DISSERTATION

PRICE AND TRADE RELATIONSHIPS IN THE MEXICO-U.S. FRESH TOMATO MARKET

Submitted by

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ABSTRACT OF DISSERTATION

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Tomato trade between the U.S. and Mexico has grown significantly during the past decade. Although the tariff reductions accorded under NAFTA may explain part of this increase, there are other supply and demand factors that affect trade flows. Similarly, increased consolidation and major structural change in the U.S. produce marketing channels took place over the last decade. This study examines the behavior of the U.S. fresh tomato market for imports during 1990's under three approaches. First, a descriptive analysis of the current situation and trends of the U.S.-Mexico fresh tomato market is developed. Second, through an U.S.-Mexico tomato trade model, with special focus on the interdependence between trading costs and volume of Mexican imports, the significance of the economic factors that affect trade flows is examined. Third, through an extended parity bounds model that follows the work of Barrett and Li, tests for market integration and market equilibrium between Mexican and American markets as well as between regional domestic markets are conducted. Findings show that the trading sector and its behavior are playing a key role in the competitiveness of this market and that industrial organization trends, together with trends in the US-Mexico marketing sector, may be more influential than tariff reductions in explaining the increased trade flows. Similarly, findings show that although markets present a propensity towards high

tradability, there exists some potential for claims of inefficient or overly competitive behavior. The more complex the marketing channels between producer and wholesaler (as indicated by distance, international jurisdictional boundaries or structure of market channels), the more likely that markets operate suboptimally.

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DEDICATION

To my beloved parents Cuauhtemoc and Maria del Carmen

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Mexico-U.S. Fresh Tomato Market

1.1.Introduction

The efficiency gains from free trade are often cited by those who support globalization of markets in trade negotiations. However, the agricultural sector has historically been more protected than other economic sectors, possibly due to the perishability, high costs of transporting agricultural products, national policies meant to protect a low income rural sector, and concerns about food security and self-sufficiency (Padberg).

Given low world agricultural prices in the mid 1980's, induced by the increasing productivity worldwide and significant protection by some countries, the United States (U.S.) urged the international community to include agriculture in the Uruguay Round of GATT (1986) (Ahrens). Before these trade negotiations, agriculture was largely exempt from most multilateral trade agreements. The North America Free Trade Agreement (NAFTA), and the earlier Canada-United States Free Trade Agreement (CUSFTA), went much further than GATT in reducing barriers to trade for agricultural products in North America (Thilmany and Barrett). Despite such protectionism, trade in fresh fruit and produce has grown tremendously over the past decade. As consumers in developed economies (primarily located in areas with seasonal production constraints) demand year-round fresh produce, the opportunities for semi-tropic and tropical countries to develop export markets have grown. Such trends are only fueled by trade liberalization.

The rapid growth in North American tomato trade prior to NAFTA is one clear example of this market trend. Although the United States (U.S.) is second in world tomato production, imports comprise around 20 percent of U.S. fresh tomato consumption. Fresh tomato imports are necessary to supplement Florida and California seasonal supplies. Currently, 95 percent of US imports are from Mexico (ERS, USDA), after the dramatic increase in imports that began in 1995. These increased trade flows led American growers to file a petition of safeguard relief, as established under NAFTA, and subsequently they filed an antidumping complaint against Mexican growers. They perceived that Mexican fresh tomatoes were being sold at less than the fair value (LTFV).

Several previous studies have examined different aspects of the Mexico-U.S. fresh tomato market. For example the studies of the United States International Trade Commission (USITC 1996a; 1996b), signal that there are several supply and demand shifts, as well as structural and performance factors, that may explain trade patterns the U.S. and Mexico have exhibited. Similarly, studies by Love and Lucier and Plunkett concur that there are different factors that impact fresh tomato trade flows and that the Mexican peso devaluation played a significant role in increasing imports over the last decade. Cook (1997) pointed out that NAFTA is only one of many factors affecting trade flows within the agricultural sector. No previous study, however, has estimated the significance of different factors that affect trade flows of fresh tomatoes from Mexico to the U.S. Similarly, none have tested whether the markets are perfectly integrated through approaches that utilize prices, transaction costs, and trade flow information. This study, in addition to estimating the impact of different factors on fresh tomato trade flows (including trading charges as a stochastic variable), utilizes a new method for market analysis as developed by Barrett and Li (1999). This approach exploits the information contained in prices, trade volumes, and intermarket marketing costs and alleviates the problems that conventional methods have for testing market integration when trade is discontinuous and transaction costs are nonstationary. This methodology also permits one to distinguish between market integration and competitive market equilibrium, two related but different concepts. According to Barrett (2001), market integration is a flow-based concept implying tradability, where the observance of trade flows are sufficient but not necessary for testing market integration. A product is tradable between two markets when it is traded between two nations, or if market intermediaries are indifferent between exporting this product, while competitive market equilibrium is related to the concept of the market efficiency implied by zero marginal profits to arbitrage. Considering this concept of market integration, markets can be integrated even when they are imperfectly competitive or inefficient. In short, this dissertation offers an analysis of the fresh tomato market through the application of a novel approach that provides useful information about whether prevailing patterns of trade are efficient, or alternatively, if there exist some trade barriers that restrict competitiveness.

1.2. Importance of Market Integration

Market integration testing methods have been developed because the usefulness of their empirical results. Some of the reasons for the application of those methods can be summarized as follows. a) Market integration analyses provide information about the spatial extent of the market (Stigler and Sherwin) which is necessary to evaluate market structure, conduct and performance. Integrated markets do not necessarily lead to competitive markets (Harriss). Based on the assumptions that buyers and sellers are spatially dispersed and the intraregional transport costs are significant, Faminow and Benson formulated an approach where the market is a linked oligopoly (or oligopsony) implying that the test for market integration are tests of an alternative price formation process. Similarly, Palaskas and Harriss evaluated the behavior of the prices of staple foods and explained this price behavior with reference to market institutions. They found that structural and institutional factors affect specific market performance.

b) Knowledge of the extent of the market also is useful for sectoral or macroeconomic analysis. When markets are not spatially integrated, the cross-sectional aggregation of demand and supply loses its logical foundation, implying that state-initiated signals may have little or no effect on local prices and behaviors (Barrett 1995, 1996). Similarly, market integration studies help to assess the potential impact on trade and prices of policy reforms that affect production, consumption, and trade (Tomek and Robinson). Such is the case for Barrett (1995), who applied market integration methods to examine the effects of liberalization policy on the food market in Madagascar.

c) Still another use of those studies is to identify inefficiencies in infrastructure and transporting or routing products. Infrastructural problems imply inefficient agricultural price transmission and higher transportation costs, which is the case of some low developed countries. As infrastructure improves (physical and institutional) the spatial and temporal integration among markets is expected to increase (Barrett 1995).

1.3. Problem Statement

The growing demand for year round fresh fruits and vegetables, and the trend toward a trade liberalization policy in some countries that now support tariff reductions has increased trade flows of these goods, since no country produces enough diversity of fresh fruits and vegetables in every week of the year. In the case of fresh tomatoes, trade flows between Mexico and the U.S. increased dramatically after 1994, the year when NAFTA was enacted and the Mexican peso suffered a high devaluation. These increased imports led American producers to request a safeguard relief and later they filed an antidumping complaint against Mexican growers and shippers arguing that Mexican tomatoes were being sold at less than the fair value (LTFV). They perceived that the U.S. fresh tomato industry was injured or threatened with material injury. This dispute was ended by an agreement between Mexican growers and the U.S. Department of Commerce that set a minimum price. Currently, Mexican fresh tomatoes can not be sold at less than a floor price.

Under NAFTA, imports of fresh tomato from Mexico were considered as a sensitive product. Sensitive products are those that require special treatment in order to protect the respective sector of the importing country against surges from the exporting country. This protection includes a longer transition period, tariff rate quotas, and for certain products, special safeguard provisions. Although tariff reductions are a welcome cost-savings for those importing tomatoes to this country, it is only one of numerous factors affecting the level and characteristics of the tomato trade sector. As pointed out by the authors (Cook 1997; Thompson and Wilson; USITC 1996a; Love and Lucier; Plunkett) of other studies, there are many influences on the demand and supply side, as well as structural and performance factors that may explain the growth in trade flows between Mexico and the U.S. It is also likely that tariff reductions will be overshadowed by such factors, creating a situation where trade liberalization receives credit for the larger forces shaping the trading sector. So, it will be particularly interesting and useful for economists and policy makers to know the significance of those factors influencing trade flows.

The last decade not only saw an increased year round demand for fresh tomatoes, but also more vertically integrated grower-shippers who have adopted extended shipping seasons in order to meet consumer demand trends. Moreover, there was increased consolidation among fresh produce retailers that changed the conventional marketing channels and the trade practices among grower-shippers[1]. These new trade practices between retailers and grower-shippers might have changed the cost of transactions. Public information about the magnitude and the nature of the transactions of grower-shippers with retailers is limited because this data is proprietary, so part of this study will attempt to estimate the "additional transaction costs" that are not publicly available. Similarly there is not much information about the effect of these trade practices on shippers, retailers, and consumers. There are concerns that the changing nature of produce markets and marketing channels, as well as new trade practices, has led to potential market power in the retail-wholesaler sector (Calvin and Cook, et al.). In short, consolidation and structural change is taking place in the fresh fruits and vegetable sector,

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[1] Trade practices refer to the way shippers and retailers do business, including fees such as volume discounts and slotting fees, as well as services like automatic inventory replenishment, special packing, and third-party food safety certification. Trade practices also include the overall structure of a transaction such as long term relationships, contracts or daily sales with no continuing commitment (Calvin and Cook, et al.).

particularly in the fresh tomato market, with possible implications for competitive behavior. Therefore, it would be interesting to know whether the increasing trade flows that imply more integrated markets (increased tradability) also resulted in the existence of a competitive equilibrium in the fresh tomato market, or instead, if it seems to have increased the potential for noncompetitive behavior. The findings from this study have important implications for grower-shippers, industry leaders, and government since there is little information about these issues of great concern.

1.4. Objectives

In order to investigate the behavior of the tomato marketing channel, this study has several objectives. The overall objective is to examine the trade and price behavior of the U.S. fresh tomato market for imports during the 1990's. Intermarket arbitrage conditions will be analyzed to determine whether the American and Mexican markets are integrated and in long-run competitive equilibrium, an approach that complements concerns among policy makers. Also, special attention will be given to the role of tariff reduction, exchange rates, and transaction costs in increased imports. The effect of the first two factors, as previously discussed, has been studied in other works (Cook 1997, Plunkett, Gunter and Ames), but this study will add transaction costs to the analysis as well to assist in our understanding of the trade relationships between the two countries.

The particular objectives of this thesis are the following:

1. To describe the current situation for U.S. and Mexican tomato producers, marketing channels and strategies, in addition to other trends in this market.

2. To model and estimate the impact of several economic, marketing sector, and trade policy factors on the volume of fresh tomato imports from Mexico to the United States during the 1990's.

3. To examine price (efficiency) and trade (integration) relationships between Mexico and the U.S. for three vine-ripe tomato import markets, with comparisons to California and Florida mature green tomato supplies.

   a. To determine if increased imports result in a more efficient market and integrated markets.

   b. To provide a framework to analyze potential noncompetitive behavior in the fresh tomato market.

   c. To estimate "less transparent" transaction costs for marketing fresh tomatoes in the domestic market and to infer their effect on market conditions[2].

The first objective is accomplished by developing a descriptive analysis of the situation for fresh tomato imports, identifying the role of Mexican and American producers, marketing channels and strategies, and other prevailing trends. The second objective is addressed by formulating a basic international trade model that allows one to test the statistical significance of the different policy and economic factors that have affected the volume of fresh tomato trade flows from Mexico over the last decade. Finally, the third objective is addressed by applying a market analysis approach that permits one to test for market integration and market equilibrium in the fresh tomato market. This method also enables estimation of the frequencies with which different market conditions, such as perfect integration, competitive equilibrium, tradability,

[2] These costs include all potentially measurable transaction costs that are not publicly available.

inefficiently integrated markets, overly competitive behavior, segmented equilibrium, and segmented disequilibrium, occur.

1.5. Structure of the Study

Following this introductory chapter, a description of the fresh tomato market is presented in chapter 2, including information on U.S. and Mexico fresh tomato trade, channels of distribution, supply and demand factors, industry trends, market structure, price agreements, as well as the role of NAFTA and exchange rates on tomato trade. In chapter 3, an international trade model is developed, so that domestic demand and supply, as well as Mexican excess supply and trading charges for marketing Mexican fresh tomatoes are estimated together with a discussion of the findings, market implications and concluding comments.

Chapter 4 includes the review of literature on market analysis methods. It is developed following the classification of Barrett (1996). He classifies the market analysis methods based on the nature of the data used. Level I methods use only price data and are most susceptible to specification error. Level II methods use prices as well as transaction costs. Level III methods, which utilizes prices, transaction costs, and trade flow data, offer greater flexibility and inferential power. Chapter 5 develops the level III model to test for market integration and market equilibrium in the fresh tomato market. The model applied is explained following an extensive description of the data series utilized, and the findings from the analysis are presented. The probability of observing the different market conditions between pairs of market studied is then presented.

Finally, chapter 6 offers a brief discussion about policy implications, empirical findings and directions for future research.

CHAPTER 2

The Fresh Tomato Market Research

2.1. Introduction

Over the last decade the fresh tomato market was characterized by high price variability, seasonality of supply (domestic and imported), growing retailer-wholesaler concentration and grower-shipper coordination, and on the demand side, increased year round consumption. Increasing consumption, the tariff reduction process implemented under the North America Free Trade Agreement (NAFTA), and the Mexican peso devaluation partially explain the significant growth in trade flows from Mexico. These increased imports led American growers to file a formal antidumping complaint against Mexican growers that ended with an agreement between the U.S. Department of Commerce and the Mexican producers. This chapter serves to describe the current situation for U.S. and Mexican tomato producers, marketing channels and strategies, in addition to other trends in this market. The first sections present a description of the U.S. fresh tomato market with special attention to demand for imports from Mexico. The channels of distribution, market structure, fresh tomato industry trends, the role of NAFTA and exchange rates in tomato trade trends, and the tenets of the price agreement are also reviewed.

2.2. U.S. and Mexico Fresh Tomato Trade

Although the United States is second in world tomato production, imports comprised more than 20 percent of U.S. fresh tomato consumption over the last decade, while the U.S. exports only 9 percent of its production (Table 2.1). Fresh tomatoes are demanded year-round in the U.S., so fresh tomato imports are necessary to supplement Florida and California seasonal supplies. Currently, around 90 percent of imports are from Mexico (ERS, USDA). Although imports from other sources such as the Netherlands and Canada are small, they have followed an increasing trend, rising from 0.1 percent and 0.2 percent of total U.S. consumption in 1991, to 1.7 percent and 2.9 percent in 1998, respectively. Mexican imports increased dramatically after 1995, from 22.2 percent of U.S. production in 1994 to 38.3 percent in 995, and more than 40 percent in following years. This marked increase is likely due to both the Mexican peso

Table 2.1. Fresh Tomatoes: U.S. Production, Exports, Imports, and Market Shares (Million pounds)

Item	1991	1992	1993	1994	1995	1996	1997	1998
Production	3,398.8	3,903.3	3,666.3	3,738.7	3,409.8	3,363.4	3,277.7	3,125.8
Exports	300.3	367.5	345.8	340.7	289.2	295.4	341.7	286.3
Domestic supply	3,098.5	3,535.8	3,320.5	3,398.0	3,120.6	3,068.0	2,936.0	2,839.5
Imports	795.5	432.2	922.4	873.0	1,368.9	1,625.1	1,636.8	1,868.0
Mexico	779.5	403.7	882.9	829.0	1,307.4	1,511.6	1,456.3	1,618.3
Canada	5.9	11.5	10.4	16.9	25.7	48.0	82.7	136.0
Netherlands	5.3	5.6	15.5	16.6	27.3	51.8	74.3	81.1
Other	4.8	11.4	13.6	10.5	8.5	13.7	23.5	32.6
Apparent Consumption	3,894.0	3,968.0	4,242.9	4,271.0	4,489.5	4,693.1	4,572.8	4,707.5
Imports share	20.4%	10.9%	21.7%	20.4%	30.5%	34.6%	35.8%	39.7%
Mexican producers Market share	20.0%	10.2%	20.8%	19.4%	29.1%	32.2%	31.8%	34.4%
U.S. producers Market Share	79.6%	89.1%	78.3%	79.6%	69.5%	65.4%	64.2%	60.3%

Source: ERS-USDA.

devaluation and the beginning of NAFTA's tariff reductions. Although the U.S. has exported some fresh tomatoes to Mexico (21,915.57 tons in 1994), these exports decreased significantly after the economic crisis in Mexico (2,284.7 tons in 1995). As the Mexican economy recovers, exports to Mexico have increased (4,792 tons in 1998).

Imports from Mexico have entered the U.S. every week in recent years, with volumes following a seasonal pattern (Figure 2.1). These imports have generally been vine-ripe round tomatoes (60.4 percent), but shipments of cherry tomatoes and roma

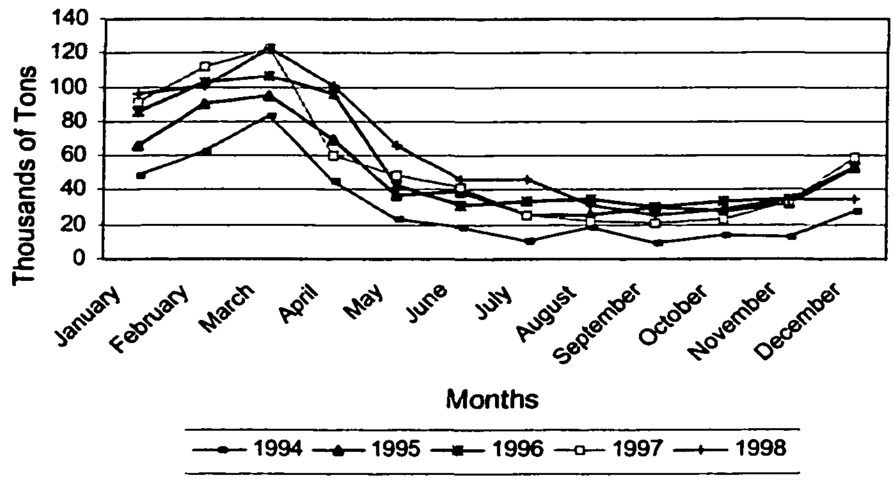


Figure 2.1. Fresh Tomato Imports from Mexico

(plum) tomatoes have been increasing in recent years (Table 2.2). The improved quality, size, flavor, and competitive price of roma tomatoes has allowed this variety to secure an increasing share of the consumer's dollar (Burfield 2000a; Harvey). On the domestic side, the majority of Florida production is round mature green tomatoes (approximately

85 percent), with minor quantities of vine-ripe round and roma tomatoes. Tomato growers located in the Sinaloa and Baja California Peninsula regions of Mexico supply the majority of fresh tomatoes exported to the U.S., but they also supply domestic markets. Sinaloa, located in the Northwest region of Mexico, has two important tomato producing regions: Culiacan and Los Mochis. Shipments from Sinaloa normally peak between January and March, while the Baja California season stretches from June to November.

Table 2.2. Shipments of Fresh Tomatoes Imported from Mexico by Type (Percentage)

Type	1995	1996	1997	1998	1999	Weighted Average
Cherry	6.9	6.1	5.9	6.8	7.6	6.6
Plum (roma)	27.1	31.3	32.1	36.5	38.9	33.0
Other (vine ripe)	66.0	62.6	61.9	56.7	53.5	60.4

Source: USITC.

Although the United States International Trade Commission (USITC) reports fresh tomato imports from Mexico through seven U.S. Custom Service Ports (Nogales, Arizona; Los Angeles, San Diego, and San Francisco in California; El Paso and Laredo in Texas; and Chicago, Illinois), virtually all imports from Mexico (99.9 percent) enter through Laredo (2.4 percent), Nogales (68.1 percent) and San Diego (29.5 percent) (Table 2.3). The Sinaloa region exports fresh tomatoes to the U.S. from December to June, primarily through Nogales, Arizona. Yet, exports through Laredo, Texas have increased considerably since 1994 (from 1,851 tons in 1994 to 12,479 tons in 1995, and 21,173 tons in 1996). It is also important to note that around 70-80 percent of shipments entering through Laredo are cherry tomatoes, rather than the vine-ripe round and plum tomatoes that make up the majority of shipments through other ports of entry. The tomato shipments entering through Laredo generally peak between May and September, whereas the majority of fresh tomatoes imported from the Baja California Peninsula, via San Diego, are shipped from June to December. Imports through San Diego increased 77 percent from 1994 to 1995, reaching their highest level in 1996 (Table 2.3).

Table 2.3. Fresh Tomatoes: Imports from Mexico by Custom Service Port (1000 of kg)

Year	Laredo	Nogales	San Diego	Total
1992	1,523	98,974	82,611	183,108
1993	2,167	290,467	107,484	400,118
1994	1,851	264,484	109,599	375,934
1995	12,479	385,124	193,830	591,433
1996	21,173	440,759	222,463	684,395
1997	16,773	457,839	185,118	659,730
1998	22,634	490,428	219,987	733,049
1999[1/]	25,777	474,860	114,071	614,708
Total	123,921	3,262,966	1,321,650	4,708,537

1/ Total imports from September to October were prorated to each Custom Service Port applying a weighted average of imports received during the months between January to August,
Source: USITC.

2.3. The U.S. Market

U.S. consumption of fresh tomatoes is relatively stable across seasons and across regions. Overall consumption of fresh tomatoes increased consistently over the last two decades. In the 1990's, Americans increased their consumption per-capita of fresh tomatoes by 14 percent relative to the 1980's. The largest increases were between 1992 and 1993 (5.8 percent), and again between 1997 and 1998 (4.6 percent) (Table 2.4). Changes in the tastes and preferences of American consumers, in addition to immigration trends, have been found to influence rising per-capita fresh tomato consumption (Lucier et al.). U.S. producers' share of domestic consumption has fallen from about 80 percent in 1991 to 60 percent in 1998. Meanwhile, the import market share has augmented primarily for Mexican producers whose U.S. market share increased from 20 percent in 1991 to 34 percent in 1998.

Table 2.4. Fresh Tomatoes: U.S. Per-capita Consumption

Year	Pounds	% Change	Decade Average		
			Decade	Pounds	% Change
1990	15.5	-7.7	1960's	12.2	
1991	15.4	-0.6	1970's	12.2	-
1992	15.5	0.6	1980's	14.6	19.7
1993	16.4	5.8	1990's	16.7	14.4
1994	16.4	0.0			
1995	17.1	4.3			
1996	17.7	3.5			
1997	17.1	-3.4			
1998	17.9	4.7			
1999	17.8	-0.6			
2000f	17.8	0.0			

f = forecast
Source: ERS-USDA.

Fresh tomatoes do not have strong substitutes in the market, so demand is relatively inelastic (Shonkwiler and Emerson). USITC (1996a) determined that the price elasticity of demand for tomatoes is in the range of 0.5 to 1.0. Although there may be some distinction among cross elasticities for tomatoes grown in various countries, the elasticity of substitution between Mexican and domestic fresh tomatoes is still in the elastic range of 2 to 4 (USITC, op.cit.). According to the Continuing Survey of Food Intakes by Individuals (CSFII), the share of respondents with higher incomes (39 percent of the population) consumed 44 percent of all fresh tomatoes while the low-income stratum (19 percent of the population) consumed only 16 percent of fresh tomatoes. In short, per capita consumption of fresh tomatoes increases as incomes rise (Lucier at al.). Thus, fresh tomatoes are considered a normal good.

The increasing popularity of salads and salad bars, the introduction of improved tomato varieties, and expanded national concern with respect to health and nutrition have contributed to the structural change in demand of fresh tomatoes. Product differentiation has become a key factor for consumers' preferences. As discussed previously, there are three major types of tomatoes imported from Mexico (plum, cherry, and vine ripe tomatoes). At the beginning of the 1990's, Mexican producers adopted better technology and new varieties with increased yields, quality, and transportability (Plunkett). One of the most common export tomatoes from Mexico was Extended-Shelf-Life (ESL) vine ripe tomatoes, characterized by greater firmness and shelf life (Cook 1994; Plunkett). Those tomatoes were highly demanded during the mid-1990's and received a price premium because they were perceived as having higher quality than other tomatoes (Thompson and Wilson). In recent years, plum (roma) tomatoes have shown increased popularity due to their longer shelf life, good taste, size, and competitive price. A similar trend has been seen in consumption of even newer variety introductions, such as grape, yellow, red baby pear, cluster, greenhouse and organic tomatoes. In general, American consumers are willing to pay higher prices for imported out of season fresh products (Calvin and Cook, et al.).

California and Florida are the largest tomato producing states in the U.S., representing 43 percent and 30 percent of domestic fresh-market tomatoes between 1994 and 1996. Florida's season runs from October to June, with the highest production during

April and May, and again during November to January. California produces tomatoes in every season but winter, with the majority of its production marketed from June through November. The major part of Florida's crop goes to eastern terminal markets and Mexico's crop is shipped primarily into western markets. However, during some months, they compete for the same terminal markets. In 1994, Florida shipped tomatoes to 22 major U.S. terminal markets, including 4 western cities (accounting for 13 percent of volume) while Mexico shipped to 9 eastern cities (accounting for 15 percent of volume), illustrating some cross continent shipping as the market dictates (Love and Lucier).

2.4. Distribution Channels

Domestic and imported vine ripe, mature green, roma, and cherry tomatoes are sold using similar channels of distribution. Domestic fresh tomatoes are generally shipped and marketed in different size containers; for mature greens, 10, 20, and 25-pounds flat/cartons, loose or in layers; for cherry tomatoes, 15 pound flats and 5-pound cartons; and for roma tomatoes, 25 pound cartons (USITC, op.cit.). Imported product from Mexico is packed in several configurations, including; 30 or 25 pound cartons with 2 layer 4 by 4 (which represents the number of rows by length and width of box), 5 by 5, and 5 by 6, and 3 layer 6 by 6 (AMS, USDA).

During the winter, the domestic product from Florida is graded, packed, and sold through intermediaries to distributors, retailers or food brokers. Between June and October, California fresh tomatoes are generally sold through the same channels and markets as winter tomatoes. It is common that shippers sell tomatoes to repackers near final consumers in order to have a uniform pack that is then sold to retailers, mass merchandisers, foodservice buyers, or other intermediaries (Calvin and Cook, et al.). In non-winter months, some of the fresh tomatoes harvested in the states of Virginia, North and South Carolina are produced under contracts or joint venture arrangements with Florida based grower-shippers. Mexican tomatoes are similarly processed by growers and domestic packers, and offered for sale through importers and brokers to the same customers as U.S. fresh tomatoes. Recently, some Mexican growers have entered into alliances with U.S. based marketers to integrate some of these marketing functions (USITC, op.cit.).

At the end of last decade, consolidation of the retail industry has also led to more concentration among shippers in the fresh produce industry. Large retailers prefer large shippers based on their ability to provide large volumes of consistent product and broader year round supply over extended seasons. At the same time, shippers may have preferential procurement agreements from their buyers, such as long term agreements and partnering. Supplying more variety of products on a year round basis may be risky and expensive as it requires more capital to deal with the production and distribution of many fresh produce items. Larger grower-shipper firms are able to support these activities, implying more consolidation and greater vertical and horizontal coordination in the shipping industry (Wilson et al.; Calvin and Cook, et al.)

