International Food and Agribusiness Management Review
Vol 5 Iss 3 2003

Price Relationships among North American Fresh Tomato Markets: A Comparison between Mexican and U.S. Markets*

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Abstract

Tomato trade between the U.S. and Mexico has grown significantly during the past decade, and market structure suggests increased market integration. This study examines fresh tomato price relationships between two major North American shipping points (Sinaloa, and Florida) and several major terminal markets in the U.S. and Mexico to infer whether business strategies vary by supply region or the geography of consumer markets. The results show some evidence of inefficient pricing behavior among some markets, and suggest that Mexican shipping point prices are less integrated with Mexico's own terminal markets than the closest U.S. market, Los Angeles. Moreover, perfectly competitive price behavior is less likely in a terminal market (Chicago) where Sinaloa and Florida compete during winter months. These results are the basis of discussion on the role of strategic behavior and trade policy influence in these markets.

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The growing year round demand for fresh fruits and vegetables stimulated trade between developed and developing countries in the last decade due to increasing demand for a wide variety of produce and counterseasonal production patterns. In the case of fresh tomatoes, trade flows between Mexico and the U.S. increased considerably during the 1990s, partly due to trade liberalization and partly due to market dynamics (Padilla). Yet, Florida growers have viewed several periods of competitive pressure from Mexico's Sinaloa producers as "unfair" (Thompson and Wilson). An initial suspension agreement established a reference price during several seasonal periods, and after a full sunset review, in December 2002 a second price agreement was signed keeping the negotiated seasonal reference prices (USITC, 2002). Discussion and trade analysis related to these trade negotiations focused on how to best protect U.S. producers from the potential harm of increased imports by setting reference prices that would control for any potential anti-dumping behavior. Yet, the increasing integration of market forces and trading agents in the two countries' tomato markets increase the complexity of such analyses.

The objective of this paper is to examine price and trade relationships between Sinaloa (Mexico's primary production area) and two American terminal markets (Los Angeles and Chicago), as well as the three main Mexican terminal markets (Guadalajara, Monterrey and Mexico City). For comparative purposes, an analogous analysis of prices between Florida and Chicago, New York, and Boston terminal markets is also presented. Although is known that fresh tomato competition is among firms (Thompson and Wilson), the formal trade disputes are between regions. Still, this analysis may inform future trade negotiations as it represents the aggregation of individual firms' reactions and strategies to regional market signals and reference prices that influence market dynamics in some periods.

The implications for agribusinesses are diverse. Private enterprises appear to compete through strategic behavior that differentiates produce by supply source or geography and within increasingly coordinated cross-border efforts. Meanwhile, trade policies may remain tied to more homogeneous commodities clearly delineated along U.S. and Mexico (and increasingly Canada) origins. The overall aim of this work is to better understand prevailing fresh tomato market conditions, including how intra-Mexico and Mexico-U.S. market price relationships vary among each other and one another. Once we determine the most integrated market pairs, and trading partners that exhibit less perfectly competitive pricing behavior, discussion of how these relationships may be influenced by distance, competitive forces and strategic tomato shipments from supply regions will be discussed.

Mexico and U.S. Fresh Tomato Trade

Although Mexico exports about 60 different vegetables to the U.S., the majority of those exports are concentrated in only a few products (tomatoes, cucumbers, bell pepper, squash, and watermelon). Those five products represent 60 percent of the total produce volume exported, with tomatoes representing 35 percent of the total volume. Historically, the highest trade flows of fresh tomatoes from Mexico to the U.S. have been during the winter and spring seasons, with the major part of total exports originating from the Sinaloa production regions (Valle de Culiacan and Los Mochis). During the summer season the major shipments of tomatoes are from Baja California. Although Sinaloa growers specialize in tomatoes for export markets, they also supply domestic markets, so placement decisions are influenced by price behavior in both domestic and export markets (Padilla, Thilmany, and Davies). The majority of Mexican grown tomato exports are sold in Western U.S. markets, such as Los Angeles and San Francisco, while Florida is the dominant supplier for Southern and Eastern U.S. markets. Mexican and Florida tomatoes have exhibited an increased market share in the North Central region, possibly due to placement strategies, making it an interesting region for analysis (Padilla, Thilmany and Loureiro).

Figures 1a and 1b illustrate how Florida and Sinaloa grown tomatoes tend to complement one another seasonally in the U.S. markets. It is interesting to note that while Sinaloa imports only begin to appear in the U.S. markets during October and November (October 23rd is the reference price switching date to a higher price level), Florida tomatoes reach their peak supply in late November. Subsequent shipments from Florida reach a supply trough in January, when Mexican tomatoes reach their supply peak. Mexican shipments start to decrease in April, when Florida shipments reach their highest volumes. In spite of this seasonal complementarily, perceived competition between the two producing regions has fueled frequent international trade disputes.

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, Schmitz, and Hillman). Trade disputes between the U.S. and Mexican tomato industries started after the trade disruption between U.S. and Cuba 40 years ago. Since then, Florida and Sinaloa, Mexico producers have leveraged their favorable winter growing conditions to increase their seasonal market shares. Florida growers have viewed several periods of competitive pressure from Mexico's Sinaloa producers as "unfair" (Thompson and Wilson).

