# Dispatches from the Tomato Wars: Spillover Effects of Trade Barriers

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**The Spillover Effects of Trade Barriers**

by

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Most trade barriers are, by their very nature, bi-lateral. Since most countries trade with more than one country in more than one product, these bilateral measures can have spillover effects, changing trading patterns among other countries and products. This paper looks at the effect of a bilateral trade barrier on trade flows within a three-country free-trading area. Specifically, this paper examines the trade distortion effects of the 1996 voluntary export restraint (VER) placed on tomato exports from Mexico to the United States. Has Mexico shifted its exports from the United States to Canada, and has Canada increased its exports to the United States? Has the VER caused Mexico to divert fresh tomatoes to the processing sector?

VERs are generally adopted by an importing country to protect its domestic industry from import competition. VERs can have the additional benefit of helping the producers in the exporting country, and are therefore sometimes seen as a politically palatable solution to a trade dispute (Harris 1985, Krishna 1985, Syropolis 1996).[1] However, VERs, like any trade barrier, may have spillover effects (for example, see Dohni 1998, De Melo and Winters 1993), diverting product to other countries and into other uses. The increased trade to and from a third country or into a new product can itself incite further protectionist responses. Thus, the spillover effect can itself create demand for further trade protection.

[1] As shown by Bjorkston 1994, this result need not hold in a three-country case.

In 1994, Canada, the United States and Mexico implemented the North American Free Trade Agreement (NAFTA). The three countries agreed to reduce and eventually eliminate the existing tariff barriers on agricultural trade within North America. Since the NAFTA was enacted, the three countries have become significant markets for each other's tomatoes and tomato products. This increase in trade has not been without friction. In 1996, The United States brought an antidumping suit against Mexican fresh tomato imports. The two countries reached a negotiated settlement (called a suspension agreement) that placed a minimum price on Mexican fresh tomato exports going to the United States. Mexican tomatoes have entered into the United States at the reference price several times each year since the VER was put into effect, giving evidence that the VER has been binding. As Canada imports winter tomatoes from both Mexico and the United States, one might expect that the trade barrier led Mexico to increase its exports of tomatoes to Canada, where they compete with imports from Florida. As well, since Mexican field tomatoes are used both for the fresh market and for processing, one may expect that the VER led to increased exports of processed tomato products from Mexico to the United States and Canada. No previous study has looked at the effect of the reference price on trade flows or price.

The reference price was (initially) constructed to protect fresh winter tomato producers in Florida. If the reference price caused Mexican tomatoes to be shipped at slightly different times in the year, or to be diverted into processing, the tomatoes or tomato paste may have competed with production from California and other states. As well, the trade barrier may have caused Mexican tomatoes to be diverted into the Canadian market, displacing Florida production, or causing Canadian tomato exports to the United States to increase. Mexico and Florida compete for the winter tomato market in both the

United States and Canada. If the floor price blocked tomatoes from entering the United States, they may have been diverted to the Canadian market instead. The United States recently pursued an anti-dumping case against Canadian (greenhouse) tomato imports, arguing that a surge of imports at below "fair" value injured the young U.S. greenhouse tomato industry. If the reference price on Mexican tomatoes caused part of this import surge, it may indicate that one of the spillover effects of a bilateral trade barrier may be to induce, or at least exacerbate, other trade disputes.

Although there is an extensive theoretical literature on VER's, the empirical work on VER's is limited. Some work has been done to determine the effect of the VER on Japanese Automobiles on the quality, profits, welfare of producers and consumers in both countries (for example, see Ries 1993, Kim 1997, Berry et al. 1999). Recent work by Ohashi (2002) studied the strategic behavior of firms producing VCRs in anticipation of a VER. Ohashi used the spillover effects of the barrier to EU-Japanese trade on the U.S. market to identify the Japanese firm behavior. There is also work illustrating that countries' other trade options will influence the level of VER's negotiated, for example Chan (1993) takes countries' other trade options into account when studying the levels of VERs set in textile imports to Canada. This may be the first empirical paper to estimate the spillover effects of a VER.

The next section presents background on the tomato industry and tomato trade within NAFTA, and gives a brief history of the trade dispute. A simple model of spillover effects is then presented. Next, the estimation technique and data are discussed. Results and conclusions follow.

**Background**

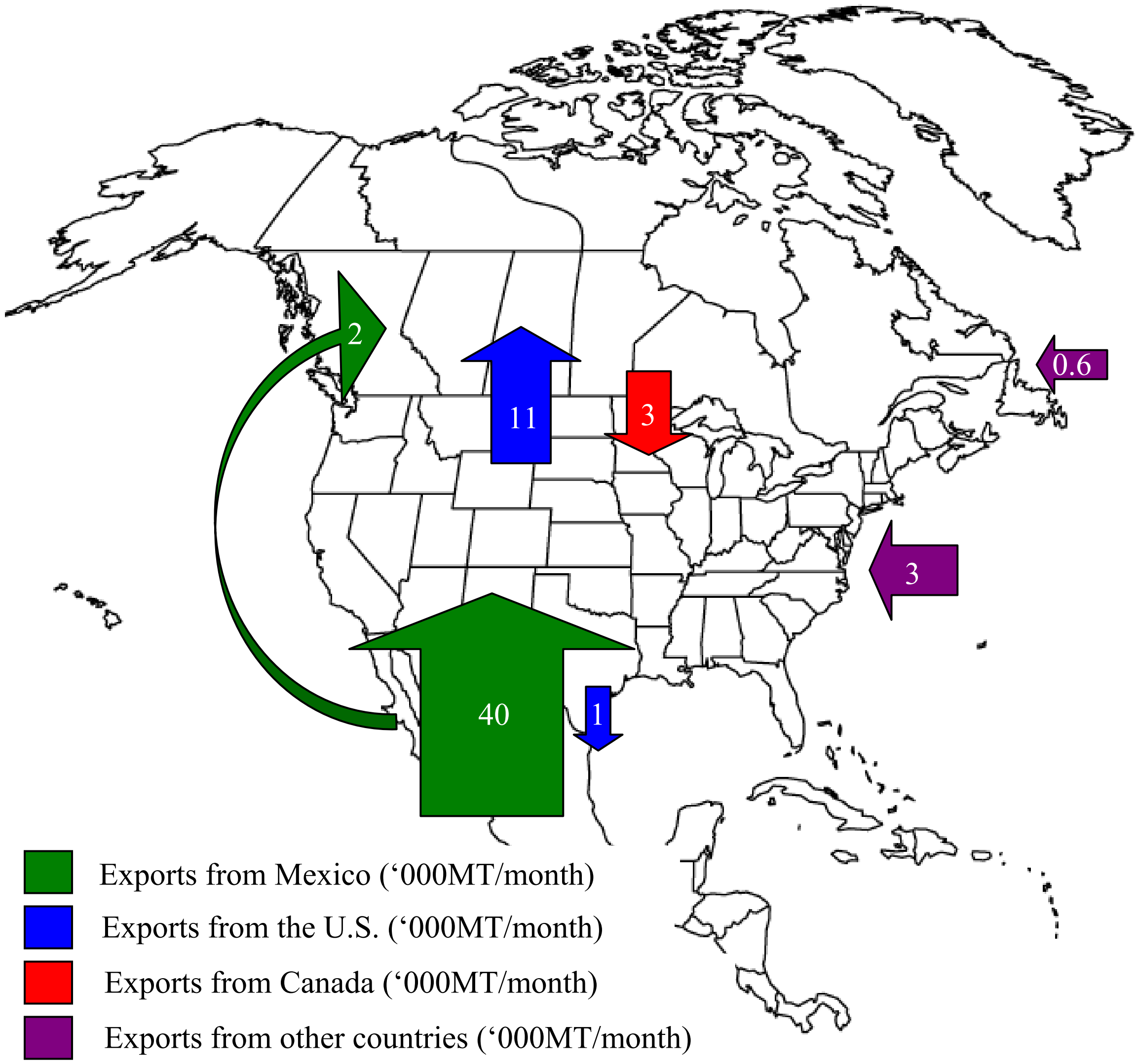
Tomatoes are an important product in all three NAFTA countries. The United States is the second largest producer of tomatoes in the world (only China is larger). Florida and California grow the majority of both fresh and processed U.S. tomatoes, (Florida produces 43 percent of all domestic fresh tomatoes, whereas California produces 31 percent of all fresh and 95 percent of all U.S. processing tomatoes). U.S. fresh-market tomatoes had a farm value of $920 million in 1999, and an estimated retail value of over $4 billion. Processed tomatoes had a farm value of slightly over $900 million (USDA-ERS).

Tomatoes are Mexico's second highest value agricultural export, bringing in about half a billion dollars per year. Export tomatoes are primarily grown in Sinaloa in the winter and Baja in the summer. Relatively few growers produce tomatoes for export to the United States, and they use more capital-intensive production technology than those growing for the domestic market (Calvin and Barrio, 1998).

Canada is by far the smallest producer of the three countries. Although tomatoes represent a small portion of Canada's agricultural production, tomatoes make up the largest value of Canadian fresh vegetable exports, and the value in increasing (C$24.5 million in 1995 to C$180.2 million in 1999). The increase in value comes primarily from the growth in the tomato greenhouse industry, which has more than quadrupled in the last 20 years (Statistics Canada, 2002).

Each country trades tomatoes and tomato products with the other two countries. Mexico is the largest exporter of fresh tomatoes to the United States (accounting for 83 percent of imports), and Canada is next (at 9 percent of imports). U.S. fresh tomato exports primarily go to Canada (91 percent of exports in 1999) with exports to Mexico (4 percent) ranking a distant second. Florida and Mexico historically compete for the U.S. (and Canadian) winter and early spring markets. Imports from Mexico tend to peak in the winter when southern Florida is the predominant U.S. producer. Over the past ten years, Mexico has increased its market share of the winter tomato market from 27 percent to close to 50 percent (Calvin and Barrios). Although some other countries (the Netherlands, Spain and Israel) export tomatoes to the United States and Canada, no non-NAFTA country provides a significant market for fresh tomatoes grown in North America (see figure 2.1 and table 2.1 for details).