In the tomato industry, the number of shippers has been decreasing over the last 5 years. In California, there were only 25 shippers in 1999 and 23 in 2000. The top eight shippers handled 62 percent of the total California volume in 1994, while in 1999 the share increased to 70 percent. Although Florida had more registered shippers in 2000 than in 1998 (65 versus 59), only 10 of those shippers account for about 70 percent of volume (Calvin and Cook, et al.). Given the increasing year round demand and growing retailer-wholesaler concentration, more shipper consolidation is expected in the future (Eldredge).

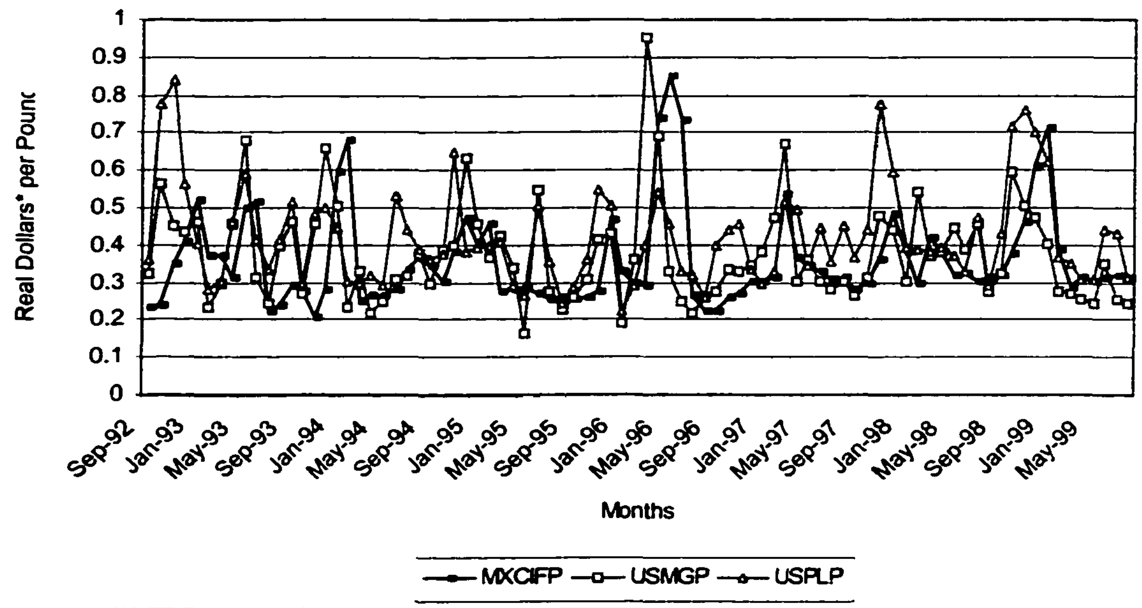
Shippers sell fresh tomatoes to the wholesale terminal market buyers, usually by telephone and on a verbal agreement basis. Written contracts are not commonly used. The price for fresh tomatoes changes daily, or several times in the same day. There exist two important price points in the fresh tomato market, one price that is the negotiated by telephone, and the second one that is the received price by the seller. Most of fresh tomatoes are sold under a price protection policy. When fresh tomatoes are sold "with protection" it means that the seller is going to receive a lower price if the market drops during the selling process (USITC, op. cit.). In order to get a landed value price in a U.S. entry port, Mexican tomatoes have to travel almost 700 miles if they are shipped from Sinaloa or about 120 if they are shipped from Baja California. Thus, a large share of the trading costs for the Mexican tomatoes is already accounted for, but there will still be differences in cross-country transportation costs, depending on the intended terminal market. Once Mexican tomatoes are packed and shipped, information related to the shipment is sent electronically to the customs importers and distributors in Nogales, who proceed with the U.S.-based selling process (Calvin and Barrios).

2.5. Supply and Demand Factors

Although more visible factors (such as exchange rate and policy reforms in Mexico) have received greater credit for increased trade flows from Mexico in recent years, weather, unit production costs, transportation costs, and technological change have also played a significant role in determining trade flows. In addition to the necessity of trade to accommodate year-round demand for fresh tomatoes, the significant trade volume between the U.S. and Mexico serves as a buffer when weather shocks affect fresh produce supplies. Thus, when occasional climatic shocks affect major tomato producing regions of the US, import flows can buffer the sharp price increases that would otherwise occur.

For Mexican producers, low wages are a favorable factor that contributes to low production costs. Some imported inputs (such as irrigation equipment, boxes, seeds, and chemicals) are paid for in U.S. dollars, and thus, would suggest similar costs of production across the two countries. Yet, in order to reach the major U.S. terminal markets, Mexican product incurs higher transportation costs than U.S. supplies. As will be shown in subsequent analyses, these costs represent a significant share of the producer's price, and there is some volatility in the level of such costs. The tariff reductions implemented under NAFTA are another factor affecting trade flows from Mexico. Finally, exchange rates represent an uncertain factor affecting Mexican inputs, prices and trade volume.

As one would expect with a perishable, seasonally-supplied product, prices change significantly from week to week, especially during the winter season. Monthly price series do not capture all these weekly price movements, but still illustrate the variable nature of tomato prices. Mexican and American prices presented in Figure 2.2 do not show as clear of seasonal trends as would be expected; for example, the highest and lowest prices for each year in each time series fall in different months. Thus, the overall variability, as well as the changing nature and timing of price peaks and valleys, would suggest that a number of supply and demand factors affect the market for fresh tomatoes.



Notes: *Deflated by consumer price index to a 1994 base price.
MXCIFP = weighted average CIF price of Mexican tomatoes at the U.S. Service Custom Port (Laredo, Nogales, and San Diego).
USMGP = average shipping point price of U.S. mature green tomato in Florida and California.
USPLP = average shipping point price of U.S. plum tomato in Florida and California.
Source: AMS, USDA.

Figure 2.2. Mexican and U.S. Fresh Tomato Prices

2.6. Trading Costs for Mexican Fresh Tomatoes

As discussed previously, Mexican fresh tomato shippers have to incur additional trading charges and the respective tariffs before entering US marketing channels. Trading charges are the transportation costs and the aggregate international charges, insurance, and freight (CIF) incurred in bringing the tomatoes from the Sinaloa region or Baja California Peninsula to the U.S. Trading charges for fresh tomatoes from Mexico were estimated as a ratio of import charges to custom value (Table 2.5). This ratio represents a percentage markup that increases the FOB price to arrive at the landed value price of tomatoes at the first port of entry to the U.S.

The mean trading charges (CIF) for fresh tomatoes that are imported through Laredo, Nogales and San Diego are 8.16, 8.59, and 1.70 percent, respectively. Cherry tomatoes have the lowest CIF in all three ports of entry. The highest cost among types of tomatoes and ports of entry was plum (roma) tomatoes imported via Laredo (13.55 percent). Moreover, this entry port registered the highest variability in import charges, with a coefficient of variation of 48.78 percent (compared with 30.66 percent and 44.85 percent for Nogales and San Diego).

Table 2.5. Fresh Tomatoes: Mean and Standard Deviation of Trading Charges/Custom Value (in percentage terms)

Port of Entry and Type of Tomato	Standard Deviation	Mean	Coefficient of Variation (Std. Dev./Mean)*100
Laredo			
Cherry	1.33	6.84	19.47
Plum (Roma)	4.70	13.55	34.69
Vine ripe	10.30	9.72	106.4
Total	3.98	8.16	48.78
Nogales			
Cherry	2.80	7.34	38.21
Plum (Roma)	3.17	8.63	36.77
Vine ripe	2.82	8.88	31.73
Total	2.63	8.59	30.66
San Diego			
Cherry	0.80	1.38	58.25
Plum (Roma)	0.84	1.80	46.59
Vine ripe	0.78	1.79	43.66
Total	0.76	1.70	44.85

Source: USITC.

2.7. Market structure

Although the 1992 Census of Agriculture reports over 15,500 tomatoes growers in the United States (including fresh market and processing producers), American fresh tomato production is dominated by about one thousand farms. In addition, the marketing channel for product moving into wholesale, retail and food services is controlled by fewer than 50 shippers, who are often growers as well (Thompson and Wilson). In Mexico, about 12 growers' groups harvest the majority of tomato production for exports. CAADES is a group of 10 Mexican growers' associations, some of which are vertically integrated with an established distributorship in Nogales, Arizona. The majority of shipments from Sinaloa are handled by fewer than 80 distributors in Nogales. Moreover, it is estimated than only 5 distributors handle three fourths of fresh tomato imports (USITC, op.cit.).

According to Thompson and Wilson, only 38 grower-shippers of fresh tomatoes represented 70 percent of fresh tomato production in California, Florida, and Sinaloa, in 1994. Most of them have adopted extended shipping seasons with year-round marketing strategies. Grower-shippers based in Sinaloa, Florida, and California are trying to implement two-way, complementary trade. In short, the seasonal production patterns of participating growers are taken into account when establishing import and export flows, and some growers have begun to produce in multiple regions throughout the year to diversify production and marketing risks (Wilson et al.; Cook 1998).

Given this structure and conduct, the market is more similar to an oligopolistic market than a perfectly competitive one (Thompson and Wilson). This implies higher trading charges and less trade flows than there would be if the market were in a competitive equilibrium. This has implications for any intended results from trade liberalization undertaken under the guises of NAFTA. Such conditions will also influence the estimation of trade flows and transactions costs since perfectly competitive outcomes should not be expected.

2.8. Fresh Tomato Industry Trends

The fresh tomato market in the 1990's has been characterized by high price variability, seasonality of supply (domestic and imported), increasing retailer-wholesaler concentration and grower-shipper coordination, and on the demand side, increased year round consumption. Americans have been changing their consumption behavior, mainly due to health and nutrition concerns. In the case of fresh tomatoes, they were consuming 2.1 pounds more per-capita in the 1990's than in the 1980's (ERS-USDA). The tomato is the third most commonly consumed fresh vegetable (per capita) in the U.S. (Calvin and Cook, et al.). According to the California Tomato Commission, tomatoes are one of the four vegetables that consumers are most willing to buy, and they would buy them more often if they were of higher quality. The Packer's Fresh Trends 2000 found that 33 percent of consumers said they had purchased organic produce (including tomatoes) in the previous six months and felt organic products tasted better than conventionally grown (Unrein). However the major concern of these consumers is their high price.

The increased consumption of fresh tomatoes has led to changes in demand for variety, convenience, and food safety. Therefore, variations of the typical vine ripe, plum cherry, and mature green tomatoes have appeared in the market, including extended-shelf life, grape, yellow, red baby pear, cluster, heirloom, greenhouse and organic varieties.

The U.S. consumers who are willing to pay higher prices for imported, out-of-season fresh products have led to the extended season and year round supply of these variety of fresh tomatoes (Calvin and Cook, et al.). This changing demand also has implications for the seasonality of supply and the structure of the shipping industry. In order to meet the year round demand for fresh tomatoes, some grower-shippers based in the U.S. and in Mexico have viewed greenhouse production as an alternative (Burfield 2000b; Lister 2000a). For example, the Chiquita-Nogales Company has been a year round greenhouse supplier for the last three years. They have greenhouse production, in addition to field products in Baja, California, during April to December, and in Sinaloa from December through June (Lister, op.cit.).

According to Symanski, greenhouse and organic tomatoes are two market niches that continue to strengthen. Greenhouse tomatoes can avoid the price fluctuations that weather creates with field crops, and they are mostly sold to retailers and mass merchandisers who often demand pricing three weeks in advance. In short, they have more consistent quality, quantity and pricing.

For most fresh produce, the main marketing channel is grocery retailers, but in the case of fresh tomatoes, the wholesaler (repacker) is more important channel due to the fact that fresh tomatoes require an uniform pack in order to be sold to retailers or other type of intermediaries. The share of the tomatoes going to the retail marketing channel has been declining in recent years, due mainly to the increasing popularity of vine ripe tomatoes and a loss in competitiveness for mature green tomatoes in the retail market. These factors have obliged shippers to sell a higher volume to the wholesaler/repacker channel and foodservice buyers. However, greenhouse tomatoes are sold directly to retailers and mass merchandisers (Calvin and Cook, et al.; Symanski).

In conclusion, the fresh tomato industry observed two major trends at the end of 1990's: a change in consumer preferences and increased foreign competition. The American consumers' preference for mature green tomatoes has been decreasing; but they are willing to consume other varieties of tomatoes. During the last decade, extended shelf life Mexican tomatoes were in high demand, although roma tomatoes and newer varieties also are increasing in popularity. In addition to the increased trade flows of Mexican fresh tomatoes, Canadian and Netherlands tomato producers have also been expanding their market share.

2.9. The Role of Trade Liberalization Policy and Exchange Rates

In the mid-1980's, the Mexican Government shifted its economic policies toward a more open economy. Subsequently, officials signed trade agreements, including the General Agreement on Tariffs and Trade (GATT) in 1986, and the North America Free Trade Agreement (NAFTA) among Canada, the United States, and Mexico that began in January 1994. Under NAFTA, all tariff and non-tariff barriers to agricultural trade will be eliminated. Many tariffs were eliminated immediately, with others being phased out over a period of five to 15 years.

U.S. tariffs on imports of fresh tomatoes from Mexico are set to phase out entirely over the 10 years period ending in the year 2003 (Table 2.6). A special agricultural safeguard provision was included in order to give protection against surges to certain sensitive products during the tariff phase-out period. United States considered seasonal imports of fresh tomatoes from Mexico as a sensitive product, therefore a seasonal tariff-rate quota (a TRQ, which grows at a compound 3-percent annual rate) was designed. The quotas imposed have been reached and exceeded by more than 40 percent since NAFTA started, except during 1999, when this difference was 27 percent (Table 2.7).

Table 2.6 The U.S. Phaseout Tariff Schedule and Safeguard Quotas for Fresh Tomatoes

Item	Season	Base Tariff	Phaseout	Safeguard Base 1/
Tomatoes	Mar 1-July 14	4.6 cents/kg	10years	165,500 mt
Tomatoes	July 15-August 31	3.3 cents/kg	5 years	N/A
Tomatoes	September 1-November 14	4.6 cents/kg	5 years	N/A
Tomatoes	November 15-February 28/29	3.3 cents/kg	10 years	172,300 mt
Cherry tomatoes	May 1-November 30	3.3 cents/kg	5 years 2/	N/A
Cherry tomatoes	December 1-April 30	3.3 cents/kg	Immediate	N/A

Notes: 1/ Increases 3% annually, compounded. N/A = not applicable.
2/ Duty free on January 1, 1998.
Source: HTSUSA (2000), p.XXII 99-89; and FAS, ERS, USDA.

Table 2.7 Growth of the Seasonal Quotas for Fresh Tomatoes from Mexico in the Transitional Period

Year	Safeguard Quota Quantity entered from March 1 to July 14 inclusive 1/ (Metric tons)	Actual quantity entered from March 1 to July 31 2/	Safeguard Quota Quantity entered from November 15 to the last day of February of the following year 3/ (Metric tons)	Actual quantity entered from November 1 to the last day of February of the following year 4/
1994	165,500	NA	No limit 5/	NA
1995	170,465	246,022	172,300	256,923
1996	175,579	292,031	177,469	275,843
1997	180,846	281,102	182,793	273,285
1998	186,272	357,531	188,277	224,987
1999	191,860	245,041	193,925	
2000	197,616		199,743	
2001	203,544		205,735	
2002	209,650		211,907	
2003			218,264	

Notes: NA = Information not available.
1/ Beginning in calendar year 2003, quantitative limitations shall cease to apply on such qualifying goods.
2/ Because the data was not available on a monthly basis, the quantities represent the period from March 1 to July 31.
3/ Beginning in calendar year 2003, quantitative limitations shall cease to apply on such goods.
4/ These quantities represent the period from November 1 to the last day of February of the following year.
5/ Entered from January 1, 1994, to February 28, 1994.
Source: HTSUSA (2000), p.XXII 99-73; and USITC.

Since 1998, only the tomatoes that enter during the two TRQ seasons are subject to tariffs. Using a weighted average[3], the ratio of U.S. duties to custom value for Mexican tomatoes entering through the Ports of Laredo, Nogales, and San Diego, was 6.51 percent in 1992. It has decreased steadily, reaching its lowest level of 2.29 percent in 1999. Still, one should note that the weighted average tariff was decreasing even before NAFTA was implemented (Table 2.8).

Table 2.8. U.S. Tariffs on Mexican Tomatoes (Percentage of FOB Price[1/])

Type	1992	1993	1994	1995	1996	1997	1998	1999[2/]
Laredo								
Cherry	NA	NA	NA	0.61	0.34	0.22	0.00	0.00
Plum	NA	NA	NA	10.54	8.73	6.23	4.84	4.51
Other	NA	NA	NA	7.58	3.52	2.91	2.16	1.92
Total	11.74	9.89	2.05	7.09	4.14	2.80	1.71	1.70
Nogales								
Cherry	NA	NA	NA	0.59	0.12	0.11	0.00	0.00
Plum	NA	NA	NA	4.53	3.65	3.45	2.99	3.49
Other	NA	NA	NA	4.58	3.33	2.83	3.59	2.45
Total	5.65	4.89	4.70	3.89	3.24	2.81	2.99	2.77
San Diego								
Cherry	NA	NA	NA	1.59	0.58	0.26	0.00	0.00
Plum	NA	NA	NA	5.06	3.87	3.61	2.91	2.81
Other	NA	NA	NA	5.03	3.10	3.50	2.61	2.38
Total	6.93	5.90	3.79	4.51	3.06	3.23	2.41	1.11
Total								
Cherry	NA	NA	NA	1.37	0.47	0.24	0.00	0.00
Plum	NA	NA	NA	4.94	3.97	3.35	2.62	3.11
Other	NA	NA	NA	5.06	3.39	3.04	2.65	2.74
Total	6.51	6.11	4.22	4.61	3.20	2.82	2.34	2.29

Notes: 1/ Calculated as weighted average of duties to custom value.
2/ The 1999 data includes only the months up through August.
Source: USITC.

[3] This weighted average was determined considering total duties paid by cherry, plum, and vine ripe tomatoes and the total volume imported of each type of tomato.

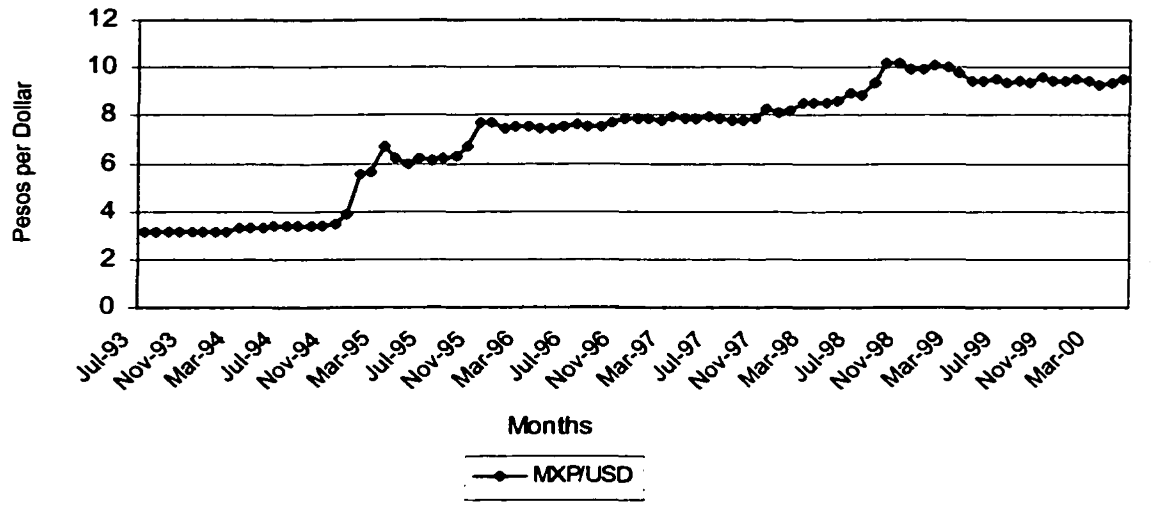
Given that the weighted average tariff was decreasing before NAFTA, it could be argued that exchange rates have played a more important role in increasing trade flows. After three years of being controlled by a floatation band, the Mexican peso fell more than 40 percent in two days from 3.47 on December 19 to 5.20 pesos per dollar on December 22. Subsequently, a floatation regime was adopted. In short, at the end of 1994 (the year that NAFTA was enacted), the Mexican peso suffered a significant devaluation. During 1995, the peso continued to weaken, ending this year with an exchange rate of 7.7 pesos per dollar (Table 2.9). At the end of the 1990's, Mexico

Table 2.9. Nominal Mexican Exchange Rate (Pesos per Dollar)

1994	Mexican pesos	Month	Average Pesos per Dollar
Jan-3	3.11	December-94	4.15
Feb-1	3.11	January-95	5.75
Mar-1	3.25	February-95	5.77
Apr-4	3.36	March-95	6.93
May-2	3.28	April-95	6.28
Jun-1	3.33	May-95	6.02
Dec-16	3.47	June-95	6.25
Dec-19	3.47	July-95	6.16
Dec-20	4.00	August-95	6.23
Dec-21	4.00	September-95	6.33
Dec-22	5.20	October-95	6.79
Dec-26	5.25	November-95	7.80
Dec-27	5.80	December-95	7.71

Source: Banco de Mexico.

showed signs of economic recovery, and the exchange rate became fairly stable (Figure 2.3). Moreover, the inflation and unemployment rate decreased while the gross domestic product (GDP) increased. The annual inflation rate reported in December 2000 was 8.96 percent, 3.36 points lower than in December 1999 and 2000 GDP was 3.2 percentage points higher than the growth rate registered in the previous year. Lower inflation rates and higher GDP helped to create 525 thousand formal jobs, implying a reduction in the open unemployment rate and recovery in real wages (Banco de Mexico). However during the last months of 2000, the United States economy entered a period of less vigorous growth and Mexican crude oil faced lower prices. These two events point toward a more complex scenario for Mexico in the year 2001 (Banco de Mexico) and economy growth is expected to slow.



Source: Banco de Mexico.

Figure 2.3. Nominal Mexican Exchange Rate

The Mexican peso devaluation made the external market more attractive than domestic shipments for Mexican producers. It stimulated an artificially high level of import demand. While the first year of NAFTA saw lower tomato import levels than

1993 (6.4 percent less volume), after the peso devaluation, imports of fresh tomatoes increased dramatically (57.32 percent in volume). They reached their highest level in 1998, at approximately 733,049 metric tons (representing 95 percent higher volume than 1994).

2.10. Recent Trade and Price Agreements

Due to increased imports after the peso devaluation, associations representing growers and packers of tomatoes and bell peppers filed a petition in March 1995. They requested global safeguard relief under section 202 of the Trade Act of 1974. They blamed the tariff reduction implemented under NAFTA for the surge in Mexican fresh tomato imports. In April 1995, the ITC made a negative determination on this petition. The petition was withdrawn on May 4, 1995, and the investigation was ended (USITC 1996a). It should be noted that imports of fresh tomatoes have been the source of many legal and political conflicts over international trade since 1893, when the U.S. Supreme Court decided its first case in this area (Bredahl et al.). Historically, trade disputes between the U.S. and Mexican tomato industries started as a disruption that also involved Cuba about 40 years ago. Since then, Florida producers have viewed several periods of competitive pressures from Mexico as "unfair" (Thompson and Wilson).

In April 1996, American tomato growers filed a petition for an antidumping investigation, arguing that they had experienced decreasing domestic prices, profits, and an overall loss of market share. They perceived that fresh tomatoes were being sold at less than the fair value (LTFV), so that the U.S. fresh tomato industry was injured or threatened with material injury. Tomato growers said that increased imports were attributed to dumping by Mexican growers and their importers.

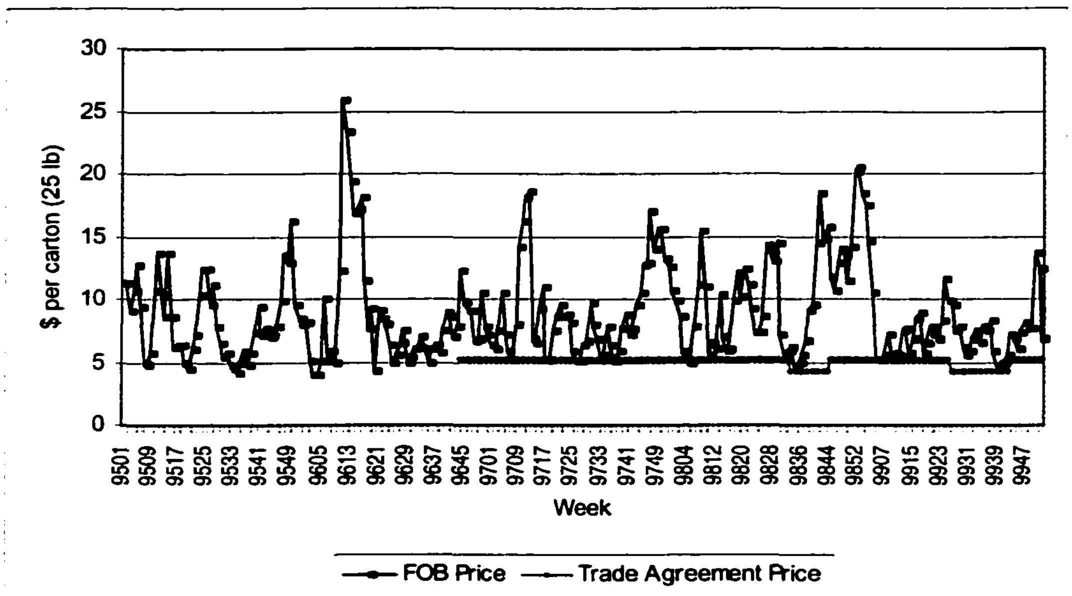
In October 1996, the Department of Commerce and Mexican tomato growers arrived at an agreement, eliminating the need to implement dumping duties. The initial period of the agreement was from November 1, 1996 to September 30, 1997, and it is expected to terminate the agreement and investigation no later than November 1, 2001. During its initial period, Mexican tomatoes will not sell at less than the reference price of $5.75 per 25-pound box ($0.2068 per pound) FOB Nogales, San Diego, and Laredo. The reference price represents the lowest average monthly price for fresh tomatoes imported from Mexico during the period of 1992 to 1994 (USDC 1996).

Given significant changes in the relationship of domestic prices to import prices from that of the base period, downward or upward adjustments to the reference price are expected. On August 6, 1998, after consultations with producers and exporters of fresh tomatoes from Mexico and members of the domestic industry, the agreement was amended. It established a second reference price, $0.172 per pound, equivalent to $4.30 per 25-pound box, during the period from July 1 to October 22 (Table 2.10). At the same time, the reference price for imports shipped during October 23 and June 30 was adjusted. This price will be $0.2108 per pound, which is equivalent to $5.27 per pound box. In addition, the amendment establishes new documentation requirements in order to release fresh tomatoes beyond the customs service ports (USDC 1997). Figures 1a, b, and c show a comparison of the reference price for FOB price Nogales and San Diego for Mexican vine ripe, plum, and cherry tomatoes.