Increasing fresh tomato imports during the mid 1990s resulted in larger market share for Mexican (Sinaloa) producers and a declining share for Florida grown tomatoes (Table 1). In 1995, Sinaloa producers' market share was 22.3 percent while Florida's was 21.1 percent. An initial suspension agreement established a reference price during several seasonal periods in 1996, and after a full sunset review, a second price agreement was signed that kept negotiated seasonal reference prices in December 2002 (USITC, 2002). Subsequently, Sinaloa's market share started decreasing in 1998, reaching 17.1 percent in 2000. Currently, Florida producers account for 36 percent of the U.S. market, a clear reversal from the 1990's market trends.

There are several factors that may explain the trade patterns exhibited between the U.S. and Mexico, including heightened U.S. fresh tomato demand with increasing product differentiation. Technological change at the beginning of the 1990s allowed Mexican growers to produce new tomato varieties with increased yields, quality and transportability (Plunkett). For example, the Extended-Shelf-Life vine ripe tomatoes, characterized by greater firmness and shelf life, exhibited strong demand (Cook; Plunkett). Similarly, plum tomatoes have shown increased popularity due to their longer shelf life, good taste**,** size, and competitive price. The increased trade flows of fresh tomatoes from Mexico was also influenced by the peso devaluation at the end of 1994 and the contraction of Mexican domestic demand that made the export market more attractive for Mexican producers (and possibly sped the process of increased integration between Mexican and US growers and shippers as a way to diversify across seasons and currencies).

Another important factor is the increasingly concentrated and integrated structure of grower-shippers. Mexican growers now produce in increasingly diverse geographical areas, which together with vertically integrated production and shipping activities, helps to meet the year round demand for fresh tomatoes and reduce marketing risk[1] (Thompson and Wilson; Wilson, Thompson, & and Cook; Schwentesius and Gomez). Florida and California producers have pursued similar strategies. It is interesting to mention that 38 businesses control 70 percent of fresh tomato production in Florida, California, and Sinaloa and that no more than 10 shippers handle about 70 percent of fresh tomatoes in each producing region (Calvin and Cook, et al). Market concentration is also observed in Mexican domestic markets, as three percent of all wholesalers accounted for 58 percent of the eleven most important horticultural products' sales at the Mexico City terminal market in 2001 (Lacroix, *et al*). This high concentration may decrease the incidence of perfectly competitive practices in the fresh tomato market (Thompson and Wilson).

Estimating Market Conditions for the U.S. and Mexico Winter Fresh Tomato Market

Spatial market integration testing methods have been developed because of the usefulness of their empirical results. Market integration analysis provides information about the spatial extent of the market (Stigler and Sherwin) that is necessary to evaluate market structure, conduct and performance. Integrated

[1] Some Sinaloa producers have extended their season by producing in Jalisco, Baja California, and Baja California Sur (Schwentesius and Gomez). Similarly Florida grower-shippers have made business arrangements with North Carolina, Virginia, Maryland, and Pennsylvania producers in order to extend their shipping season, while California growers-shippers have similar alliances with Baja California producers (Thompson and Wilson).

markets do not necessarily lead to competitive markets (Harris) or a full price transmission between markets (Padilla, Thilmany, and Davies). Ultimately, 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). Conventional spatial market integration theory assumes that two regions are integrated if the law of on price (LOP) holds. Nevertheless, numerous empirical studies have been developed for testing international price relationships where results have failed to show strong support for the LOP (Officer; Baffes; Ardeni; Zanias). Miljkovic explains that the failure of observing the LOP in international markets may be explained by one or more of the following reasons: a) pricing to market, meaning price discrimination exerted by exporters across destination markets and where export prices are a function of bilateral exchange rate; b) exchange rate risk; and c) and geographical separation of markets with respect to transportation costs, trade regionalization and institutional factors. Some studies have shown that the effect of distance on trade is based on transportation costs, potential risk of perishability with extended transport time and marketing risk, in addition to higher unobservable transaction costs such as familiarity with laws, institutions, and nontariff trade barriers.

Most conventional approaches that use only prices for testing market integration signal price comovement as evidence of market integration. In contrast to conventional market analysis methods, Baulch's Parity Bounds Model (PBM) addressed several of the problems facing conventional approaches, such as trade discontinuity, nontrivial costs of commerce and the binary hypothesis of market integration. Long-run market equilibrium implies zero marginal profit to arbitrage, meaning that the intermarket arbitrage conditions are binding. But when terminal market prices are less than the sum of shipping point prices and marketing costs (transaction costs), and trade does occur, it may suggest strategic behavior.

Moreover, shipping point to terminal market price differentials relative to transaction costs may provide indirect evidence of the effects of unobservable transaction costs (presence and magnitude of risk premia, discount rate, information gaps or non tariff trade barriers), providing additional information for analysis of intermarket price relationships. In order to be able to determine the probability of existence for different market conditions among Mexican (Sinaloa) fresh tomatoes and Florida supplies, an extended parity bounds model (EPBM) was applied. The EPBM was constructed following the general structure designed by Barrett and Li (2001) (BLM) using data on prices, transaction costs, and trade flows.