**Figure 2.1** Average Monthly Trade Flows of Fresh Tomatoes within North America, 1989-2001 (Arrows represent '000 metric tonnes)




Source: USITC and Statistics Canada (2002)

**Table 2.1** Average Monthly Exports within and to North America, 1989-2001

| Exports ('000 MT) | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| U.S. to Canada | 10.74 | 2.62 | 3.36 | 16.11 |
| Canada to U.S. | 3.25 | 5.39 | 0.00 | 25.90 |
| Mexico to U.S. | 40.48 | 27.76 | 7.29 | 122.81 |
| Mexico to Canada | 1.78 | 2.17 | 0.00 | 8.10 |
| U.S. to Mexico | 1.05 | 1.88 | 0.00 | 9.90 |
| Other to U.S. | 3.25 | 6.96 | 0.00 | 64.22 |
| Other to Canada | 0.59 | 1.42 | 0.00 | 7.75 |

Source: USITC and Statistics Canada (2002)

The three countries also trade processed tomato goods. Although during the 1990s, the United States became a net exporter of processed tomato products, the United States still imports some tomato products, primarily from Canada (24 percent), Chile (22 percent) and Mexico (18 percent) (ERS 2002). Whereas processing and fresh tomatoes are distinct varieties and the two tomato markets are separate in the United States and Canada, the processing market is the residual market for fresh tomatoes in Mexico, using about 10 percent of the tomatoes grown in Mexico. Tomatoes that cannot be sold in the fresh market are sold for processing.

These close trade ties in a sensitive agricultural product have, perhaps predictably, led to a number of trade disputes. In the 1980s, Florida producer groups brought an anti-dumping case against Mexican winter vegetable production. The USITC did not find evidence of dumping, and the case was dropped but tension between Floridian and Mexican producers continued. On April 1, 1996, various U.S. tomato growers (representing growers in Florida, South Carolina, and other states) filed an antidumping petition alleging that their industry was threatened by fresh tomatoes from Mexico imported "at less than fair value." The petition was in response to a sharp rise in tomato imports (276 percent) from 1992 to 1996, the bulk of which (93 percent in 1996) came from Mexico. Meanwhile, U.S. production fell by 21 percent over the same time period, and prices dropped from $0.79 per kg to $0.63 in 1996. In May, 1996, the Department of Commerce found that tomato imports did threaten the domestic industry with material injury, the first step in setting supplemental "anti-dumping" tariffs to protect the U.S. industry.

On December 6, 1006, the two countries reached an agreement where Mexico would voluntarily limit its exports and in return, the United States would suspend the anti-dumping case and remove the anti-dumping tariffs, called a suspension agreement. Mexico agreed to set a single reference (floor) price of $5.17 per 25 lb carton of tomatoes exported to the United States. In 1998, two separate reference prices were set, one for winter and one for summer production. Until July 2002, summer tomatoes (primarily produced in Baja Mexico) were covered under one reference price that ran from July 1 to October 22 ($4.30 per 25-lb box) while winter tomatoes (affecting tomatoes produced in Sinaloa) were covered October 23 to June 30 with a higher floor price ($5.27 per 25-lb box). In July 2002, the suspension agreement was repealed after a number of Mexican tomato shippers refused to renew their commitment to the reference price agreement. The end of the suspension agreement has re-initiated the 1996 anti-dumping case, and the Department of Commerce has resumed its investigation. Initial anti-dumping duties (or a new suspension agreement) are expected later in 2003.

Mexican vegetable exports are concentrated. For tomatoes, there are 40 shippers in total, and the largest ten export about 70 percent of Mexico's tomato exports. Most of these firms also ship other vegetables, including green peppers, eggplants and cucumbers. Twenty-four of these shippers are owned by the Mexican growers, and the rest operate under contract. Most of the Mexican tomatoes cross into the United States at one of three border crossings: at Laredo, TX; Nogales, AZ or San Diego, CA. Most of the tomatoes are sold by contract to distributors and are therefore priced before they enter the United States. Other truckloads of tomatoes are sold at the Phoenix market. These tomatoes are bought by distributors, retailers and shippers who in turn sell them at regional terminal markets throughout the United States. If the market in Phoenix cannot accept all the tomatoes at the reference price, shippers will often wait for a few days in hopes that the price will rise. Their ability to wait is limited, since tomatoes need to be sold (at the retail stores) within two to three weeks of shipping. If when the tomatoes are nearly ripe and still cannot be sold in the Phoenix market, they are either sent back to Mexico and turned into paste, or are destroyed.

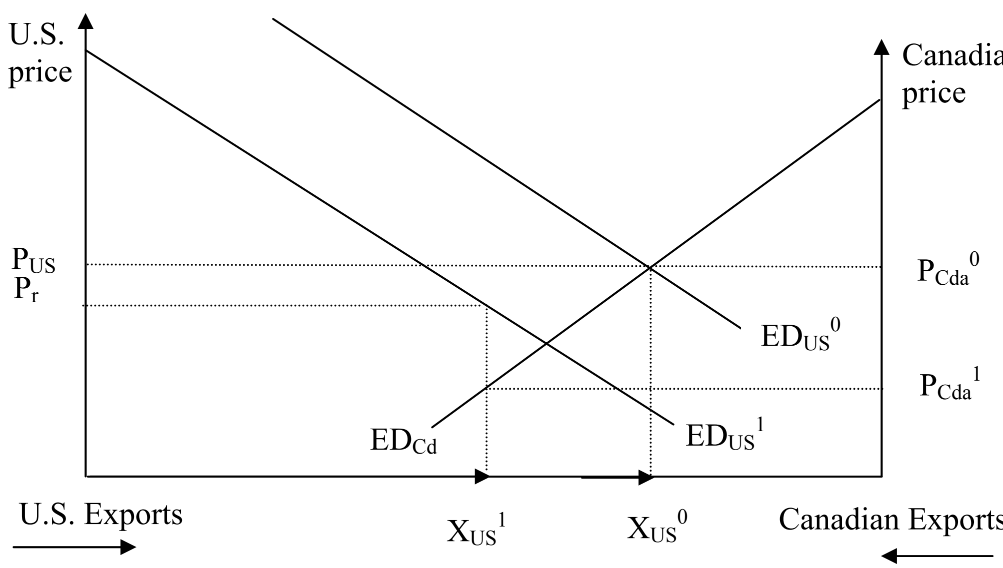
**Theoretical Model**

The following model illustrates the simplest of the potential spillover effects where tomatoes are diverted into Canada when they cannot be sold into the United States without violating the reference price. For simplicity, assume that a grower from Mexico has the option of only selling into the United States or Canada. Second, assume that at any point in time, the supply of tomatoes from Mexico is fixed. If the excess demand of tomatoes in the United States is large, illustrated in Figure 2.2 as $ED_{US}^{0}$ (say, due to a small harvest in Florida), tomatoes will be sold in both countries for price $P_{US}=P_{Cda}^{0}$, and the reference price, $P_r$, is not binding.

If, however, the excess demand decreases to $ED_{US}^{1}$, the market price drops to the reference price, limiting the quantity that Mexico can export to the United States to $X_{US}^{1}$. Mexican shippers divert the other tomatoes to the Canadian market, decreasing the price in Canada to $P_{Cda}^{1}$. Thus, when the reference price is binding, the quantity shipped to Canada increases and the price drops.

For this simple analysis, assume that the price in the Mexican market (either for fresh or processed tomatoes) is lower than the price shippers can receive in Canada. Also assume there is no market power by either sellers or distributors and that the Mexican shippers are not changing the quality of tomato products being sold to the two countries when the reference price is binding.

**Figure 2.2** Mexican tomato exports to the United States and Canada




In a more general model with trade between all three countries, the VER could also affect trade between the United States to Canada. By artificially raising the price in the United States, the reference price may encourage an increase in sales of domestic tomatoes in the United States (relative to there being no reference price), and reduce exports of U.S. tomatoes to Canada. Likewise, exports from Canada and other countries to the United States should also increase because of the reference price. Similarly, the

VER may cause some fresh Mexican tomatoes to be diverted to the processing sector. This paper formally tests these hypotheses about how the VER affected trade flows. The results are presented later.

There have been a number of papers that develop theoretical models of firms (usually with market power) under a VER. Some of these papers have looked at the dynamic games played by firms in anticipation of a (quantity) based VER (Yano 1989, Jans et al 1995). This aspect of dynamic game playing is not captured in the estimation, primarily because I do not have firm-level data, and not all firms sign on to the VER. As well, unlike most VERs, this agreement sets minimum price for the industry, not quantity for each exporting firm, which would remove the incentive to compete heavily leading up to the VER.

Some papers have argued that VER's will encourage the affected export industry to increased quality, whereas other recent papers have shown that this need not always be the case (Ries, 1993) Because there are quality differences between tomatoes that are not captured in the data, I ignore the effect of changes in quality for the purposes of this paper, and focus purely on quantity of trade flows.

**Empirical Model**

Each country's exports are determined by their domestic supply and demand in the absence of the VER. Supply is a function of expected profit and weather. Expected profit, in turn, is a function of expected price, input prices, and expected yield. Domestic demand is a function of the size of the domestic economy and tastes. Excess demand and excess supply are determined by the quantity demanded less the quantity supplied, and, under free trade, the quantity traded is determined by the intersection of the sum of the excess supply curves and the sum of the excess demand curves. Of course, trade barriers affect the equilibrium. If a reference price is binding on one exporter, the quantity exported to the restricted market equals the quantity of imports demanded at the reference price, not the quantity of exports the country wants to supply at that price. As shown above, this trade barrier can affect trade between other countries, making other import markets more attractive. Therefore, the equilibrium trade flows will be determined by bilateral trade barriers as well as supply and demand in all countries.

Because reliable price data controlled for quality are not available, it is not possible to estimate a full structural model. Instead, I estimate a reduced form model, where the quantity of fresh tomatoes exported from Country *i* to Country *j* is estimated as a function of exogenous supply and variables for all countries in the trading region, and the various border measures in place. For a three-country trading area, the supply, demand and border measures of all countries will come into play, thus:

$$(1) \qquad q_{ij} = f\left(S_i, S_j, S_k, D_i, D_j, D_k, z_{ij}, z_{ik}, z_{jk}\right)$$

where $S_i$ is a vector of exogenous supply variables for Country *i*, $D_i$ is a vector of exogenous demand variables, and $z_{ij}$ are the border measures in place between Countries *i* and *j,* as well as between *i* and *k,* and *j* and *k.*

With aggregate national data, countries are observed to both export and import fresh tomatoes simultaneously while a simple excess demand and supply model would dictate that a country only be an exporter or importer of a single product at any one time. As can be seen in figure 1, both Canada and the United States export tomatoes to each other, often in the same month. Likewise, even though Mexico exports large quantities of fresh tomatoes to the United States, the United States also exports some tomatoes to

Mexico. This two-way trade occurs because of seasonality, quality and geography, which are obscured by the national data. However, if only net trade were considered, it would be impossible to determine the full spillover effects of the trade barrier. For example, looking at net trade flows, one could not determine the effect of the trade barrier on Canadian exports to the United States, since they are almost always smaller than the U.S. exports to Canada, and would therefore be netted out. Therefore, in this model, each bilateral export quantity is considered separately.