Table 2.10. Fresh Tomatoes: Average Weights Suspension Agreement of Fresh Tomatoes from Mexico

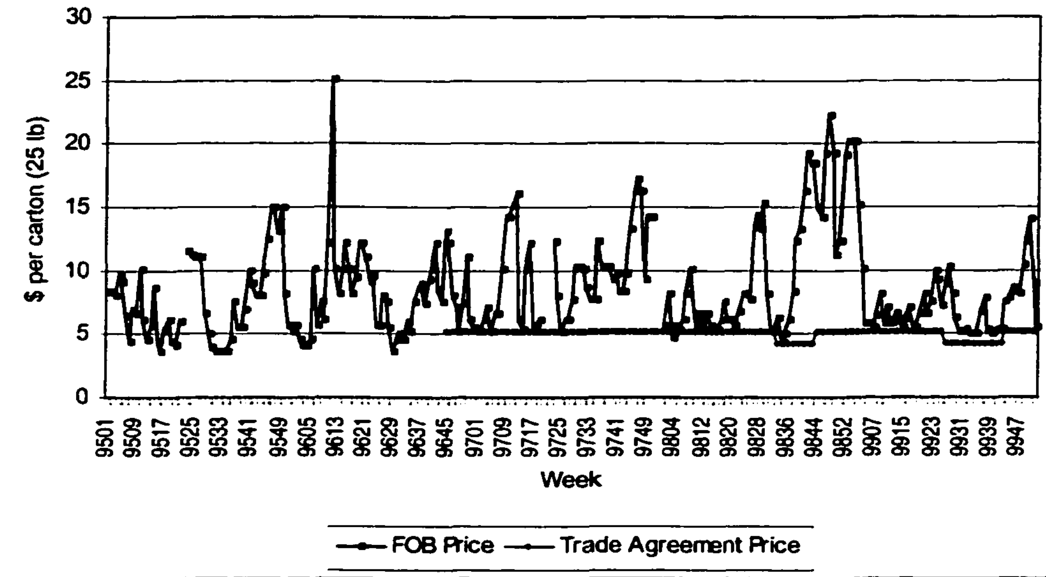
Type	Layers	Size	Average Kg Weight	Average Lb.* Weight	Reference Price ($)	
					$0.172/lb July 1 – October 22	$0.2108/lb October 23 – June 30
Tomato (cherry)		12 baskets	6.32	13.93	2.40	2.94
Tomato (cherry)	Bulk	Bulk	8.13	17.92	3.08	3.78
Tomato (roma)	Bulk	UC 82**	11.69	25.77	4.43	5.43
Tomato	2	4 x 4	10.78	23.77	4.09	5.01
Tomato	2	4 x 5	10.81	23.83	4.10	5.02
Tomato	2	5 x 5	10.43	22.99	3.96	4.85
Tomato	2	5 x 6	9.71	21.41	3.68	4.51
Tomato	3	6 x 6	13.33	29.39	5.05	6.19
Tomato	3	6 x 7	12.92	28.48	4.90	6.00
Tomato	Bulk	LRG 25 lb	12.15	26.79	4.61	5.65
Tomato (20/box)	Bulk	Sml. Ctn	5.57	12.28	2.11	2.59
Tomato (1 layer)	1	Long Box	7.41	16.34	2.81	3.44
Tomato (green) # 20	Bulk	Small	8.16	17.99	3.09	3.79
Tomato	1	4 x 5	5.12	11.29	1.94	2.38
Tomato	1	5 x 5	4.99	11.00	1.89	2.32
Tomato (30/box)	1	Clusters	4.70	10.36	1.78	2.18

Notes: *Conversion factor from kg to lb based on 1 kg = 2.20462 lb.
** Also applicable to 4/7 bushel cartons.
Source: U.S. Department of Commerce.



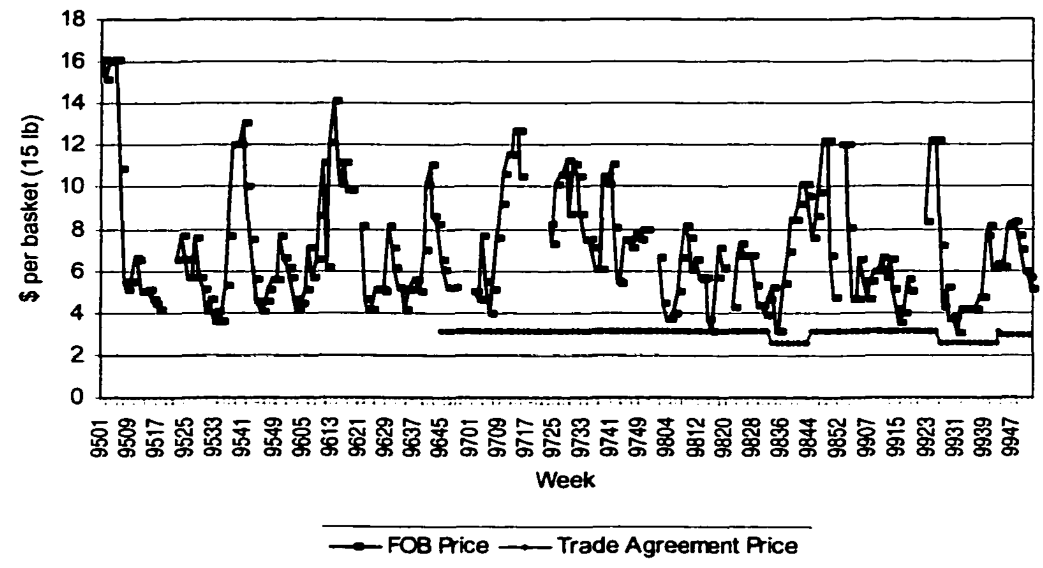
Note: FOB prices at Nogales are from mid December to May and FOB prices at San Diego are from June to mid December.
Source: USDA, AMS and U.S. Department of Commerce.

Figure 2.4a. Nogales and San Diego FOB Price for MexicanVine Ripe Tomatoes



Note: FOB prices at Nogales are from mid December to May and FOB prices at San Diego are from June to mid December.
Source: USDA, AMS and U.S. Department of Commerce.

Figure 2.4b. Nogales and San Diego FOB Price for Mexican Roma Tomatoes



Note: FOB prices at Nogales are from mid December to May and FOB prices at San Diego are from June to mid December.
Source: USDA, AMS and U.S. Department of Commerce.

Figure 2.4c Nogales and San Diego FOB Price for Mexican Cherry Tomatoes

CHAPTER 3

A Model of Mexico-U.S. Fresh Tomato Trade

3.1. Introduction

This chapter focuses on determining the significance of various economic factors that trade theory and prevailing market structure suggest should affect trade flows of fresh tomatoes from Mexico to the United State (U.S.), using an international trade model represented as a simultaneous equation system. In this model, special attention is given to transaction costs, assuming the levels and changes in these costs will significantly affect the trade relationship between the U.S. and Mexico. Specifically, the objective of this chapter is to model and estimate the impact of several economic, marketing sector, and trade policy factors on the volume of fresh tomato imports from Mexico to the United States during the 1990's.

3.2. The Structural Model

In order to model the relationship between various economic, marketing sector, and policy variables and the volume of Mexican fresh tomato imports an international trade model was designed. It is a simultaneous equation system that follows the general framework of Helmberger and Chavas. The structural model includes four behavioral equations and two identities. The first equation represents U.S. domestic demand for fresh tomatoes while the second controls for U.S. domestic supply for fresh tomatoes.

The third equation represents Mexico's excess supply of fresh tomatoes to the U.S., and the fourth is a trading cost function, as a proxy for a stochastic series of transaction costs, shown as MXCIF in Figure 3.1. The first identity is the FOB price at the Sinaloa and Baja California shipping points for Mexican fresh tomatoes plus trading charges set equal to the CIF price at the port of entry (Laredo, Nogales, and San Diego). Finally, the second identity is the market clearing conditions determined as a difference between U.S. domestic demand and the Mexican supply of fresh tomatoes to the U.S. Although it is possible that the fresh tomato market is structured as a non-competitive market (Thompson and Wilson; Jordan and VanSickle), the model assumes a competitive equilibrium for the purposes of modeling the industry's trade.

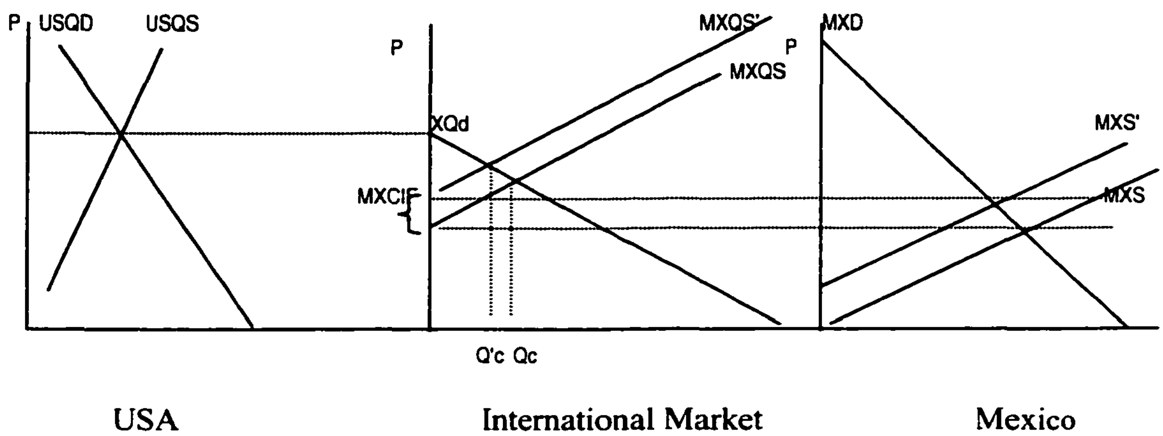


Figure 3.1 U.S.-Mexico Fresh Tomatoes Trade with Import Charges

The equation for U.S. domestic demand specifies the quantity demanded of fresh tomatoes in tons ($USQD_t$) as a function of the U.S. shipping point price per kilogram for fresh tomatoes ($USSTP_t$), the weighted average price per kilogram of tomatoes at the port of entry ($MXCIFP_t$)[4], and U.S. disposable personal income ($USPCY_t$). Since this study's objectives relate to understanding changes in levels of imports from Mexico due to market shocks, and significant, persistent domestic demand and trade volumes exist from year to year, the quantity demanded during the same period the previous year is also included in the model ($USQD_{t-12}$)[5].

$$(3.1) \quad USQD_t = f(USSTP_t, MXCIFP_t, USPCY_t, USQD_{t-12})$$

The U.S. domestic supply of fresh tomatoes ($USQS_t$),[6] in tons, is specified as a function of the U.S. shipping point price per kilogram for fresh tomatoes at planting time ($USSTP_{t-4}$)[7], the total fresh tomato acreage harvested in the U.S. ($USACRE_t$), and the U.S. producer price index for fresh tomatoes ($USPPT_{t-4}$) at planting time, which serves as a proxy for production costs. Thus, US domestic supply is modeled in the system as:

$$(3.2) \quad USQS_t = f(USSTP_{t-4}, USACRE_t, USPPT_{t-4})$$

The Mexican excess supply of fresh tomatoes to the U.S. ($MXQS_t$), in tons, is determined as a function of the weighted average price of imported fresh tomatoes per kilogram at the border at the time of planting ($MXCIFP_{t-4}$), the Mexican producer price

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[4] This price was determined by dividing the total custom value plus import charges for Mexican fresh tomatoes (entering through Laredo, Nogales, and San Diego) by the respective total volume imported. Import charges are all freight, insurance, and other expenditures required to bring the fresh tomatoes from the Sinaloa and Baja California regions in Mexico to the border entry ports.

[5] Inclusion of this variable was also necessary for estimation considerations since significant autocorrelation was present without a lagged dependent variable.

[6] This number represents total domestic shipments of fresh tomatoes from domestic shipping points.

[7] According to the Vegetable Research and Information Center at the University of California, once planted, fresh tomatoes require from three to four months to be harvested, depending on the varieties, production practices, and climatic conditions. Taking into account the production period and the process of grading, packing, and shipping, it was assumed that these activities take 4 months, on average.

index for tomatoes at planting time ($MXPPT_{t-4}$) (once again, as a proxy for production costs), the Mexican price of vine ripe tomatoes in dollars per kilogram ($MXVRP_t$) at the Guadalajara, Mexico wholesale market[8], the weighted average tariff per kilogram of Mexican fresh tomatoes ($GTTX_t$)[9], and Mexican per-capita income ($MXPCY_t$). Given persistent trade flows of fresh tomatoes from year to year, the previous year's Mexican supply volume ($MXQS_{t-12}$) was also included, following the structure of the U.S. demand equation. Two seasonal dummy variables (DS1A, DS3) were also included for Mexican fresh tomato exports to control for the two trading periods specifically delineated under NAFTA tariff reductions (Table 3.1). So, this equation can be modeled as:

$$(3.3) \quad MXQS_t = f(MXCIFP_{t-4}, MXPPT_{t-4}, MXVRP_t, GTTX_t, MXPCY_t, MXQS_{t-12}, DS1A_t, DS3_t)^{10}$$

Finally, trading costs per kilogram ($MXCIF_t$) are a function of the total volume of fresh tomatoes imported from Mexico, in tons ($MXQS_t$), the real exchange rate index defined as pesos per dollar ($MXRER_t$), the weighted average tariff per kilogram for Mexican fresh tomatoes ($GTTX_t$), and the weighted average price per kilogram for

[8] Approximately 60 percent of fresh tomatoes imported from Mexico in the 1990's were vine ripe tomatoes. Mexican producers have the alternative of selling their tomatoes in the domestic market, so it was decided that vine ripe tomatoes from the terminal market of Guadalajara, Jalisco, Mexico, could serve as a domestic, competitive product for Mexican fresh tomato exports.

[9] This number was determined by dividing the total calculated duties for cherry, plum (roma), and other tomatoes imported from Mexico (entered through Laredo, Nogales, and San Diego) by the total volume of Mexican fresh tomatoes imported.

[10] It should be noted that a real exchange rate variable was not included in this equation in order to prevent multicollinearity in the model since the tomato producer price index is strongly influenced by the behavior of the real exchange rate.

Mexican fresh tomatoes at the shipping point ($MXFOBP_t$). So, the equation that represents the marketing sector in this trade model is:

$$(3.4) \quad MXCIF_t = f(MXQS_t, MXRER_t, GTTX_t, MXFOBP_t)$$

The first identity equates the CIF price for Mexican fresh tomatoes per kilogram ($MXCIFP_t$) to the sum of the FOB Mexican price ($MXFOBP_t$) and the trading charges per kilogram ($MXCIF_t$).

$$(3.5) \quad MXCIFP_t = MXFOBP_t + MXCIF_t$$

The final equation is another identity that equates the tonnage of U.S. fresh tomatoes supply ($USQS_t$) to the difference between the U.S. domestic demand for fresh tomatoes ($USQD_t$) and the Mexican supply of fresh tomatoes to the U.S. ($MXQS_t$).

$$(3.6) \quad USQS_t = USQD_t - MXQS_t$$

Table 3.1. Harmonized Tariff Schedule for Fresh Tomatoes

HTS Code[1/]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0702.00.20			10 [2/]				14		10.[3/]		14	
0702.00.40 [3/]							15	31				
0702.00.60 [2/]		28									15	
Cherry[3/]												

Notes: 1/ HTS code for fresh tomatoes entered during the period indicated.
2/ Duty free on January 1, 2003.
3/ Duty free on January 1, 1998.
Source: USITC.

The structural model is therefore defined as follows:

(3.7) U.S. domestic demand for fresh tomatoes

$$USQD_t = \alpha_0 + \alpha_1 USSTP_t + \alpha_2 MXCIFP_t + \alpha_3 USPCY_t + \alpha_4 USQD_{t-12}, + \varepsilon_1$$

(3.8) U.S. domestic supply for fresh tomatoes

$$USQS_t = \beta_0 + \beta_1 USSTP_{t-4} + \beta_2 USACRE_t + \beta_3 USPPT_{t-4} + \varepsilon_2$$

(3.9) Mexican supply of fresh tomatoes to the U.S.

$$MXQS_t = \gamma_0 + \gamma_1 MXCIFP_{t-4} + \gamma_2 MXPPT_{t-4} + \gamma_3 MXVRP_t + \gamma_4 GTTX_t$$

$$+ \gamma_5 MXPCY_t + \gamma_6 MXQS_{t-12}, + \gamma_7 DS1A_t + \gamma_8 DS3_t + \varepsilon_3$$

(3.10) Trading costs

$$MXCIF_t = \varphi_0 + \varphi_1 MXQS_t + \varphi_2 MXRER_t + \varphi_3 GTTX_t + \varphi_4 MXFOBP_t + \varepsilon_4$$

(3.11) Price identity

$$MXCIFP_t = MXFOBP_t + MXCIF_t$$

(3.12) Quantity identity

$$USQS_t = USQD_t - MXQS_t$$

The expected results from the four structural equations are based on the literature cited previously, and the basic tenets of economic trade theory. In the domestic demand and excess supply equations (3.7 & 3.8), the quantity demanded and consequently imported during the same month in the previous year ($USQD_{t-12}$ and $MXQS_{t-12}$) are expected to have a positive relationship with current levels. Moreover, the coefficient on these variables will indicate the share of imports that could be based on institutional trading relationships, rather than impacts from more market-oriented variables.

For equation 3.7, the price variable ($USSTP_t$) is expected to have a negative impact on the quantity of domestic fresh tomatoes demanded by U.S. market intermediaries. According to the United States International Trade Commission (USITC), there is a moderate degree of substitution between domestic and imported tomatoes ($MXCIFP_t$), although Mexican producers argue that imports from Mexico are complementary to demand for US tomatoes since they cover seasonal shortfalls in U.S. production. According to the ERS-USDA, fresh tomatoes are considered a normal product, so U.S. disposable per-capita income ($USPCY_t$) is expected to have a positive relationship with the imports of fresh tomatoes.

For the U.S. domestic supply equation (3.8), lags in tomato shipping point price and the producer price index for fresh tomatoes were considered. Since product prices and production costs are uncertain at the time the decision on acreage in production is made, it is assumed that decision is made with information from prices at planting time. Once the decision is made on acreage in production, the influence of tomato prices on supply at harvesting time is assumed to be minimal. A positive relationship is expected between the quantity of fresh tomatoes supplied and the lagged tomato shipping point price ($USSTP_{t-4}$), as well as the tomato acreage harvested ($USACRE_t$), since an increase in either variable reflects an increase in U.S. domestic tomato supply. The relationship between the tomato producer price index ($USPPT_{t-4}$) and quantity supplied should be negative since that index is a proxy for production costs.

In the case of the excess supply equation (3.9), the variables included were based on production theory as well as possible trade considerations. Following production theory, the supply of Mexican tomatoes available to import to the U.S. should be positively related to price in the U.S. entry markets (MXCIFP). Also, as costs of production for Mexican tomato growers (MXPPT) increase, the supply of tomatoes available to the world market should decline. Although many Mexican growers specialize in tomatoes for export markets, almost 50 percent of tomatoes do remain in the domestic market. Thus, the relationship between the price of vine ripe tomatoes in the Mexican market (MXVRP) and excess supply should be negative. Similarly, with higher trade tariffs (GTTX), supply of Mexican imports to the U.S. market should decrease. To account for Mexican-based demand factors that may impact the level of excess supply, Mexican per-capita income (MXPCY) is included, and a negative relationship is expected. Finally, the USITC has divided the tariff charges for Mexican imports into three seasons, and the season with lower import levels (by definition) serves as a reference period, so the two seasons included in the model are expected to have a positive sign.

Although most models allow for a fixed level of transaction costs to shift up the excess supply curve from the exporting country, this model also allows for the trading costs to vary with market conditions. This allows us to test whether arguments presented in the market integration literature on the importance of these costs to this market. The relationship between trading charges (MXCIF) and the Mexican FOB price (MXFOBP) and/or the volume of fresh tomato imports (MXQS) is thought to be positive, since an increase in either variable represents an increase in demand for trading services. Since the real exchange rate (MXRER) may reduce the Mexican-based trading expenditures in dollar terms, it is expected to have a negative relationship with overall trading charges. Finally, there may be a positive relationship between tariffs (GTTX) and the marketing margin if there is a complementary relationship between these two factors that make up the difference between shipping point and entry prices.

3.3. Data and Estimation

The equation system was estimated with a monthly data series spanning the time period from September 1992 to August 1999. Data on the volume of Mexican fresh tomatoes, imported Mexican fresh tomatoes CIF and FOB prices, trading charges, and fresh tomato tariffs were constructed with information reported by the USITC. Data on U.S. fresh tomatoes' shipping point price; domestic shipments of fresh tomatoes, which are assumed to be U.S. production since exports are minimal, and the U.S. producer price index for fresh tomatoes, are from the USDA's Economic Research Service. Terminal market prices for Mexican fresh tomatoes are from the USDA's Agricultural Marketing Service and the U.S. acreage harvested data was from the USDA's National Agricultural Statistical Service. The Mexican real exchange rate, the Mexican price producer index for tomatoes, and the U.S. disposable per-capita income were collected from publications of the Banco de Mexico and the Bureau of Economic Analysis within the U.S. Department of Commerce. The Mexican per-capita income was constructed with the information from the Instituto Nacional de Estadistica, Geografia e Informatica in Mexico. All the price and tariff variables in the model are in real terms (deflated by the consumer price index to a 1994 base price) (Table 3.2).

The structural model consists of six endogenous variables; four lagged endogenous variables, two lagged exogenous variables, and nine exogenous variables (Table 3.3). The model is identified by rank and overidentified by order (Table 3.4).

Table 3.2. Variable Definition, Description, and Descriptive Statistics

Variable Definition	Description	Mean	Standard Deviation	Maximum	Minimum
USQD	U.S. domestic demand of fresh tomatoes (tons). USQS + MXQS = USQD[1]	138,992.60	23,199.47	190,510.20	89,225.40
USQS	U.S. fresh tomatoes shipments (tons)	92,015.53	28,465.28	146,778.20	20,747.80
MXQS	Mexican supply of fresh tomatoes to the U.S. (tons)	46,977.10	30,806.13	122,610.00	7,295.00
MXCIF	Trading cost ($/kg)	0.04	0.02	0.07	0.01
MXCIFP	Mexican fresh tomato weighted average price at the port of entry ($/kg) MXCIFP = MXFOBP + MXCIF	0.76	0.27	1.78	0.46
USSTP	U.S. fresh tomato shipping point price ($/kg)	0.67	0.25	1.72	0.32
USPCY	U.S. disposable personal income ($)	20,242.99	639.81	21,588.27	19,275.71
USSTP(-4)	U.S. fresh tomato shipping point price, lagged 4 months ($/kg)	0.68	0.25	1.72	0.32
USACRE	U.S. fresh tomato acreage harvested	31,837.74	16,722.25	74,490.00	11,000.00
USPPT(-4)	U.S. fresh tomatoes producer price index, lagged 4 months	132.33	53.33	323.32	54.19
MXRER	Mexican real exchange index (pesos per dollar)	169.22	63.36	273.06	85.41
MXPPT(-4)	Mexican tomatoes producer price index, lagged 4 months	141.27	60.68	408.63	71.87
MXVRP	Mexican terminal market vine ripe tomato price ($/kg)	0.64	0.32	1.76	0.21
GTTX	Mexican fresh tomato weighted average tariff ($/kg)	0.03	0.01	0.05	0.00
MXPCY	Mexican per-capita income (pesos)	15,325.17	651.75	16,684.43	13,481.70
DS1A	Seasonal dummy variable (March, April, May, and June =1)				
DS3	Seasonal dummy variable (November, December, January, and February = 1)				
MXFOBP	Mexican fresh tomato weighted average shipping point price ($/kg)	0.72	0.27	1.73	0.44
MXCIFP(-4)	Mexican fresh tomato weighted average price at the port of entry, lagged 4 months ($/kg)	0.77	0.28	1.78	0.46
USQD(-12)	U.S. domestic demand of fresh tomatoes, lagged one year (tons).	137,109.30	22,520.98	190,510.20	89,225.40
MXQS(-12)	Mexican supply of fresh tomatoes to the U.S., lagged one year (tons)	46,615.72	31,726.16	122,610.00	7,295.00

Note: 1/ Exports were not considered given that they represented only around 8 percent of total U.S. fresh tomato production in the 1990's.

Table 3.3. Variables Included in the Model

Endogenous (M)	Predetermined (K)
$USQD_t$	$USSTP_{t-4}$
$USQS_t$	$USPCY_t$
$MXQS_t$	$USACRE_t$
$MXCIF$	$USPPT_{t-4}$
$MXCIFP_t$	$MXRER_t$
$USSTP_t$	$MXPPT_{t-4}$
	$MXVRP_t$
	$GTTX_t$
	$MXPCY_t$
	$DS1A_t$
	$DS3_t$
	$MXFOBP_t$
	$MXCIFP_{t-4}$
	$USQD_{t-12}$
	$MXQS_{t-12}$

Table 3.4. Identification of Equations

Equation	No. of predetermined variables excluded (K-k)	No. of endogenous variables included less one (M-1)	Identification	
			Order K-k > m-1	Rank [1/]
1. U.S. domestic demand for fresh tomatoes	13	2	Overidentified	$\rho(A_1) = 5$
2. U.S. domestic supply for fresh tomatoes	12	0	Overidentified	$\rho(A_2) = 5$
3. Mexican supply for fresh tomatoes	7	0	Overidentified	$\rho(A_3) = 5$
4. Trading costs	12	1	Overidentified	$\rho(A_4) = 5$
5. Prices identity	14	0	Overidentified	$\rho(A_5) = 5$
6. Quantities identity	12	-1	Overidentified	$\rho(A_6) = 5$

Note: 1/ Rank was determined considering the rank of the matrix of excluded variables within each equation.

In order to determine the technique necessary to produce consistent and efficient parameter estimates, the model was tested for the presence of simultaneity problems by applying the Hausman specification error test. The regressors USSTP and MXCIFP in equation (3.7) are being considered as endogenous and therefore it is hypothesized that they are correlated with the disturbance/error term. Because of the possibility of simultaneity between USQD and USSTP, the reduced form regression of USSTP was estimated[11]. From this regression, the calculated residuals (•) were obtained and then considered as a regressor in equation (3.7). The results were as follows.

$$(3.13)\quad \underset{t}{USQD_t} = \underset{(-0.212)}{-14787.53} + \underset{(0.201)}{2662.51 USSTP_t} - \underset{(-0.106)}{787.90 MXCIFP_t} + \underset{(0.897)}{3.26 USPCY_t} + \underset{(6.496)}{0.644 USQD_{t-12}} - \underset{(-1.818)}{32247.15\bullet}$$

The coefficient of • is statistically significant at the 10% level, therefore, the hypothesized presence of simultaneity cannot be rejected. Given that the problem of simultaneity is evident in the equation system, a two-stage least squares (2SLS) technique was applied for model estimation. The 2SLS method will give estimators that are consistent and efficient. In order to determine the behavior of the dependent variables, they were tested for stationarity. A standard augmented Dickey Fuller test (ADF) was applied to each time series ($USQD_t$, $USQS_t$, $MXQS_t$, $MXCIF_t$, $MXCIFP_t$, *and* $USSTP_t$)[12]. All of them indicated stationarity at 95 percent confidence level, following a I(0) process. It indicates that they are mean reverting and have a constant variance. The estimation of the structural parameters was conducted using EVIEWS version 3.1.

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[11] USSTP was regressed on AUS, USPPT(-4), MXCIF(-4), MXPPT(-4), MXVRP, GTTX, MXPCY, MXRER, MXFOBP, USPCY, USSTP(-4), DS1A, DS3, USQD(-12), and MXQS(-12).

[12] For each time series the specification of 4 lags was chosen, since 4 months is representative of a season.

3.4. Empirical Results

The estimated structural equations from the simultaneous equation system are shown in Table 3.5. Values of the goodness of fit measures (R^2) are 0.58, 0.55, 0.85, and 0.80 for the four structural equations, respectively. The *t*-statistics associated with the estimated coefficients appear in parentheses[13]. In order to correct for serial correlation in the model, a first order autoregressive term was added to all equations, with the exception of equation two which needed an additional second order autoregressive term in order to correct for autocorrelation. Based on Durbin Watson and Durbin-*h* statistics, serial correlation problems are no longer evident in the system.