The extended parity bounds model (EPBM), as applied in this work, considers three different regimes[2] that result from observations of time series distributions of

[2] Padilla (2001) applied an extended parity bounds model (EPBM) considering six regimes (three when trade is observed and three when trade is not observed) in order to determine market and price relationships for Mexican and American fresh tomato markets. Given that Sinaloa and Florida are

market prices when trade flows are observed (table 2). Letting P_t^i and P_t^j be the wholesale terminal market price and the FOB price for fresh tomatoes, respectively, T_{ji} be the observable transfer costs from *j* to *i*, and l_k the probability of observing the each k_{th} regime, being $\sum_k^3 l_k = 1$. In order to estimate the portion of transaction costs that are not available publicly, as well as the probability of observing each k_{th} regime in the fresh tomato market, a switching regimes model is estimated. It is assumed that in each regime the error term v_t is independently and identically distributed with zero mean and variance s_v^2. The error term u_t, considered for regimes 2 and 3, is a one-sided error term, independent of v_t, assuming independent and identically half normal distribution with variance s_u^2. The full model description follows Sexton, Kling and Carman, and is the special case of the model estimated by Padilla, Thilmany and Loureiro where trade flows always occur. The probabilities of observing each regime (l_k), the transfer costs for marketing fresh tomatoes that are not available publicly (β), and the variances s_v^2 and s_u^2, are estimated.

Mexico-U.S. Fresh Tomato Markets Data

The EPBM was estimated using a weekly data series[3] for Sinaloa vine ripe (bola) and plum (saladette) tomatoes and Florida mature green and plum tomatoes. For Sinaloa grown tomatoes, the price relationships between two U.S. and three Mexican markets were analyzed. The choice of U.S. terminal markets was based on a desire to look at a nearby market with high demand, Los Angeles, where Sinaloa is the largest supplier as well as a more distant market, Chicago, where a higher level of perceived competition with Florida tomatoes exists (Padilla, Thilmany and Loureiro). In Mexico, Guadalajara, Monterrey and Mexico City are the most important consumer markets for Sinaloa producers. For Florida, the Chicago, Boston and New York terminal markets were considered, the latter two are the biggest Eastern consumer markets and are dominated by Florida tomato supplies, while Chicago will provide a comparative market with Sinaloa tomatoes. The data series in Mexican markets run from 1998 to 2002, while data from American markets (for Florida and Sinaloa tomatoes) run from 1995 to 2001, except for the New York market where data covers 1999 to 2001. All data series are in dollars per carton[4] expressed in real terms, with April 2002 serving as the base price. The FOB

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two seasonal producing regions that consistently ship their product to the main domestic or international terminal markets during each week analyzed, only three regimes are defined in this study.

[3] Florida and Sinaloa data series were constructed using the prices and transfer costs registered during the respective trade season. Sinaloa's season runs from November to June, supplying domestic markets only from January to June, while Florida's season runs from October to June.

[4] In U.S. markets, vine ripe, plum, and mature green tomatoes data were constructed for a 25-pound carton. In Mexico, data are in dollars for 10, 15, and 10 kg cartons of vine ripe (bola) tomatoes in

prices at Nogales, AZ[5] and Orlando, FL[6] for Mexican tomatoes were from the Fresh Produce Association of the Americas (FPAA) and United States Department of Agriculture (USDA) Agricultural Marketing Service (AMS), respectively. The Los Angeles, Chicago, Boston and New York terminal market price series for Sinaloa and Florida grown tomatoes were assembled with data from USDA-AMS, tracking the same product specifications as for FOB prices. Tariffs on imports of Mexican fresh tomatoes (TX) decrease according to the tariff reduction process implemented under NAFTA. These are added to the international freight, insurance, and charges (CIF) for fresh tomatoes from Mexican shipping points to the first entry port in the U.S., and were constructed with information reported from the United States International Trade Commission (USITC). Domestic transportation costs[7] from the U.S. shipping point to the respective terminal market were collected from the USDA-AMS' National Truck Rate and Cost Report[8]. Given that there is no weekly FOB price time series for Sinaloa export tomatoes, the Sinaloa shipping point prices were determined by deducting CIF and tariffs from the FOB prices at Nogales, an assumption that will bias results toward fuller integration in the Mexico-U.S. market pairs since it assumes shipping and CIF prices are directly related.

Guadalajara, Monterrey, and Mexico City terminal market prices[9] and source prices[10] for Sinaloa tomatoes were constructed with data reported by the *Sistema Nacional de Información e Integración de Mercados* (SNIIM). Sinaloa shipping point prices for tomatoes supplied to domestic markets were constructed by adding the

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Guadalajara, Monterrey and Mexico City, respectively, while plum tomato data were for 15, 15, and 17 kg cartons in the same markets.

[5] The FOB weekly price series for Mexican tomatoes was constructed using the vine ripe average price of 25-pound cartons with two layer, 5X5 and 5X6 configurations, and the weekly average price for plum tomatoes in 25-pound cartons with large and extra large tomatoes.

[6] FOB price series for Florida tomatoes were assembled with weekly average mature green tomato prices for 25-pound cartons with 5X6, 6X6 and 6X7 configurations, and the weekly average plum tomato prices of 25-pound cartons with large tomatoes, both from Central and South Florida.

[7] This data series represents a 25-pound carton as an arithmetic average of the weekly rate range that shippers or receivers pay depending on basis of sale per load, and including truck broker fees.

[8] USDA-AMS reports a weekly truck rate for seven cities in the U.S., including Chicago, Los Angeles and New York. The Boston series was estimated by extrapolating from the cost data reported for New York.

[9] Mexican domestic terminal market prices were based on the reported "frequent price" for 10, 15 and 10 kg cartons of vine ripe (bola) tomatoes in Guadalajara, Monterrey, and Mexico City, respectively. In the case of plum (saladette) tomatoes, 15, 15 and 17 kg cartons were reported for Guadalajara, Monterrey and Mexico City, respectively.