A reduced-form model is consistent with both perfect competition and with market power. As noted above, producing regions tend to grow in only summer or winter, and the industry structure is potentially different for each. In the summer, tomatoes are produced throughout most of North America. Large producers in California and Mexico compete against smaller local farmers and market gardens throughout the United States and Canada. In the winter, production is primarily limited to Florida and Mexico, with some Canadian and southern U.S. greenhouse production beginning in the early spring. Therefore, if there is the possibility of some market power, it would likely occur during the winter (Bredahl et al. 1987).

Because the shippers and regions differ between the summer and the winter, the two seasons were estimated separately. However, there is some overlap, so the months are not exclusive – winter includes the months from November to May. This time-frame corresponds with the shipping season of Florida and Sinaloa, Mexico. Summer includes the months from April to October, which covers the shipping season of Canada, California and Baja, Mexico. Results for the policy variables are robust whether to whether the summer is defined as beginning in May as opposed to April.

The United States only primarily exports fresh tomatoes to Mexico in the summer months, therefore the quantity of exports was only estimated during the summer. The quantity of paste exported from Mexico to the United States was sporadic, and therefore was estimated using a tobit. Paste production primarily uses winter tomatoes, however the paste is storable, therefore paste exports were not split into seasons.

The quantity of tomatoes exported from one country to another was regressed on a number of supply and demand variables. The supply variables included a number of weather variables, such as average temperature and rain during planting and harvest, as well as the price of various agricultural inputs such as fertilizer, chemicals and labor at the time of the growing season they would be used. Monthly seasonal dummies were also included.

**Data**

The compiled data include the monthly quantity of tomatoes traded among Canada, the United States, and Mexico, from January 1989 to November 2001 (Statistics Canada and USITC). The government regulations of interest are the VER and tariffs. A dummy equal to one during the period that the VER was in effect was created. Weekly prices at which Mexican tomatoes were imported into the United States were collected, and these data were used to create a variable to approximate the degree to which the reference price was binding. The variable is the percentage of weekly observations of all quality and quantities in a month that were at or below the reference price.

Along with the VER, each country imposed tariffs on fresh tomato imports during this period. These tariffs were small and were decreased as a result of the trade agreements. Since the hypotheses test whether there are spillover effects of trade rules, the tariffs were included in all regressions. However, because of collinearity between the tariffs and the VER dummy, they could not be estimated separately, and the Canadian tariffs on U.S. and Mexican exports were not included.

To capture supply weather shocks, I use temperature and rainfall variables for various cities in Canada, California, Florida, Ohio and Sinaloa, Mexico which were chosen as representative on the primary growing regions in each country. Weather variables were not available for Baja Mexico for the entire time-period, therefore, I use temperature from the Imperial valley, California to proxy for weather patterns in Baja California and to supplement the information from Mazatlan, in Sinaloa, Mexico. The weather data come from the National Climatic Data Center (2002) for the United States, and the Global Historical Climatology Network (2002) for Mexico and Canada. A number of months are missing for the Canadian and Mexican data. These were filled in using monthly averages and totals from daily data obtained from a website with historical daily weather reports (Weather Underground 2003). Since weather does not have the same effect throughout the year, rain and temperature variables were interacted with dummies for months during the growing season. Some rain during the growing season can be beneficial, but rain late in the crop year may delay harvest and cause the fruit to rot. A drought proxy was calculated by taking the cumulative rainfall in the year preceding the harvest and dividing by the ten-year average. Frost damage in winter crop was captured by the minimum temperature during winter months. Heat stress was captured using maximum temperatures during early the summer months.

Also included in the data are price indexes for fertilizer and agricultural chemicals for Canada and the United States (Statistics Canada and USDA-ERS). In Mexico, the price of manufactured inputs was assumed to be correlated with the Mexican rate on inflation. Since tomatoes for the fresh market are picked by hand, wages are a significant cost of production. Agricultural wages were collected for Canada, and the agricultural minimum wage was used for the United States (Statistics Canada and USDA-ERS). All variables were converted to real dollar terms. Like the weather variables, these were interacted with the months in which the inputs would be used. Because inputs prices were not readily available for Mexico, the Mexican rate of inflation was included to proxy for changes in inputs costs (Banco del Mexico).

Exogenous demand was proxied by country GDP (Bank of Canada, Federal Reserve Board and Banco del Mexico). Exchange rates between Canada and the U.S. and Mexico and the U.S. were also included (Federal Reserve Board)).

**Results**

First, the variable indicating the degree that the reference price was binding was tested for endogeneity using the Hausman test as specified in Appendix A. The results from the consistent estimator (estimating the percent binding from a tobit) were compared with those from ordinary least squares (OLS), and the results indicated that one could not reject the hypothesis that the OLS estimators were consistent (p-stats of 0.25, 0.20, 0.96, 0.66, 0.36 and 0.95 for U.S. to Canada, Canada to the U.S., Mexico to the U.S., Mexico to Canada, U.S. to Mexico and the rest of the world to the U.S. respectively). The estimation was then completed using GLS to correct for heteroskedasticity.[2] Autocorrelation was a concern, and lags of the exports were included.

[2] The coefficient for the potentially endogenous percent binding variable using an instrumental variables technique are included immediately following those using OLS

The various regressions were tested whether the summer and winter were different. In most cases (the United States to Canada, Canada to the United States, Mexico to Canada, and the United States to Mexico), the two seasonal estimations were significantly different at the five percent level (p-stats of 0.02, 0.01, 00.0 and 0.01 respectively)[3]

Trade flows were affected by the border measure. In the summer, the United States exported fewer tomatoes to Canada when the border measure was binding although this result is only significant at the 10 percent level. (In the winter, the coefficient is also negative, although only significant at the 12 percent level). This result is consistent with the theory that the border measure was keeping the price in the United States artificially high. In both the winter and summer, Canada exported more to the United States when the border measure was binding. In the summer, other countries also exported more to the United States when the border measure was binding. Other countries did not seem to change their exports to Canada; if anything, they decreased their exports after the VER, although this was only significant at the 10 percent level. Surprisingly, the quantity of Mexican exports to the United States did not drop when the border measure was binding. However, during the winter, Mexico did substantially reduce its exports to the United States after the VER was implemented. See table 2.2 for details.

The effect of the floor price is substantial. When the floor price was binding at an average level (at about 30 percent), exports from Canada to the United States increased by 32 percent in the summer and 35 percent in the winter compared to when the floor price is

[3] Although the difference was not significant at the five percent level, the regression on the quantity of exports from Mexico to the United States gave indication that the two seasons were different with a p-stat of 0.15. One could not reject the hypothesis that exports from non-NAFTA countries did not differ significantly in the two seasons, with a p-stat of 0.87.

not binding.  Per year, that is an increase of 9,350 and 4,300 metric tonnes during the summer and winter respectively.  Since the primary winter exports from Canada to the United States are greenhouse tomatoes, some of the overall increase in greenhouse tomato exports is due to the VER between the United States and Mexico.

The United States exports 6 percent fewer tomatoes to Canada during the summer. That translates to an annual decrease of 6,000 metric tonnes.  Mexico increased its exports to Canada by 37 percent during the summer when the floor price was binding at an average level.   On average, this means a total increase in exports of 1,700 metric tonnes during the summer.

In total, after the border measure was put in place, Mexico decreased its exports by 51 percent in the winter, which translates to a total annual decrease of 167,000 metric tonnes.  Other countries also increased their exports to the United States as a result of the VER.  In the summer, other countries increased their exports by 73 percent, for a total of 11,000 metric tonnes.  The annual percent change in trade flows are illustrated in figure 2.3.

As a comparison, the IV estimates are given in table 2.3, where the percent binding variable was instrumented using (non-horticultural) domestic agricultural price indexes in Mexico.  The IV estimates are similar for the summer, and have a larger magnitude in the winter.  This result would seem to indicate that the GLS estimates, if anything, underestimate the spillover effects of the trade barrier.

**Table 2.2** Summary of Results of GLS Regression of Trade Barriers on Exports

| Exports ('000 MT) | U.S. to Canada | | | Canada to U.S. | | | Mexico to U.S. | | | Mexico to Canada | | | U.S. to Mexico | | | Other to U.S. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Coef. | Std. Err. | P>z | Coef. | Std. Err. | P>z | Coef. | Std. Err. | P>z | Coef. | Std. Err. | P>z | Coef | Std. Err. | P>z | Coef. | Std. Err. | P>z |
| **Summer** | | | | | | | | | | | | | | | | | | |
| Percent binding | *-2.25* | *1.26* | *0.08* | **5.19** | **0.86** | **0.00** | 1.67 | 6.28 | 0.79 | **0.93** | **0.46** | **0.04** | -0.16 | 1.05 | 0.88 | **6.52** | **2.85** | **0.02** |
| VER dummy | 1.20 | 4.46 | 0.79 | 4.50 | 3.04 | 0.14 | 26.46 | 22.24 | 0.23 | -0.51 | 1.63 | 0.75 | -0.21 | 3.72 | 0.95 | -1.25 | 10.09 | 0.90 |
| **Winter** | | | | | | | | | | | | | | | | | | |
| Percent binding | -2.05 | 1.32 | 0.12 | **2.37** | **1.20** | **0.05** | -14.26 | 14.05 | 0.31 | -0.52 | 0.95 | 0.59 | | | | 8.85 | 7.90 | 0.26 |
| VER dummy | 1.83 | 1.20 | 0.13 | 0.64 | 1.10 | 0.56 | **-27.97** | **12.84** | **0.03** | 0.12 | 0.86 | 0.89 | | | | *13.59* | *7.22* | *0.06* |

