EVALUATION OF THE EFFECTS OF NAFTA ON U.S.-MEXICO TOMATO TRADE

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ABSTRACT
This report analyzes the effects of the phased elimination of U.S. tariffs on tomato imports from Mexico as required under the North American Free Trade Agreement (NAFTA) on U.S., Canadian, and Mexican tomato markets. The report concludes that the tariff elimination has had a minimal impact on the level and pattern of tomato production, consumption, and trade in the U.S., Mexico, and Canada.

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EXECUTIVE SUMMARY

This report presents an analysis of the effects of the phased elimination of U.S. tariffs on tomato imports from Mexico as required under the North American Free Trade Agreement (NAFTA) on U.S., Canadian, and Mexican tomato markets. When NAFTA was implemented, the existing U.S. tomato tariffs were 3.3 cents/kg for the periods of November 15 to February 28 (window 1) and July 15 to August 31 (window 3) and 4.6 cents/kg for the periods of March 14 to July 14 (window 2) and September 1 to November 14 (window 4). NAFTA required a gradual elimination of these tariffs in two phases. During the first phase, the tariffs for the second half of the year (July 15 through November 14) were to be gradually eliminated between 1994 and 1998. During the second phase, the tariffs for the rest of the year (November 15 through July 14) were to be gradually eliminated between 1998 and 2004. Consequently, by January 1, 2004, all U.S. tomato imports were to be free of any tariff or other import restrictions.

This report analyzes the effects of each phase of the U.S. tomato tariff elimination on U.S., Canadian, and Mexican tomato production, consumption, and trade through the use of a spatial and inter-temporal model of the tomato markets and trade in the three countries for the average year of 1999-2001. The study finds that the first phase of U.S. tomato import tariffs under NAFTA had little net effect on North American tomato markets. If the tariffs had not been eliminated, U.S. and Canadian tomato consumption and Mexican tomato production would have been marginally smaller while U.S. and Canadian tomato production and Mexican tomato consumption would have been marginally higher. On net, tomato consumption and production in 1999-2001 across the three countries would have been virtually the same without a tariff reduction as what actually occurred when the first phase tariff reduction was completed. This result is not surprising, however, because the tariffs during those periods of the year were already historically low and because the largest volume of U.S. imports of Mexican tomatoes occurs during the periods when the tariffs had not yet been eliminated.

Nevertheless, the study finds that the second phase elimination of U.S. tomato import tariffs that took place between 1998 and 2004 had only a marginally larger effect on tomato consumption, production, and trade in the three countries than was the case for the first phase elimination of tariffs. With tomato trade completely free of tariffs, the tomato consumption in the U.S. and Canada and the tomato production in Mexico in 1999-2001 would all have been only marginally higher than would have been the case had the tariffs not been removed. At the same time, tomato consumption in Mexico and tomato production in the U.S. and Canada all would have been only marginally smaller. The net impact of completely free trade in 1999-2001 on tomato production and consumption across the three countries would have been negligible.

The implication of these findings is that the strong growth in Mexican tomato exports to the U.S. since NAFTA was implemented must be due to factors other than the provisions of NAFTA - such as the devaluation of the Mexican peso against the U.S. dollar that occurred in late 1994 and early 1995. Other potential causes of the growth in U.S. tomato imports from Mexico include growing U.S. tomato demand, frosts and other weather problems in Florida, and an increase in productivity in Mexican tomato producing regions. Although Mexican tomato producers and U.S. and Canadian consumers appear to be the clear winners from the NAFTA tomato provisions, their gain is minimal and only slightly outweighs the loss of U.S. tomato producers and Mexican consumers.

TABLE OF CONTENTS

LIST OF TABLES

Evaluation of the Effects of NAFTA on U.S.-Mexico Tomato Trade

Between 1999 and 2001, the three member countries of the North American Free Trade Agreement (NAFTA) were nearly self-sufficient in fresh tomatoes, consuming 4.37 million metric tons (mt) of which all but 1.7% were produced within the region. The few tomatoes that were imported originated from a variety of countries, including primarily the Netherlands, Israel, Belgium, and Spain. The U.S. dominates the consumption of tomatoes accounting for 56.7% of the consumption in the 3 countries compared to 37.5% for Mexico, and only 5.8% for Canada. In contrast, Mexico dominates the production of tomatoes, accounting for 52.0% of the production in the 3 countries compared to 43.8% for the U.S., and only 4.2% for Canada.

Among the NAFTA countries, the primary flow of tomatoes is from Mexico to the United States. A secondary flow is from Canada to the United States. Traditionally, Mexico has been the main U.S. supplier during the winter season. Since the implementation of NAFTA in 1994, Mexican exports of tomatoes to the U.S. have grown 5.5% annually from 457,000 mt to 628,000 mt in 1999/2000. Nevertheless, the Mexican share of U.S. tomato imports has dropped from 95% in the early 1990s to a little over 80% in 1999/2001 while the Canadian share has increased to 12.5% over the same period.