[10] This price represents bulk tomatoes, before grading and packing, as reported by the SNIIM.

costs of grading, packing, materials, and indirect costs[11]. Given that the transportation data from the shipping point to Mexican terminal markets (Guadalajara, Monterrey and Mexico City) were not available, a single point in time (obtained by interview with CAADES officials) was extrapolated (using the CPI) to create a transportation cost time series.

Estimation Results

The EPBM was estimated through a maximum likelihood technique using the TSP International version 4.5. Results from estimation of the model for Sinaloa and Florida tomatoes are presented in tables 3a and 3b. It is important to mention that two estimations were made for each pair of markets, one of them assuming perfect and symmetric flow of information, where markets may find their equilibrium instantaneously, this is, we assume contemporaneous equilibrium between shipping point and terminal prices. The other alternative estimation is made assuming that two separated markets for a homogeneous good may not be in equilibrium instantaneously, but may need a period to adjust as traders react to price changes (Goodwin, Grennes, and Wohlgenant). Although shipping tomatoes from Nogales to Chicago or Boston takes up to 4 days, shipping from Nogales to Los Angeles takes as little as four hours. Still, the positive effects of price shocks in terminal markets for Mexican fresh tomatoes (either Mexico and U.S.) last at least one week (Padilla, Thilmany, and Davies), but this effect may vary by the distance and relative market share between city pairs. This implies that traders may consider the expected future price from shipping points, so binding arbitrage conditions will be $P_t^i - P_{t+1}^j = T_{ji} + v_t$. Secondary discussion will focus on whether this modeling strategy improves or changes the market integration results for some market pairs.

Most of the estimated coefficients from the U.S. terminal market price equations, for both Mexican and U.S. tomatoes, were statistically significant. In the case of Mexican markets, more parameter estimates were insignificant, especially those for plum tomatoes. It could be due to the static price behavior observed since prices paid to producers stayed almost constant over time, while terminal market prices exhibited high volatility. It should be noted that the probability of having positive profits to arbitrage (λ_2 contemporaneous and lagged) for Mexican tomatoes in domestic markets was very high (and statistically significant) for both types of tomatoes (vine ripe and plum). It may be explained by the highly integrated production-wholesale system in Mexico, if concentrated marketing agents (with

[11] These costs were extrapolated from a single point in time data estimate elicited through an interview with officials from the CAADES at *Culiacán* , Sinaloa and complemented with information from researchers from the Colegio de Postgraduados. Estimated costs were extrapolated using the CPI and then indexed by the exchange rate. As Baulch (1997) found, time series data on transaction costs are not usually available, but if credible, detailed information on different components of costs at a single point in time are available, they serve as a good proxy.

little competition from imports) can exert influence on trading margins (Lacroix, *et al*).

Tables 4a and 4b presents market condition indicators for both Mexico and U.S. grown tomatoes, which were constructed with the estimated coefficients from tables 3a and 3b. The probability of fully integrated and equilibrium market conditions (λ_1) for Mexican tomatoes in the U.S. markets is higher, for contemporaneous prices, in Los Angeles (0.79 vine ripe and 0.73 plum) than Chicago (0.50 vine ripe and 0.71 plum). This was somewhat expected given evidence from past studies and a priori beliefs about the importance of distance in market integration for perishable products (Padilla, Thilmany and Davies; Padilla, Thilmany and Loureiro). When considering lagged prices, no improvements in U.S. market conditions are found, but integration with the Mexico City market improves. This may suggest that U.S. market price signals dominate Mexican tomato shipment response, while Mexico City shipments may represent a delayed, strategic volume control in response to larger or smaller U.S. demand. Overall, the lagged results indicate that short-term price adjustments provide little additional information.

In the case of Florida grown tomatoes, the probability that markets were in competitive equilibrium was high considering contemporaneous prices for both types of tomatoes in the Boston market (0.72 mature green and 0.74 plum) and New York (0.88 mature green and 0.55 plum). However, in the Chicago market, where the Sinaloa tomato market share has been increasing in recent years, the probability of inefficient integration ($l_2 + l_3$) among contemporaneous prices is higher for Florida tomatoes (0.60 mature green and 0.71 plum). Similarly, Sinaloa tomatoes were more likely to be inefficiently integrated in the Chicago market relative to Los Angeles. It is possible that there are periods where marketing agents decide to trade even when conditions suggest negative profits (l_3) and other periods when they trade with potential positive profits (l_2). Although lagged prices increase the probability of perfect integration for Florida mature green supplies to Chicago, there is no improvement for plum tomatoes.

The market-specific results may suggest that trade behavior is fueled by a rational, strategic plan among highly integrated grower-shippers who face different producer and marketing service supply forces, as well as varying demand schedules, in specific geographic markets. As expected, the probability of observing less efficiently integrated markets in the U.S. markets increase as the distances between markets increases. The estimates of mean transaction costs, *ë*, that were not available from data sources (but estimated in the EPBM as a time-invariant constant) are presented in tables 3a, 3b and 5. All β's were significant except for those for Mexico City (plum) and Monterrey (vine ripe). For Sinaloa tomatoes marketed in the U.S., the share of market price that goes towards marketing activities does appear to increase with distance and ranges from 25.83% in Los Angeles (plum) to 38.71% (vine ripe) in Chicago. Similarly, in the case of Florida tomatoes, the total transaction costs for mature green tomatoes behave as expected.