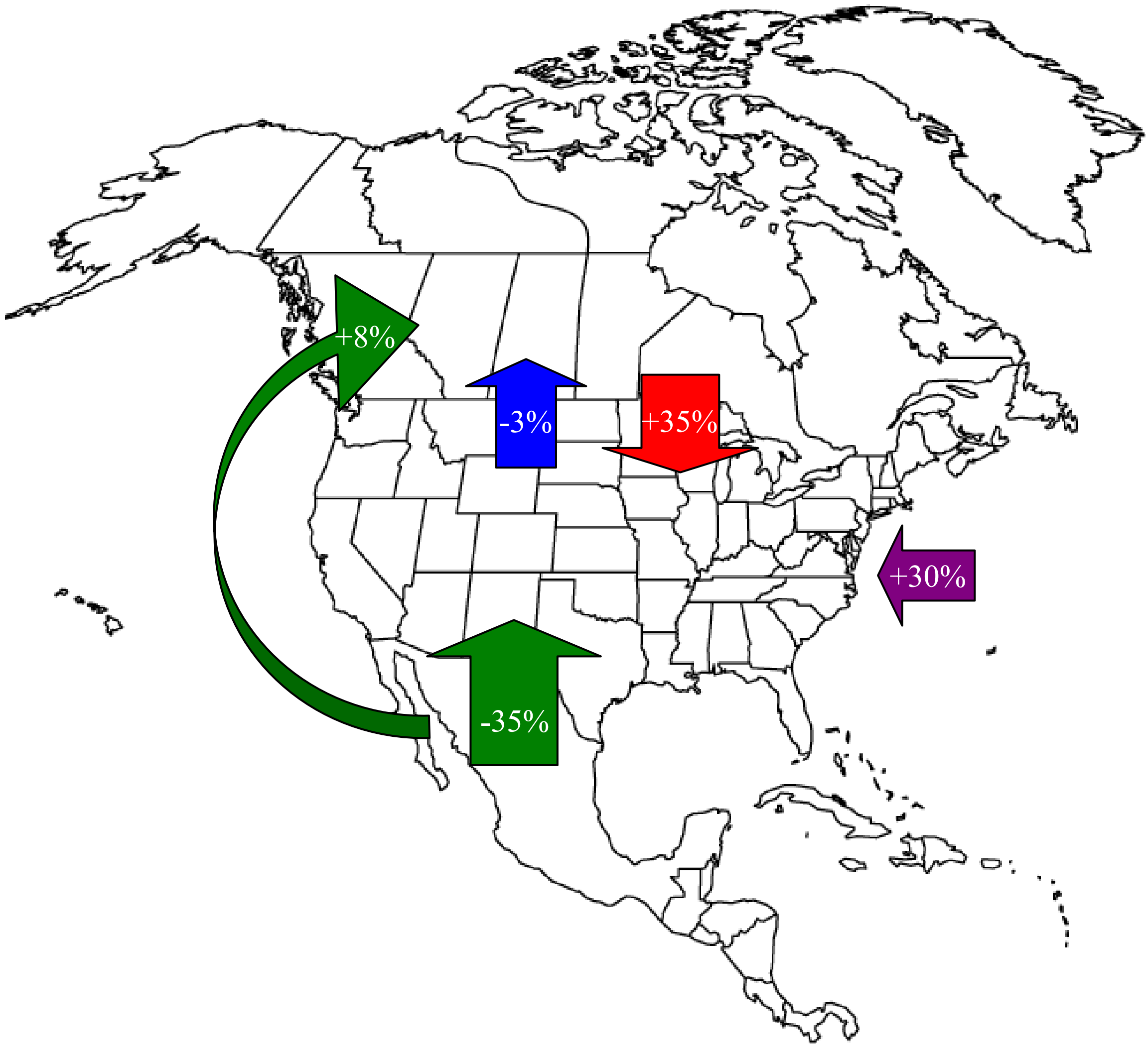
Bold coefficients are significantly different from zero at the five percent level; coefficients in italics are significant at the ten percent level.

**Table 2.3** Summary of Results of IV Regression of Trade Barriers on Exports (percent binding assumed to be endogenous)

| Exports ('000 MT) | U.S. to Canada | | | Canada to U.S. | | | Mexico to U.S. | | | Mexico to Canada | | | U.S. to Mexico | | | Other to U.S. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Coef. | Std. Err. | P>z | Coef. | Std. Err. | P>z | Coef. | Std. Err. | P>z | Coef. | Std. Err. | P>z | Coef. | Std. Err. | P>z | Coef. | Std. Err. | P>z |
| **Summer** | | | | | | | | | | | | | | | | | | |
| Percent binding | **-6.99** | **2.34** | **0.00** | **9.73** | **1.70** | **0.00** | 8.10 | 10.87 | 0.46 | *1.47* | *0.80* | *0.07* | -2.10 | 1.84 | 0.26 | -5.36 | 5.39 | 0.32 |
| VER dummy | 6.26 | 5.23 | 0.23 | -0.33 | 3.80 | 0.93 | 19.62 | 24.28 | 0.42 | -1.09 | 1.78 | 0.54 | 1.85 | 4.12 | 0.65 | 11.41 | 12.03 | 0.34 |
| **Winter** | | | | | | | | | | | | | | | | | | |
| Percent binding | -1.89 | 2.30 | 0.41 | **8.92** | **2.43** | **0.00** | -17.34 | 24.51 | 0.48 | *-2.90* | *1.71* | *0.09* | | | | -8.27 | 14.14 | 0.56 |
| VER dummy | 1.83 | 1.20 | 0.13 | 0.71 | 1.27 | 0.58 | **-28.00** | **12.85** | **0.03** | 0.10 | 0.90 | 0.91 | | | | *13.41* | *7.41* | *0.07* |

Bold coefficients are significantly different from zero at the five percent level; coefficients in italics are significant at the ten percent level.

**Figure 2.3** Percent Change in Average Annual Trade Flows of Fresh Tomatoes within North America, 1989-2001 (arrows percent reflect change)




Source: Author's calculations

As one might expect, as the United States decreased its tariff on Canadian tomatoes, exports from Canada to the United States increased. However, tariffs also seemed to have a spillover effect on three-way trade. The higher the U.S. tariff on Mexican tomatoes, all else equal, the more tomatoes exported from Mexico to Canada (this result was only significant in the winter). Less intuitively, the higher the U.S. tariff on Canadian tomatoes, the larger the quantity of exports from the United States and Canada. As well, the higher the U.S. tariff on Canadian tomatoes, the lower the exports from Mexico to the United States. These results may result because these tariffs are correlated with the missing Canadian tariff on Mexican tomatoes. All in all, the reduction in tariffs due to the North American trade agreements (both NAFTA and the Canada-U.S. trade agreement before it), increased tomato trade in North America by 50 percent

In most cases, the coefficients on supply variables had the expected signs and were statistically significantly different from zero. For example, the higher the minimum temperature in Ohio, the greater the tomato exports from the United States to Canada and the fewer exports from Mexico to the United States in the summer. As well, the average temperature in the early part of the season in Mexico generally corresponded with increased exports from Mexico to the United States and/or Mexico to Canada. Variables that were designed to capture frost and drought also had the expected signs. The more cumulative annual rain facing Florida, and the higher the minimum temperature at the early part of their growing season, the higher the quantity of exports from the United States to Canada. The U.S.-Mexico exchange rate had the expected signs. As the peso devalued, exports from the United States to Mexico decreased, and imports of Mexican tomatoes into the United States increased (although this latter coefficient was not significant at the 5 percent level). Likewise, as the Canadian dollar devalued relative to the U.S. dollar, U.S. exports to Canada decreased (although these effects were only significant in the summer). Lastly, as the Mexican economy improved, the fewer tomatoes were exported to the United States. This may imply that when the domestic economy was more robust, the local market, which tends to be a residual market for tomatoes, provided a better option for Mexican producers. For the complete regression results, see tables 2.4 and 2.5.