Because imported Mexican tomatoes compete with domestically produced tomatoes in the U.S., tomatoes were afforded tariff rate quota (TRQ) safeguard protection and a transition period for gradual tariff elimination. Higher initial tariff rates were established for those seasons when U.S. tomatoes are harvested and marketed. For the period of November 15 to February 28, a tariff of 3.3 cents/kg was established initially which was then to be reduced gradually over 10 years (by January 2004) with a safeguard quota of 172,300 mt which was to grow at an annual compound rate of 3%. For the period of March 1 to July 14, an initial tariff of 4.6 cents/kg was also to be eliminated completely over 10 years with a safeguard quota of 165,500 mt set to increase at a 3% annual compound rate over the 10-year period. For the periods of July 15 to August 31 and September 1 to November 14, a 5-year tariff elimination period was agreed on with initial tariffs of 3.3 cents/kg and 4.6 cents/kg with no safeguard quota in either case (Bay, DeFrehn, and Fox).

Despite the fact that the U.S. fresh winter produce market was expanding even before the implementation of NAFTA, unfavorable U.S. production and trade trends along with short term phenomena such as frosts and the Mexican peso devaluation have encouraged growth in Mexican produce exports to U.S. markets, which could explain the demand by Florida tomato producers for continued import protection (Schmitz *et al.*).

Bredahl *et al.* wrote an exhaustive review and analysis of the so-called *Great Tomato War* between Florida and Sinaloan tomato producers, focusing on the legal, political, and economic issues for both countries. One conclusion of their study was that Florida producers have not been able to increase their economic rents by lobbying for tariff protection and quotas and suggest that a coalition with Mexican producers is not feasible.

Prior to the implementation of NAFTA, several studies concluded that the effects of NAFTA on U.S. imports of Mexican tomatoes would not be large. Burfisher, House, and Langley, for example, reviewed the results of nine studies on possible NAFTA impacts on U.S.-Mexico trade and concluded that the impact on the flow from the U.S. to Mexico would be greater than on the flow in the other direction. For tomatoes, Schwentesius and Gómez forecasted little impact on U.S. imports of Mexican tomatoes due to the low pre-NAFTA U.S. tariffs on tomatoes.

The increases in U.S.-Mexico tomato trade observed in post-NAFTA years have been attributed to many factors besides NAFTA itself. The U.S. Department of Agriculture (USDA) contends that the growth of U.S. tomato imports from Mexico since 1994 is due to a combination of factors such as the peso devaluation that occurred after 1994, an increase in U.S. demand for improved tomato varieties, and adverse weather conditions that have reduced Florida tomato production (USDA June 2002). Plunkett argues that the tariff elimination under NAFTA has played a minor role in the growth of U.S. the tomato imports. He attributes the growth to the peso devaluation that depressed U.S. prices, increased Mexican prices, and led to a contraction in the Mexican demand for tomatoes.

Based on scenario analysis using a simultaneous equations, econometric simulation model of U.S. and Mexican vegetable markets, Málaga, Williams, and Fuller conclude that the elimination of the U.S. import tariffs under NAFTA has had only moderate effects on U.S.-Mexico trade in vegetables (including tomatoes). In the case of tomatoes, they find that, over the period of tariff elimination under NAFTA, the relative growth rates of production yields, real income, and/or wage rates between the U.S. and Mexico are likely to be more important determinants of the volume of U.S. imports than the trade liberalizing effects of NAFTA.

Schwentesius and Gómez maintain that the 1994/95 peso devaluation and the continuing slide of the peso against the dollar along with a substantial technological innovation occurring in tomato production and marketing in Sinaloa (the main tomato producing and exporting region in Mexico) explain the growth in Mexican exports of fresh winter produce to the United States.

In contrast, Florida tomato producers, who are the most affected by the growth in U.S. imports of Mexican tomatoes, have claimed that the influx of Mexican tomatoes is the result of dumping and other unfair trade practices of Sinaloan producers. Over the last two decades, Florida producers have registered two antidumping complaints against the Mexican tomato producers. Several studies have demonstrated that a few Sinaloan companies have actually participated in explicit dumping activities (Salazar, 1997; González, 1997). Nevertheless, at the time of both antidumping complaints, a peso devaluation and frosts in Florida have accentuated the conflict and obfuscated the actual causes of the import surges.

García argues that Sinaloan producers have achieved some comparative advantage in tomato production over Florida producers through successful investments in new production technology and marketing techniques. The consequence, he argues, has been increased availability of Mexican tomatoes to the U.S. market at lower prices.