However, it is interesting to note that for plum tomatoes these costs are $0.84 (or 25%) smaller in New York than in Chicago, even though they are similar distances from the Florida shipping point.

It is also interesting to more closely examine general market behavior. For instance, the lowest terminal market price for Florida plum tomatoes was in the New York market ($13.88, with only 17% from transaction costs). Yet, there is only a 55% probability of market equilibrium (lower than Boston but higher than Chicago), suggesting geographic and interseasonal price discrimination (with periods of apparent negative and positive short-term profits from trade). These market dynamics may be due to the wide array of substitute tomato products in that market, including Mexican vine-ripes, domestic greenhouse supplies and overseas shipments.

Finally, it is important to note that the mean of Chicago market price for vine ripe (MX) and mature green (FL) tomatoes were not statistically different while the mean of plum tomato prices for Sinaloa and Florida tomatoes was significantly different, with Florida tomatoes sold at higher prices during the 1995-2001 period. If one believes that the marketing costs for these products are similar, it leaves one to question why price behavior varies across product types.

Concluding Remarks

This paper presents extended price analysis of intermarket relationships for Florida and Sinaloa grown tomatoes in the fresh winter market, with detail by product type and terminal market destination. Results show that as distance increases between markets, the probability of observing perfectly integrated markets decreases. Results for Florida grown tomatoes show a high probability of efficient markets in the Eastern markets where Florida tomatoes dominate consumer market share. But in Chicago, it appears that marketing agents practice strategies that lead to less direct price relationships between the shipping point and terminal market. Meanwhile, the probability of intra-Mexican traders making positive profits was very high in Guadalajara, Monterrey, and Mexico City where few competing suppliers exist for both vine ripe and plum tomatoes. These findings are consistent with a strategy of export development to move quantities while keeping domestic prices high, but one could expect an increasingly complex situation if you consider continued export volume constraints under reference price regimes.

Overall, Chicago is the exception to price relationship findings. Two factors may influence this finding, the relatively great distance from the shipping points to Chicago, as well as the relatively high level of competition between the two winter suppliers, Florida and Mexico. For example, even though Florida mature green and Sinaloa vine ripe tomatoes sell for similar market prices in Chicago, Florida plum tomatoes (which are a relatively smaller share of the total market volume, and thus, have less supply pressure) are sold at a higher price than Mexican plums in

Chicago. It is likely that more markets will exhibit this same behavior as the number of competing substitute products (by production source and product type) and growers in any one market increases.

In addition to estimates on the likelihood of efficient integration between markets, a summary of compiled transfer data (transport, trade fees and shipment costs) and estimated transaction costs (non-transport distribution costs) provides some rich information on the supply and demand of tomatoes and their allied marketing services, for those intereseted in examining behavior across time and markets. Some discussion points that may be of interest to agribusiness include:

1. Will shipper-growers use supply-chain management as a method to optimize marketing margins as well as to geographically diversify production and improve production response?

2. What role will national trade policies play in a marketplace that is increasingly globalized (vertically integrated grower-shippers), yet where market-specific strategies may be in place (domestic vs. export and nearby vs. distant markets)? Can overarching trade policies be effective in product markets with increasing product differentiation?

3. How will the quickly emerging greenhouse production sector influence the price behavior and market dynamics of the tomato sector and other fresh produce industries?

These findings do motivate the need for further analysis of how these estimated probabilities of potential arbitrage relate to other factors, such as how the probable disequilibria align with the point in the Mexico vs. U.S. production season, reference prices as a binding price floor, supply shocks to the market, product type (plum vs. vine ripe) or other strategic behavior, especially since there is fairly even shares of both positive and negative profit regimes (except in the case of Sinaloa vine ripes where positive profit probability is higher). The increasing share of greenhouse production will also need to be considered in subsequent analysis, as these supplies began to consistently be reported in the winter data series in the last years of the 1990's.

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Table 1. United States Apparent Consumption of Tomatoes and Florida and Sinaloa Market Share (Thousand Tons)

Year	U.S. Production	U.S. Exports	U.S. Imports	Apparent Consumption	U.S. Producers Market Share	Mexican Producers Market Share	Florida Producers Market Share	Sinaloa Producers Market Share
1991	1541.7	136.2	360.8	1766.3	79.6%	20.0%	34.2%	15.0%
1992	1770.5	166.7	196.0	1799.9	89.1%	10.2%	38.3%	6.0%
1993	1663.0	156.9	418.4	1924.5	78.3%	20.8%	29.9%	16.7%
1994	1695.8	154.5	396.0	1937.3	79.6%	19.4%	29.7%	15.8%
1995	1546.7	131.2	620.9	2036.4	69.5%	29.1%	21.1%	22.3%
1996	1525.6	134.0	737.1	2128.8	65.4%	32.2%	23.6%	22.7%
1997	1486.7	155.0	742.4	2074.2	64.2%	31.8%	29.8%	25.0%
1998	1480.0	129.9	847.3	2197.4	61.4%	33.4%	28.2%	23.4%
1999	1666.3	151.7	740.7	2255.3	67.2%	27.3%	33.9%	18.4%
2000	1676.7	186.1	730.1	2220.7	67.1%	26.6%	36.6%	17.1%

Source: USITC.