All the coefficients have their anticipated signs, but many of the modeled relationships were insignificant in these estimations. It should be mentioned that in order to improve the results, several model and variable specifications were tried, such as a model with distributed lags in price of domestic and import supply. The model was also adapted to include the domestic tomato price index (weighted by shares of type of tomatoes), and in yet another specification this price was considered as a weighted average of mature green and plum tomatoes. The results obtained though these models did not change significantly from those that are presented in Table 3.5. It is important to say that the overall model presented high autocorrelation. In the U.S., domestic demand and Mexican supply equations a lagged dependent variable was included to control for autocorrelation and to more accurately measure changes in demand and import levels. The high significance of these variables indicate that institutionalized volumes may be more significant indicators of trade volumes than market oriented variables. These results

[13] The significance level chosen for this study is the 0.10 level.

may also indicate that imperfect conditions do exist. It is important to note that, in this analysis, it is assumed that the competitive price for Mexican and U.S. fresh tomatoes is based on the import price at the port of entry and the U.S. shipping point price, respectively. Therefore, U.S.-based marketing intermediaries and their methods of doing business play a key role in inter-border and intra-U.S. trade, but such factors are not directly addressed in this model. However, it should be clear that since the model is working with shipping point prices, the domestic demand is a derived demand.

The results obtained in the U.S. demand equation show that domestic and import prices, as well as U.S. personal income, are not significant at this market level. However, as hypothesized, there is a significant, positive share of demand that can be explained from the previous year's levels. This result supports the prior argument that much of the flow shipments (domestic and imported) in this market could be related to established marketing relationships.

As expected, the domestic quantity of fresh tomatoes supplied is significant and positively related to the lagged shipping point price, and significant and negatively related to the lagged U.S. tomato producer price index. The quantity of fresh tomato acres harvested has a positive relationship with domestic supply, but is insignificant. According to the USITC (1996b), if the price falls below the grower's pick and pack costs, the growers will leave tomatoes in the field: this is one possible reason that the acreage and supply responses are not strongly correlated.

Table 3.5. Estimated Structural Equations for Fresh Tomatoes International Trade Model

(7a) U.S. domestic demand for Mexican fresh tomato

$$USQD_t = -10{,}617.44 - 8{,}013.86USSTP_t + 6{,}467.33MXCIFP_t + 3.73USPCY_t +$$
$$(-0.092) \quad (-0.694) \quad (0.792) \quad (0.658)$$

$$0.55USQD^*_{t-12} + 0.483AR(1)$$
$$(5.483) \quad (4.172)$$

$R^2 = 0.581$ Durbin-h = 1.140

(8a) U.S. domestic supply for fresh tomatoes

$$USQS_t = 79418.82^* + 51{,}382.09USSTP^*_{t-4} + 0.229USACRE_t - 217.68USPPT^*_{t-4}$$
$$(8.164) \quad (2.768) \quad (0.191) \quad (-2.880)$$

$$+ 0.813AR(1) - 0.328AR(2)$$
$$(6.975) \quad (-2.799)$$

$R^2 = 0.554$ DW = 1.99

(9a) Mexican supply of fresh tomatoes to the U.S.

$$MXQS_t = 53{,}608 + 4{,}539.48MXCIFP_{t-4} - 68.0307MXPPT_{t-4} - 11{,}699.20MXVRP_t$$
$$(1.276) \quad (0.670) \quad (-1.551) \quad (-1.496)$$

$$-71{,}558.54GTTX_t - 2.049MXPCY_t + 0.79MXQS^*_{t-12} + 8{,}129.40DS1A_t +$$
$$(-0.281) \quad (-0.733) \quad (10.057) \quad (1.188)$$

$$8{,}348.14DS3^*_t + 0.346AR(1)$$
$$(1.609) \quad (2.615)$$

$R^2 = 0.858$ Durbin-h = -0.014

(10a) Trading charges

$$MXCIF_t = 0.014 + 0.0000005MXQS^*_t - 0.00008MXRER^*_t + 0.1399GTTX_t$$
$$(1.415) \quad (8.488) \quad (-2.049) \quad (0.945)$$

$$+ 0.009MXFOBP^*_t + 0.495AR(1)$$
$$(1.968) \quad (4.236)$$

$R^2 = 0.808$ DW = 1.749

Note: t-values in parentheses. Asterisk indicates statistical significance at the 0.10 level.

Differing from expectations, the quantity of fresh tomatoes supplied to the U.S. market from Mexico is insignificantly related to the lagged entry market price of tomatoes ($MXCIFP_{t-4}$) and the lagged Mexican producer price index for tomatoes ($MXPPT_{t-4}$). As was the case in the domestic demand equation, the $MXQS_{t-12}$ variable shows a significant and positive effect between this and last year's import levels, supporting the argument that established marketing relationships drive some trade flows. The results on the Mexican vine ripe tomato price (MXVRP), the U.S. tariffs (GTTX), and Mexican per-capita income variables are all insignificant, but do have the negative signs expected for the model. Finally, the coefficients on the seasonal dummy variables, S1A and S3, indicate an increased quantity of Mexican supply during the season running from November to June of the following year (relative to the omitted reference period). This is logical since these dummies represent seasons when US production and supplies are low or nonexistent.

Arguably, the most interesting and informative results come from the marketing margin equation (3.10). This equation shows that the volume of fresh tomatoes imported from Mexico (MXQS) and the fob price of those tomatoes (MXFOBP) have a significant, positive influence on trading costs, indicating that the marketing sector reacts to shifts in the demand for their services. It is interesting to note that the tariff variable had the expected positive, but insignificant effect on trading charges, reinforcing the idea that tariff reductions have not played as major of a role in trade trends as some would suggest. Finally, the real exchange rate had a significant, negative impact on trading charges, which is consistent with the theory that a currency devaluation discourages the demand for goods and services paid for with the currency that domestic capital is devalued against. For Mexican grower-shippers, the Mexican peso devaluation implies higher expenditures with respect to trading charges.

3.5. Implications and Concluding Comments

Tomato trade between the U.S. and Mexico has increased dramatically during the past decade, partially due to NAFTA and favorable exchange rate conditions. However, there are other supply and demand factors that appear to influence trade flows, including the dynamics of marketing margins between Mexican shipping points and the U.S. ports of entry. This study presents an U.S.-Mexico tomato trade model, with special focus on the interdependence between trading costs and the volume of Mexican imports.

As expected, the exchange rate is a significant determinant of trading costs, but the level of tariffs was insignificant in both the trading and Mexican tomato supply equations. The Mexican shipping point price level and volume of imports also appear to affect the level of trading costs. Congruent with production theory, for American tomato growers, the shipping point price and production costs are significant determinants in the quantity of fresh tomatoes supplied. The acreage harvested also has a positive effect on tomato supply, but the coefficient is not significant, possibly due to the limited control that American producers can exert on yields. It is interesting to note that the U.S. yields per acre reported at the end of 1990's (269 cwt), are lower than those obtained in the middle of the decade (from 296 to 279 cwt).

For the import supply and domestic demand models, there appears to be a significant share of imports and domestic demand that rely on previous levels of imports and domestic quantity demanded, rather than the expected prevailing economic factors such as prices, per-capita income, and producer price index. It might be partially due to changes observed in the marketing process, where grower-shippers have become more vertically integrated and retailers have undergone notable consolidation, leading to new trade practices that are more institutionalized and less flexible to respond to market signals. There exist some concerns among produce shipper, growers, and related economic agents that the emerging methods of doing business among retailer-wholesalers have serious implications for competitive behavior (Calvin and Cook, et al.).

Given that fresh tomatoes are repacked before they are delivered to retailers, mass merchandisers, food service buyers, or other intermediaries, the prevalent marketing channel for this commodity is the wholesaler-repacker. However, at the end of 1990's the fresh tomato market saw that the foodservice and mass merchandiser marketing channels were exhibiting increased volumes. It is interesting to note that repackers have an increased percentage of sales via short term and long term contracts with these two latter tomato buyers. This growing sales share under contracts[14] may have a direct effect on the response of demand with respect to changes in prices, which is consistent with results obtained through this model.

Other factors that might be affecting the model results for domestic demand and import supply are the technological innovations, changing consumption patterns, and increased foreign competition. Technological innovations (improvements in communication in marketing produce, better transportation, and improved tomato varieties) translate to improved inventory control and reduced shrinkage, improved

[14] Calvin and Cook, et al. report 20 and zero percent of sales of foodservice, and one and two percent for mass merchandisers via short term and long term contracts during 1994, respectively. In 1999, these shares were 28 and 30 percent for foodservice and 41 and 29 percent for mass merchandisers, respectively.

efficiency in handling produce, and more diversity in tomato types and hybrids to meet consumer tastes, as well as faster and improved communication and reduced risk in transporting fresh tomatoes to the intended terminal market, intermediaries or retailers. It is also important to comment that American consumers have shifted their preferences, valuing improved quality, increased variety, and year round availability, as well as the growing importance of convenience (Kaufman, et al.). Finally, it should be recalled that imports are playing a greater role in the fresh tomato market. In the mid 1990's, the U.S. fresh tomato market saw increased imports from Mexico, yet these levels were lessened by the price agreement between the U.S. Department of Commerce and Mexican producers. During the 1999 and 2000 seasons, many Mexican tomato shipments were sent back from the border because the market had such low prices (Offner; Lister 2000b; and Burfield 2000c). Some shippers argue that the price agreement has improved quality of tomato imports, as well as communication between shippers and growers. However, some shippers consider this price agreement as an obstacle to free trade (Burfield 2000c). These three developments have affected the volume of sales, price and quality of many fresh fruits and vegetable, including tomatoes. It is very probable that these changes are having profound effects on the produce industry's structure and in the way that they conduct business (Kaufman, et al.)

It is important to recall that the model used in this study assumes perfect competition, therefore, its application and prediction level is limited to this market condition and the relationship between the variables utilized. Results obtained showed that a favorable exchange rate had a higher influence in encouraging trade flows than the tariff reduction process. Although it should be clear that the tomatoes tariff rate quote

(TRQ) and tariffs will eventually be eliminated by the year 2003. Similarly, the price agreement is expected to terminate no later than November 2001, meaning that the full effects of the free trade agreement on fresh tomatoes are yet to come. Finally, it is important to note that the structure and conduct of the fresh tomato market and its marketing channels are changing and that the results suggest that those changes are having implications on competitive behavior. In short, industrial organization trends together with trends in the U.S.-Mexico marketing sector may be more influential than tariff reductions in explaining increased trade flows. It should be mentioned that the results obtained in this model also are supported in the analysis developed in the following chapter. Discussion of the joint implications from these empirical studies will follow in the final chapter.

CHAPTER 4

Review of Literature in Market Analysis Methods

4.1. Introduction

As defined by Houck (1984), a market is a collection of actual or potential buyers and sellers of a specific good or service, where prices are determined through the interaction of these buyers and sellers, who have no option to purchase or to sell the item outside this collection. The principles or process of aggregation that define which economic agents are in this collection identify the market within space, time and political boundaries[15]. Market analysis plays an important role in economics, consequently, the examination of traders' behavior and price relationships in the market are the key factors in market analyses. The price relationships in markets can be defined spatially, temporally or vertically and those are maintained through the marketing functions of transportation, storage and processing. Under competitive conditions, the price relationship between two or more markets should follow the law of one price (LOP). This law states that prices within a market tend to move together, once prices are adjusted by the respective marketing functions (Carman).

Market integration analyses have primarily focused on price relationships over space, time, and form. Most empirical studies have dealt with the analysis of integration

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[15] It is related to the behavior of the nations that can act direct or indirectly through their policy schemes in the way individual demand and supply functions.

within spatial markets, which are markets that are not located in one particular place. It can be said that two locations belong to the same economic market if they are integrated so that the LOP holds. Traditional market integration theory assumes two regions are in the same economic market for a homogeneous good if the price differential for that good is exactly the transaction costs related to trade (Sexton, Kling, and Carman). If this price differential is greater than transaction costs, profitable arbitrage should occur. Under a competitive equilibrium, trade flows will exist until potential profits are exhausted, unless barriers to trade exist, thereby leading to economic rents. On the other hand, if the price differential is less than transaction costs, markets are segmented. There do exist some explanations for the failure of the LOP such as imperfect information and/or risk aversion, or if the regions represent autarkic markets (Spiller and Huang), so they are not linked by arbitrage. Efficient intertemporal or form market integration implies the presence of rational speculative arbitrageurs taking advantage of positive profits related to commodity storage across periods or processing until they are extinguished. When markets are integrated across time, price differentials between markets for a commodity should be equal to the storage costs. Vertical market integration implies that these price differentials should be equal to the costs involved in the different stages of marketing and processing the product.

Considering international trade, two markets are spatially integrated if the prices for a commodity between two countries, once appropriately adjusted for exchange rate and transaction costs, are equal so that the LOP holds. Numerous empirical analyses on the LOP in international markets have been developed, but the results are mixed, offering no strong support for the LOP (Officer; Goodwin; Goodwin, Grennes and Wohlgenant; Baffes; Ardeni; Zanias).

Miljkovic pointed out that "modern trade theory" presents different reasons for the failure of the LOP, such as pricing to market, exchange rate risk, and geographical separations of markets. Pricing to market refers to the situation where exporters may exert price discrimination across destination markets, taking into account export demand elasticities and the bilateral exchange rate. Exchange rate risk impacts trade, thereby affecting export prices and trade flows. For example, empirical studies have shown that imports/exports are sensitive to short-term variations in nominal bilateral exchange rates, as is the case presented in the study related to the bilateral soybean trade between the United States and Japan, France, and Spain (Anderson and Garcia). The authors of this work conclude that the effects of exchange rate risk vary across countries depending on access to forward markets, the availability of alternative supplies, the degree of market concentration in the domestic soybean processing sector and the degree of currency risk importers are willing to assume. Omitting the effects of geographical separation of markets such as transportation costs, travel time, laws of importing countries, institutions, habits, and tariff and non-tariffs barriers may prevent market arbitrage from forcing convergence among international prices.

4.2. Market Analysis Methods

Price relationships are the central point in market analysis methods, and these price relationships have been primarily studied through models of spatially integrated markets where price co-movements are indicative of market integration. As pointed out by Barrett (2001), market integration is a concept that is distinct, but closely related to market equilibrium. Markets are in competitive equilibrium if the price differentials between these markets are equal to transaction costs when trade takes place, and the price differential is equal or less than transaction costs when there is no trade. This is the classical market equilibrium concept of Samuelson; and Takayama and Judge. According to Barrett (1996), market integration concerns the free flow of goods and information – and thus prices- over space, form and time. This author argues that market integration is strongly related to intermarket tradability where the observation of trade is sufficient to demonstrate market integration. He explains that tradability exists if a good is traded between two nations, or if market intermediaries are indifferent between trade this product from one nation to the other or not. Consequently, the product is tradable between those markets.

Barrett (1996) classifies the market analysis methods into three levels. Level I methods that utilize only price data, so these methods assume that transaction costs are either constant or proportional. Level II methods use prices as well as transaction costs, and level III methods combine price data, transaction costs, and trade flows. Following this classification of methods, the first group (level I methods) includes the conventional market integration testing methods, such as the bivariate correlation coefficient, Granger causality test, Ravallion's method, and cointegration testing. Although those methods have been widely applied when analyzing price relationships in several markets for different goods, it is recognized that they have some methodological limitations. Therefore, these methodologies are not perfect for testing intermarket relationships (Li; Miljkovic; Barrett, Li, and Bailey).

Market Analysis Methods Using Only Prices

The first studies of market integration focused their analysis in measuring the linear association of two price series in distinct markets through the correlation coefficient. Although there are some limitations in using the correlation coefficient for testing market integration, it is one of the most popular and easy to apply techniques. The higher the correlation coefficient, the higher the association between market prices. If two markets are perfectly integrated this coefficient should be positive and equal to 1, meaning a perfectly positive relationship between the two price series.

The most serious weaknesses of the bivariate correlation coefficient for testing market integration are the existence of common price trends within prices over time such as inflation and population growth that result in high correlation coefficients, this technique also require filtering to eliminate bias due to common periodicity (Barrett 1996). Similarly, as Harriss pointed out the presence of potential autocorrelation in time and space reduce the validity of correlation coefficient for testing market integration. At the same time, contemporaneous correlation tests fail to investigate the true relationship between two price series if there exist delivery or information lags in response to price fluctuations (Barrett 1996). Another problem with bivariate coefficients, as pointed out by Baulch, is that the market does not always trade. Two markets will trade if their price differentials exceed transaction costs. Thus, correlation coefficients may be low even though markets are well integrated in the arbitrage sense. In short, the bivariate coefficient is not a reliable test for market integration.

The Granger causality test, first proposed by Granger (1969), is another technique used for testing market integration. This test assumes that the information relevant to the prediction of the variables, Y and X, is contained in the respective time series data on these variables. The test can be developed estimating the following regressions:

$$(4.1) \quad Y_t = \sum_{i=1}^{n} \alpha_i X_{t-i} + \sum_{j=1}^{n} \beta_j Y_{t-j} + u_{1t}$$

$$(4.2) \quad X_t = \sum_{i=1}^{m} \lambda_i X_{t-i} + \sum_{j=1}^{m} \delta_j Y_{t-j} + u_{2t}$$

It is assumed that the disturbances u_{1t} and u_{2t} are uncorrelated white noise series; and *n* and *m* are the optimal lags to be included in each equation.

Equation (4.1) considers that the current value of Y is related to past values of Y and X. The same behavior is considered in equation (4.2). Four cases can be analyzed: a) Unidirectional causality, the series X "Granger causes" Y, denoted by X ➔ Y; b) the series Y "Granger causes" X, denoted by Y ➔ X; c) bilateral causality, usually denoted by X ➔ Y, if X "Granger causes" Y and X ← Y, if Y "Granger causes" X. Finally, d) independence, which is suggested when the sets of Y and X coefficients are not statistically significant in both regressions. Granger causality was applied by Bessler and Brandt in order to support conclusions about price leadership in livestock markets. Jordan and VanSickle used this technique for testing integration of the fresh tomato market between Florida and Mexico.

The Granger causality test solves some of the problems detected in the bivariate correlation coefficient for testing intermarket relationships, given that it accounts for the leading or lagged effects on price movements. In the same way, the problem of common trends can be overcome by applying the approach proposed by Pierce and Haugh who detrended prices, in other words they "pre-whiten" the series. Although this test shows some advantages over the bivariate correlation coefficient, there exist some drawbacks to applying it as a measure of market integration. The results of a causality test are sensitive to the particular technique used in identifying the causal relationship (Chowdhury) as well as to the specification of the functional form of the regressions used in the tests (Roberts and Nord), which are commonly assumed to be linear. An additional shortcoming of this methodology is the omission of other relevant variables (besides prices) that may influence the variables that are being examined, therefore increasing the probability of finding unreliable results.

Martin Ravallion (1986) proposed a dynamic model for testing market integration, which allows the investigator to distinguish between short-run and long-run market integration. The basic model is as follows

$$(4.3) \quad P_{1t} = \sum_{j=1}^{n} a_{1j} P_{1t-j} + \sum_{k=2}^{N} \sum_{j=0}^{n} b_{1j}^{k} P_{kt-j} + X_{1t} c_1 + e_{1t}$$

$$(4.4) \quad P_{it} = \sum_{j=1}^{n} a_{ij} P_{it-j} + \sum_{j=0}^{n} b_{ij} P_{1t-j} + X_{it} c_i + e_{it} \quad (i = 2, \ldots, N)$$

where P_1 is the price in a central (urban) market, P_i is the price in the *i*th local (rural) market, X_1 and X_i are the vector of other influences on the urban and local markets, respectively, such as inflation or seasonality, *e's* are white noise error processes and the *a*'s, *b*'s, and *c*'s are fixed. The radial configuration of Ravillion's model assumes that central (urban) market prices, considered exogenous, may be able to predict the local market prices. However, price variations are caused not only by demand shocks in cities, they also may be due to supply shocks in production areas (rural). In order to prevent potential simultaneity bias, Ravallion proposed to use lagged local market prices as an instrument for P_{1t} in (4.4). Nevertheless, there are problems with this model when trade is observed between local markets and when there are bidirectional trade flows between the central and local market (which violates the radial markets assumption). In addition, the model assumes that transport costs are constant, yet if transfer costs are non-stationary, it may lead to artificially high rates of rejecting the hypothesis of market integration (Li; Barrett 1996). Ravallion's Model can be represented as an error-correction mechanism where the price series are cointegrated and maintain a stable relationship, which leads to the next discussion on cointegration tests for market integration.

Two or more non-stationary time series (integrated of the same order), that exhibit permanent shocks, are said to be cointegrated if some long run equilibrium relation exists that move the series together through a linear combination (Enders). Thus, applying bivariate cointegration, it can be said that two time series, $P_{1t} \sim I(1)$ and $P_{2t} \sim I(1)$, are cointegrated if the error term e_t, from the regression $P_{1t} = a + bP_{2t} + e_t$ is stationary. This concept of cointegration implies that the series are in a long-run equilibrium relationship, even though they may diverge in the short run. The bivariate cointegration testing was developed by Engle and Granger and Engle and Yoo and it has been a popular method applied for testing the LOP (Ardeni; Baffes; Zanias). According to Enders, the long-run relationship may be causal, behavioral, or simply a reduced-form relationship among similar trending variables. Goodwin pointed out that the Engle and Granger tests for market integration are limited by the fact that cointegration tests are confined to a pair-wise comparisons, and because such tests require one of the two prices to be designated as exogenous. Moreover, the method has no systematic procedure for the separate estimation of the multiple cointegration vectors (Enders). Hall argues that the Engle and Granger testing procedures do not have well defined limiting distributions, and consequently, do not offer straightforward testing procedures. Finally, Banerjee et al.

express concerns related to the potential for small-sample biases in parameter estimates obtained from the Engle-Granger tests.

Johansen and Stock and Watson introduced multivariate cointegration tests. This technique follows a maximum likelihood estimation procedure that provides estimates of all the cointegrating vectors that exist among a group of variables. In addition, these tests allow the researcher to test restricted versions of the cointegrating vector(s) and speed of adjustment parameters. Some advantages of Johansen's maximum likelihood approach over the Engle and Granger testing procedures is that Johansen's multivariate cointegration uses test statistics that have an exact limiting distribution that is function of a single parameter (Goodwin). Such multivariate cointegration tests have been used for testing market integration in domestic and international commodity markets (Palaskas and Harriss-White; Silvapulle and Jayasuriya; Goodwin)

According to Barrett (1996), cointegration is neither a necessary nor a sufficient condition for market integration. He argues that if transaction costs are non-stationary, the LOP may be observed even when statistical tests reject the hypothesis of cointegration. He adds that cointegration is insufficient for four reasons. First cointegration may be consistent with a negative relationship between prices, rather than positive as the LOP suggests. Second, the magnitude of the cointegration coefficient that is informative about the relative rates of change is often reported as a magnitude implausibly far from unity. Third, market segmentation may result either from intermarket margins larger than transfer costs or from margins less than transfer costs, implying an absence of rational arbitrage or a rational absence of arbitrage, respectively. Cointegration tests identify only the second case, although both imply inefficiency in arbitrage. Fourth, trade flows may be temporally discontinuous due to perturbations and seasonal shifts in supply and demand or transaction costs. The periods of discontinuous trade flows implies a slope of the relation between prices equal to zero, while at other times it will be approximately one. In short, the discontinuity in trade flow results in nonlinear relationships between market prices (McNew). Consequently, linear cointegration testing may not be reliable in the presence of numerous periods with no trade flows.

Market Analysis Methods Using Prices and Transaction Costs

Different studies have shown that transaction costs are primordial for market integration analysis, so omitting them will lead to incorrect results (Baulch; Baffes; Goodwin; Goodwin, Grennes, and Wohlgenant). One recent study that explicitly considers transaction costs and prices is Baulch's study of spatial price equilibrium and food market integration. He applied a switching regressions model to determine whether efficient arbitrage exists in Philippine rice markets. He treated transport costs as an exogenous variable in the model. Spiller and Huang first developed the switching regressions methodology when they applied it to define wholesale gasoline markets in the northeastern United States. Later, Sexton, Kling, and Carman (SKC) developed the first switching regimes model applied to agricultural markets. They designed a model to test for efficiency of interregional commodity arbitrage in the U.S. celery market. SKC also applied the model to test price discrimination, and thus, competitiveness of markets and product substitutability. Unlike the Baulch model, the last two models considered the intermarket expenditures as an endogenous variable estimated within the model, but the three models were estimated using maximum likelihood methods. Baulch's model overcame the problem of making an arbitrary choice of a price variable as exogenous, and accounts of the possibility of discontinuous trade between markets. The switching regressions model estimates the probability that markets are integrated over time, implying that integration is not treated as an "all or nothing" binary hypothesis.

The basic switching regressions model, as developed by SKC, defines three trade regimes considering all possible arbitrage conditions between the producing regions and any terminal market.

Regime 1: Price differentials equal transaction costs.

(4.5) $P_t^i - P_t^j = T_{ij} + v_t^i$ with probability $1 - \lambda_1 - \lambda_2$

Regime 2: Price differentials exceed transaction costs.

(4.6) $P_t^i - P_t^j = T_{ij} + v_t^i + u_t^i$ with probability λ_1

Regime 3: Price differentials are less than transaction costs.

(4.7) $P_t^i - P_t^j = T_{ij} + v_t^i - u_t^i$ with probability λ_2

where P_t^i is the price at time t in terminal markets i, and P_t^j is the price in the production market j, T_{ij} is the transportation cost per unit between markets j and i, v_t^i is an error term distributed randomly, and u_t^i is a positive random variable.

The first regime represents an efficient arbitrage condition. The second one is a relative shortage situation where fewer products were allocated to the terminal market than indicated by the efficient arbitrage conditions, but shipping product from market j to i is still profitable for arbitrageurs. Regime 3 represents a market glut, where price differentials do not cover shipping costs. Terminal price is below the FOB price plus transaction costs, due to excess shipments relative to the efficient arbitrage conditions. It is assumed that the error term v_t, is independently and identically distributed with mean zero and variance σ_v^2, and that u_t is distributed independent of v_t with half normal distribution truncated from below at zero with a zero mean and variance σ_u^2.

In order to estimate the switching regression model with three regimes (efficient arbitrage, shortage and glut) the likelihood function may be specified as follows

$$(4.8) \quad L = \prod_{t-1}^{n} \left[(1-\lambda_1-\lambda_2) f_t^1 + \lambda_1 f_t^2 + \lambda_2 f_t^3 \right]$$

where f_t^1, f_t^2 and f_t^3 are the density functions of equations 4.5, 4.6, and 4.7 respectively, and n is the number of observations. The density functions can be expressed as follows:

$$(4.9) \quad f_t^1 = \frac{1}{\sigma_v} \phi \left[\frac{Y_t - T_t}{\sigma_v} \right],$$

$$(4.10) \quad f_t^2 = \left[\frac{2}{(\sigma_u^2 + \sigma_v^2)^{.5}} \right] \phi \left[\frac{Y_t - T_t}{(\sigma_u^2 + \sigma_v^2)^{.5}} \right] \left[1 - \Phi \left[\frac{-(Y_t - T_t)\sigma_u / \sigma_v}{(\sigma_u^2 + \sigma_v^2)^{.5}} \right] \right],$$

$$(4.11) \quad f_t^3 = \left[\frac{2}{(\sigma_u^2 + \sigma_v^2)^{.5}} \right] \phi \left[\frac{Y_t - T_t}{(\sigma_u^2 + \sigma_v^2)^{.5}} \right] \left[1 - \Phi \left[\frac{(Y_t - T_t)\sigma_u / \sigma_v}{(\sigma_u^2 + \sigma_v^2)^{.5}} \right] \right],$$

where $\phi(\ )$ denotes the standard normal density function, and $\Phi(\ )$ denotes the cumulative distribution function for the standard normal; T_t and Y_t are transport costs and price differentials between the terminal and producing markets at time t, respectively.

