income level was 4.22% in 1994, as the incomes increased, the budget share increased to 8.29% in 2000.[2] Nicholson (1995) argued that the biggest changes in dairy consumption in Mexico would come from income changes at the lowest income strata. OECD forecasts that the Mexican economy will be growing at a 4% rate over the next five years.

The annual population growth rate has averaged 1.9% for the period of study. Data on total consumption (production + imports) indicates that the total demand for dairy (Table 5.1), measured in milk equivalents, has grown an average of four percent annually.

Table 5.2. Mexico Income and Population Statistics, 1990-2001.

Year	*GDP per capita(USD)*	*Population (Millions)*
1990	3026	81.657
1991	3489	83.265
1992	3937	84.941
1993	4656	86.613
1994	4771	88.389
1995	3180	90.164
1996	3612	92.159
1997	4274	93.938
1998	4403	95.676
1999	4929	97.362
2000	5800	99.05
2001	6170	100.6

Source: Central Bank of Mexico

In order to forecast future demand for dairy products in Mexico, a log-log demand function was estimated as:

(1) $\ln Q = \alpha + \beta_1 \ln P + \beta_2 \ln GDP + \beta_3 \ln POP$,

[2] Further discussion on this survey can be found in table 2.8 of chapter two that has a more detailed classification of the income levels and their respective expenditures on dairy products.

where Q represents total dairy consumption in metric tons and measured as the summation of total milk production and dairy imports (in milk equivalents). P is the consumer dairy price index reported by the Central Bank of Mexico. GDP, representing income, is the Gross Domestic Product in USD millions as reported by the World Bank, and POP represents population in millions reported by the Mexican Census Department (INEGI). The log-log functional form was selected because the β coefficients measure the elasticity of demand. Data for estimation of (1) were available from 1980 to 2001, a total of 22 annual observations.

Table 5.3. Results for the Log-log Demand Function for Total Dairy in Mexico.

Parameter	*Estimate*	*T-statistic*	*P-value*	*Definition*
α	-10.1748	-4.33979	0.000	Intercept
β_{price}	-0.09383	-3.00666	0.008	Price elasticity
β_{GDP}	0.192001	4.27905	0.000	GDP elasticity
β_{POP}	2.29126	3.58409	0.002	Population elasticity
R^2	0.927092	-	-	R-squared
DW	2.73197	-	-	Durbin-Watson statistic

All the parameters were significant a the 1% level and the $R^2 = 0.93$ indicates that fit was satisfactory (Table 5.3). The estimate for the price elasticity suggests that total milk demand was price inelastic. With these estimates is possible to forecast the future demand for dairy products in Mexico. Since the GDP, Price Index and Population variables are exogenous, ARIMA models for these stationary series were estimated and used to forecast their future values. These values were input in equation (1) and the forecast for total dairy consumption was obtained (Table 5.4).

Table 5.4. Mexico Milk Deficit Projections

Year	*Milk Production*	*Milk Consumption*	*Milk Deficit*
2002	9.18	12.75	3.57
2003	9.21	13.27	4.06
2004	9.54	13.85	4.31
2005	9.92	14.38	4.47
2006	10.21	15.01	4.79
2007	10.86	15.79	4.93
2008	10.45	16.50	6.05
2009	11.45	17.12	5.67
2010	12.50	17.76	5.26
2011	12.26	18.36	6.10

* All values in million metric tons of milk equivalents.

Projections Implications

These projections make clear that Mexico will have to import dairy products to meet its deficit, which is projected to increase from current levels as demand outgrows supply. Investments in technology, infrastructure and improvement in the marketing practices are necessary to increase supply to self-sufficiency levels. Mexico does not have a comparative advantage in milk production and would take many resources to become self-sufficient in milk production (Fernandez, personal communication).

This study does not consider what the effect of the 2008 milk-powder quota removal will be, nor does contemplate external shocks in the macroeconomic variables such as GDP, interest rates, or other. However, the Mexican economy appears to be stable and is projected to continue to grow.

Another factor of consideration in international trade are exchange rates. The impact of the exchange rate is important for domestic producers that rely on the grain world markets to meet their grain demands. It is clear that the exchange rate has made some the input costs very expensive and arguably might have affected dairy imports. Probably, the most important effect of the exchange rate is the cost of imported technology. The technological effects discussed in chapter three remarked that technology has been a crucial factor in achieving higher milk production levels, but at least for the period of study, technology has arguably created a negative influence on the relation between technology cost and profitability.