**Table 2.4** Results of Regression on Quantity of Tomatoes Exported in Summer

| Exports ('000 MT) | U.S. to Canada | | | Canada to U.S. | | | Mexico to U.S. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Coef | Std.Err. | P-stat | Coef | Std.Err. | P-stat | Coef | Std.Err. | P-stat |
| April | **3.36** | **1.46** | **0.02** | -1.22 | 1.00 | 0.22 | **51.35** | **7.30** | **0.00** |
| May | **4.49** | **0.94** | **0.00** | 1.05 | 0.64 | 0.10 | **20.05** | **4.68** | **0.00** |
| June | **4.01** | **0.75** | **0.00** | **1.04** | **0.51** | **0.04** | **12.64** | **3.74** | **0.00** |
| July | **4.28** | **0.46** | **0.00** | **0.86** | **0.31** | **0.01** | 2.11 | 2.31 | 0.36 |
| September | **-3.02** | **0.82** | **0.00** | 0.48 | 0.56 | 0.39 | **9.74** | **4.07** | **0.02** |
| October | -1.00 | 0.99 | 0.31 | 0.89 | 0.67 | 0.18 | **16.02** | **4.91** | **0.00** |
| Ave Temp in Sinaloa in April | **-4.84** | **1.66** | **0.00** | 0.39 | 1.13 | 0.73 | **52.68** | **8.26** | **0.00** |
| Ave Temp in Sinaloa in May | **2.67** | **0.48** | **0.00** | **0.83** | **0.32** | **0.01** | **-18.81** | **2.38** | **0.00** |
| Ave rain in Sinaloa in April | -5.31 | 2.72 | 0.05 | -1.94 | 1.85 | 0.29 | **60.14** | **13.56** | **0.00** |
| Ave rain in Sinaloa in July | 0.00 | 0.00 | 0.47 | 0.00 | 0.00 | 0.58 | 0.00 | 0.01 | 0.92 |
| Max. temp. in Imperial in May | -0.01 | 0.10 | 0.95 | **-0.13** | **0.07** | **0.05** | **1.50** | **0.49** | **0.00** |
| Max. temp. in Imperial in April | **-0.69** | **0.31** | **0.03** | **-0.61** | **0.21** | **0.00** | **6.63** | **1.53** | **0.00** |
| Canadian energy price in Mar | 0.43 | 0.25 | 0.09 | 0.32 | 0.17 | 0.06 | **-6.97** | **1.26** | **0.00** |
| Canadian ag. chemical price index in Mar | 1.52 | 1.29 | 0.24 | **2.19** | **0.88** | **0.01** | **-23.26** | **6.42** | **0.00** |
| Canadian ag. Wage in May | 2.70 | 2.40 | 0.26 | -0.54 | 1.64 | 0.74 | 13.30 | 11.98 | 0.27 |
| Montreal ave. temp. in Mar | -0.28 | 0.22 | 0.19 | -0.10 | 0.15 | 0.50 | **5.02** | **1.07** | **0.00** |
| Vancouver ave. temp. in April | 1.41 | 1.06 | 0.18 | -0.45 | 0.72 | 0.53 | 4.32 | 5.27 | 0.41 |
| Ave temp. in Stockton in July | -0.05 | 0.11 | 0.64 | -0.07 | 0.08 | 0.34 | **2.02** | **0.55** | **0.00** |
| Ave temp. in Stockton in Aug | -0.14 | 0.09 | 0.11 | 0.06 | 0.06 | 0.30 | 0.08 | 0.43 | 0.85 |
| Ave rain in Stockton in Sept | 3.61 | 8.06 | 0.65 | 10.37 | 5.49 | 0.06 | 83.55 | 40.19 | 0.04 |
| Tot. ann. rain by Jul. as % of normal in Imperial | **1.02** | **0.38** | **0.01** | 0.04 | 0.26 | 0.88 | -2.33 | 1.90 | 0.22 |
| Ag. min. wage in Sep | **-4.02** | **1.53** | **0.01** | **2.41** | **1.04** | **0.02** | **18.11** | **7.63** | **0.02** |
| Chemical price index in May | **-0.42** | **0.17** | **0.01** | **-0.30** | **0.11** | **0.01** | 0.84 | 0.82 | 0.31 |
| Fertilizer price index in Mar | **-0.83** | **0.37** | **0.02** | -0.20 | 0.25 | 0.41 | **10.43** | **1.82** | **0.00** |
| Min. temp. in Columbus, OH in May | **0.32** | **0.08** | **0.00** | 0.07 | 0.06 | 0.25 | **-2.38** | **0.42** | **0.00** |
| Ave. rain in Columbus in May | **12.26** | **3.27** | **0.00** | 4.99 | 2.22 | 0.03 | 5.90 | 16.29 | 0.72 |
| Ave. rain in Columbus in July | **-5.76** | **2.11** | **0.01** | -0.38 | 1.44 | 0.79 | **25.36** | **10.53** | **0.02** |
| Peso/US$ | -0.79 | 0.83 | 0.34 | -0.10 | 0.57 | 0.87 | 5.54 | 4.15 | 0.18 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Mexican GDP | -0.01 | 0.02 | 0.81 | -0.03 | 0.02 | 0.08 | **-0.37** | **0.12** | **0.00** |
| Mexican inflation | 0.54 | 0.45 | 0.23 | 0.00 | 0.00 | 0.99 | **0.00** | **0.00** | **0.00** |
| U.S. income per capita | 0.00 | 0.00 | 0.19 | -0.57 | 0.30 | 0.06 | **-11.90** | **2.22** | **0.00** |
| Canadian GDP | **-0.96** | **0.47** | **0.04** | -0.41 | 0.32 | 0.19 | **9.44** | **2.33** | **0.00** |
| Canadian$/US$ | **-21.23** | **8.51** | **0.01** | -4.05 | 5.80 | 0.48 | 33.97 | 42.45 | 0.42 |
| Percent binding | *-2.25* | *1.26* | *0.08* | **5.19** | **0.86** | **0.00** | 1.67 | 6.28 | 0.79 |
| Voluntary export restraint (1 after VER introduced) | 1.20 | 4.46 | 0.79 | 4.50 | 3.04 | 0.14 | 26.46 | 22.24 | 0.23 |
| Yearly time trend | -4.54 | 5.80 | 0.43 | **-10.91** | **3.95** | **0.01** | 39.29 | 28.94 | 0.18 |
| time trend squared | -0.22 | 0.33 | 0.51 | **0.70** | **0.23** | **0.00** | **6.53** | **1.65** | **0.00** |
| U.S. tariff on Mexican tomatoes | 0.42 | 0.93 | 0.66 | 0.60 | 0.63 | 0.34 | 2.92 | 4.64 | 0.53 |
| U.S. tariff on Canadian tomatoes | 0.51 | 1.42 | 0.72 | **-1.93** | **0.97** | **0.05** | **-17.27** | **7.09** | **0.02** |
| Mexican tariff on U.S. tomatoes | -0.27 | 0.82 | 0.74 | -0.51 | 0.56 | 0.36 | -6.14 | 4.08 | 0.13 |
| Lagged exports from U.S. to Canada ('000 MT) | **-0.22** | **0.10** | **0.03** | 0.00 | 0.07 | 0.98 | -0.24 | 0.52 | 0.65 |
| Lagged exports from Canada to U.S. ('000 MT) | -0.12 | 0.09 | 0.16 | **0.48** | **0.06** | **0.00** | -0.63 | 0.43 | 0.14 |
| Lagged exports from Mexico to U.S. ('000 MT) | -0.04 | 0.02 | 0.06 | 0.00 | 0.01 | 0.93 | 0.15 | 0.10 | 0.12 |
| Lagged exports from Mexico to Canada ('000 MT) | -0.10 | 0.28 | 0.72 | 0.08 | 0.19 | 0.69 | **-5.63** | **1.40** | **0.00** |
| Lagged exports from U.S. to Mexico ('000 MT) | 0.09 | 0.14 | 0.49 | -0.11 | 0.09 | 0.25 | **1.38** | **0.68** | **0.04** |
| Lagged exports from Other to U.S. ('000 MT) | -0.09 | 0.05 | 0.09 | -0.01 | 0.04 | 0.78 | **-0.51** | **0.26** | **0.046** |
| Constant | **158.44** | **53.01** | **0.00** | 28.97 | 36.09 | 0.42 | **-566.18** | **264.34** | **0.03** |
| R-squared | 0.92 | | | 0.99 | | | 0.96 | | |
| | 84 | | | | | | | | |
| | 46 | | | | | | | | |