The parameters T, λ_1, λ_2, σ_v^2, and σ_u^2 can be estimated using maximum likelihood methods.

As stated above, the parity bounds model (PBM) developed by Baulch is different from the original model because it includes transportation costs as an exogenous variable rather than estimating it within the model. He argues that price spreads are more than transaction costs. There exists the possibility that they reflect other influences such as quality differences, the effect of transportation bottlenecks, or the ability of traders to earn super normal profits. Baulch's PBM estimates the probability of market integration based on price differentials and transport costs. This model defines three similar regimes to the SKC study; regime 1 is when price differentials equal transaction costs; regime 2, price differentials are less than transaction costs; and regime 3, price differentials exceed transaction costs. It should be noted that the definition that Baulch uses for regimes 2 and 3 is the opposite of that applied by SKC.

Although Baulch's PBM overcomes many of the problems for testing market integration that occur with conventional models, such as trade discontinuity, non trivial costs of commerce, the binary hypothesis of market integration, and the assumption of a linear relation among intermarket price relations, the model may be improved by adding trade flow information (Li; Barrett 1996, Barrett, Li, and Bailey). Trade flows may be observed even if price differences are greater (less) than transaction costs. Given that it is not possible to detect all the costs related to trade, such as risk premia or lags in information, trade flows may offer indirect evidence of the effects of unobservable transaction costs, resulting in better information for analysis of intermarket relationships.

Market Analysis Methods Using Prices, Transaction Costs, and Trade Flows

Although Baulch's PBM improves upon the ability of conventional models to test for market integration, his model application failed to solve the problem of nonstationary transaction costs, bidirectional trade, and taking the information available from trade flows into account (Li; Barrett 1996; 2001; Barrett, Li, and Bailey). Based on Baulch's PBM, Barrett and Li developed a model that considers prices, trade volumes, and transaction costs. In addition to improving on the drawbacks of the prior methods, the Li-Barrett model (LBM), allows for distinction between market integration and competitive market equilibrium.

Barrett, Li, and Bailey applied the LBM to examine price and trade relationships in eight Pacific Rim factor and product markets central to the Canadian and U.S. pork industries. They note that market integration implies trade flows between two countries, and specifically, it represents the Walrasian transfer of excess demand from one market to another as captured in actual or potential physical flows. It is a quantity-based measure and prices do not need to be equilibrated, therefore it is not possible to infer anything about efficiency and welfare. Positive trade flows are the basic condition for market integration (Krugman). Under this concept, trade flows are sufficient for market integration even though arbitrage conditions are not binding with equality (Barrett 2001).

The concept of competitive spatial equilibrium is related to the zero marginal profit condition, therefore conclusions about efficiency and welfare can be inferred from these models. This concept, in addition to implying firm level profit maximization, also implies a perfectly competitive long-run equilibrium, where nonnegative marginal profits are minimized. Consequently, there are no incentives for other firms to enter. This equilibrium condition depends on prices, transaction costs, and trade flows. Traditional research on market integration focused on the case when two markets are both integrated and in long-run equilibrium, which may be classified as the case of "perfectly integrated" markets. When price differentials are greater than transaction costs, positive profits may be earned by arbitrageurs, and the product is tradable. In this case, if trade is observed, markets are spatially integrated although they are not in competitive equilibrium since profits to arbitrage should be zero. In the opposite case, when price differentials are less than transaction costs and trade takes place, markets also are integrated even though arbitrageurs are earning negative profits. However, if trade is not observed, the two markets are in equilibrium (segmented equilibrium) but they are not integrated. Trade flows provide important information about market relationships since analyzing the arbitrage conditions alone will not allow you to distinguish between market integration (intermarket tradability) and market equilibrium (zero marginal profit to arbitrage).

According to Li and Barrett, Li, and Bailey, unobservable transaction costs such as risk premia, non-tariff trade barriers, or trader's preferences do (not) promote the existence of trade flows even when price differentials exceed (are less than) observable transaction costs. It is possible that arbitrageurs do (not) participate in a market if they find first mover advantages (disadvantages), although they make current negative (positive) profits to arbitrage. Still, the net present value of trade may be positive (negative). They conclude that trade flows contain additional information about market integration in addition to that offered by observable price and transfer cost data.

Recognizing the importance of trade flows in the analysis of intermarket relationships, the LBM extends the PBM to six regimes, based on whether trade actually occurred or not (Table 4.1). In regimes 1, 3, and 5, trade is observed and price differentials are equal, greater, and less than transfer costs. Conversely, in regimes 2, 4, and 6, trade does not occur but the differentials in prices are the same as regimes 1, 3, and 5, respectively.

Table 4.1. Intermarket Regimes of the LBM

	Price Differentials = Transaction Costs	Probability	Price Differentials > Transaction Costs	Probability	Price Differentials < Transaction Costs	Probability
Arbitrage Conditions	$P_t^i - P_t^j = T_{ji} + v_t$		$P_t^i - P_t^j = T_{ji} + v_t + u_t$		$P_t^i - P_t^j = T_{ji} + v_t - u_t$	
Trade	Regime1: Perfect Integration with Trade	λ_1	Regime 3: Inefficient Integration (positive marginal profits to arbitrage)	λ_3	Regime 5: Inefficient Integration (negative marginal profits to arbitrage)	λ_5
No trade	Regime 2:Perfect Integration without Trade	λ_2	Regime 4: Segmented Disequilibrium	λ_4	Regime 6: Segmented Equilibrium	λ_6

Considering the arbitrage conditions shown in table 4.1, P_t^i and P_t^j are the prices in markets *i* and *j*, respectively; T_{ji} is the observable transaction costs from markets *j* to *i*; λ_k is the probability of occurrence for each regime, implying $\sum_{k=1}^{6} \lambda_k = 1$. It is assumed that the error term v_t is an independently and identically distributed normal variable with zero mean and variance σ_v^2, this is, N(0, σ_v^2), and u_t is distributed independently of v_t and it has a half normal distribution truncated from below at zero with zero mean and variance σ_u^2.

Regimes 1 and 2 present a situation where price differentials are equal to transfer costs, meaning zero marginal profits to spatial arbitrage and tradability (trade occurring or not). Thus, under these two regimes, the product may or may not be traded between integrated markets that are in competitive equilibrium. When observing these regimes, the two markets may be classified as perfectly integrated.

In regimes 3 and 4, the price differentials are greater than transfer costs, resulting in positive marginal profits to arbitrage (regime 3), or a situation where trade appears profitable but it does not occur (regime 4). In regime 4, it may be inferred that there exist unobservable effects, due to omitted transaction costs such as nontariff trade barriers or information gaps, that are influencing trade between markets.

The case when price differentials are less than transfer costs is present in regimes 5 and 6. Regime 5 presents a situation when trade takes place even when it is not profitable to arbitrageurs. One explanation for this can be that the long-run net present value of the returns may be positive, although the value of the current period is negative. Another reason may be related to contract rigidity of firms or asset fixity, implying short-term losses even though long-term prospects are more favorable. The price difference in this regime also may be explained by the effect of unobservable transaction costs on trade, suggesting the existence of noncompetitive behavior, or temporary disequilibria due to information or contracting lags. In regime 6, trade between markets does not take place since it produces negative profits for arbitrageurs, resulting in a segmented equilibrium where markets are not integrated.

In order to estimate the probability of occurrence for each regime, it should be noted that there exists only partial information, trade = 1 and no trade = 0. A switching regimes model is applied using maximum likelihood estimation techniques, conditional on knowing whether trade occurs or not, and the distribution assumption made about the errors associated with each regime. Applying Weinstein's results for the sum of a normal random variable and a truncated normal random variable, the distribution functions in the LBM for each regime are:

$$(4.12)\quad f_t^1 = f_t^2 = \frac{1}{\sigma_v}\phi\left[\frac{Y_t - T_t}{\sigma_v}\right],$$

$$(4.13)\quad f_t^3 = f_t^4 = \left[\frac{2}{(\sigma_u^2+\sigma_v^2)^{1/2}}\right]\phi\left[\frac{Y_t - T_t}{(\sigma_u^2+\sigma_v^2)^{1/2}}\right]\left[1-\Phi\left[\frac{-(Y_t - T_t)\sigma_u/\sigma_v}{(\sigma_u^2+\sigma_v^2)^{1/2}}\right]\right],$$

$$(4.14)\quad f_t^5 = f_t^6 = \left[\frac{2}{(\sigma_u^2+\sigma_v^2)^{1/2}}\right]\phi\left[\frac{Y_t - T_t}{(\sigma_u^2+\sigma_v^2)^{1/2}}\right]\left[1-\Phi\left[\frac{(Y_t - T_t)\sigma_u/\sigma_v}{(\sigma_u^2+\sigma_v^2)^{1/2}}\right]\right],$$

where $Y_t = (P_t^i - P_t^j)$, the price difference between two markets, T_t is the transfer costs at time t, $\phi(\bullet)$ is the standard normal density function, and $\Phi(\bullet)$ is the cumulative distribution function for the standard normal. The likelihood function of the LBM model is:

$$(4.15)\quad L = \prod_{t-1}^{T}\left\{A\cdot\left[\lambda_1 f_t^1 + \lambda_3 f_t^3 + \lambda_5 f_t^5\right] + (1-A)\cdot\left[\lambda_2 f_t^2 + \lambda_4 f_t^4 + \lambda_6 f_t^6\right]\right\},$$

where A is a dummy variable, when trade is observed A = 1, otherwise A = 0. The probability of each regime and the variances σ_v^2 and σ_u^2 can be estimated maximizing the logarithm of equation (4.15) constrained to $\lambda_k \geq 0$, and $\sum_k \lambda_k = 1$.

As pointed out above through the LBM, it is possible to distinguish when two markets are integrated, (defined as tradability) and when they are in competitive equilibrium (zero marginal profit to arbitrage). The indicators of the frequency of particular market conditions are obtained by adding the probability of occurrences for regimes with similar market conditions (Table 4.2). These market conditions are of interest to economists and business leaders concerned about the efficient operation of markets. However, specific market conditions can also be aggregated to provide broader information and generalizable results to academic and industry researchers. This motivates the case of the fresh tomato market explored in this thesis, as there exists a strong interest in understanding whether there is overly competitive behavior in the trading sector. In Chapter 5 an adaptation of the LBM to the fresh tomato market is developed.

Table 4.2. Indicators of the Frequency of Market Conditions

Market Condition	Indicator (frequency)	Occurs whenever
Perfectly Integrated	$\lambda_1 + \lambda_2 = PI$	Intermarket arbitrage conditions are binding [1/]
Competitive Equilibrium	$\lambda_1 + \lambda_2 + \lambda_6 = CE$	Intermarket arbitrage conditions hold (zero marginal trader profit)
Intermarket Tradability	$\lambda_1 + \lambda_2 + \lambda_3 + \lambda_5 = IT$	Trade is observed or the intermarket arbitrage condition is binding
Inefficiently Integrated	$\lambda_3 + \lambda_5 = II$	Trade is observed but intermarket arbitrage conditions is not binding with equality
Segmented Equilibrium	$\lambda_6 = SE$	Trade is not observed and intermarket arbitrage conditions hold
Segmented Disequilibrium	$\lambda_4 = SD$	Trade is not observed and arbitrage conditions do not hold

Note: 1/ In regime 2, traders are indifferent between trading or not.

CHAPTER 5

Tradability and Market Equilibrium for U.S.-Mexico Fresh Tomatoes

5.1. Introduction

Trade flows of fresh fruit and produce between developing and developed countries has increased in recent years, due principally to the increasing demand for year round fresh produce, as well as the trend toward global trade liberalization. In the specific case of fresh tomato trade between Mexico and the U.S., flows increased dramatically during the 1990's. U.S. markets saw a considerable increase in fresh tomato imports from Mexico after 1994, the year when NAFTA was enacted and in the period in which the Mexican peso suffered a significant devaluation.

There has been a great deal of attention placed on unfair trade practices in the tomato industry, which was the primary motivation for this study. The increased imports of the 1990's led American producers to file a formal dumping complaint against Mexican growers, arguing that they had experienced decreasing domestic prices, profits, and an overall loss of market share. They perceived that fresh tomatoes were being sold at less than fair value (LTFV), so that the U.S. fresh tomato industry was injured or threatened with material injury. The antidumping investigation was suspended by an agreement between Mexican growers and the U.S. Department of Commerce.

Still, there is continued interest in whether tomato trade is efficient and fair. Given the increased trade flows of fresh tomatoes from Mexico to the U.S. in recent years, it is assumed that the fresh tomato import market is more integrated with Mexican supplies. Yet, it is not clear if they are in equilibrium, or operating in a more efficient manner. A better understanding of trade relationships is important for better informing policymakers on the likely implications of further trade negotiations and concessions to industries that are directly impacted by liberalization.

Over the last decade, the fresh fruits and vegetable sector experienced increased retailer-wholesaler concentration that led to new trade practices between grower-shippers and retailers-wholesalers, and a marked evolution in the structure of marketing channels (Kaufman, et al.). This retailer-wholesaler concentration and new ways of doing business have affected the marketing and trade costs for the produce industry, and consequently, the fresh tomato sector. Growers, shippers and related agents are concerned about the impact of those trade costs on the structure of the tomato market. They perceive that increasing fees and services in the sector may lead to market power on the part of retailer-wholesalers (Calvin and Cook, et al.). Although these changes are hard to analyze with publicly available data, these influences are taken into consideration in the development of the model and interpretation of results.

The objective of this paper is to examine price (efficiency) and trade (integration) relationships between Mexico and the U.S. for three vine ripe tomato import markets, with comparisons to California and Florida mature green tomato supplies. Special attention is given to determining if increased imports result in a more efficient market and integrated markets. A secondary objective is to provide a framework to analyze potential noncompetitive behavior in the fresh tomato market, such as the likelihood that non-tariff barriers, dumping, cost absorption to gain market share or imperfect information exist.

The last objective is to estimate "less transparent"[16] transaction costs for marketing fresh tomatoes in the domestic market and to infer their effect on market conditions. Through the application of an extended parity bounds model (EPBM), using a maximum likelihood technique, both the probabilities of observing specific intermarket conditions, and the "additional" transaction costs that are not available publicly, will be estimated.

5.2. International Market Integration

Traditional spatial market integration assumes that two regions are in the same economic market for a homogeneous good if the price differential for that good is exactly the transaction costs related to trade (Sexton, Kling, and Carman). If this price differential is greater than transaction costs, profitable arbitrage should occur. Under a competitive equilibrium, trade flows will exist until potential profits are exhausted, unless barriers to trade exist that lead to economic rents (Li). On the other hand, if the price differential is less than transaction costs, markets are segmented. There are some explanations for the failure of observing market integration such as imperfect information and/or risk aversion (Ravillion). An alternative explanation for the failure of observing spatial market integration is that the regions represent autarkic markets (Spiller and Huang). It is common to define market integration as the satisfaction of the law of one price (LOP). The LOP states that prices within two related markets tend to move similarly if trade occurs and all profitable arbitrage opportunities are extinguished. In short, prices are equalized up to the cost of commerce (Barrett 2001).

[16] These costs include all potentially measurable transaction costs that are not publicly available.

For international trade, two markets are spatially integrated if the prices for a commodity that is traded between two countries, once appropriately adjusted for the exchange rate and transaction costs, are equal (so that the LOP holds). Numerous empirical analyses in international markets have been developed, but the results are mixed, offering no strong support for the LOP (Officer; Goodwin; Goodwin, Grennes and Wohlgenant; Baffes; Ardeni; Zanias). Miljkovic pointed out that, according to "modern trade theory," some potential reasons for the failure of the LOP are pricing to market, exchange rate risk, and the geographical separation of markets.

Most of the conventional market analysis methods to study price relationships in agricultural markets have used price co-movement as indicators of market integration, (such as the bivariate correlation coefficient, the Granger causality test, cointegration, or error correction mechanism). Although those approaches have been widely applied, it is recognized that they have some methodological flaws that make them unreliable or inadequate for testing intermarket relationships (Li; Miljkovic; Barret, Li, and Bailey). For example, these methods fail to test for market integration when trade is discontinuous or bidirectional, or when transaction costs are nonstationary, as these approaches generally assume linear functional forms and constant transaction costs. Trade discontinuity implies a nonlinear or piecewise linear relationship between price series, so the inferential power of these tests is reduced. Similarly, when transaction costs are not taken into account, they form part of the error term, and if they are nonstationary, it implies that artificially high rates of rejecting the hypothesis of market integration can be expected (Barrett 2001).

Different studies have shown that transaction costs are primordial for market integration analysis, so omitting them will lead to incorrect results (Baulch; Baffes; Goodwin; Goodwin, Grennes, and Wohlgenant). A recent study that explicitly considers transaction costs and prices is Baulch's study of spatial price equilibrium and food market integration. He applied a switching regressions model to determine whether efficient arbitrage exists in the Philippine rice markets. Although Baulch's model solves many of the problems that testing market integration with conventional models presents (such as trade discontinuity, non trivial costs of commerce, the binary hypothesis of market integration, and the assumption of a linear relation among intermarket price relations), the model may be improved further by adding trade flow information (Li; Barrett 1996, Barrett, Li, and Bailey). Barrett and Li developed the first method of market analysis that fully utilizes information on prices, trade volumes, and cost of commerce, which serves as the methodological basis for this study.

5.3. The Extended Parity Bounds Model

In order to examine market conditions for Mexican fresh tomato imports and California and Florida supplies (whether the respective fresh tomato markets are perfectly integrated, in segmented equilibrium, or exhibit tradability), an extended parity bounds model (EPBM) will be applied following the general structure designed by Barrett and Li (1999) (LBM). The LBM model is an extension of the parity bounds model (PBM) proposed by Baulch (1994). Baulch's model solves the main problems of the conventional methods to test for market integration in the food agricultural markets, including trade discontinuity and zero or constant transaction costs while the parity bounds model, as applied by Barrett, Li, and Bailey (LBM), takes into account the problems of nonstationary transaction costs and bidirectional trade. In contrast to conventional methods that use only prices for testing market integration, and supplementing the PBM that use both prices and trading charges data, the LBM exploits information in prices, transaction costs, and trade flows. Since it is not possible to detect all the costs related to trade, such as the presence and magnitude of risk premia, discount rates, or non tariff trade barriers, trade flows may offer indirect evidence of the effects of unobservable transaction costs, resulting in better information for analysis of intermarket relationships. In addition, the LBM model allows the researcher to distinguish between market integration (defined as tradability), and market equilibrium, when the zero marginal profit to arbitrage criteria is met.

Although grocery retail sales are still the most important marketing channel for most produce commodities, California and Florida grower-shippers sell the majority of their product to wholesalers and distributors in order to be repacked for selling to retailers or other intermediaries. The increased concentration among fruit and vegetable retailers reported at the end of the 1990's has encouraged the development of new trade practices between grower-shippers and retailers-wholesalers[17] and to a changing structure of marketing channels (Kaufman, et al.; Calvin and Cook, et al.). This retailer concentration and new ways of doing business have affected the produce industry, and consequently, the fresh tomato sector. Grower-shippers are concerned about increasing transaction costs, arguing that retail-wholesaler consolidation has led to abuses of market power.

[17] New trade practices include less transparent fees and services, such as volume discounts and slotting fees, automatic inventory replenishment, special packing, and food safety certification. It also refers to the overall structure of transactions as daily sales, short term or long term contracts (Calvin and Cook, et al.).

Imported tomatoes use the same marketing channels as American supplies once they reach U.S. entry service ports, therefore observable transaction costs (transaction costs that are measurable) for marketing them are still comparable. In order to reach American markets, imported tomatoes do have additional transaction costs such as the trading costs, insurance, international freights, loading/ unloading costs, and tariffs reported by the USITC. As noted, there is little public information about domestic grower-shippers' costs since data are proprietary, a fact that is taken into consideration in the development of the model and interpretation of results.

In addition to overcoming many of the problems detected in the conventional models for testing market integration, the EPBM applied in this work allows for estimation of the "additional" measurable transaction costs that are not public information. Moreover, it provides a methodological framework to analyze claims of anticompetitive behavior in the fresh tomato market and permits one to distinguish between market integration and competitive market equilibrium.

According to Tomek and Robinson, the classical principles that underlie price differences between regions, assuming a competitive market with homogeneous commodities are as follows: (*a*) price differences between any two regions (or markets) that trade with each other will just equal transfer costs; and (*b*) price differences between any two regions (or markets) that do not trade with each other will be less or equal to transfer costs. But as Carman pointed out, ". . . since these assumptions are often violated in real world commodity markets, it is possible to find price differences that are greater than transfer costs with no trade occurring, or price differences that differ from the transfer cost when there is trade."

Following Barrett (2001; Barrett et al., 2000), market integration is a quantity-based measure where the observance of trade flows is sufficient to test that two markets are integrated. His approach draws on the intermarket transfer of Walrasian excess demand that is reflected in trade flows. So markets may be perfectly integrated, which is the case when markets are also in a long run competitive equilibrium, or they may be imperfectly integrated when trade is observed but the arbitrage conditions are not binding. On the other hand, the spatial long run competitive equilibrium is when marginal profits to intermarket arbitrage are zero, so there is no incentive for entry to this market. In order to know if there is any positive or negative profit to arbitrage, one must take into account all price, transaction costs, and trade flows data.

In order to determine if Mexican imports and American markets are in long run competitive equilibrium, let's consider the following intermarket arbitrage conditions. $P_{at} \leq T(P_{mt}, Q_{mt}, d_{mt}, c_{mat.}, z_t) + P_{mt}$, with P_{at} being the wholesale terminal market price for fresh tomatoes at time t, and T representing measurable transaction costs that are a function of FOB prices (P_{mt}), imported quantity (Q_{mt}), unit average duties for Mexican tomatoes (d_{mt}), costs of transportation (c_{mat}), and other transaction costs z_t at time t. When trade flows are observed and the intermarket conditions bind with equality, the Mexican and American markets are in equilibrium. If trade flows are not observed and the arbitrage conditions hold, these conditions may be slack so that markets are in equilibrium (segmented equilibrium) even though prices in the respective markets are not related. When the equilibrium condition is binding and trade flows do not occur, traders should be indifferent between trading or not trading (tradability exists), implying that markets are integrated. Consequently, if Mexican and American fresh tomato markets are integrated and in long-run competitive equilibrium, they are perfectly integrated. If trade takes place and the intermarket arbitrage condition is not binding, it can be inferred that markets are inefficiently integrated.

The central idea behind the EPBM is to measure the probability of intermarket arbitrage conditions binding, thereby making it possible to establish whether Mexican and American fresh tomato markets are perfectly integrated or to infer, through probability, other distinct market relationships. The model is also applied to California and Florida tomatoes markets as market integration is an important market condition to analyze within domestic marketing channels as well. Taking into account the intermarket equilibrium conditions specified above and time series data for FOB prices, wholesale terminal market prices in the US, trade costs, insurance, and freight, tariffs, domestic transportation costs, and the binary observation of trade (or no trade) flows of Mexican fresh tomatoes, six regimes are defined (Table 5.1).

Table 5.1. Intermarket Regimes of the Extended Parity Bounds Model

Regime Definition	Intermarket Conditions	Probability
Trade Is Observed		
Regime1: Perfect Integration with Trade	$P_t^i - P_t^j = T_{ji} + v_t$	λ_1
Regime 3: Inefficient Integration (positive marginal profits to arbitrage)	$P_t^i - P_t^j = T_{ji} + v_t + u_t$	λ_2
Regime 5: Inefficient Integration (negative marginal profits to arbitrage)	$P_t^i - P_t^j = T_{ji} + v_t - u_t$	λ_3
Trade Is Not Observed		
Regime2: Perfect Integration without Trade	$P_t^i - P_t^j = T_{ji} + v_t$	λ_4
Regime 4: Segmented Disequilibrium	$P_t^i - P_t^j = T_{ji} + v_t + u_t$	λ_5
Regime 6: Segmented Equilibrium	$P_t^i - P_t^j = T_{ji} + v_t - u_t$	λ_6

When the spatial arbitrage conditions bind, $P_t^i - P_t^j = T_{ji} + v_t$, it signals that the markets are integrated and in long-run competitive equilibrium (whether trade is observed or not), thereby signifying perfect integration as is the case of regimes 1 and 2. If price differentials exceed measurable transaction costs, $P_t^i - P_t^j = T_{ji} + v_t + u_t$, this implies positive marginal profits to the trading sector (regime 3) or the case when trade appears profitable but it does not take place (regime 4). In regime 4, there may exist the possibility that there are some unobservable effects, due to omitted transaction costs, such as nontariff trade barriers or imperfect information that prevents trade from taking place. Finally, if price differentials are less than measurable transaction costs, $P_t^i - P_t^j = T_{ji} + v_t - u_t$, the market exhibits the nature of regimes 5 and 6. Regime 5 presents a situation when trade takes place even when it is not profitable to arbitrageurs. One explanation for observing this regime is that traders are expecting the long-run, net present value of the returns be positive, although the current period's returns are negative. Another reason may be related to contract rigidity of firms or asset fixity that lead to short-term losses and expectations of long term marginal profits. It can also be explained by the presence of unobservable transaction costs, suggesting the existence of noncompetitive behavior, or temporary disequilibria due to information or contracting lags. It is important to mention that regime 5 may also provide a framework that could make it possible to infer anticompetitive behavior in the fresh tomato market. In regime 6, when trade is not observed, one can infer a no-trade, segmented equilibrium exists.

Letting P_t^i and P_t^j be the wholesale terminal market price for fresh tomatoes and the FOB price, respectively, T_{ji} are the measurable transaction costs (trade costs, insurance, and freight, tariffs, domestic transportation) from j to i. Finally, v_t and u_t are error terms.

In order to estimate the "other measurable" transaction costs (less transparent transaction costs), and the probability (λ_k) of observing each the kth regimes in the fresh tomato market, a switching regimes model was constructed taking into account the regime frequencies found in the sample, conditional to the binary variable representing that trade occurred. It is assumed that the error term v_t, is independently and identically distributed with mean zero and variance σ_v^2, and that u_t is distributed independent of v_t, assuming a half normal distribution with a zero mean and variance σ_u^2. Following the sum of a normal random variable and truncated normal random variable as derived by Weinstein, the density function of ($v_t + u_t$) is as follows.

$$(5.1) \quad f(v_t + u_t) = \frac{2}{\sigma}\phi\left(\frac{v_t + u_t}{\sigma}\right)\left[1 - \Phi\left(\frac{-(v_t + u_t)^{\sigma_u}/_{\sigma_v}}{\sigma}\right)\right],$$

where: $\sigma = \left(\sigma_v^2 + \sigma_u^2\right)^{1/2}$; ϕ denotes the standard normal density function[18], and Φ is the cumulative density function for the standard normal distribution. Based on the density function (5.1) the distribution functions for the observations in each regime are determined as follows.

$$(5.2) \quad f_t^1 = f_t^2 = \frac{1}{\sigma_v}\phi\left[\frac{Y_t - (\beta + CIF_t + TX_t + DT_t)}{\sigma_v}\right],$$

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[18] The standard normal density function is determined as follows. $\phi = f\left(\frac{v_t + u_t}{\sigma}\right) = \frac{1}{(2\pi)^{0.5}}\exp^{\left(-\frac{1}{2}\frac{(v_t + u_t)^2}{\sigma^2}\right)}$

(5.3) $$f_t^3 = f_t^4 = \left[\frac{2}{(\sigma_u^2 + \sigma_v^2)^{1/2}}\right]\phi\left[\frac{Y_t - (\beta + CIF_t + TX_t + DT_t)}{(\sigma_u^2 + \sigma_v^2)^{1/2}}\right]$$

$$\cdot \left[1 - \Phi\left[\frac{-(Y_t - (\beta + CIF_t + TX_t + DT_t))\sigma_u / \sigma_v}{(\sigma_u^2 + \sigma_v^2)^{1/2}}\right]\right] ,$$

(5.4) $$f_t^5 = f_t^6 = \left[\frac{2}{(\sigma_u^2 + \sigma_v^2)^{1/2}}\right]\phi\left[\frac{Y_t - (\beta + CIF_t + TX_t + DT_t)}{(\sigma_u^2 + \sigma_v^2)^{1/2}}\right]$$

$$\cdot \left[1 - \Phi\left[\frac{(Y_t - (\beta + CIF_t + TX_t + DT_t))\sigma_u / \sigma_v}{(\sigma_u^2 + \sigma_v^2)^{1/2}}\right]\right] ,$$

where $Y_t = P_t^i - P_t^j$, are the price differentials between the wholesale terminal market price of the importing market and the FOB price of the exporting market, CIF_t is insurance, international freight, and loading/unloading costs, TX_t is the tariffs for fresh tomatoes, DT_t is domestic transportation at time t, and β is inferred ("other") transaction costs (based on an estimated model of price differences and publicly available transaction cost data).