Nicholson (1995), however, argued that exchange rates exhibit counter-intuitive results and do not influence trade patterns, since the deficit of milk in Mexico is somewhat constant. Exchange rates change the comparative advantage of different exporters to Mexico. Evidence suggests that even during the 1995 crisis, imports represented 18.59% of the total dairy consumption as contrasted with the period average of 22%. Table 5.5 displays the exchange rate (Peso/Dollar) during the period of study. In spite of its depreciation, the exchange rate that operates under free flotation has been very stable during the last years and is backed up by monetary reserves that make the peso the strongest currency in the emerging markets (Ortiz, 2002).

Table 5.5. Exchange rate 1990-2001 (Peso/Dollar)

Year	*Exchange Rate (MX Pesos/USD)*
1990	2.8126
1991	3.0179
1992	3.0945
1993	3.1152
1994	3.3751
1995	6.4190
1996	7.5994
1997	7.9185
1998	9.1357
1999	9.5605
2000	9.4556
2001	9.3425

Source: Central Bank of Mexico.

Prospects for U.S. Exporters

Since the prospects indicate that Mexico will have a milk deficit and that the general economic conditions will not change drastically in the medium-term, it follows to determine how this deficit will be filled by using some of the results from the RSAIDS estimated in chapter four. It is not assumed that most of the commodities exported to Mexico will be subsidized, as contrasted with Cranney (1992). In fact, the U.S. Dairy Export Council (USDEC) reports that 85% of the sales to Mexico are unsubsidized products.

Before considering some of the factors that may influence the trade patterns, it is important to consider what NAFTA has done for U.S. dairy exporters and how this could benefit/affect their prospects vis-à-vis with other world exporters. NAFTA effectively converted import licenses into tariffs that were gradually phased out, except for milk powder, which has an expandable quota and a 139% over-quota tariff that will disappear in 2008. Despite this tariff, Mexico assigned almost one third of its world quota on milk powder to the U.S. as the most favored country - around 40,000 metric tons dropping the tariffs and representing a great advancement for the U.S. dairy industry against its competitors. However, other countries, especially the European multi-national companies such as Nestle and Dannon have been operating in the Mexican dairy sector and have differentiated some European products as well.

To assess how increases in income affect the demand for dairy imports, expenditure elasticities estimates calculated in chapter four were used, following the approach of Song and Sumner (1999). To complement this analysis, the effect of allocating an additional dollar spent on dairy imports is assessed by calculating the marginal shares as suggested by Seale et al. (2002). Marginal shares are defined by:

(1) $\beta_i + W_i^*$,

where β represents the expenditure parameter in the RSAIDS model and w* represents the average import share. Table 5.6 displays these values for the RSAIDS system estimated in chapter 4. Recall that the system consisted of cheese, milk powder and other dairy imported from the U.S., European Union, Oceania (New Zealand and Australia), and Other Countries.

The concept of expenditure elasticity and marginal share are related but different. Expenditure elasticities estimate the percent change in quantity demanded when total expenditures increase by 1%. Marginal shares estimate how an additional dollar spent would be allocated (Seale et al. 2002). According to Yang and Koo (1994), a country is regarded as having strong export potential in an import market if demand for the product is insensitive to price changes but increases with import expenditure. Based on these results, it is possible to evaluate the potential for U.S. dairy exports to Mexico by category.

Prospects for cheese

In terms of import cheese market, the U.S. seems to have a good position. If income (private consumption) in Mexico were to rise, *ceteris paribus*, the demand for U.S. cheese would increase, as indicated by the estimate of expenditure elasticity (2.3044), but not as much as the demand for cheese from Other Countries (2.7690).

Table 5.6 Expenditure, Own-price Elasticities and Marginal Shares for Imported Dairy Products

Product	Origin	*Expenditure Elasticity**	*Marginal Share*	*Own Price Elasticity**
Cheese	US	2.3044	0.1086	-1.4090
	EU	1.6200	0.0630	-3.1013
	Oceania	2.0301	0.0668	-1.7545
	Other	2.7690	0.0953	-1.4827
Milk Powder	US	0.4986	0.0635	0.6671
	EU	-0.3970	-0.0857	-0.2465
	Oceania	1.6188	0.2115	2.7387
	Other	1.3356	0.1032	1.8641
Other Dairy	US	1.6241	0.3255	-2.1987
	EU	0.2948	0.0123	-1.8361
	Oceania	0.2797	0.0084	-1.3376
	Other	1.1737	0.0276	-1.3003

*The values for Expenditure Elasticities were previously reported in Table 4.7 in chapter four.