Table 2.4 cont'd

| Exports ('000 MT) | Mexico to Canada | | | U.S. to Mexico | | | Rest of the World to U.S. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Coef | Std.Err. | P-stat | Coef | Std.Err. | P-stat | Coef | Std.Err. | P-stat |
| April | **2.95** | **0.53** | **0.00** | -1.84 | 1.22 | 0.13 | -1.20 | 3.31 | 0.72 |
| May | **0.73** | **0.34** | **0.03** | **-2.03** | **0.78** | **0.01** | -2.25 | 2.12 | 0.29 |
| June | 0.50 | 0.27 | 0.07 | **-1.77** | **0.63** | **0.01** | -1.94 | 1.70 | 0.25 |
| July | 0.14 | 0.17 | 0.41 | -0.56 | 0.39 | 0.15 | 0.49 | 1.05 | 0.64 |
| September | 0.43 | 0.30 | 0.15 | -0.85 | 0.68 | 0.21 | 0.59 | 1.85 | 0.75 |
| October | 0.70 | 0.36 | 0.05 | -1.11 | 0.82 | 0.18 | 1.90 | 2.23 | 0.39 |
| Ave Temp in Sinaloa in April | **2.91** | **0.61** | **0.00** | 1.61 | 1.38 | 0.25 | 5.29 | 3.75 | 0.16 |
| Ave Temp in Sinaloa in May | **-1.27** | **0.17** | **0.00** | -0.19 | 0.40 | 0.64 | 0.19 | 1.08 | 0.86 |
| Ave rain in Sinaloa in April | **3.84** | **0.99** | **0.00** | 1.89 | 2.27 | 0.40 | 10.05 | 6.15 | 0.10 |
| Ave rain in Sinaloa in July | 0.00 | 0.00 | 0.46 | **-0.01** | **0.00** | **0.00** | 0.01 | 0.01 | 0.36 |
| Max. temp. in Imperial in May | **0.16** | **0.04** | **0.00** | 0.08 | 0.08 | 0.34 | -0.16 | 0.22 | 0.46 |
| Max. temp. in Imperial in April | **0.31** | **0.11** | **0.01** | 0.48 | 0.26 | 0.06 | 1.03 | 0.69 | 0.14 |
| Canadian energy price in Mar | **-0.40** | **0.09** | **0.00** | -0.21 | 0.21 | 0.33 | -0.76 | 0.57 | 0.18 |
| Canadian ag. chemical price index in Mar | **-1.57** | **0.47** | **0.00** | 1.20 | 1.07 | 0.26 | -3.68 | 2.91 | 0.21 |
| Canadian ag. Wage in May | -1.26 | 0.88 | 0.15 | 1.29 | 2.00 | 0.52 | 10.47 | 5.44 | 0.05 |
| Montreal ave. temp. in Mar | 0.13 | 0.08 | 0.10 | **0.68** | **0.18** | **0.00** | -0.05 | 0.49 | 0.92 |
| Vancouver ave. temp. in April | 0.69 | 0.39 | 0.08 | **-3.10** | **0.88** | **0.00** | 0.19 | 2.39 | 0.94 |
| Ave temp. in Stockton in July | **0.09** | **0.04** | **0.03** | **-0.21** | **0.09** | **0.02** | **-0.53** | **0.25** | **0.04** |
| Ave temp. in Stockton in Aug | 0.05 | 0.03 | 0.13 | 0.03 | 0.07 | 0.69 | 0.12 | 0.19 | 0.52 |
| Ave rain in Stockton in Sept | 0.27 | 2.94 | 0.93 | **-20.73** | **6.72** | **0.00** | **-49.14** | **18.24** | **0.01** |
| Tot. ann. rain by Jul. as % of normal in Imperial | -0.17 | 0.14 | 0.21 | -0.34 | 0.32 | 0.29 | 0.64 | 0.86 | 0.46 |
| Ag. min. wage in Sep | 0.66 | 0.56 | 0.24 | **-4.71** | **1.28** | **0.00** | **-8.62** | **3.46** | **0.01** |
| Chemical price index in May | **0.29** | **0.06** | **0.00** | 0.20 | 0.14 | 0.15 | -0.06 | 0.37 | 0.87 |
| Fertilizer price index in Mar | **0.56** | **0.13** | **0.00** | -0.32 | 0.30 | 0.30 | **1.83** | **0.83** | **0.03** |
| Min. temp. in Columbus, OH in May | **-0.09** | **0.03** | **0.00** | -0.10 | 0.07 | 0.15 | -0.04 | 0.19 | 0.84 |
| Ave. rain in Columbus in May | **-4.60** | **1.19** | **0.00** | 3.34 | 2.73 | 0.22 | 2.14 | 7.39 | 0.77 |
| Ave. rain in Columbus in July | 0.48 | 0.77 | 0.54 | -1.23 | 1.76 | 0.48 | -8.49 | 4.78 | 0.08 |
| Peso/US$ | 0.58 | 0.30 | 0.06 | **-1.44** | **0.69** | **0.04** | **-5.45** | **1.88** | **0.00** |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Mexican GDP | **-0.02** | **0.01** | **0.03** | -0.01 | 0.02 | 0.72 | -0.11 | 0.06 | 0.05 |
| Mexican inflation | **0.00** | **0.00** | **0.01** | **0.00** | **0.00** | **0.03** | 0.00 | 0.00 | 0.26 |
| U.S. income per capita | **-0.69** | **0.16** | **0.00** | -0.09 | 0.37 | 0.82 | -0.95 | 1.01 | 0.35 |
| Canadian GDP | **0.84** | **0.17** | **0.00** | 0.17 | 0.39 | 0.66 | 1.63 | 1.06 | 0.12 |
| Canadian$/US$ | -2.64 | 3.11 | 0.40 | -10.89 | 7.10 | 0.13 | 10.75 | 19.26 | 0.58 |
| Percent binding | **0.93** | **0.46** | **0.04** | -0.16 | 1.05 | 0.88 | **6.52** | **2.85** | **0.02** |
| | | | | | | | | | |
| Voluntary export restraint (1 after VER introduced) | -0.51 | 1.63 | 0.75 | -0.21 | 3.72 | 0.95 | -1.25 | 10.09 | 0.90 |
| Yearly time trend | 3.06 | 2.12 | 0.15 | -2.85 | 4.84 | 0.56 | 8.05 | 13.13 | 0.54 |
| time trend squared | **0.32** | **0.12** | **0.01** | 0.10 | 0.28 | 0.71 | 0.09 | 0.75 | 0.90 |
| U.S. tariff on Mexican tomatoes | 0.13 | 0.34 | 0.70 | -0.74 | 0.78 | 0.34 | -1.73 | 2.11 | 0.41 |
| U.S. tariff on Canadian tomatoes | -0.77 | 0.52 | 0.14 | 2.34 | 1.19 | 0.05 | 4.58 | 3.22 | 0.15 |
| Mexican tariff on U.S. tomatoes | -0.34 | 0.30 | 0.25 | 0.82 | 0.68 | 0.23 | 0.86 | 1.85 | 0.64 |
| Lagged exports from U.S. to Canada ('000 MT) | -0.06 | 0.04 | 0.11 | -0.15 | 0.09 | 0.09 | 0.41 | 0.24 | 0.09 |
| Lagged exports from Canada to U.S. ('000 MT) | 0.01 | 0.03 | 0.84 | **0.18** | **0.07** | **0.01** | 0.30 | 0.19 | 0.13 |
| Lagged exports from Mexico to U.S. ('000 MT) | -0.01 | 0.01 | 0.35 | **-0.09** | **0.02** | **0.00** | 0.04 | 0.04 | 0.31 |
| Lagged exports from Mexico to Canada ('000 MT) | 0.04 | 0.10 | 0.67 | **0.93** | **0.23** | **0.00** | 0.16 | 0.64 | 0.80 |
| Lagged exports from U.S. to Mexico ('000 MT) | 0.03 | 0.05 | 0.55 | **-0.45** | **0.11** | **0.00** | **-0.65** | **0.31** | **0.04** |
| Lagged exports from Other to U.S. ('000 MT) | 0.00 | 0.02 | 0.83 | **0.17** | **0.04** | **0.00** | **0.35** | **0.12** | **0.00** |
| Constant | **-59.15** | **19.37** | **0.00** | **-118.64** | **44.22** | **0.01** | **-266.61** | **119.95** | **0.03** |
| R-squared | 0.94 | | | 0.87 | | | 0.78 | | |

**Table 2.5** Results of Regression on Quantity of Tomatoes Exported in Winter

| Exports ('000 MT) | U.S. to Canada | | | Canada to U.S. | | | Mexico to U.S. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Coef | Std.Err. | P-stat | Coef | Std.Err. | P-stat | Coef | Std.Err. | P-stat |
| November | -1.42 | 1.12 | 0.20 | 0.92 | 1.02 | 0.37 | **-32.35** | **11.92** | **0.01** |
| December | 0.17 | 1.15 | 0.88 | 0.37 | 1.05 | 0.73 | **-31.02** | **12.23** | **0.01** |
| February | 0.41 | 0.72 | 0.57 | **1.60** | **0.66** | **0.02** | 12.22 | 7.71 | 0.11 |
| March | 0.56 | 0.95 | 0.56 | **6.14** | **0.87** | **0.00** | 16.44 | 10.18 | 0.11 |
| April | **3.14** | **1.11** | **0.01** | **7.78** | **1.01** | **0.00** | -2.52 | 11.84 | 0.83 |
| May | **3.44** | **1.01** | **0.00** | **6.93** | **0.92** | **0.00** | **-24.41** | **10.75** | **0.02** |
| Ave rain in Imperial in Dec | 0.03 | 0.02 | 0.13 | **-0.04** | **0.02** | **0.05** | -0.26 | 0.22 | 0.22 |
| Ave temp in Sinaloa in Feb | 0.30 | 0.21 | 0.15 | 0.10 | 0.19 | 0.61 | **4.76** | **2.21** | **0.03** |
| Min temp in Imperial in Dec | 0.05 | 0.05 | 0.33 | -0.04 | 0.05 | 0.43 | -0.19 | 0.54 | 0.73 |
| Max temp in Imperial in April | **-0.39** | **0.08** | **0.00** | -0.05 | 0.07 | 0.49 | 0.24 | 0.82 | 0.77 |
| Max temp in Imperial in May | 0.09 | 0.07 | 0.21 | -0.08 | 0.06 | 0.22 | **1.59** | **0.73** | **0.03** |
| Canadian energy price in Feb | 0.01 | 0.03 | 0.72 | 0.04 | 0.03 | 0.12 | **-1.05** | **0.33** | **0.00** |
| Canadian chemical price in Mar | 0.25 | 0.18 | 0.18 | -0.25 | 0.17 | 0.14 | 1.09 | 1.97 | 0.58 |
| Canadian ag. Wage in Apr | **-5.05** | **2.37** | **0.03** | 0.06 | 2.16 | 0.98 | -27.83 | 25.24 | 0.27 |
| Montreal ave. temp. in Mar | **0.41** | **0.13** | **0.00** | -0.09 | 0.12 | 0.46 | -1.34 | 1.43 | 0.35 |
| Vancouver ave. temp. in April | **1.22** | **0.37** | **0.00** | -0.13 | 0.34 | 0.69 | 0.92 | 3.94 | 0.82 |
| Min. temp. in Miami in Feb | **0.17** | **0.04** | **0.00** | 0.02 | 0.04 | 0.64 | -0.52 | 0.42 | 0.21 |
| Ave. rain in Miami in April | -5.53 | 4.87 | 0.26 | **-10.47** | **4.44** | **0.02** | -73.57 | 51.95 | 0.16 |
| Wfljanp | -0.57 | 3.08 | 0.85 | 2.32 | 2.81 | 0.41 | **-120.13** | **32.88** | **0.00** |
| Chemical price index in Nov | **0.54** | **0.21** | **0.01** | **0.58** | **0.19** | **0.00** | 0.65 | 2.25 | 0.77 |
| Ag. Min. wage in Feb | -0.93 | 2.10 | 0.66 | -3.85 | 1.91 | 0.04 | 15.07 | 22.37 | 0.50 |
| Peso/US$ | **-1.97** | **0.56** | **0.00** | -0.89 | 0.51 | 0.08 | 11.01 | 5.95 | 0.06 |
| Mexican GDP | -0.02 | 0.02 | 0.17 | -0.01 | 0.01 | 0.65 | -0.02 | 0.17 | 0.92 |
| Mexican inflation | **0.52** | **0.15** | **0.00** | -0.10 | 0.14 | 0.49 | -0.30 | 1.64 | 0.85 |
| U.S. income per capita | **0.00** | **0.00** | **0.00** | 0.00 | 0.00 | 0.30 | 0.00 | 0.00 | 0.43 |
| Canadian GDP | 0.08 | 0.26 | 0.75 | -0.14 | 0.24 | 0.56 | -1.48 | 2.78 | 0.60 |
| Canadian$/US$ | 8.47 | 8.23 | 0.30 | 5.11 | 7.50 | 0.50 | -26.48 | 87.75 | 0.76 |
| percent binding | -2.05 | 1.32 | 0.12 | **2.37** | **1.20** | **0.05** | -14.26 | 14.05 | 0.31 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Voluntary export restraint (1 after VER introduced) | 1.83 | 1.20 | 0.13 | 0.64 | 1.10 | 0.56 | **-27.97** | **12.84** | **0.03** |
| Yearly time trend | 0.39 | 1.36 | 0.78 | **-3.76** | **1.24** | **0.00** | -14.91 | 14.50 | 0.30 |
| Yearly time trend squared | -0.01 | 0.07 | 0.93 | **0.30** | **0.06** | **0.00** | 0.65 | 0.70 | 0.36 |
| U.S. tariff on Mexican tomatoes | -0.05 | 0.60 | 0.94 | -0.41 | 0.55 | 0.45 | 3.62 | 6.43 | 0.57 |
| U.S. tariff on Canadian tomatoes | **3.08** | **1.03** | **0.00** | **-3.54** | **0.93** | **0.00** | -13.06 | 10.93 | 0.23 |
| Mexican tariff on U.S. tomatoes | -0.41 | 0.31 | 0.18 | -0.45 | 0.28 | 0.11 | 0.42 | 3.26 | 0.90 |
| Lagged exports from U.S. to Canada ('000 MT) | **-0.37** | **0.12** | **0.00** | -0.04 | 0.11 | 0.69 | 0.36 | 1.26 | 0.77 |
| Lagged exports from Canada to U.S. ('000 MT) | 0.15 | 0.11 | 0.17 | **1.06** | **0.10** | **0.00** | -0.84 | 1.15 | 0.47 |
| Lagged exports from Mexico to U.S. ('000 MT) | **-0.04** | **0.02** | **0.02** | **-0.03** | **0.01** | **0.04** | 0.23 | 0.17 | 0.18 |
| Lagged exports from Mexico to Canada ('000 MT) | -0.38 | 0.26 | 0.15 | -0.12 | 0.24 | 0.60 | -1.31 | 2.81 | 0.64 |
| Lagged exports from Other to U.S. ('000 MT) | **-0.11** | **0.03** | **0.00** | -0.03 | 0.03 | 0.26 | 0.15 | 0.30 | 0.62 |
| Constant | 31.35 | 22.11 | 0.16 | 29.67 | 20.15 | 0.14 | -15.56 | 235.72 | 0.95 |
| R-squared | 0.84 | | | 0.93 | | | 0.87 | | |
| Obs | 87 | | | | | | | | |
| Param | 39 | | | | | | | | |