The likelihood function that estimates the extended parity bounds model can be expressed as follows:

(5.5) $$L = \prod_{t=1}^{T}\left\{A \cdot \left[\lambda_1 f_t^1 + \lambda_3 f_t^3 + \lambda_5 f_t^5\right] + (1 - A) \cdot \left[\lambda_2 f_t^2 + \lambda_4 f_t^4 + \lambda_6 f_t^6\right]\right\}$$

where A is a binary variable for the observance of trade, A=1 if trade occurred, and 0 otherwise. Maximizing the log-likelihood function stated in equation (5.5), the probabilities of each regime (λ_k), the "other measurable" transaction costs for marketing fresh tomatoes β, and the variances σ_v^2 and σ_u^2 are estimated, subject to the constraint that $\sum_k \lambda_k = 1$ and, $\lambda_k \geq 0 \; \forall$ k. If trade is always observed, only the respective parameters representing regimes 1, 3, and 5 are calculated. The indicators of the frequency for each market condition are presented in Table 5.2.

Table 5.2. Indicators of the Frequency for Market Conditions

Market Condition	Indicator (frequency)	Occurs whenever
Perfectly Integrated	$\lambda_1 + \lambda_2 = PI$	Intermarket arbitrage conditions are binding [1/]
Market Equilibrium	$\lambda_1 + \lambda_2 + \lambda_6 = ME$	Intermarket arbitrage conditions hold (zero marginal trader profit)
Intermarket Tradability	$\lambda_1 + \lambda_2 + \lambda_3 + \lambda_5 = IT$	Trade is observed or the intermarket arbitrage condition is binding[1/]
Inefficiently Integrated	$\lambda_3 + \lambda_5 = II$	Trade is observed but intermarket arbitrage conditions may not hold
Overly Competitive Behavior	$\lambda_5 = OC$	Trade is observed (negative profits to arbitrage)
Segmented Equilibrium	$\lambda_6 = SE$	Trade is not observed intermarket arbitrage conditions hold
Segmented Disequilibrium	$\lambda_4 = SD$	Trade is not observed and intermarket arbitrage conditions do not hold

Note: 1/ In regime 2 traders should be indifferent between trading or not.

5.4. Data Description

The EPBM was estimated using weekly data for imported Mexican vine ripe tomatoes (from January 1995 through August 1999), and California and Florida mature green tomatoes (through December 1999). Shipping point prices from Nogales and San Diego[19] for Mexican tomatoes and for California and Florida[20] tomatoes were constructed

[19] These time series were constructed as an average price of a 25 pound carton of vine ripe tomatoes with a 2 layer, 4x5, 5x5, and 5x6 configurations. From January to May, Mexican prices are for tomatoes grown in Sinaloa, Mex, crossing through Nogalez, AZ. From June to December, these prices are for tomatoes produced in Baja California, Mex, crossing through Otay Mesa.

[20] This price time series was determined as an arithmetic average price of a 25-pound carton with Xlarge, large, and medium mature green tomatoes. From November to June, prices are for Florida tomatoes, and from July to October, prices are for tomatoes grown in California.

from USDA Agricultural Marketing Service (AMS) data. Tariffs (TX) for imported Mexican vine ripe tomatoes and the import charges[21] that represent the aggregate cost of all international freight, insurance, and other charges (CIF) for bringing the fresh tomatoes from the shipping point in Mexico to the first entry port in the U.S. were constructed with information reported by the United States International Trade Commission (USITC). Terminal-market wholesale prices[22] and domestic transportation (DT)[23] data is from USDA's AMS (Terminal Prices and Fruit and Vegetable Truck Rate Report). Given that there is no weekly time series of FOB prices available for Sinaloa and Baja California, this price series was determined by deducting import charges and tariffs from the shipping point prices at Nogales and San Diego. For the construction of the dummy variable that represents trade flows (A=trade flows, A=0 no trade flows between markets), it was assumed that trade flows were observed if prices for vine ripe or mature green tomatoes were reported at the shipping point and at the terminal market[24]. All time series were in terms of dollars per 25-pound carton (vine ripe and mature green tomatoes).

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[21] This time series was constructed taking into account the periods when substantial volumes of Mexican tomatoes typically cross through Nogales and Otay Mesa.

[22] This time series was derived as an arithmetic average price following the same procedure applied to the shipping point prices at Nogales and San Diego for Mexican vine ripe tomatoes, and for Florida and California mature green tomatoes.

[23] This time series was constructed for 25-pound cartons by taking into account the arithmetic average of the weekly rate range that shippers or receivers pay depending on basis of sale per load, including truck broker fees for shipments in truck load volume to a single destination. DT series also takes the actual U.S. shipping point (for Mexican and domestic supplies) into consideration.

[24] The reporting of a price within a shipping point or terminal market suggests that supplies and trade are at least fairly light. According to AMS-USDA this concept is used when buyer interest and trading are slightly below average, but still of sufficient volume to assure a threshold of market activity.

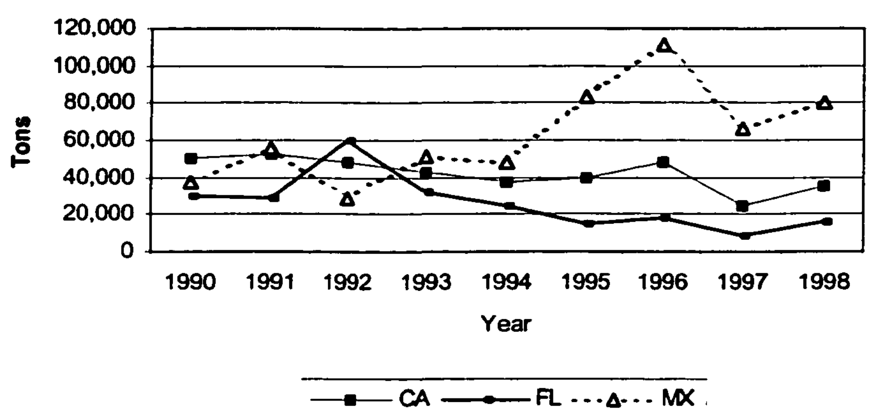
Although United States annual tomato production averaged about 1.7 million tons over the last decade, about 20 percent of U.S. fresh tomato production was imported in order to meet increased year-round demand. Currently, around 90 percent of imports are from Mexico (ERS, USDA). These imports supplement California and Florida supply and the largest share of imports from Mexico (60.4 percent) are vine ripe tomatoes, although demand for roma tomatoes has been increasing. U.S. exports some fresh tomatoes to Mexico[25], but these exports decreased significantly after the 1994 Mexican economic crisis. The majority of fresh tomatoes imported from Mexico go to Western urban markets, while Florida shipments dominate in the Northeastern and Southern terminal markets, and Florida and Mexican crops often compete for the same terminal markets in the North Central region (Thompson and Wilson; Love and Lucier). In order to examine the price relationships between Mexican and American markets for vine ripe tomatoes, three terminal markets are studied; Los Angeles in the Western region, Chicago as a representative of the North Central terminal markets, and Boston[26] for the Northeast. For mature green tomatoes supplied by California and Florida, only Chicago and Boston terminal markets are included since California supplies have big market share in the Los Angeles market.

[25] The U.S. exported 21,915.57 tons of tomatoes to Mexico in 1994, compared to 2,284.7 tons in 1995, and 4,792.78 tons in 1998.

[26] Weekly truck rate reports from USDA's AMS exist for only seven destination cities, which include Chicago and Los Angeles. The Boston domestic transportation time series was estimated based on the information reported for New York.

5.5. Prices and Trade Relationships

Although the U.S. has seen fresh tomato imports from Mexico every week in recent years, only the closer wholesale terminal markets (Los Angeles and San Francisco) have received Mexican tomato shipments with this frequency. These shipments increased considerably after 1995 in each terminal market studied, partially due to the Mexican peso devaluation at the end of 1994, as well as the beginning of tariff reductions under NAFTA. Although Los Angeles, Chicago, and Boston demanded 48,351 tons, 6,084 tons, and 2,497 tons of tomatoes from Mexico in 1994, subsequent shipments increased considerably[27] in each market. Meanwhile, shipments of fresh tomatoes from California and Florida have declined in relative terms (Figures 5.1a, b & c). This

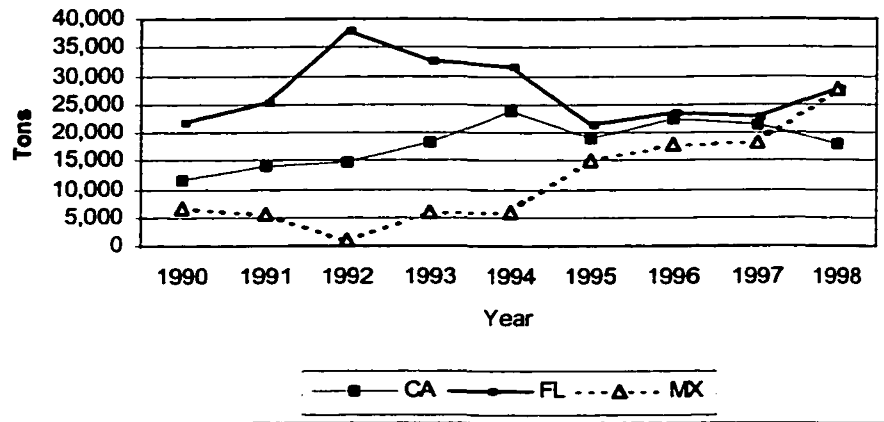


Source: USDA, ERS. U.S. Tomato Statistics 1960-98.

Figure 5.1a. Arrivals of Fresh Tomatoes to Los Angeles

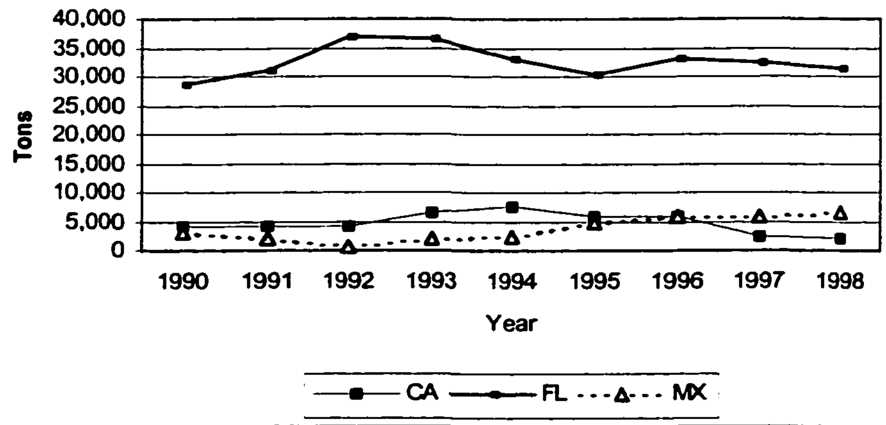
[27] Shipments of fresh tomatoes from Mexico in 1998 totaled 79,949 tons in Los Angeles, 27,785 tons in Chicago, and 6,492 tons in Boston.

decreasing demand for American mature green tomatoes may be explained by a shift in consumer preferences away from mature green tomatoes toward other types of tomatoes, in addition to increased foreign competition (Calvin and Cook, et al.).



Source: USDA, ERS. U.S. Tomato Statistics 1960-1998.

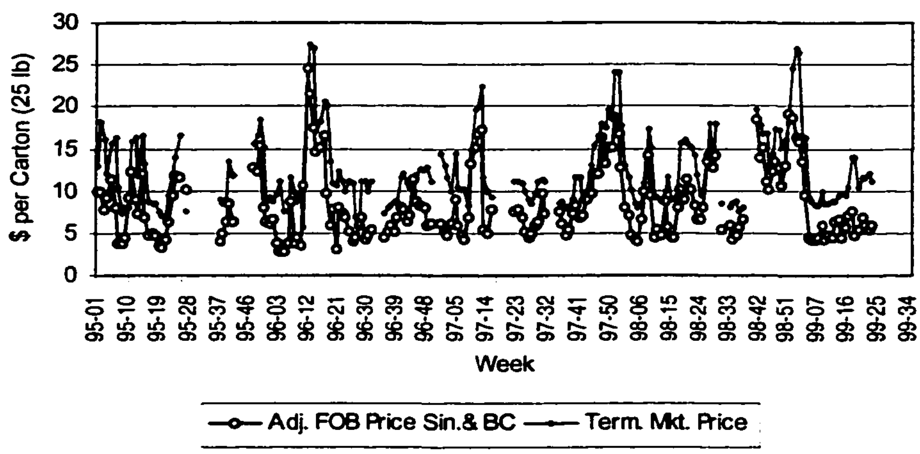
Figure 5.1b. Arrivals of Fresh Tomatoes to Chicago



Source: USDA, ERS. U.S. Tomato Statistics 1960-98.

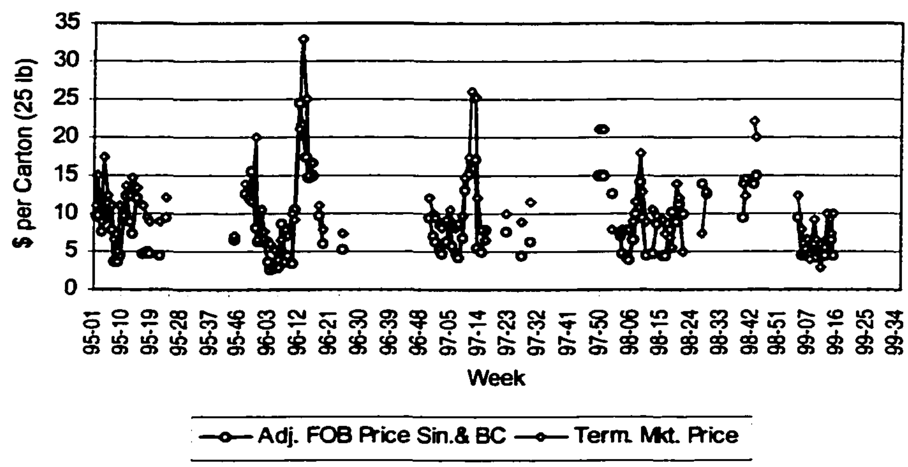
Figure 5.1c. Arrivals of Fresh Tomatoes to Boston

Chicago and Boston do not receive vine ripe Mexican tomatoes year-round, possibly due to the geographical distance from Mexican shipping points. The Chicago market exhibits stronger seasonal competition between Mexico and domestic producers, receiving trade flows of vine ripe tomatoes from Mexico during 81.5 percent of the periods analyzed, while Boston received Mexican tomatoes during only 42.6 percent of these periods (Figure 5.2a & b). In order to examine the price and trade relationships for mature green tomatoes in Chicago and Boston, the shipping point price, wholesale-terminal market, and measurable transaction costs time series were assembled taking into account year-round American supplies. From November to June, domestic prices are for Florida tomatoes, and from July to October, the prices are for tomatoes grown in



Note: The X-axis represents the respective week and year of observations.
Source: AMS, USDA.

Figure5.2a. Mexican Vine Ripe Tomatoes in Chicago Terminal Market



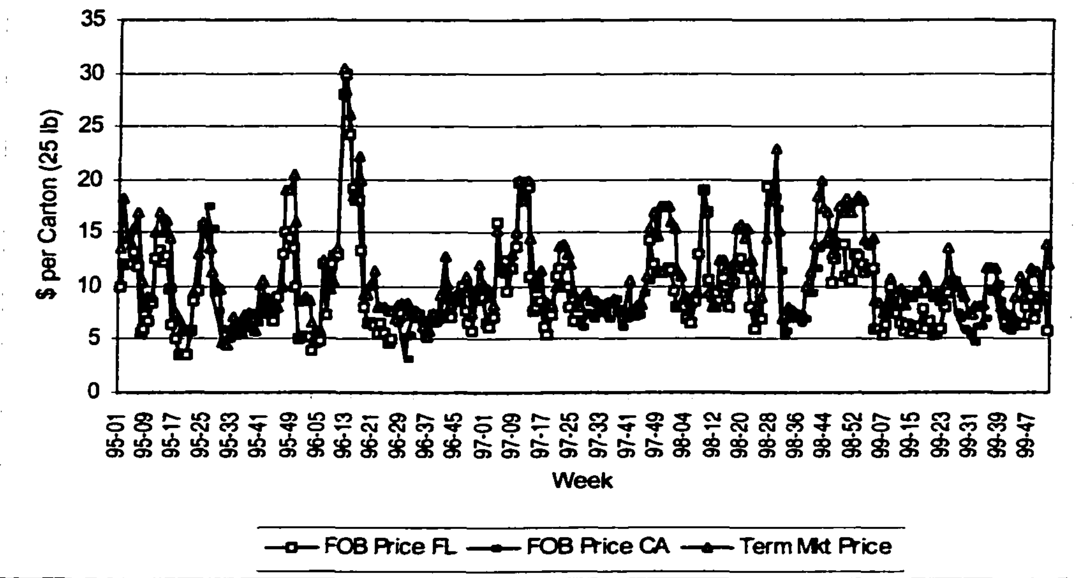
Note: The X-axis represents he respective week and year of observations.
Source: AMS, USDA.

Figure5.2b. Mexican Vine Ripe Tomatoes in Boston Terminal Market

California (Figure 5.3a & and b). Because of the relatively small trade flows of fresh tomatoes from U.S. to Mexico, and the fact that Boston and Chicago are only consumption markets, unidirectional analyses are developed for Mexican and American tomatoes in these markets.

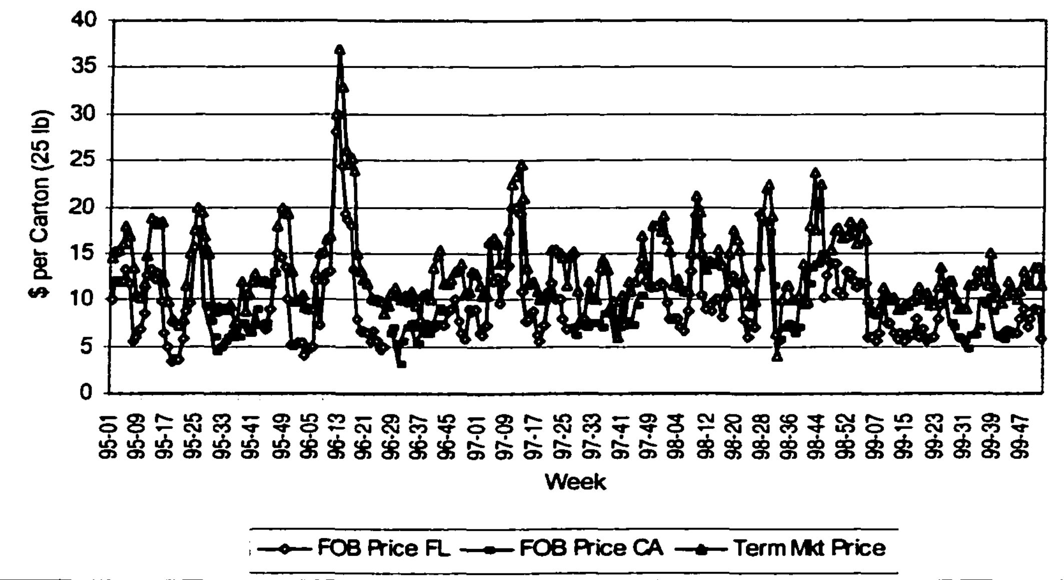
5.6. Transaction Costs for Vine Ripe and Mature Green Tomatoes

Transaction costs are not only those costs incurred for shipping the product from one location to another, referred to here as direct shipping costs (such as freight, insurance and loading/off loading costs, tariffs, and domestic transportation) which vary across season. They also include information costs such as learning about arbitrage opportunities, and costs that result from complying with governmental regulations and policies (and their enforcement), as well as hedging costs required to make arbitrage a



Note: The X-axis represents the respective week and year of observations.
Source: AMS, USDA.

Figure 5.3a. California and Florida Mature Green Tomato Prices in the Chicago Terminal Market



Note: The X-axis represents the respective week and year of observations.
Source: AMS, USDA.

Figure 5.3b. California and Florida Mature Green Tomato Prices in the Boston Terminal Market

less risky activity (Spiller and Huang). When trading internationally, the transaction costs become arguably higher than those of domestic markets due to differences in language, culture, laws and dispute procedures, as well as imperfect information sources (Thilmany and Barrett). In addition, there exist other transaction costs due to uncertainty about government regulations in foreign markets, exchange rate policy, tariffs or non-tariff barriers (Abdel-Latif and Nugent). In short, whether analyzing domestic or international markets, as defined by Spiller and Wood, arbitrage costs are those marginal costs that have to be incurred in order to perform riskless arbitrage. It is clear that getting a full, direct and exact measure of transaction costs in domestic or international markets is difficult given that they are diverse and often subjective, due mainly to the inherent unobservability of some transaction costs.

The measurable transaction costs for marketing Mexican vine ripe tomatoes applied in this study are the import charges that represent the aggregate cost of all freight, insurance, and other charges and expenses (CIF) incurred in bringing fresh tomatoes from the Sinaloa region or the Baja California Peninsula to the first port of entry in the U.S. Nogales and San Diego serve as the dominant ports of entry for tomatoes[28]. Tariffs (TX) were estimated based on the calculated duties reported by USITC. Calculated duties represent the estimated import duties collected and they are estimated on the applicable rate of duty as shown in the Harmonized Tariff Schedule (HTS) of the U.S. For imported Mexican vine ripe tomatoes, the calculated duties were collected using the code signified by "Other tomatoes", assuming that this code includes the majority of vine ripe tomatoes.

[28] Although USITC reports fresh tomato imports from Mexico through seven U.S. Custom Service Ports (Nogales, Arizona; Los Angeles, San Diego, and San Francisco in California; El Paso and Laredo in Texas; and Chicago, Illinois), virtually all imports from Mexico (97.6 percent) enter through Nogales (68.1percent) and San Diego (29.5 percent).

Finally, domestic transportation represents all the expenses required in order to deliver the fresh tomatoes from the shipping point in the United States to the wholesale terminal market. It is important to recall that other measurable transaction costs for fresh tomatoes will be estimated through the EPBM.

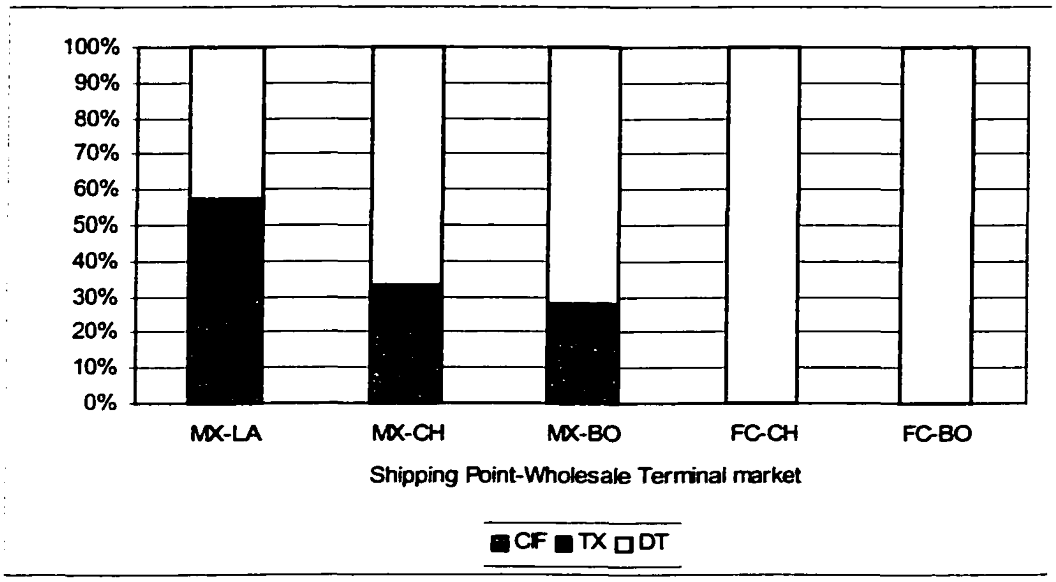
Table 5.3 shows the mean, standard deviation, and coefficient of variation of the observable (measurable) transaction costs time series utilized in the EPBM. The highest CIF ($0.56) and tariffs ($0.27) are reported for tomatoes that are delivered to Boston. It is due to the fact that the majority of trade flows from Mexico to Boston are during December through May, which is the season when the demand for Mexican transportation services is higher and the tomatoes were charged with higher duty tariffs since the tariff rate quota was in effect.

In general, the closer the terminal market to the Mexican border, the lower the domestic transportation costs. The Los Angeles terminal market reports the lowest average domestic transportation cost ($0.46) with the lowest variability (coefficient of variation is 6.63 percent). In order to reach the terminal markets of Chicago and Boston, Mexican tomatoes incur higher domestic transportation costs ($1.34 and $2.10 respectively) than California and Florida mature green tomatoes (with expenditures of $1.19 to Chicago and $1.77 to Boston). The highest coefficient of variation is for American tomatoes in the terminal market of Boston (44.27 percent). Figure 5.4 shows that, for vine ripe tomatoes, the more distant the terminal market, the relatively higher the domestic transportation costs, as one would expect.

Table 5.3. Fresh Tomatoes: Standard Deviation, Mean, and Coefficient of Variation for Publicly Reported Transaction Costs ($ per 25 lb carton)

Shipping Point and Wholesale Terminal Market	Standard Deviation	Mean	Coefficient of Variation (Std.D/Mean)*100	Number Observations
CIF[1/]				
From Sinaloa and Baja California to Nogales, AZ and San Diego-Los Angeles	0.27	0.38	72.92	244
From Sinaloa and Baja California to Nogales, AZ and San Diego-Chicago	0.27	0.42	64.95	199
From Sinaloa and Baja California to Nogales, AZ and San Diego-Boston	0.22	0.56	39.64	104
Tariffs				
Mexican vine ripe tomatoes-Los Angeles	0.13	0.24	53.26	244
Mexican vine ripe tomatoes-Chicago	0.12	0.25	50.20	199
Mexican vine ripe tomatoes-Boston	0.10	0.27	38.00	104
Domestic Transportation				
From Nogales, AZ and San Diego to Los Angeles	0.03	0.46	6.63	244
From Nogales, AZ and San Diego to Chicago	0.28	1.34	20.75	199
From Nogales, AZ and San Diego to Boston	0.43	2.10	20.37	104
From Orlando, FL and San Diego to Chicago	0.35	1.19	29.41	262
From Orlando, FL and San Diego to Boston	0.79	1.77	44.27	262
Total Known Transaction Costs				
From Sinaloa and Baja California to Los Angeles	0.37	1.08	33.79	244
From Sinaloa and Baja California to Chicago	0.32	2.01	15.72	199
From Sinaloa and Baja California to Boston	0.37	2.93	12.49	104
From Orlando, FL and San Diego to Chicago	0.35	1.19	29.41	262
From Orlando, FL and San Diego to Boston	0.79	1.77	44.27	262

Note: 1/ The mean changes because Chicago and Boston terminal markets do not receive Mexican vine ripe tomatoes during every period.