The results in table 5.6 indicate that in terms of own-price elasticity (-1.4090), U.S. cheese is less sensitive to changes in its own-price. In order to make clear the opportunities of U.S. cheese vis-à-vis with other exporters, the marginal shares were employed, which indicate how an additional dollar would be allocated. U.S. cheese would benefit the most by taking 10.86 cents of that dollar. The U.S. advantage, in this sense, is slight, since 9.53 cents would be allocated to cheese from Other Countries, followed by Oceania and the European Union.

<u>Prospects for milk powder</u>

In terms of the market for milk powder, the U.S. is not competitive in the Mexican import market. In terms of own-price elasticity, U.S. milk powder exhibits an inelastic estimate (0.6671) as contrasted with high elastic estimates for milk powder from Oceania (2.7387) and Other Countries (1.8641). In terms of expenditure elasticity, if private consumption were to rise, *ceteris paribus*, Oceania would be the most favored country (1.6188), followed by Other Countries (1.3356) and the U.S. (0.4986). Europe would exhibit a decrease of its exports to Mexico (-0.3970). In terms of the marginal share, milk powder from Oceania would take 21.15 cents of an extra dollar allocated to dairy imports, followed by Other Countries with 10.32 cents and the U.S. with 6.35 cents. These large estimates for the marginal shares suggest the constant need for milk powder in Mexico. In this sense, the European Union exhibits the worst competitive position in terms of own-price (-0.2465) and expenditure elasticity (-0.3979). The EU milk powder, in fact, exhibits a negative marginal share, which means that importers would spend less money on EU milk powder and would allocate it somewhere else.

Prospects for other dairy products

In the case of Other Dairy, the U.S. faces a very competitive market, but exhibits a good outlook. In terms of own-price expenditure, the Other Countries category exhibited the least elastic estimate (-1.3003), followed by Oceania (-1.3376) and the EU (-1.8361). The U.S. exhibited the most elastic estimate in terms of own-price elasticity (-2.1987), which means that if U.S. prices for Other Dairy increased one percent, *ceteris paribus*, the U.S. would be the most affected supplier of this category. In terms of expenditure elasticity, the U.S. would enjoy a 1.6241% gain of an increase in expenditure followed by Other Countries (1.1737). However, the U.S. would certainly benefit the most of an additional dollar allocated to dairy imports by taking 32.55 cents, by far the largest marginal share, posing a great advantage to the U.S. as compared to other exporters. These results suggest that the U.S. faces a very competitive export market in Mexico. As pointed out by Dobson and Proctor (2002), Mexico is a mature market that has attracted many world-class competitors. The conception that NAFTA and proximity to the market would make the Mexican market a "low-hanging fruit" for U.S. exporters is wrong and U.S. exporters will have to pursue new strategies to keep their shares. The U.S. is expected to remain the main supplier to Mexico in cheese and other dairy products, but will face increasing competition from other countries, mainly Argentina and Uruguay, which under the Latin American Integration Agreement (ALADI) have also preferential tariffs and lower production costs than the U.S. Jesse (1997) explains that Argentina is targeting Mexico as an export market, but the extent to which Argentina and other South American countries can keep a presence in the Mexican markets will depend on how much milk can be imported by Brazil, their main trade partner and their ability to improve quality over price. According to Fernandez (personal communication), "South American nations are looking to Mexico more for need than for long-term interest given the bad economic situation that Brazil is facing right now."

During the period of study (1990-2001), the U.S. became the main supplier of dairy products to Mexico outranking the European Union and according to the USDEC, the U.S. will continue to strengthen and cultivate relationships in Mexico. In fact, the analysis of the marginal shares suggests that the U.S. would take 49.76 cents of an additional dollar allocated to dairy imports in Mexico. The government no longer regulates the Mexican market and its involvement is minimal. Banning or delaying the duty-free entry of U.S. milk powder in 2008 despite pressure from local dairy organization are minimal, because Mexico would have more to lose in the case of trade retaliation from the U.S. (Garcia Hernandez, personal communication). However, the final outcome of trade patterns will depend on the WTO decisions on agricultural su

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subsidies and trade liberalization. At this time and in Cancun Mexico, the latest WTO meeting is taking place, developing countries are demanding increased trade liberalization and less subsidies in developed countries agricultural sectors. However, it is not possible to predict what the outcome and effects on dairy trade will be.