Given the importance of tomato production in Mexican agriculture and its role as both an employer of farm labor and as a generator of exports and foreign exchange, the main objective of this study is to evaluate the effects of NAFTA tariff elimination on U.S.-Mexico tomato trade. The main finding of this study is that the tariff reduction under NAFTA has had only minimal effects on U.S. imports of Mexican tomatoes and that the total opening of the U.S. tomato market scheduled for January 1, 2004 will have only moderate effects on that trade. In other words, this study supports the hypothesis that the growth of Mexican tomato exports to United States between 1994 and 2001 as U.S. import tariffs have been reduced as required in NAFTA is primarily the result of factors other than NAFTA.

Spatial and Temporal Characteristics of the Tomato Market

The spatial and temporal distribution of tomato consumption and production in North America and the fact that tomatoes are a perishable product that cannot be stored for long periods of time create the conditions for trade among the NAFTA countries and explain the seasonal flows of tomatoes among them. During the period of 1999 to 2001, 69.1% of U.S. tomato consumption was supplied by domestic production, 25.3% was supplied by Mexico, 3.9% by Canada, and 1.7% by other countries. Almost all (98.2%) of the tomatoes consumed in Mexico were produced domestically with the rest being supplied by the U.S. and non-NAFTA countries during periods when the Mexican domestic supply is exhausted. About half (55.5%) of Canada's tomato consumption was supplied by the U.S., 33.7% was supplied by domestic production, and the remaining 10.8% from other countries, including the 0.2% that came from Mexico.

On the supply side, nearly all U.S. tomato production (90.8%) was consumed domestically, 7.5% was exported to Canada, and 1.7% was exported to Mexico and non-NAFTA countries between 1999 and 2001. Only 28.1% of Mexican tomato production was exported to the U.S. while 71.8% was consumed in Mexico and the remaining 0.1% was exported to other countries. Exports from Mexico to Canada were minimal. About half (52.5%) of Canada's fresh tomato production was exported to the United States, 47.2% was consumed domestically, and only 0.3% was exported to other countries.

Some important aspects of the tomato trade among NAFTA countries include the following:

- The largest volume of trade in tomatoes in North America flows from Mexico to the U.S. even though Mexico imports some U.S. tomatoes during certain times of the year;
- Canada-U.S. tomato trade is complementary in that the two countries export tomatoes to each other during different seasons of the year;
- Canada and the U.S. import a small but important percentage of their domestic tomato consumption from non-NAFTA countries, including the European Union and Israel;
- The Canada-Mexico trade in tomatoes is minimal due primarily to geographic considerations; and
- North American tomato exports to the rest of the world are negligible.

The spatial and temporal characteristics of tomato consumption and production within each NAFTA country are also important to consider in analyzing North American tomato markets. Although tomatoes are produced in 20 U.S. states, nearly 75% of the average U.S. tomato production in 1999/2001 occurred in two states (Florida with 42.3% and California with 30.9%).

The other major tomato producing states include Georgia, Michigan, North Carolina, South Carolina, Arkansas, New Jersey, Virginia, Tennessee, and Ohio. Florida produces and ships tomatoes throughout the year except for the July, August, and September window which is when the majority of tomatoes from California and the other producing states hit the market.

In the case of Mexico, tomatoes are produced in 29 of the 32 states of the country. Nevertheless, production is concentrated in the states of Sinaloa (35.7%) and Baja California (15.9%). A majority of the production in these two states is exported to the United States. Other principal tomato producing states in Mexico include San Luis Potosí, Michoacán, and Jalisco. Most of the production in these states and other producing regions of Mexico is destined for local markets. Only a small portion of their production is shipped to foreign markets. Favorable climatic conditions allow Mexico to produce tomatoes throughout the year in most regions of the country. The production in Sinaloa and Baja California, the major Mexican tomato exporting states, is concentrated in the winter months just when the total U.S tomato output is at its lowest point but when the production in Florida is at its highest point.

In the case of Canada, most of the fresh tomato production is located in the eastern provinces, primarily Ontario which accounts for 65% of Canadian tomato production. British Colombia, on the western coast of Canada, produces 20% of Canadian tomatoes and is the source of tomatoes for Vancouver and much of the Western side of the county.

Methodology

This section first presents the model used for the analysis of the effects of NAFTA on U.S.-Mexico tomato trade and then reviews the data used in the model and analysis. Finally, the validation of the model for the analyses undertaken in the following section is discussed.

The Model

The spatial and temporal characteristics of tomato production and consumption in NAFTA countries suggested the use of a spatial and temporal equilibrium model to evaluate the effects of the NAFTA tariff reduction on North American tomato markets and trade. The model includes 19 tomato consuming regions - 12 in the U.S., 4 in Mexico, and 3 in Canada. Each consuming region is referred to by the name of the city used as a reference point in each region to determine the costs of transportation. In the U.S., the consuming regions include Los Angeles; Seattle; Billings; Denver; Dallas; Omaha; Minneapolis; Chicago; Atlanta; Washington, D.C.; and New York. In Mexico the consuming regions include Tijuana; Culiacán; Monterrey; and Mexico City. In Canada, the consuming regions included Montreal; Winnipeg; and Vancouver.