Table 2. Intermarket Regimes

Regime Definition	Intermarket Conditions[1]	Probability
Regime1: Perfect Integration with Trade	$P_t^i - P_t^j = T_{ji} + v_t$	l_1
Regime 2: Inefficient Integration (positive marginal profits to arbitrage)	$P_t^i - P_t^j = T_{ji} + v_t + u_t$	l_2
Regime 3: Inefficient Integration (negative marginal profits to arbitrage)	$P_t^i - P_t^j = T_{ji} + v_t - u_t$	l_3

1/ In regime 1, price differentials are equal to transaction costs, in regime 2 (3) price differentials are greater (less) than transaction costs.

Table 3a. Parameter Estimators for Sinaloa Tomatoes

	Los Angeles		Chicago		Guadalajara		Monterrey		Mexico City	
	Contemporaneous	Lagged	Contemporaneous	Lagged	Contemporaneous	Lagged	Contemporaneous	Lagged	Contemporaneous	Lagged
Vine-Ripe Tomatoes										
s_v^2	1.02	1.10	1.02	0.61	0.08	0.12	0.72	0.74	0.01	1.07
	(9.11)	(5.07)	(5.23)	(4.46)	(1.96)	(1.94)	(4.70)	(4.12)	(2.53)	(8.15)
s_u^2	2.23	4.26	3.44	5.27	1.67	1.49	3.93	3.89	3.32	4.04
	(4.17)	(10.84)	(9.11)	(14.11)	(12.03)	(10.96)	(10.17)	(9.97)	(12.67)	(6.08)
b	1.94	1.85	2.95	2.61	0.72	0.46	-0.04	0.05	0.35	1.42
	(10.21)	(6.45)	(9.75)	(16.38)	(13.56)	(4.67)	(-0.16)	(0.13)	(33.08)	(6.91)
l_1	0.79	0.39	0.50	0.25	0.09	0.09	0.22	0.25	0.04	0.64
	(5.64)	(4.22)	(3.98)	(4.51)	(1.91)	(1.55)	(2.05)	(1.83)	(1.67)	(6.39)
l_2	0.21	0.39	0.43	0.50	0.49	0.52	0.78	0.75	0.88	0.36
	(1.51)	(4.37)	(3.49)	(8.66)	(7.75)	(7.41)	(7.62)	(5.41)	(23.49)	(3.54)
l_3	0.00	0.22	0.07	0.25	0.42	0.39	0.00	0.00	0.08	0.00
	(0.11)	(3.96)	(2.06)	(5.82)	(6.80)	(4.60)	(0.62)	(0.43)	(2.76)	(0.71)
Log-likelihood	-276.27	-407.45	-350.46	-443.21	-156.95	-143.13	-187.94	-186.50	-183.24	-175.04
Observations	163	158	159	158	85	82	84	84	84	84
Plum Tomatoes										
s_v^2	0.87	0.85	1.39	0.94	0.35	0.02	0.49	0.32	1.02	1.00
	(5.40)	(5.84)	(6.84)	(4.08)	(1.52)	(2.84)	(2.25)	(2.16)	(2.18)	(2.21)
s_u^2	3.38	4.11	3.39	4.87	3.09	2.99	3.20	3.47	3.78	3.69
	(5.84)	(11.63)	(5.39)	(12.03)	(10.74)	(12.27)	(9.16)	(10.26)	(5.26)	(5.11)
b	1.39	1.13	2.27	1.97	0.69	0.52	1.33	0.93	0.26	0.05
	(12.03)	(6.62)	(11.45)	(9.52)	(2.19)	(54.77)	(2.26)	(2.16)	(0.23)	(0.04)
l_1	0.73	0.40	0.71	0.38	0.11	0.05	0.08	0.01	0.07	0.05
	(7.67)	(5.75)	(5.72)	(4.73)	(1.39)	(1.93)	(0.43)	(0.11)	(0.28)	(0.19)
l_2	0.09	0.33	0.16	0.38	0.70	0.75	0.92	0.99	0.93	0.95
	(1.54)	(5.52)	(1.99)	(5.52)	(6.92)	(14.95)	(5.11)	(10.27)	(4.08)	(3.79)
l_3	0.18	0.27	0.13	0.24	0.18	0.20	0.00	0.00	0.00	0.00
	(3.19)	(4.85)	(1.76)	(4.76)	(3.30)	(4.47)	(0.03)	(0.08)	(0.01)	(0.08)
Log-likelihood	-321.14	-417.24	-390.88	-476.70	-195.22	-180.87	-170.25	-171.95	-192.74	-188.47
Observations	171	168	180	179	84	80	84	84	84	83

Note: *t*-statistics are in parentheses.