The results obtained in this study are consistent with opinions of analysts in the Mexican industry and point out that Oceania is a strong competitor that could represent a challenge to the U.S. Garcia Hernandez (personal communication) and Proctor & Dobson point out that the organization of the New Zealand Dairy Board, now Fonterra, is superior to any American company operating in Mexico. The marginal share analysis suggests that Oceania would obtain 32.98 cents of an extra dollar allocated to dairy imports, closely following the U.S. and could potentially become the second largest supplier to Mexico.

Summary

This chapter forecasted Mexican dairy supply and demand models in order to determine whether Mexico would likely depend on imports. The yearly deficit of milk (in milk equivalents) was forecasted to fluctuate between 4.05 and 6.10 million metric tons in 2003 and 2011 respectively. Rising prices in fluid milk and high subsidies on products such as milk powder, create an import incentive for processors and the government, thus the international price of dairy products effectively becomes a ceiling in domestic production. The results suggest that U.S. imports will face strong competition, but the U.S. will potentially continue to be the largest dairy supplier to Mexico. Competition from Oceania and South America is expected to be strong in the milk powder and cheese markets.

CHAPTER SIX

SUMMARY AND CONCLUSIONS

This study examined the changing structure and results in supply and demand of the Mexican dairy sector in the 1990's. Several analyses were performed to make an assessment of the sector and to evaluate prospects for U.S. exporters. NAFTA, the accession to OECD, and a currency devaluation in 1995 were covered in the time period of this study. As more data on the dairy sector becomes available, better assessments on the sector can be performed. This study incorporated the most information available.

The Mexican dairy sector is characterized by the diversity of the production and marketing systems. Moreover, Mexico's dependence on production inputs such as grains, technology and replacement calves allows only some producers, those that specialize in milk production, to be profitable and to produce milk effectively. The processing sector in Mexico is characterized by an oligopolistic structure, where 17 companies concentrate more than 75% of the total industry sales worth $4,322 million USD.

In the 1990's, the Mexican government implemented a series of policies to make the dairy sector more competitive and increase the domestic milk production. The most important was milk price liberalization. As a result, the milk production grew at a rate of 5.34% during the 1990's, increasing from 5,200 million of liters in 1990 to 9,500 million of liters in 2001. However, this growth was not enough to keep up with demand and around 20% of the total consumption was filled by dairy imports.

An aggregate profit function with a technological parameterization was estimated to assess the response of Mexico's dairy sector to changes in prices and technology from 1988 through 2001. The milk supply elasticity value estimated was 0.0075, which suggests that milk production was very inelastic. The results suggests that milk supply was the most sensitive to changes in feed (-0.2206) and capital (-0.1201) prices. The results also suggest that technological advancement has been a considerable factor in the increasing quantity of milk production, but this has often been accompanied by a negative effect on profitability. However, these signals have not been strong enough to discourage milk production.

The implementation of NAFTA and other free trade policies had two effects. The first is that producers have access to inputs world prices that are lower than domestic prices. The second is that dairy world prices, highly subsidized, effectively placed a ceiling on the price that could be paid to producers, creating an incentive to rely on imports.

The economic forecast estimated for milk supply using the supply response model suggests that milk production will continue to grow in Mexico, but at a slower rate. Milk production is forecasted to reach 12.26 millions of metric tons by 2011. However, demand will continue to outgrow supply because of income and population increases, the forecast for this study estimates that Mexico's total demand for milk will be 18.36 million metric tons, which creates a milk deficit of 6.10 million metric tons that will have to be imported from the U.S. and other sources of origin.

The Mexican dairy market has matured and attracted world-class exporters. NAFTA has indeed benefited the U.S. by completely phasing out tariffs in 2003 and receiving one third of the milk powder quota. In 2008, the U.S. will be the only country capable of exporting duty free milk powder to Mexico. The U.S. made a grand entrance into the Mexican dairy market in the 1990's, surpassing the European Union and supplying 41% of the total dairy imports in 2001. Results obtained by estimating a Source Differentiated Almost Ideal Demand System suggest that the U.S. will face strong competition from Oceania and South America, but could potentially continue to supply the deficit in the Mexican dairy market. Oceania, particularly New Zealand, is expected to become the second largest supplier to Mexico.

These results suggest that importers in Mexico effectively differentiate U.S. products from other sources of origin. Furthermore, the marginal share results suggest that if an additional dollar were allocated to dairy imports, then 49.76% of that dollar would be allocated to U.S. dairy products in the following manner 32.55% to products such as butter, whey, ice cream, and other dairy. 10.86% would be allocated to cheese and 6.35% to milk powder. Competition from Oceania in the milk powder market will be the greatest, but U.S. exporters should rely less on it and focus more on other dairy products, until NAFTA allows exporting milk powder duty free in 2008.

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