Table 2.5 cont'd

| Exports ('000 MT) | Mexico to Canada | | | Rest of the World to U.S. | | |
|---|---|---|---|---|---|---|
| | Coef | Std.Err. | P-stat | Coef | Std.Err. | P-stat |
| November | **-2.82** | **0.80** | **0.00** | -7.36 | 6.70 | 0.27 |
| December | **-3.30** | **0.82** | **0.00** | -5.60 | 6.87 | 0.42 |
| February | **1.95** | **0.52** | **0.00** | -1.64 | 4.33 | 0.71 |
| March | 1.32 | 0.69 | 0.05 | -7.93 | 5.72 | 0.17 |
| April | -1.32 | 0.80 | 0.10 | -10.31 | 6.66 | 0.12 |
| May | **-3.03** | **0.72** | **0.00** | -10.65 | 6.05 | 0.08 |
| Ave rain in Imperial in Dec | 0.00 | 0.01 | 0.90 | -0.03 | 0.12 | 0.77 |
| Ave temp in Sinaloa in Feb | -0.09 | 0.15 | 0.56 | -1.08 | 1.24 | 0.38 |
| Min temp in Imperial in Dec | -0.03 | 0.04 | 0.46 | -0.43 | 0.30 | 0.16 |
| Max temp in Imperial in April | 0.08 | 0.06 | 0.16 | 0.40 | 0.46 | 0.38 |
| Max temp in Imperial in May | 0.08 | 0.05 | 0.12 | 0.05 | 0.41 | 0.90 |
| Canadian energy price in Feb | -0.02 | 0.02 | 0.30 | 0.26 | 0.19 | 0.16 |
| Canadian chemical price in Mar | -0.13 | 0.13 | 0.32 | 1.05 | 1.11 | 0.35 |
| Canadian ag. Wage in Apr | 1.91 | 1.70 | 0.26 | 12.15 | 14.19 | 0.39 |
| Montreal ave. temp. in Mar | -0.12 | 0.10 | 0.22 | 0.85 | 0.80 | 0.29 |
| Vancouver ave. temp. in April | -0.24 | 0.27 | 0.36 | -0.63 | 2.22 | 0.78 |
| Min. temp. in Miami in Feb | -0.03 | 0.03 | 0.35 | -0.24 | 0.24 | 0.31 |
| Ave. rain in Miami in April | -3.67 | 3.50 | 0.29 | 3.04 | 29.20 | 0.92 |
| Wfljanp | 0.79 | 2.21 | 0.72 | **39.94** | **18.49** | **0.03** |
| Chemical price index in Nov | -0.25 | 0.15 | 0.10 | 0.64 | 1.27 | 0.61 |
| Ag. Min. wage in Feb | **-3.22** | **1.51** | **0.03** | **-28.56** | **12.58** | **0.02** |
| Peso/US$ | 0.68 | 0.40 | 0.09 | -4.33 | 3.35 | 0.20 |
| Mexican GDP | -0.02 | 0.01 | 0.16 | -0.05 | 0.09 | 0.60 |
| Mexican inflation | **-0.29** | **0.11** | **0.01** | -0.24 | 0.92 | 0.79 |
| U.S. income per capita | **0.00** | **0.00** | **0.00** | 0.00 | 0.00 | 0.74 |
| Canadian GDP | 0.02 | 0.19 | 0.90 | 1.36 | 1.56 | 0.38 |
| Canadian$/US$ | -10.31 | 5.91 | 0.08 | 6.98 | 49.33 | 0.89 |
| percent binding | -0.52 | 0.95 | 0.59 | 8.85 | 7.90 | 0.26 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Voluntary export restraint (1 after VER introduced) | 0.12 | 0.86 | 0.89 | **13.59** | **7.22** | **0.06** |
| Yearly time trend | -1.77 | 0.98 | 0.07 | 0.16 | 8.15 | 0.98 |
| Yearly time trend squared | 0.04 | 0.05 | 0.40 | 0.09 | 0.39 | 0.83 |
| U.S. tariff on Mexican tomatoes | **0.88** | **0.43** | **0.04** | 3.30 | 3.62 | 0.36 |
| U.S. tariff on Canadian tomatoes | -1.20 | 0.74 | 0.10 | 1.36 | 6.14 | 0.83 |
| Mexican tariff on U.S. tomatoes | 0.18 | 0.22 | 0.41 | -2.06 | 1.83 | 0.26 |
| Lagged exports from U.S. to Canada ('000 MT) | -0.04 | 0.08 | 0.63 | 0.36 | 0.71 | 0.61 |
| Lagged exports from Canada to U.S. ('000 MT) | -0.13 | 0.08 | 0.08 | 0.70 | 0.65 | 0.28 |
| Lagged exports from Mexico to U.S. ('000 MT) | 0.00 | 0.01 | 0.79 | -0.08 | 0.10 | 0.42 |
| Lagged exports from Mexico to Canada ('000 MT) | 0.10 | 0.19 | 0.58 | 0.92 | 1.58 | 0.56 |
| Lagged exports from Other to U.S. ('000 MT) | 0.03 | 0.02 | 0.10 | 0.32 | 0.17 | 0.06 |
| Constant | -4.56 | 15.87 | 0.77 | -178.08 | 132.52 | 0.18 |
| R-squared | 0.91 | | | 0.53 | | |

There is evidence that Mexico was diverting some tomatoes into paste. The amount of paste exported by Mexico depends on the VER (see table 2.6). The quantity of paste exported from Mexico to the United States was estimated as a function of variables affecting tomato supply two months earlier. Demand variables were assumed to be in the same month as the exports. Since the exports primarily occur during the early summer (using the winter tomato crop), and other months are often zero, a tobit was used.

Paste exports increased when the border measure was binding. At the average rate of binding, that implies a 70 percent increase in paste exports, for a total annual increase of 10,100 metric tonnes. At a conversion rate of 6.5 tonnes of tomatoes for one tonne of paste, that translates into 66,000 tonnes of tomatoes that were diverted from the U.S. fresh market into the Mexican paste market when the VER was binding. This quantity makes up 39 percent of the decrease in fresh exports to the United States. Increased exports to Canada consumed a much smaller share of the diverted tomatoes, using up only one percent.

Like their fresh counterparts, tomato paste exports increased with a decrease in the tariff. Strangely, they also increased with a decrease on the tariff on fresh tomato tariffs and increased with an increase in the Mexican tariff on U.S. tomatoes. This result may be because combined, these tariffs may be picking up other effects of the NAFTA.

**Table 2.6** Tobit on Exports of Tomato Paste from Mexico to U.S. on (lagged) Trade Barriers of Fresh Tomatoes

| Quantity of paste exports from Mexico to U.S. ('000 MT) | Coef. | Std. Err. | P>t |
|---|---|---|---|
| March | 3.10 | 1.88 | 0.10 |
| **April** | **7.45** | **1.89** | **0.00** |
| **May** | **12.43** | **2.11** | **0.00** |
| **June** | **9.46** | **2.11** | **0.00** |
| **July** | **4.16** | **1.59** | **0.01** |
| August | 1.80 | 1.38 | 0.20 |
| September | 1.53 | 1.25 | 0.22 |
| October | 1.64 | 1.33 | 0.22 |
| November | -0.76 | 1.31 | 0.56 |
| December | -2.29 | 1.73 | 0.19 |
| Lagged ave rain in Sinaloa in Dec | 0.02 | 0.03 | 0.58 |
| Lagged ave temp in Sinaloa in Feb | -0.25 | 0.32 | 0.44 |
| Lagged min temp in Imperial in Dec | -0.08 | 0.06 | 0.19 |
| Max temp in Imperial in April | 0.07 | 0.11 | 0.54 |
| Max temp in Imperial in May | 0.15 | 0.15 | 0.30 |
| Lagged ave temp in Sinaloa in April | -1.23 | 0.72 | 0.09 |
| Lagged ave temp in Sinaloa in May | -1.31 | 0.61 | 0.04 |
| Lagged ave rain in Sinaloa in April | 0.14 | 0.40 | 0.74 |
| Lagged ave rain in Sinaloa in July | 0.00 | 0.00 | 0.23 |
| Lagged ave temp. in Stockton in July | 0.13 | 0.16 | 0.42 |
| Lagged ave temp. in Stockton in Aug | 0.17 | 0.13 | 0.20 |
| Lagged ave rain in Stockton in Sept | 31.40 | 14.15 | 0.03 |
| Lagged tot. ann. rain by Jul. as % of normal in Imperial | -0.15 | 0.57 | 0.79 |
| Lagged ag. min. wage in Sep | 6.56 | 4.14 | 0.12 |
| Lagged chemical price index in May | 0.28 | 0.20 | 0.16 |
| Lagged fertilizer price index in Mar | 0.11 | 0.15 | 0.48 |
| Lagged Montreal ave. temp. in Mar | 0.15 | 0.17 | 0.41 |
| **Lagged Vancouver ave. temp. in April** | **1.76** | **0.42** | **0.00** |
| **Lagged Canadian energy price in Mar** | **-0.12** | **0.05** | **0.01** |
| Lagged Canadian chemical price in Mar | -0.51 | 0.27 | 0.06 |
| Lagged Canadian ag. wage in May | -1.07 | 2.60 | 0.68 |
| Lagged min. temp. in Miami in Feb | -0.05 | 0.06 | 0.45 |
| Lagged ave. rain in Miami in April | -5.27 | 6.28 | 0.40 |
| Lagged tot. ann. rain to Jan as a % of normal in Miami | -2.44 | 4.60 | 0.60 |
| Lagged chemical price index in Nov | -0.19 | 0.32 | 0.56 |
| Lagged ag. min. wage in Feb | -1.81 | 4.41 | 0.68 |
| Lagged U.S. GDP | -0.06 | 0.03 | 0.09 |
| U.S. GDP | 0.00 | 0.00 | 0.62 |
| Lagged Peso/US$ | 0.34 | 0.73 | 0.64 |
| Peso/US$ | -0.57 | 0.87 | 0.52 |
| Lagged Mexican GDP | -0.01 | 0.02 | 0.74 |