Table 3b. Parameter Estimators for Florida Tomatoes

	Chicago		Boston		New York	
	Contemporaneus	Lagged	Contemporaneous	Lagged	Contemporaneous	Lagged
Mature Green						
s_v^2	1.24 (4.58)	2.22 (5.25)	1.24 (9.40)	1.74 (8.48)	1.35 (10.61)	1.69 (5.62)
s_u^2	2.43 (8.76)	5.42 (6.60)	3.23 (6.85)	5.66 (9.24)	3.93 (2.88)	4.01 (3.60)
b	1.98 (4.91)	2.18 (5.93)	2.96 (19.42)	3.15 (12.34)	2.10 (11.34)	2.21 (6.47)
l_1	0.40 (2.43)	0.63 (4.29)	0.72 (7.98)	0.61 (7.65)	0.88 (12.95)	0.74 (4.85)
l_2	0.30 (2.14)	0.18 (1.77)	0.22 (2.91)	0.23 (3.41)	0.12 (1.70)	0.22 (1.83)
l_3	0.30 (2.14)	0.19 (2.61)	0.06 (1.73)	0.16 (3.95)	0.00 (0.78)	0.04 (0.49)
Log-likelihood	-502.09	-613.21	-488.22	-617.69	-146.07	-170.23
Observations	227	224	237	231	75	74
Plum Tomatoes						
s_v^2	0.78 (1.90)	1.69 (1.46)	1.25 (9.18)	0.47 (3.11)	0.75 (5.61)	1.81 (3.39)
s_u^2	2.39 (10.66)	3.96 (6.35)	4.75 (6.73)	4.24 (15.56)	2.97 (6.24)	4.03 (3.83)
b	2.11 (5.32)	4.46 (2.44)	1.75 (11.83)	1.56 (7.95)	1.15 (6.31)	1.39 (1.99)
l_1	0.29 (1.81)	0.01 (0.02)	0.74 (10.80)	0.14 (2.86)	0.55 (5.04)	0.61 (2.14)
l_2	0.30 (1.77)	0.14 (1.24)	0.14 (3.01)	0.48 (8.87)	0.24 (3.09)	0.28 (1.09)
l_3	0.41 (3.72)	0.85 (1.73)	0.12 (2.66)	0.38 (6.86)	0.21 (2.39)	0.11 (1.19)
Log-likelihood	-361.42	-426.25	-388.44	-456.26	-150.35	-176.38
Observations	168	158	175	164	74	71

Note: *t*-statistics are in parentheses.

Table 4a. Estimates of the Probability for Sinaloa Fresh Tomato Market Condition

Market Condition	Indicator	Los Angeles Vine Ripe	Los Angeles Plum	Chicago Vine Ripe	Chicago Plum	Guadalajara Vine Ripe	Guadalajara Plum	Monterrey Vine Ripe	Monterrey Plum	Mexico City Vine Ripe	Mexico City Plum
Contemporaneous											
Market Equilibrium and Integration[1]	$l_1 = ME$	0.79	0.73	0.50	0.71	0.09	0.11	0.22	0.08	0.04	0.07
Inefficiently Integrated	$l_2 + l_3 = II$	0.21	0.27	0.50	0.29	0.91	0.88	0.78	0.92	0.96	0.93
Lagged											
Market Equilibrium and integration[1]	$l_1 = ME$	0.39	0.40	0.25	0.38	0.09	0.05	0.25	0.01	0.64	0.05
Inefficiently Integrated	$l_2 + l_3 = II$	0.61	0.60	0.75	0.62	0.91	0.95	0.75	0.99	0.36	0.95

[1]Markets are perfectly integrated.

Table 4b. Estimates of the Probability for Florida Fresh Tomato Market Condition

Market Condition	Indicator	Chicago Mature Green	Chicago Plum	Boston Mature Green	Boston Plum	New York Mature Green	New York Plum
Contemporaneous							
Market Equilibrium and integration[1]	$l_1 = ME$	0.40	0.29	0.72	0.74	0.88	0.55
Inefficiently Integrated	$l_2 + l_3 = II$	0.60	0.71	0.28	0.26	0.12	0.45
Lagged							
Market Equilibrium and integration[1]	$l_1 = ME$	0.63	0.01	0.61	0.14	0.74	0.61
Inefficiently Integrated	$l_2 + l_3 = II$	0.37	0.99	0.39	0.86	0.26	0.39

Table 5. Mean of Publicly Available and Estimated Transaction Costs (Dollars per Unit)

	Observations	Unit Size	Mexican Transport Cost[1]	CIF[1]	Tariffs[1]	U.S. Domestic Transportation[1]	Total Transaction Costs[2]	Estimated Transaction Costs[3] $(\hat{b})$	Intermarket Transaction Costs (TC)[4]	Mean Terminal Market Price	TC as a % of Mean Terminal Market Price
Vine Ripe Tomatoes											
From Sinaloa to:											
Los Angeles	163	25 pound		0.72	0.29	0.53	1.54	1.94*	3.48	11.91	29.22
Chicago	159	25 pound		0.71	0.28	1.36	2.35	2.95*	5.30	13.69	38.71
Guadalajara	85	10 kg	0.56				0.56	0.72*	1.28	4.72	27.12
Monterrey	84	15 kg	0.93				0.93	-0.04	0.93	7.49	12.42
México City	84	10 kg	0.79				0.79	0.35*	1.14	7.00	11.29
Plum Tomatoes											
From Sinaloa to:											
Los Angeles	171	25 pound		0.71	0.32	0.53	1.56	1.39*	2.95	11.42	25.83
Chicago	180	25 pound		0.71	0.31	1.39	2.41	2.27*	4.68	13.73	34.09
Guadalajara	84	15 kg	0.85				0.85	0.69*	1.54	6.14	25.08
Monterrey	84	15 kg	0.93				0.93	1.33*	2.26	7.56	29.89
Mexico City	84	17 kg	1.34				1.34	0.26	1.60	7.50	21.33
Mature Green Tomatoes											
From Florida to:											
Chicago	227	25 pound				1.08	1.08	1.98*	3.06	13.40	22.84
Boston	237	25 pound				1.41	1.41	2.96*	4.37	15.07	29.00
New York	75	25 pound				1.21	1.21	2.10*	3.31	12.77	25.92
Plum Tomatoes											
From Florida to:											
Chicago	168	25 pound				1.09	1.09	2.11*	3.20	14.59	21.93
Boston	175	25 pound				1.42	1.42	1.75*	3.17	15.24	20.80
New York	74	25 pound				1.21	1.21	1.15*	2.36	13.88	17.00

Notes: An asterisk (*) on estimated transaction costs ($\hat{b}$) indicates statistical significance at the 5 percent level.