Note: MX-LA = Mexico- Los Angeles, MX-CH = Mexico-Chicago,
MX-BO = Mexico-Boston, FC-BO = Florida/California-Chicago,
FC-BO = Florida/California-Boston
*/ Measurable transaction costs publicly available.

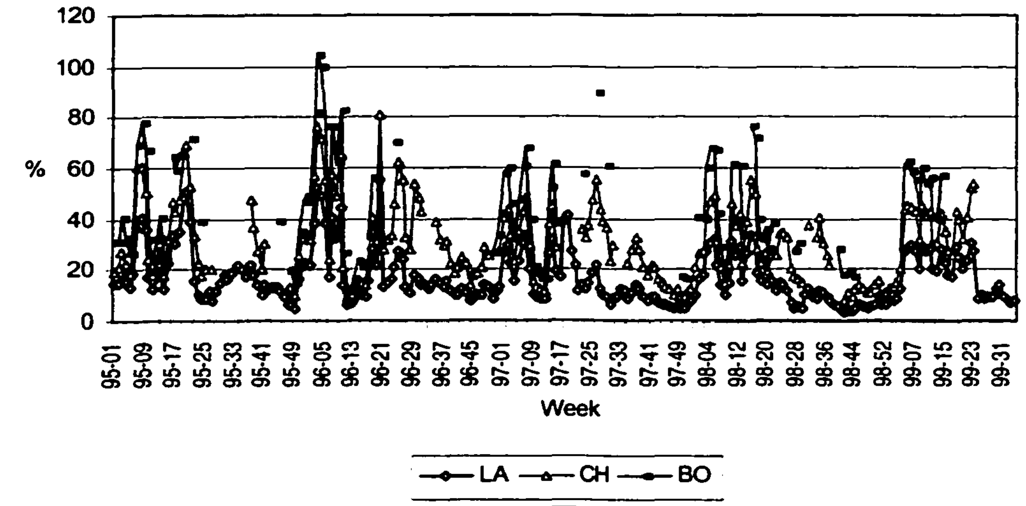
Figure 5.4. Observable Transaction Costs* for Fresh Tomatoes

The publicly available, measurable transaction costs (CIF+TX+DT) were included in a ratio with the adjusted FOB price for Sinaloa, Baja California, California and Florida (Table 5.4). This ratio represents a percentage markup that increases the (adjusted) FOB price to arrive at the landed value price of tomatoes at wholesale terminal markets. The highest average ratio was for those tomatoes grown in Mexico and marketed in Boston and Chicago (44.51 percent and 30.40 percent), while the highest variability is reported for mature green tomatoes in the Boston terminal market. This ratio reached a maximum of 115.45 percent for American tomatoes marketed in Boston, while the minimum (2.95 percent) is for Mexican tomatoes that were sold in Los Angeles. Figure 5.5a shows that the ratio of measurable transaction costs to FOB price follows a similar trend for Mexican tomatoes in the three terminal markets analyzed,

Table 5.4. Observable Transaction Costs*/FOB Price Ratio Summary Statistics (%)

Shipping Point and Wholesale Terminal Market	Mean	Standard Deviation	Coefficient of Variation (Std.D/Mean) *100	Maximum	Minimum	Number Observations
From Sinaloa and Baja California to Los Angeles	16.70	10.26	61.41	55.57	2.95	244
From Sinaloa and Baja California to Chicago	30.40	15.05	49.52	80.74	7.80	199
From Sinaloa and Baja California to Boston	44.51	20.82	46.78	104.61	11.64	104
From Florida and California to Chicago	15.31	8.07	52.74	61.54	3.00	262
From Florida and California to Boston	23.32	15.37	65.90	115.45	3.95	262

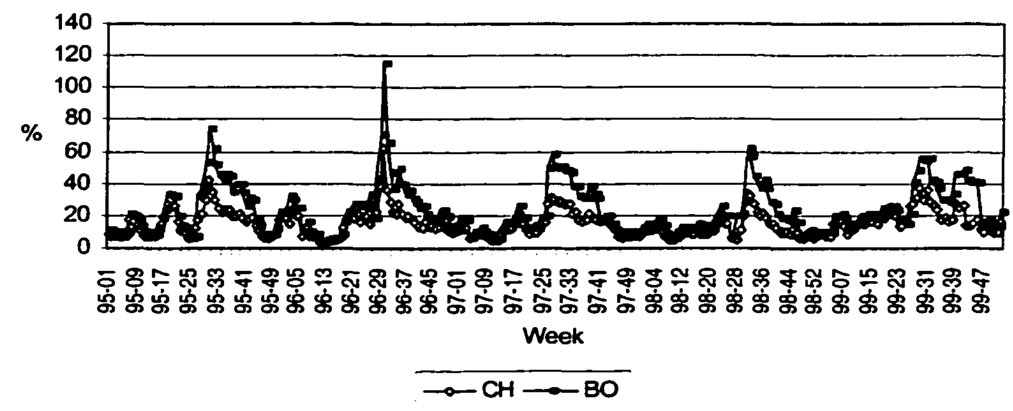
Note: */ Measurable transaction costs publicly available.



Notes: */ Measurable transaction costs publicly available.
The X-axis represents the respective week and year of observations.

Figure 5.5a. Mexican Vine Ripe Tomatoes: Ratio of Observable Transaction Costs*/FOB Price

and the final and first months of each year report higher ratios than remaining months. This is the season when the majority of vine ripe tomatoes grown in Sinaloa enter the U.S. Figure 5.5b presents the data for American tomatoes and displays similar behavior among tomatoes marketed in Boston and Chicago, since the higher ratios are during the weeks that mature green tomatoes are shipped from California (accounting for higher transportation costs from those markets).



Notes: */ Measurable transaction costs publicly available.
The X-axis represents the respective week and year of observations.

Figure 5.5b. American Mature Green Tomatoes: Ratio of Observable Transaction Costs*/FOB Price

Transaction costs play a key role in market integration tests. Given the importance that transaction costs have in the intermarket arbitrage conditions, and therefore, in the definition of specific market conditions, the different time series components of measurable transaction costs were tested for stationarity. Because of the recent changes observed in the trade practices between shippers and retailers-wholesalers in the produce sector, and the trend toward trade liberalization by the Mexican government in the last decade, it was hypothesized that the time series of the measurable transaction costs components would be nonstationary.

Technological innovations are some of the many factors that underlie the new shipper/retailer-wholesaler relationship. Changes in information technologies, as well as improvements in transportation and scientific advancements that prolong the life of fresh tomatoes, have both affected transaction costs in the fresh fruits and vegetables sector (Calvin and Cook, et al.). Under NAFTA, fresh tomatoes imported from Mexico were considered as a sensitive product[29], so they are experiencing a gradual, tariff reduction process. U.S. tariffs on imports from Mexico are set to phase out entirely over the 10-year period ending by 2003[30], and they fall under a tariff rate quota in order to give protection against surges while tariffs are being phased out.

In order to determine whether the known measurable (observable) transaction cost series for marketing fresh tomatoes are stationary or not, a standard augmented Dickey Fuller test (ADF) is applied to each time series component of the measurable transaction costs (freight charges, insurance and loading/off loading costs (CIF), tariffs for Mexican vine ripe tomatoes (TX), and domestic transportation costs (DT)) as well as the sum of

[29] Under NAFTA, sensitive products are those that require special treatment in order to protect the respective sector of the importing country against surges from the exporting country. This protection includes longer transition periods, tariff rate quotas, and for certain products, special safeguard provisions, as is the case on imports of fresh tomatoes to the U.S.

[30] Mexican vine ripe tomatoes have been imported duty free during the period July 15 through August 31 since 1998.

those series for each pair of markets analyzed. The ADF test was based on regressions of the following form[31]:

$$(5.6) \quad \Delta CIF_t = \alpha_0 + \alpha_1 CIF_{t-1} + \sum_{j=1}^{k} \beta_j \Delta CIF_{t-j} + e_t$$

where • is the first difference operator and e_t is a normally distributed error term. The null hypothesis that Ho: $\alpha_1 = 0$ against the alternative hypothesis of H_1: $\alpha_1 \neq 0$ was tested by comparing the calculated *t*-ratio of $\hat{\alpha}_1$ with Mackinnon critical values of –2.873 and -3.459 for a 5% and 1% significance level, respectively[32] (which essentially serve as adjusted *t* values) (Enders). Given that 4 weeks represent one month, for each time series analyzed, the specification of k = 4 was chosen. The results for the ADF test statistics are presented in Table 5.5. Contrary to what was hypothesized, all time series components of measurable transaction costs follow a I(0) process, indicating that they are stationary, mean reverting and have a constant variance. Only the sum of measurable transaction costs for vine ripe tomatoes marketed in Los Angeles was nonstationary. It suggests that these series have synergistic effects that lead the total measurable transaction costs to a nonstationary process. These results also support previous research (Cook; Love and Plunkett; Padilla and Thilmany) that concludes that the tariff reduction process implemented under NAFTA had only a minor effect on imports of Mexican fresh tomatoes. It also suggests that technological innovations in the fruit and vegetable sector have had little impact on prices in the fresh tomato sector.

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[31] The coefficients of the regression changed according to the time series analyzed.

[32] The critical values for mature green domestic transportation costs (262 observations) are –2.872 and –3.457 at the 5% and 1% significance levels, respectively.

Table 5.5. Augmented Dickey Fuller Test for Public Transaction Costs

Shipping Point and Wholesale Terminal Market	Freight, Insurance and Other Charges	Tariffs	Domestic Transportation	Total Known Transaction Costs
From Sinaloa and Baja California to Los Angeles	-3.421*	-3.078*	-3.354*	-2.752
From Sinaloa and Baja California to Chicago	-3.421*	-3.078*	-3.907**	-3.223*
From Sinaloa and Baja California to Boston	-3.421*	-3.078*	-3.394*	-3.487**
From Florida and California to Chicago	-	-	-4.251**	-4.251**
From Florida and California to Boston	-	-	-3.785*	-3.785*

*/Time series are stationary at 95% confidence level.
**/ Time series are stationary at 99% confidence level.

5.7. Estimation Results

The maximum likelihood estimation of the EPBM was conducted using TSP International version 4.5. Results from estimation of equation (5.5) for Mexican vine ripe and California and Florida mature green tomatoes are summarized in table 5.6. Most of the estimated coefficients are statistically significant. The Wald test for joint significance of parameter estimates was applied, and in all cases, the null hypothesis that the estimates were equal to zero was rejected.

As expected, the terminal market nearest to domestic supply regions, Los Angeles, has the highest probability (0.80) of perfect market integration (with trade) with Mexican markets, while the same market relationship was observed in Boston in only 7 percent of all periods analyzed. Similarly, mature green tomatoes in the Boston market have a higher probability for perfectly integrated trade (0.71) with California and Florida markets. As distance between markets increases, it could be argued that the risk of doing business in those markets increases due to time lags and loss in quality, so the probability of having higher non-observable transaction costs increases.

In Chicago, Mexican tomatoes exhibited an incidence of perfectly integrated markets with no trade (regime 2 with binding intermarket arbitrage conditions) at an estimated probability of zero,[33] inferring perfect integration only with trade. The small number of observations (45) for the no trade regimes, and the high probability obtained for the segmented equilibrium regime (0.18), may also explain this estimate. Regime 3, where trade takes place with positive apparent profits, has the highest probabilities in Chicago for both vine ripe (0.28) and mature green (0.62) tomatoes. This may imply that the market is arbitraged, but insufficiently to fully extinguish profit opportunities or it may also indicate the presence of some unobservable transaction costs. These high probabilities of regime 3, and low likelihood of regime 2 in the Chicago market, may be explained by the increased demand for fresh tomatoes in this market. The total demand in 1995 was 63,378 tons, while in 1998 this figure grew to 82,219 tons.

The probability of regime 4 (trade appears profitable but it does not take place) and regime 5 (temporarily losses) in Boston, for both vine ripe and mature green tomatoes was not fully unexpected. Regime 4 for vine ripe tomatoes has a probability of 0.29, while the probability of regime 5 (trade with negative profits to arbitrage) is 0.25. In the case of domestic mature green tomatoes, the probability of regime 5 in Boston is 0.15. According to these results, it may suggest some lags in information or that it is a risky or difficult proposition to trade fresh tomatoes in Boston given a high rate of unobservable

[33] It is important to note that originally the model was estimated with six regimes and the results showed that the probability associated with regime 2 in Chicago market was zero, so then the estimation for this market was conducted eliminating regime 2.

transaction costs, leading to periods when arbitrageurs decide to not take advantage of potential positive profit opportunities (regime 4). At the same time, there are other periods when even there is no apparent profit, but distributors still decide to trade (regime 5), which may be due to the competition for market share between Florida and Sinaloa tomato shippers. Alternative explanations, as discussed previously, are the existence of contract rigidities among traders (the incidence of short run and long run contracts have increased in the fresh tomato market in recent years), asset fixity or the long-run net present value of returns might be positive, even though the value of the current period is negative. These results also suggest the existence of noncompetitive behavior in this market.

The estimates of mean "other measurable transaction costs" $(\hat{\beta})$ were highly significant, with one exception, the Chicago terminal market for mature green tomatoes. Therefore, the null hypothesis of $\beta=0$ was not rejected. The model estimation showed that the β estimate was not statistically significant so the model was re-estimated restricting this estimate equal to zero. It is important to note that a significant portion of the (adjusted) FOB tomato price is due to these inferred "other transaction costs" $(\hat{\beta})$. This "inferred marketing margin" ranges from 7.98 percent for vine ripe tomatoes to 25.92 percent for mature green tomatoes, both in the Boston market, based on mean 1995-1999 shipping point prices.

Table 5.6. EPBM Estimates for Mexican and Domestic Tomatoes

	Mexico-LA	Mexico-Chicago	Mexico -Boston	CA & FL-Chicago	CA&FL-Boston
β	0.87	1.73	0.64	0	2.38
	(8.79)[a/]	(8.00)	(2.38)		(10.78)
σ_v^2	0.95	1.07	0.85	1.47	1.57
	(9.29)	(7.03)	(4.17)	(6.19)	(6.32)
σ_u^2	2.27	2.44	3.36	1.98	2.90
	(5.16)	(11.31)	(16.70)	(6.25)	(4.74)
Trade					
λ_1	0.80	0.38	0.07	0.29	0.71
	(9.03)	(3.31)	(1.96)	(2.02)	(3.83)
λ_3	0.14	0.28	0.10	0.62	0.14
	(2.09)	(2.96)	(3.53)	(5.57)	(1.26)
λ_5	0.06	0.15	0.25	0.09	0.15
	(1.42)	(2.23)	(5.67)	(1.34)	(1.50)
No Trade					
λ_2	-	0.0	0.17	-	-
			(3.04)		
λ_4	-	0.01	0.29	-	-
		(0.98)	(4.82)		
λ_6	-	0.18	0.11	-	-
		(6.71)	(3.57)		
Log Likelihood	-407.52	-629.33	-763.69	-560.13	-572.22
β as % of known TC	80.55	86.06	21.84	-	134.46
β as % of FOB price	10.84	21.57	7.98	-	25.92
Mean known TC	1.08	2.01	2.93	1.19	1.77
Mean measurable TC	1.95	3.74	3.57	1.19	4.15
Mean measurable TC as % of mean FOB price	24.31	46.63	44.51	12.96	45.20

Note: a/ t-statistics are in parentheses.

Boston is located 890 miles farther from the Nogales, AZ shipping point than Chicago, but the total mean of measurable transaction costs indicates that the margin per vine ripe tomato carton was actually $0.17 less for Boston than Chicago. This suggests the potential use of price discrimination by shippers. Boston is also located farther form

California and Florida[34] production regions than Chicago, and has total measurable transaction costs of $4.15 per carton for mature green tomatoes, $2.96 more than in Chicago. This also suggests some cost absorption by the trading sector in this market, or a possible markup above competitive prices in Boston[35]. Yet this last inference may not be feasible given that the most prevalent market condition for mature green tomatoes in Boston was perfect integration, diminishing the likelihood of noncompetitive behavior for the mature green tomatoes. Alternatively, if the same set of grower-shippers exist in each market, they may control tomato supply regardless of production source, and use pricing strategies that optimize their returns.

Table 5.7 shows the estimates for the frequencies of particular market conditions prevailing in the fresh tomato market. Perfect integration ($\lambda_1 + \lambda_2$) was found with 80 percent frequency between Mexico-Los Angeles and 71 percent of the time between California and Florida-Boston, while the frequencies of perfect integration were less than 40 percent for the remaining market pairs analyzed.

As expected, intermarket tradability ($\lambda_1 + \lambda_2 + \lambda_3 + \lambda_5$) occurred with 100 percent frequency between Mexican markets and Los Angeles, and between the California/Florida producing regions and Chicago and Boston terminal markets. The frequency of tradability between Mexico and Chicago was 81 percent while between Mexico and Boston this frequency dropped to 59 percent. It is interesting to note that

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[34] Boston is located 128 miles farther from Orlando, FL and 948 miles farther from the San Diego, CA shipping point than Chicago.

[35] The mean terminal market price during the 1995-1999 period analyzed for mature green tomatoes in Boston was $13.30 while in Chicago it was $11.21. The mean FOB price during the same period was $9.18.

Mexico has a higher market share in Chicago than in Boston. Although it is clear that those markets are highly integrated in the sense of tradability, it is not possible to say the same about equilibrium. The frequency for this market condition ($\lambda_1 + \lambda_2 + \lambda_6$) is estimated at 80 percent for Mexico-Los Angeles, 56 percent for Mexico-Chicago, and only 35 percent for Mexico-Boston. This finding is consistent with the distance between the Mexican border and these markets, and representative of the market share[36] for Mexican fresh tomatoes in each market. In short, the farther the distance between markets, the less frequent the trade flows, and the lower the frequency of market equilibrium.

Table 5.7. Estimates of the Frequency for Fresh Tomato Market Conditions

Indicator (frequency)	Mexico-Los Angeles	Mexico-Chicago	Mexico-Boston	CA & FL-Chicago	CA & FL-Boston
$\lambda_1 + \lambda_2 = PI$	0.80	0.38	0.24	0.29	0.71
$\lambda_1 + \lambda_2 + \lambda_6 = ME$	0.80	0.56	0.35	0.29	0.71
$\lambda_1 + \lambda_2 + \lambda_3 + \lambda_5 = IT$	1.00	0.81	0.59	1.00	1.00
$\lambda_3 + \lambda_5 = II$	0.20	0.43	0.35	0.71	0.29
$\lambda_5 = OC$	0.06	0.15	0.25	0.09	0.15
$\lambda_6 = SE$	-	0.18	0.11	-	-
$\lambda_4 = SD$	-	0.01	0.29	-	-

PI = Perfect market integration, ME = Market equilibrium, IT = Intermarket tradability, II = Inefficiently integrated, OC = Overly competitive behavior, SE = Segmented equilibrium, and SD = Segmented disequilibrium.

A similar situation exists for California and Florida tomatoes, where the equilibrium condition is expected 71 percent of the time in Boston, but only 29 percent of the time in Chicago, signaling some market inefficiencies in those markets for American

[36] The average market share during the 1995-1999 period for Mexican tomatoes in Los Angeles, Chicago, Boston was 63, 25, and 10 percent, respectively.

tomatoes. In effect, one of the objectives of this work is to provide a framework to analyze potential noncompetitive behavior in the fresh tomato market given the antidumping complaint filed against Mexican grower-shippers in April 1996 (based on increased imports after the peso devaluation and the beginning of NAFTA). American growers argued that they were experiencing decreasing domestic prices, profits, and an overall loss of market share. They perceived that fresh tomatoes were sold by Mexican producers and/or shippers at less than the fair market value (LTFV). This dispute resulted in an agreement between the Department of Commerce and Mexican tomato growers, eliminating the need to implement dumping duties. Mexican tomatoes were not going to be sold at less than a reference FOB price in Nogales, San Diego and Laredo[37] (see Chapter 2). Given the difficulties in compiling a weekly time price series of FOB prices for Sinaloa and Baja California this series was estimated and the model was run with an adjusted FOB price time series (Sinaloa and Baja California). Thus, in this work it is not possible to provide evidence of whether Mexican growers were exhibiting anticompetitive behavior. But, if the real FOB time series (Sinaloa and Baja California) become available, this work could be easily re-estimated with price differentials between the FOB price for Sinaloa and Baja California, and FOB prices for Nogales and San Diego.

[37] The initial reference price for vine ripe tomatoes was $5.75 per 25-pound box (November 1, 1996 to August 6, 1998). The agreement had an amendment in August 6, 1998, resulting in a second reference price of $4.30 per 25-pound box during July 1 to October 22 and $5.27 per 25-pound box for imports between October 23 and June 30 (U.S. Department of Commerce).

5.8. Conclusions

This chapter applies an EPBM to examine the vine ripe tomato market relationships between Mexico and the U.S., and between California/Florida supplies and American terminal markets using prices, transaction costs, and trade flow data following the model developed by Barrett and Li. Utilizing maximum likelihood techniques, the approach allowed us to generate indicators of frequency of perfect market integration, competitive market equilibrium, intermarket tradability, segmented equilibrium, segmented disequilibrium, overly competitive behavior, and inefficiently integrated markets. This method, in addition to overcoming many of the problems detected in the conventional models for testing market integration, makes inferences about "other measurable" (less transparent) transaction costs for marketing fresh tomatoes (such as repacking costs, other fees and services) possible. Moreover, it provides a methodological framework to analyze claims of noncompetitive behavior in the fresh tomato market. The study was developed in order to examine price and trade relationship between three American markets –Los Angeles, Chicago, and Boston- and the Mexican market as well as between Chicago and Boston domestic supplies from California and Florida.

Results from the application of the extended parity bounds model to American and Mexican markets indicate increased tradability between markets and a high positive relationship between perfect integration and market equilibrium with market shares. Estimates of the frequency of inefficiently integrated markets in Chicago and Boston markets for both Mexican and American supplies are relatively high, ranging from 29 percent between California/Florida-Boston to 71 percent between California/Florida and Chicago, which provides some insights about imperfect competition or inefficient arbitrage in these markets. Similarly, the probabilities of segmented disequilibrium and what is termed "overly competitive" behavior in those markets are higher than expected. This finding indicates a high level of unobserved transaction costs (or information failures) that may wrongly encourage trade flows of fresh tomatoes between regions generating negative marginal profits, and prevent trade flows from taking place when positive profits are possible.

A comparison of results for observable transaction costs for the various terminal markets where Mexico ships indicates the possibility of price discrimination practices in the Boston terminal market. Results indicate that some absorption of measurable transaction costs by the trading sector occurs, leading to lower prices for vine ripe tomatoes in this market. A similar situation is indicated in the case of California/Florida supplies to Chicago and Boston, supporting the assumption of imperfect competition in these markets.

CHAPTER 6

Empirical Implications and Future Research

6.1. Introduction

The overall objective of this work is to examine the market behavior of U.S. fresh tomato imports during the last decade. This goal was reached by analyzing the fresh tomato market with three different, but related approaches. First, a descriptive analysis of the current status and trends influencing U.S. and Mexican tomato producers, marketing channels and strategies was presented. Second, in order to estimate the impact of several economic, marketing sector, and trade policy factors on the volume of fresh tomato imports from Mexico to the United States, an international trade model was developed. This model emphasizes the role of transaction costs as variables that may provide useful information about trade relationships in addition to traditional price, production and demand factors. Third, a model that allows one to investigate whether importing and domestic markets are integrated and in long run equilibrium was formulated. In contrast to conventional market analysis methods that utilize only prices, the model developed in this dissertation applies prices, transaction costs, and trade flow data, thereby allowing one to infer the probability of different intermarket relationships. Moreover, this method makes it possible to estimate "other measurable transaction costs" for marketing fresh tomatoes and provides a methodological framework to analyze claims of noncompetitive behavior in this market. The sections that follow summarize the empirical findings, potential economic and policy implications and future research.

6.2. Summary of the Empirical Results

Although there are many factors that affected the increased trade flows of fresh tomatoes from Mexico to the U.S. in the last decade, policy changes implemented under NAFTA and exchange rates are those that have received the greatest attention. This public focus on international trade and finance factors may be partially explained by the controversial expectations of NAFTA's impact on the U.S. fruit and vegetable sector, and the extreme nature of the 1994 Mexican peso devaluation.

The relationships among economic, marketing sector and policy variables that impact the volume of fresh tomato imports were analyzed through an international trade model. This model has a special focus on the trading sector. It was assumed that modeling the marketing sector's behavior would provide additional information and insights about U.S.-Mexico fresh tomato trading relationships. The main results obtained in the estimation of this model are summarized as follows.

All the coefficients had the anticipated signs, but many of the relationships that were expected to be important were insignificant in the estimation. This may be partially explained by the high serial correlation detected in the model, which led to the inclusion of two lagged dependent variables that explain much of the "fitted" portion of the modeled variables. It also may indicate the possibility of imperfect competition since variables that proxy for institutionalized trade flows (lagged dependent variables) are more relevant in explaining trade flows than market oriented variables. It is important to mention that this model assumes competitive equilibrium and that the competitive price for Mexican and U.S. fresh tomatoes is based on the import price at the port of entry and the U.S. shipping point price, respectively. Although the US-based marketing intermediaries' business methods are not expressly addressed in this model, their behavior may be captured through the domestic demand function since they affect FOB prices (particularly, California and Florida).

As expected in the trading cost equation, the volume of fresh tomato imports, exchange rate, and shipping point price were significant. It indicates that this sector is fairly sensitive to changes in the demand for their services. The tariff variable had the expected positive, but insignificant effect on trading charges, suggesting a lower-than-expected impact from the tariff reduction process implemented under NAFTA on fresh tomato marketing services, and consequently, on increased trade flows.

Results obtained for the U.S. domestic demand for fresh tomato equation show that the market-oriented variables, such as domestic and import prices and U.S. disposable income, were insignificant but exhibiting the expected signs. A similar situation is presented in the equation for Mexican supply, as the variables for CIF lagged price, lagged Mexican producer price index, price of competitive product, tariffs, and Mexican per-capita income were also insignificant. However, for these two equations there is a significant and positive relationship with the previous year's level of demand and the import supply of fresh tomatoes, respectively. These results indicate that the greatest share of domestic demand and import supply is due to institutionalized marketing relationships.

Finally, results obtained on the U.S. domestic supply equation suggest that the domestic quantity of fresh tomatoes supplied has a highly significant and positive relationship with the lagged shipping point price and a significant negative relationship with the lagged U.S. tomato producer price index. These results are consistent with production theory. Nevertheless, the acreage-harvested variable was unexpectedly insignificant in this equation.