| | | | |
|---|---|---|---|
| Lagged Mexican inflation | 0.17 | 0.29 | 0.56 |
| **Lagged percent binding** | **2.80** | **1.41** | **0.05** |
| Lagged voluntary export restraint (1 after VER introduced) | -2.39 | 5.07 | 0.64 |
| Yearly time trend | -0.64 | 2.73 | 0.81 |
| Yearly time trend squared | 0.01 | 0.10 | 0.89 |
| **Lagged Mexican agricultural producer price index** | **0.04** | **0.02** | **0.04** |
| Lagged fixed goods price index (t-1) | 0.09 | 0.08 | 0.27 |
| U.S. tariff on Mexican paste | -1.46 | 0.85 | 0.09 |
| **Lagged U.S. tariff on Mexican tomatoes** | **-1.98** | **0.73** | **0.01** |
| **Lagged U.S. tariff on Canadian tomatoes** | **1.46** | **0.58** | **0.01** |
| **Lagged Mexican tariff on U.S. tomatoes** | **3.30** | **0.94** | **0.00** |
| Lagged (t-3) Fresh Tomato Exports from U.S. to Canada | -0.15 | 0.14 | 0.29 |
| Lagged (t-3) Fresh Tomato Exports from Canada to U.S. | 0.11 | 0.10 | 0.24 |
| Lagged (t-3) Fresh Tomato Exports from Mexico to U.S. | 0.02 | 0.02 | 0.34 |
| Lagged (t-3) Fresh Tomato Exports from Mexico to Canada | -0.67 | 0.35 | 0.06 |
| Lagged (t-3) Fresh Tomato Exports from U.S. to Mexico | 0.14 | 0.19 | 0.46 |
| Lagged (t-3) Fresh Tomato Exports from Other Countries to U.S. | 0.07 | 0.05 | 0.17 |
| Lagged (t-t) Exports of paste from Mexico to U.S. | -0.07 | 0.11 | 0.54 |
| Constant | 48.28 | 70.01 | 0.49 |

All lags are two months (t-2) unless otherwise noted.

## Conclusions

Government trade policies on fresh tomatoes, including voluntary export restrictions and tariffs, have substantial spillover effects on trade with other countries and processing. These spillover effects can increase import competition faced by other industries and regions, and may incite or exacerbate other trade tensions. Often trade papers only look at the effect of trade distortions on net trade. By ignoring the two-way trade, they miss many potential spillover effects that can mitigate against the effect of the trade distortion, or distort other regional markets.

In the case of the VER on Mexican fresh tomato imports to the United States, Mexico shipped more fresh tomatoes to Canada during the summer when the floor price on exports to the United States was binding. Whenever the border measure was binding, the United States decreased its exports to Canada. Likewise, other countries increased their exports to the United States (in the summer). These results may imply that the border measure was effective in keeping prices in the United States higher than they would have been otherwise, making the U.S. market relatively attractive to U.S. growers. At the same time, it led the United States to decrease its market share abroad to the detriment of those producers who grow primarily for the export market.

Canada also increased its exports to the United States whenever the reference price was binding, in both summer and winter. Given the recent trade dispute precipitated by an increase in greenhouse tomato exports from Canada to the United States, one wonders whether the existing border measure on the U.S.'s southern border caused or at least exacerbated the tension with the U.S.'s neighbor to the north. In total the VER reduced exports from NAFTA countries to the United States by a total of 120,000 metric tonnes, and kept another 10,000 of tomatoes at home (instead of being exported to Canada).

The direct effect of the VER was to decrease imports of fresh tomatoes from Mexico to the United States by 168,000 metric tonnes annually. The spillover effects of the border measure decreased the effect of the VER by almost one-fifth – be increasing exports from other countries and decreasing exports from the United States. Thus, the net effect of the border measure was to decrease exports to the United States by 153,000 per year, approximately equal to one-tenth of U.S. total production. Therefore, it is likely that even with the spillover effects, the border measure did have an effect on returns for U.S. tomato producers. That said, the border measure also may have benefited Canadian producers by increasing the attraction of the U.S. market. This in turn may have harmed (or at least incensed) U.S. greenhouse producers who would be most affected by the Canadian imports.

One option for the tomatoes turned away at the border is for them to be converted into paste. There is evidence that two months after the reference price was binding (and presumably some tomatoes were turned away), the exports of paste from Mexico increased. The increase in paste exports was not trivial, being the equivalent of 66,000 metric tonnes of tomatoes (about one percent of U.S. domestic processed production). Since the tomatoes being diverted would have competed with Florida tomatoes, and the paste produced competes with California production, the VER effectively shifted the competition from one area of the country to the other. Unlike may other processed products, in the United States, tomato growers affected by increased competition in the processed market are not the same as those in the fresh market, thus the VER had spillover effects into what was otherwise an unrelated industry.

In general, this paper finds that a VER does not only have trade distorting effects for the countries involved, but that the spillover effects to third countries can be substantial. These spillover effects may exacerbate trade tensions and lead to further trade disputes. As well, the paper gives evidence for the long-standing hypothesis that VER's on a raw product can encourage countries to further process that product at home and then increase the competition to the protected countries processors.

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## Appendix A. Endogeneity Test

Since how binding the border measure is may be a function of the excess supply and demand variables, I first test for endogeoneity. The potentially endogenous variable is the percent of times the price of Mexican tomatoes are entering at the binding price. This variable is censored at zero, and less than half of the observations are non-zero. Thus, one can write the equations as follows:

(A1) $y_1 = x_1'\beta_1 + \varepsilon_1$

where $y_1$ is the percent of Mexican import prices at the border, $x_1$ is a matrix of exogenous variables that are not affected by the quantity of trade flows, and e is assumed to be distributed normally. Because of concerns of autocorrelation, $y_{1,t-1}$ was also included on the right-hand side.

The expectation of $y_1$ can be written as:

(A2) $E(y_1) = \Phi\left(x_1'\beta_1/\sigma_{11}\right)\left[x_1'\beta + \sigma_{11}\lambda_1\right]$

where $\lambda_1 = \dfrac{\phi\left(x_1'\beta_1/\sigma_{11}\right)}{\Phi\left(x_1'\beta_1/\sigma_{11}\right)}$

The predicted value of the tobit is then used as an instrument in the second stage. The second stage is a linear equation giving the quantity of trade between two countries as a function of various excess supply and demand variables:

(A3) $y_2 = x_2'\beta + \gamma_2 y_1 + \varepsilon_2$

where $y_2$ is the quantity exported from one country to another, $x_2$ is a matrix of variables that affect supply and demand in the region, including border measures, and $y_1$ is as above.

To ensure that the predictor of $y_2$ is consistent, I must correct for the correlation between the error terms in the two equations. However, a correction must be made for the correlation between the error terms of the two equations. The correlation can be defined as follows:

(A4) $E(\varepsilon_1 \varepsilon_2) = \rho \sigma_{11} \sigma_{22}$

where $\rho = \dfrac{\sigma_{12}}{\sigma_{11}\sigma_{22}}$

One can then write the conditional expectation of $\varepsilon_2$ given $\varepsilon_1$

(A5) $E(\varepsilon_2 | \varepsilon_1) = \rho \left( \dfrac{\sigma_{22}}{\sigma_{11}} \right) \varepsilon_1$

$$E_{\varepsilon_1 \geq -x_1'\beta_1} E(\varepsilon_2 | \varepsilon_1) = \rho \left( \frac{\sigma_{22}}{\sigma_{11}} \right) E(\varepsilon_1 | \varepsilon_1 \geq -x_1'\beta_1)$$

$$= \rho \sigma_{22} \frac{\phi\left(-x_1'\beta_1 / \sigma_{11}\right)}{\Phi\left(x_1'\beta_1 / \sigma_{11}\right)}$$

Now, calculate a consistent estimator for $y_2$

$$E(y_2 | \varepsilon_1) = \left[1 - \Phi\left(x_1'\beta_1 / \sigma_{11}\right)\right] E(y_2 | \varepsilon_1 \geq -x_1'\beta_1) + \Phi\left(x_1'\beta_1 / \sigma_{11}\right) E(y_2 | \varepsilon_1 < -x_1'\beta_1)$$

$$= \left[1 - \Phi\left(x_1'\beta_1 / \sigma_{11}\right)\right] \left[ x_2'\beta_2 + \gamma_2 \left(x_1'\beta_1 + \sigma_{11}\lambda_1\right) + \rho \sigma_{22} \frac{\phi\left(x_1'\beta_1 / \sigma_{11}\right)}{\Phi\left(x_1'\beta_1 / \sigma_{11}\right)} \right]$$

$$+ \Phi\left(x_1'\beta_1 / \sigma_{11}\right) \left[ x_2'\beta_2 + \gamma_2 \left(x_1'\beta_1 + \sigma_{11}\lambda_1\right) + \rho \sigma_{22} \frac{\phi\left(x_1'\beta_1 / \sigma_{11}\right)}{\Phi\left(x_1'\beta_1 / \sigma_{11}\right)} \right]$$

which reduces to

(A6) $$E(y_2|\varepsilon_1) = x_2'\beta_2 + \gamma_2\left(x_1'\beta_1 + \sigma_{11}\lambda_1\right) + \rho\sigma_{22}\lambda_1$$

The estimate in equation (7) is then used to perform the Hausman test for endogeneity. If we fail to reject the hypothesis of exogeneity, ordinary least squares can be used.