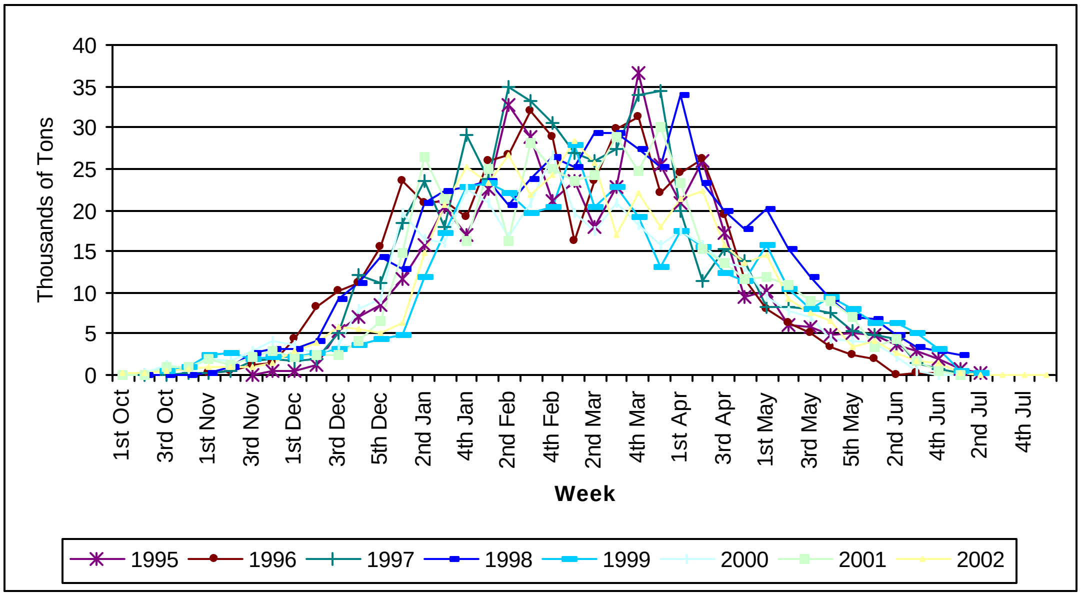
1/ Mean of available data used for the EPBM estimation.

2/ Total transaction costs represent publicly available data and include the sum of CIF, tariffs, U.S. domestic transportation for the U.S. markets and Mexican transport costs for Mexican markets.

3/ Estimated with the EPBM.

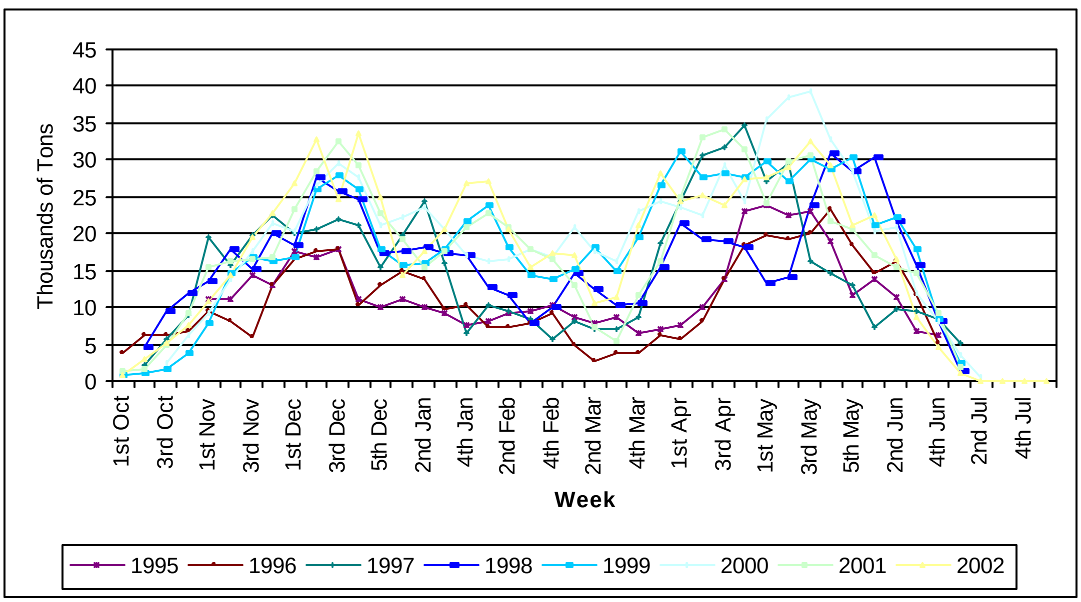
4/ Intermarket transaction costs are the sum of total transaction costs and $\hat{b}$. When $\hat{b}$ was statistically insignificant, it was not included.

Figure 1a. Shipments of Fresh Tomatoes From Sinaloa, Mexico



Source: Fresh Produce Association of the Americas (FPAA) and AMS, USDA.

Figure 1b. Shipments of Fresh Tomatoes from Florida



Source: Fresh Produce Association of the Americas (FPAA) and AMS, USDA.