As previously discussed, an extended parity bounds model (EPBM) was applied in order to conduct tests for market integration and market equilibrium among fresh tomato markets. Through this model an examination of fresh tomato price and trade relationships between Mexican producing regions and three American wholesale terminal markets, in addition to the domestic producing regions and two terminal markets, is developed. The most important results obtained in the estimation of this model follow.

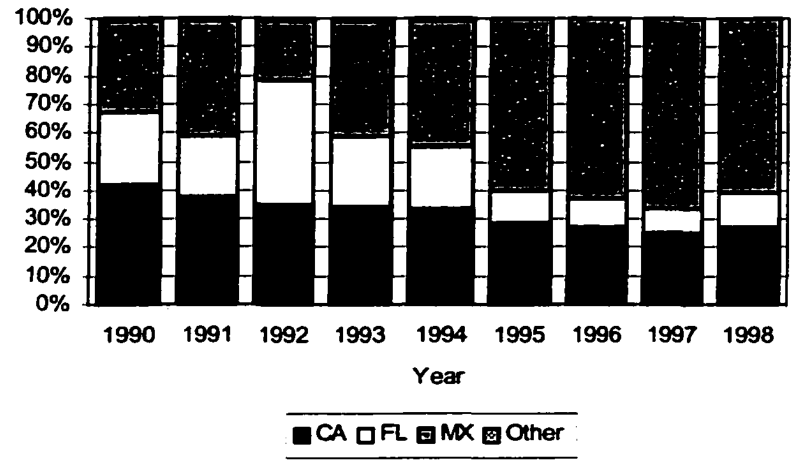
It was detected that, for both Mexican and American markets, the closer the terminal market to the producing regions, the more frequently trade flows occur between these regions. The estimate of the frequency of tradable market conditions ($\lambda_1 + \lambda_2 + \lambda_3 + \lambda_5$) between Mexican or domestic suppliers and Los Angeles markets was 100 percent. This is a stark, but not unexpected contrast to Chicago and Boston terminal markets where this indicator was observed in only 81 percent and 59 percent of the periods, respectively. The perfect integration ($\lambda_1 + \lambda_2$) market condition between Mexican and American markets was the most common in Los Angeles, while among domestic markets this market condition was the most common between California/Florida and Boston.

Markets may be integrated in the sense of tradability but it does not mean that those markets are in equilibrium. The likelihood of equilibrium (represented as $\lambda_1 + \lambda_2 +$

λ_6) for imported tomatoes also drops as distance between markets increases and market share decreases. The market equilibrium condition between domestic markets was observed in 71 percent of the periods analyzed for Boston, while in Chicago it was expected only 29 percent of the time. This may suggest that either transportation costs (which one would expect to be a function of distance) or presence of institutionalized market networks (which one would expect with higher market share) may influence market integration and efficiency.

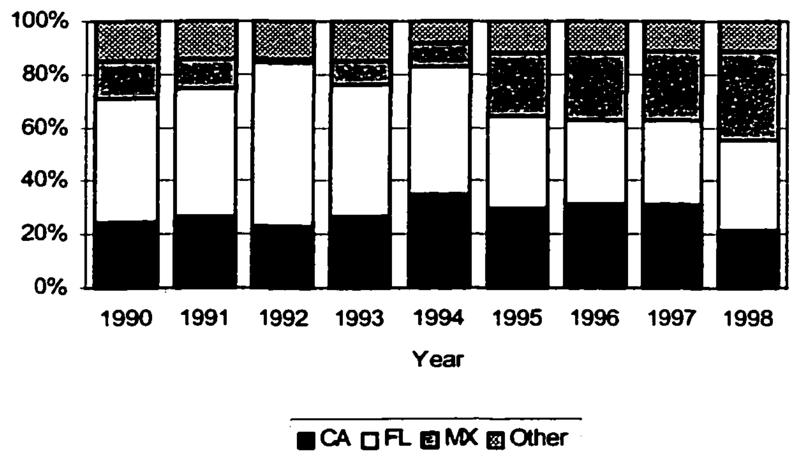
It should be noted that Mexico accounted for a smaller share of the Boston market than Florida and California (10 percent compared to 64 percent during the 1995-1999 period), but this share grew slightly over the periods analyzed here. Although the Chicago market share for Mexican tomatoes increased more significantly at the end of 1990's (from 24 percent in 1995 to 34 percent in 1998), it still remains low compared to the 56 percent market share secured by American supplies during the same period. In Los Angeles, the share of Mexican tomatoes also has been increasing in recent years, from 40 percent at the beginning of the decade to 60 percent in 1998 (Figures 6.1a, b, & c).

Figure 6.2 shows the results for Mexican tomato market conditions including the estimated frequency of perfect integration, market equilibrium, and intermarket tradability for the three terminal markets analyzed. It should be noted that the varying frequency of these estimators may be related to the relative location of the terminal market, as discussed previously. In short, inefficiently integrated markets and overly competitive market conditions increase in frequency as distance increases.



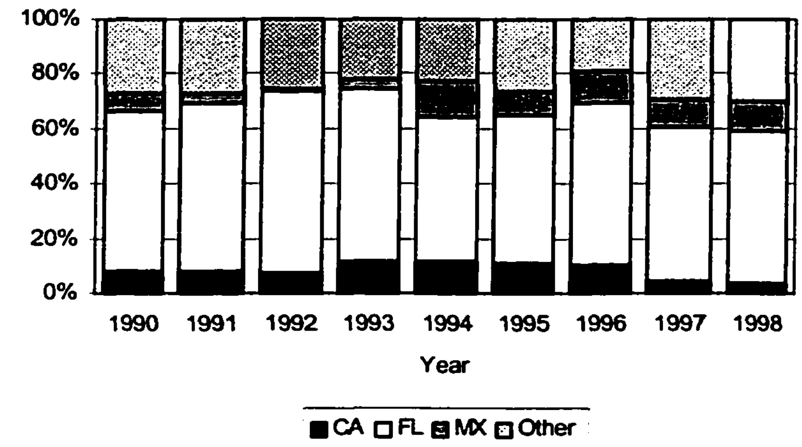
Source: USDA, ERS. U.S. Tomato Statistics, 1960-98.

Figure 6.1a. Market Share of Fresh Tomatoes in Los Angeles Terminal Market



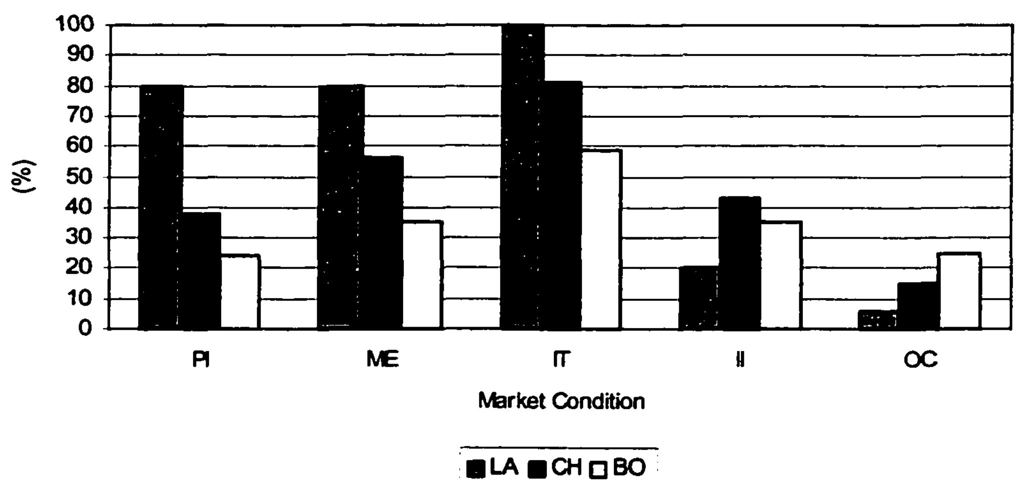
Source: USDA, ERS. U.S. Tomato Statistics, 1960-98.

Figure 6.1b. Market Share of Fresh Tomatoes in the Chicago Terminal Market



Source: USDA, ERS. U.S. Tomato Statistics, 1960-98.

Figure 6.1c. Market Share of Fresh Tomatoes in the Boston Terminal Market



PI = Perfect market integration, ME = Market Equilibrium, IT = Intermarket tradability, II = Inefficiently integrated markets, and OC = Overly competitive behavior.

Figure 6.2. Estimates of the Frequency for Fresh Tomato Market Condition of Mexican Producing Regions with Three American Terminal Markets

The less frequent observances of market equilibrium conditions ($\lambda_1 + \lambda_2 + \lambda_6$) in Boston for Mexican tomatoes, and in Chicago for both Mexican and American tomatoes, signal some market inefficiencies in those markets. Resulted obtained through calculating the ratio $(\lambda_3+ \lambda_5)/(\lambda_1+ \lambda_2+ \lambda_3+\lambda_5)$ (Table 6.1) represent the portion of inefficiently integrated conditions with respect to the total number of periods when tradability is observed. In short, it tells us what share of trading periods exhibit suboptimal market conditions. This ratio showed that in more than 50 percent of the periods when trade takes place between Mexico and two domestic markets (Chicago and Boston), it is not efficient. Surprisingly, the ratio was 71 percent for domestic tomatoes in Chicago, while in Boston it was only 29 percent.

Table 6.1. Other Economic Indicators Related to Fresh Tomato Market Condition

Indicator	Mexico-Los Angeles	Mexico-Chicago	Mexico-Boston	CA & FL-Chicago	CA & FL-Boston
$(\lambda_1+ \lambda_2)/(\lambda_1+ \lambda_2+ \lambda_3+ \lambda_5)$	0.80	0.47	0.41	0.29	0.71
$(\lambda_3+ \lambda_5)/(\lambda_1+ \lambda_2+ \lambda_3+\lambda_5)$	0.20	0.53	0.59	0.71	0.29
$\lambda_4/(\lambda_2+ \lambda_4+ \lambda_6)$		0.05	0.51		

It is particularly interesting to note the relatively high probability of observing λ_4 (segmented disequilibrium) in the Boston market (29 percent) and λ_5 (overly competitive behavior) in Boston (25 percent) and Chicago (15 percent) markets for imported tomatoes. One measure, λ_4 , shows that there are some periods when arbitrageurs decide not to trade even though the possibility of positive profits exists. On the other hand, there are other periods that they decide to trade with negative profits (λ_5). These results suggest the possibility of temporary disequilibria, possibly due to information lags or a strategy implemented by traders in Chicago and Boston, where in order to expand their market share in those markets they absorbed temporary losses. The increased trade flows and market share for Mexican product in the Chicago market may been a result of the high number of periods with estimated positive profits for domestic tomatoes that were found in this analysis. Another possible explanation for observing a relatively high probability for (λ_5) in Boston and Chicago is the increasing share of sales under contract[38], implying contract rigidities that allow for short-term losses because long-term prospects are more favorable. An alternative reason for observing temporary disequilibria (λ_4) or (λ_5) may be the presence of unobservable transaction costs that diminish apparent positive profits or possible first mover advantages. The presence of such costs is also a valid reason for a high estimated λ_3 (positive profits to arbitrage with trade) in Chicago for both domestic and imported tomatoes, (62 and 28 percent, respectively).

Assuming that λ_4 signals a probability that markets are segmented due to unobservable transaction costs, then the ratio $\lambda_4/(\lambda_2+\lambda_4+\lambda_6)$ (Table 6.1) shows the proportion of no trade periods associated with such costs. The magnitude of this ratio for imported tomatoes in the Boston market (0.51) suggests a need to examine such nontransparent costs to trading, and its relationship with changing distribution channels.

[38] At the end of the last decade, wholesaler-repackers reported that they increased their sales via short term and long term contracts with foodservice and mass merchandisers.

Empirical results show that the portion of the wholesale terminal market price[39] related to measurable transaction costs ($\hat{\beta}$ + CIF + TX + DT)[40] ranges from 10.61 percent in Chicago (for domestic tomatoes) to 32.45 percent in Boston (for imported tomatoes). The level of these costs in Chicago for Mexican tomatoes is $0.17 more than those costs in Boston, while the average terminal market prices during the period analyzed were $12.37 and $11.00 per carton for Boston and Chicago, respectively. Since Boston is farther from the Mexican tomato shipping points, and this market reports less measurable transaction costs and a lower terminal market price per carton, one could infer this is evidence of price discrimination by shippers. These results also support the previous discussion suggesting that the high magnitude of one market condition (λ_5) is attributed to overly competitive behavior in the Boston market. In the case of domestic tomatoes, Chicago reports $2.96 less in measurable transaction costs than Boston. Given the location of these two markets and the average terminal market price reported during the period studied, this result may suggest some cost absorption by the trading sector in this market. However, the latter result is difficult to support since the probability reported for λ_5 (overly competitive behavior) is only 9 percent of all periods while the λ_3 (positive profits to arbitrage) is more frequent at 62 percent of all periods.

Results obtained from the international trade model estimation suggest that institutional factors are more influential in explaining fresh tomato trade flows between

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[39] During the period studied (1995-1999), the mean of wholesale terminal market price per 25-pound carton for Mexican vine ripe tomatoes in Los Angeles, Chicago, and Boston was $ 10.14, $12.37, and $ 11.00, respectively, while for American mature green tomatoes in Chicago and Boston it was $11.21 and $13.30.

[40] $\hat{\beta}$ = "other measurable transaction costs", CIF = international freight, insurance, and other charges, TX = tariffs, and DT = domestic transportation.

Mexico and the US than market factors, a finding that suggests that noncompetitive behavior exists. This inference is also supported by results obtained through the extended parity bounds model. This model shows a high probability of observing inefficiently integrated markets ($\lambda_3 + \lambda_5$) in Chicago and Boston for domestic and imported tomatoes as well as a more frequent observance of overly competitive behavior (λ_5) in those markets. Given these results, it is possible to conclude that fresh tomato traders may sustain temporary profit losses in order to gain market share in the Boston and Chicago market if they believe that institutional trading relationships established with increased market share will be rewarded with long-run profits.

6.3. Economic and Policy Implications

Over the last decade, fresh tomato trade from Mexico to the U.S. increased dramatically, partially due to NAFTA negotiations and favorable exchange rate conditions. Empirical results show that other supply, demand, marketing factors, and market trends strongly influence trade flows as well. For instance, the finding that the previous year's level of imports and domestic quantity demanded explain much of the current year's levels is consistent with changes observed in the grower-shipper and retailer wholesaler sector in the recent years. As those economic agents become more consolidated, modifying the way that they do business, it implies new marketing channels will exhibit more transaction rigidities. In short, broad market forces will matter less than personal, established trade networks and contractual relationships.

Based on the findings from the estimation of the international trade model and previous discussion, it can be concluded that:

a) the tariff reduction process has played a more minor role in increased fresh tomato imports than some expected. Still it is important to recall that the fresh tomatoes tariff rate quota (TRQ)[41] and tariffs will eventually be eliminated by the year 2003. Consequently, the full effects of the free trade agreement on the fresh tomato market are yet to come.

b) Favorable exchange rates had a stronger impact on trade flows than tariff reduction. The Mexican peso devaluation relative to the dollar stimulated import demand.

c) Trading sector dynamics play a key role in the fresh tomato market. Consequently, industrial organization trends, together with trends in the US-Mexico marketing sector, may be more influential than tariff reductions in explaining increased trade flows.

Results obtained through the extended parity bounds model supports the following discussion. Increased trade flows of fresh tomatoes from Mexico to the U.S. imply increased market integration (tradability) between Mexican and American markets. However, it does not establish that those markets were perfectly integrated and in a long run competitive equilibrium that implies the increased efficiency many expect from freer trade.

Findings on the analysis of measurable transaction costs for imported tomatoes in Chicago and Boston indicate the possibility of price discrimination by the trading sector to the Boston market. A similar situation is inferred in the case of California/Florida

[41] TRQ on fresh tomatoes were reached and exceeded in all periods analyzed, so that only a portion of total imports received the benefits of tariff reduction.

tomatoes in the Chicago and Boston markets, supporting the previous discussion (related to the international trade model) on the potential for imperfect competition in these markets.

This work, in addition to presenting a complex analysis of price and trade relationships in the U.S.-Mexico fresh tomato market, also provides an indirect assessment of the impact of NAFTA. It shows that the trade liberalization policy has had a minor effect on this market. It also showed that this market is highly influenced by institutional factors and that the high tradability observed could be translated to higher welfare gains for the terminal markets that are closer to the Mexican border. However, this result is less generalizable to those markets and consumers that are located farther away from the producing regions. In those markets potential gains may be linked to the market structure and performance exhibited by competing producing regions (domestic and Mexican) who either strive for greater market share or may exploit rents from established institutionalized trade relationships.

6.4. Future Research

The international trade model was developed assuming perfect competition in the fresh tomato market. Findings in this model and those of the extended parity bounds model suggest that imperfect competition in the marketing sector may exist. Given that this work focused mainly on trade behavior, additional empirical analysis could be developed to analyze the retailer sector and its potential role in exerting market power. Methodologically, a trade model that assumes strategic behavior and interaction among trading agents could be developed to more accurately represent the marketing sector's structure and conduct.

The extended parity bounds model assumed price signals between terminal and shipping markets were contemporaneous. This is, it was assumed that arbitrageurs were able to determine price differentials between markets and transactions costs instantaneously. This situation is highly probable since weekly prices are being used and technological innovations in communications allow easy, timely access to information. However, it may be important to include some dynamics in the model in order to test if there are some lags in information or delivery that are affecting the behavior of the trading sector.

Finally, through the estimation of the total known transaction costs, it was inferred that some cost absorption by the trading sector occurs in the Boston terminal market for imported tomatoes, and a similar possibility exists for domestic tomatoes in the Chicago terminal market. Future research is necessary in order to apply specific techniques that provide direct evidence of cost absorption by traders. In order to provide more information about the less transparent transaction costs, it would also be interesting to understand and analyze the behavior of those costs. Specifically to address whether they are changing over time or are a more direct function of volume or change in relation to the market share of the supplier in each terminal market.

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APPENDIX

APPENDIX. Sample TSP International Code for Extended Parity Bounds Model

```
OPTIONS CRT;          ? TSP program to estimate the extended parity bounds model
SET CONVERGE=0;  ?
FREQ N; SMPL 1 244;
READ (FILE='A:\BOVR_DA.XLS') BOVRSHP, BOVRTMP, BOVRDT, BOVRCIF,
BOVRTX, BOVRA;
CIF=BOVRCIF;
DT=BOVRDT;
TX=BOVRTX;
Y=BOVRTMP-BOVRSHP;  ? Calculate price difference
A=BOVRA>0  ;

? Constrain sum of regime probabilities to sum to one
FRML RLAM1 LAM1=0.001+(0.999-0.001)*CNORM(LAMBDA1);

FRML RLAM2 LAM2=0.001+(1-(0.001+(0.999-0.001)*CNORM(LAMBDA1))
   -0.001)*CNORM(LAMBDA2);

FRML RLAM3 LAM3=0.001+(1-(0.001+(0.999-.001)*CNORM(LAMBDA1))
   -(0.001+(1-(0.001+(0.999-0.001)*CNORM(LAMBDA1))-0.001)
   *CNORM(LAMBDA2))-0.001)*CNORM(LAMBDA3);

FRML RLAM4 LAM4=0.001+(1-(0.001+(0.999-0.001)*CNORM(LAMBDA1))
   -(0.001+(1-(0.001+(0.999-.001)*CNORM(LAMBDA1))-0.001)
   *CNORM(LAMBDA2))
   -(0.001+(1-(0.001+(0.999-.001)*CNORM(LAMBDA1))
   -(0.001+(1-(0.001+(0.999-0.001)*CNORM(LAMBDA1))-0.001)
   *CNORM(LAMBDA2))-0.001)*CNORM(LAMBDA3))-0.001)
   *CNORM(LAMBDA4);

FRML RLAM5 LAM5=0.001+(1-(0.001+(0.999-0.001)*CNORM(LAMBDA1))

   -(0.001+(1-(0.001+(0.999-0.001)*CNORM(LAMBDA1))
   -0.001)*CNORM(LAMBDA2))

   -(0.001+(1-(0.001+(0.999-.001)*CNORM(LAMBDA1))
   -(0.001+(1-(0.001+(0.999-0.001)*CNORM(LAMBDA1))-0.001)
   *CNORM(LAMBDA2))-0.001)*CNORM(LAMBDA3))
```

```
-(0.001+(1-(0.001+(0.999-0.001)*CNORM(LAMBDA1))
-(0.001+(1-(0.001+(0.999-.001)*CNORM(LAMBDA1))-0.001)
*CNORM(LAMBDA2))
-(0.001+(1-(0.001+(0.999-.001)*CNORM(LAMBDA1))
-(0.001+(1-(0.001+(0.999-0.001)*CNORM(LAMBDA1))-0.001)
*CNORM(LAMBDA2))-0.001)*CNORM(LAMBDA3))-0.001)
*CNORM(LAMBDA4))
-0.001)*CNORM(LAMBDA5);

FRML RLAM6 LAM6=1-(0.001+(0.999-0.001)*CNORM(LAMBDA1))

-(0.001+(1-(0.001+(0.999-0.001)*CNORM(LAMBDA1))
-0.001)*CNORM(LAMBDA2))

-(0.001+(1-(0.001+(0.999-.001)*CNORM(LAMBDA1))
-(0.001+(1-(0.001+(0.999-0.001)*CNORM(LAMBDA1))-0.001)
*CNORM(LAMBDA2))-0.001)*CNORM(LAMBDA3))

-(0.001+(1-(0.001+(0.999-0.001)*CNORM(LAMBDA1))
-(0.001+(1-(0.001+(0.999-.001)*CNORM(LAMBDA1))-0.001)
*CNORM(LAMBDA2))
-(0.001+(1-(0.001+(0.999-.001)*CNORM(LAMBDA1))
-(0.001+(1-(0.001+(0.999-0.001)*CNORM(LAMBDA1))-0.001)
*CNORM(LAMBDA2))-0.001)*CNORM(LAMBDA3))-0.001)
*CNORM(LAMBDA4))

-(0.001+(1-(0.001+(0.999-0.001)*CNORM(LAMBDA1))

-(0.001+(1-(0.001+(0.999-0.001)*CNORM(LAMBDA1))
-0.001)*CNORM(LAMBDA2))

-(0.001+(1-(0.001+(0.999-.001)*CNORM(LAMBDA1))
-(0.001+(1-(0.001+(0.999-0.001)*CNORM(LAMBDA1))-0.001)
*CNORM(LAMBDA2))-0.001)*CNORM(LAMBDA3))

-(0.001+(1-(0.001+(0.999-0.001)*CNORM(LAMBDA1))
-(0.001+(1-(0.001+(0.999-.001)*CNORM(LAMBDA1))-0.001)
*CNORM(LAMBDA2))
-(0.001+(1-(0.001+(0.999-.001)*CNORM(LAMBDA1))
-(0.001+(1-(0.001+(0.999-0.001)*CNORM(LAMBDA1))-0.001)
*CNORM(LAMBDA2))-0.001)*CNORM(LAMBDA3))-0.001)
*CNORM(LAMBDA4))
-0.001)*CNORM(LAMBDA5));
```

```
? Expression for the likelihood function
FRML LOGLEQ LOGL=LOG(A*(LAM1*F1+LAM3*F3+LAM5*F5)+(1-A)
          *(LAM2*F2+LAM4*F4+LAM6*F6));

? Distribution functions for the six regimes of the likelihood function

FRML REGIME1 F1=(1/SQRT(SIGV**2))*NORM((Y-
(B+CIF+TX+DT))/SQRT(SIGV**2));

FRML REGIME3 F3=(2/(SQRT(SIGU**2+SIGV**2)))
  *NORM((Y-(B+CIF+TX+DT))/SQRT(SIGU**2+SIGV**2))
  *(1-CNORM((-(Y-(B+CIF+TX+DT))*(SQRT(SIGU**2)/SQRT(SIGV**2)))
  /SQRT(SIGU**2+SIGV**2)));

FRML REGIME5 F5=(2/(SQRT(SIGU**2+SIGV**2)))
  *NORM((Y-(B+CIF+TX+DT))/SQRT(SIGU**2+SIGV**2))
  *(1-CNORM(((Y-(B+CIF+TX+DT))*(SQRT(SIGU**2)/SQRT(SIGV**2)))
  /SQRT(SIGU**2+SIGV**2)));

FRML REGIME2 F2=(1/SQRT(SIGV**2))*NORM((Y-
(B+CIF+TX+DT))/SQRT(SIGV**2));

FRML REGIME4 F4=(2/(SQRT(SIGU**2+SIGV**2)))
  *NORM((Y-(B+CIF+TX+DT))/SQRT(SIGU**2+SIGV**2))
  *(1-CNORM((-(Y-(B+CIF+TX+DT))*(SQRT(SIGU**2)/SQRT(SIGV**2)))
  /SQRT(SIGU**2+SIGV**2)));

FRML REGIME6 F6=(2/(SQRT(SIGU**2+SIGV**2)))
  *NORM((Y-(B+CIF+TX+DT))/SQRT(SIGU**2+SIGV**2))
  *(1-CNORM(((Y-(B+CIF+TX+DT))*(SQRT(SIGU**2)/SQRT(SIGV**2)))
  /SQRT(SIGU**2+SIGV**2)));

? Substitute constituent parts into likelihood function
EQSUB(NOPRINT) LOGLEQ RLAM1 RLAM2 RLAM3 RLAM4 RLAM5 RLAM6
REGIME1 REGIME2 REGIME3 REGIME4 REGIME5 REGIME6;

? Set starting values
SET SIGU=2.5          ;
SET SIGV=1.           ;
SET LAMBDA1 = 0.4     ;
SET LAMBDA2 = 0.01    ;
SET LAMBDA3 = 0.1     ;
SET LAMBDA4 = 0.01    ;
SET LAMBDA5 = 0.08    ;
SET B = 1.5           ;
```

```
PARAM SIGU,SIGV,LAMBDA1,LAMBDA2,LAMBDA3,LAMBDA4,LAMBDA5,
LAMBDA6, B;

? Perform maximum likelihood estimation
ML(HITER=B,HCOV=BNW,MAXIT=50,TOL=0.01) LOGLEQ;
SET N=@NOB;
SET CONVERGE=@IFCONV;

? Use gallant-Holly method to compute standard errors
? and T-statistics of unconstrained regime probabilities
ANALYZ (NOPRINT) RLAM1; SET PROBREG1=@COEFA;
ANALYZ (NOPRINT) RLAM2; SET PROBREG2=@COEFA;
ANALYZ (NOPRINT) RLAM3; SET PROBREG3=@COEFA;
ANALYZ (NOPRINT) RLAM4; SET PROBREG4=@COEFA;
ANALYZ (NOPRINT) RLAM5; SET PROBREG5=@COEFA;
ANALYZ (NOPRINT) RLAM6; SET PROBREG6=@COEFA;

ANALYZ (NOPRINT) RLAM1 RLAM2 RLAM3 RLAM4 RLAM5 RLAM6;

FRML SU SIGU;
FRML SV SIGV;
FRML L1 LAMBDA1;
FRML L2 LAMBDA2;
FRML L3 LAMBDA3;
FRML L4 LAMBDA4;
FRML L5 LAMBDA5;

FRML BO B;

ANALYZ SU SV L1 L2 L3 L4 L5 BO;
SET SUM1=LAM1+LAM3+LAM5;
SET SUM2=LAM2+LAM4+LAM6;

PRINT PROBREG1;
PRINT PROBREG2;
PRINT PROBREG3;
PRINT PROBREG4;
PRINT PROBREG5;
PRINT PROBREG6;

PRINT SUM1 LAM1 LAM3 LAM5;
PRINT SUM2 LAM2 LAM4 LAM6;
PRINT N;

? Check convergence
PRINT CONVERGE;
```