As defined, the consuming regions include the following states/provinces:

- Los Angeles: California
- Seattle: Oregon and Washington

- Denver: Colorado, Arizona, New Mexico, Utah, and Nevada
- Billings: Wyoming and Montana
- Dallas: Texas, Oklahoma, Louisiana, and Arkansas
- Omaha: Nebraska, Iowa, Kansas, and Missouri
- Minneapolis: Minnesota, South Dakota, and North Dakota
- Miami: Florida
- Atlanta: Georgia, Alabama, and Mississippi
- Chicago: Illinois, Wisconsin, Indiana, Ohio, and Michigan
- Washington, D.C.: The District of Columbia, Virginia, West Virginia, Tennessee, North Carolina, South Carolina, and Kentucky
- New York City: New York, New Jersey, Pennsylvania, Delaware, Maryland, Connecticut, Massachusetts, Vermont, Rhode Island, New Hampshire, and Maine.
- Tijuana: Baja California and South Baja California
- Coahuila: Sinoloa and Sonora;
- Monterrey: Chihuahua, Coahuila, Durango, Nuevo León, Tamaulipas, Zacatecas, and San Luis Potosí
- Mexico City: Central, East, South, and Southeast regions of Mexico.
- Montreal: Ontario, Newfoundland, Prince Edward Islands, Nova Scotia, New Brunswick, and Quebec
- Winnipeg: Manitoba, Saskatchewan, Alberta, and the Northwest Territories
- Vancouver: British Columbia and Nunavut.

On the production side, the model includes 17 producing regions - 10 in the U.S., 4 in Mexico, and 3 in Canada. The U.S. regions are Florida, California, Arkansas, Georgia, North Carolina, South Carolina, Tennessee, Virginia, New Jersey, and Michigan. The Mexican regions are Baja California, Sinaloa, Northern Mexico, and Central Mexico. The Canadian regions are Eastern, Central, and Western. The state-by-state (or province-by-province) makeup of the Mexican and Canadian producing regions is the same as for the consuming regions. For the U.S., the state composition of the producing regions is somewhat different than is the case for the consuming regions. The U.S. producing regions of California, Florida, South Carolina, North Carolina, Tennessee, and Virginia only include the state for which the region is named. The Arkansas producing region, however, also includes the production of Louisiana and Texas. The Georgia producing region also includes Alabama. The New Jersey producing region also includes Connecticut, Maryland, New York, and Pennsylvania. The Michigan producing region also includes Ohio and Indiana.

Based on Takayama and Judge, the objective function of the quadratic programming model maximizes Net Social Welfare (NSW) which is equal to the area below the demand curve minus the area below the supply curves minus the value of the imports from outside NAFTA minus the costs of transportation. Because tomatoes are highly perishable and cannot be stored from one month to the next, the objective function does not include storage costs. The area below the demand curve is obtained by integrating the demand functions across the consumer regions in the different time periods. The area under the supply curve is obtained by integrating the supply functions in the producing regions in different time periods. The quadratic programming model generates interregional trade flows and prices that result from maximizing the NSW.

Because a small portion of the tomato consumption in the U.S., Canada, and Mexico is supplied by imports from other countries, Los Angeles; Seattle; Chicago; New York; Washington, D.C.; Savannah; Miami; Montreal; Vancouver; and Veracruz are considered to be the entry points for imports from those countries. The model includes information on regional availability and demands. Availability is defined as the production from the various regions within the three countries. Any deficit in the three countries is allowed to be supplied by imports from other countries. Demand is defined as the consumption of the three countries.

Excess supplies in U.S. tomato producing regions are linked to the consuming regions in all three NAFTA countries. Excess tomato supplies in Mexican producing regions are linked to consuming regions in Mexico and the U.S. but not in Canada because of the lack of trade between Mexico and Canada. For the same reason, excess tomato supplies in Canadian producing regions are linked to consuming regions in only Canada and the U.S. The tomato supplies from other countries shipped through the entry points of each country are linked to the consumption regions of those countries through the cost of transportation by truck, which is the primary means of transporting tomatoes in all three countries.

Assuming that $j(j=1,2\ldots12=J)$ represents U.S. consumption regions; $d(d=1,2\ldots4=D)$ Mexican consumption regions; $h(h=1,2\ldots3=H)$ Canadian consuming regions; $i(i=1,2\ldots10=I)$ U.S. producing regions; $s(s=1,2\ldots4=S)$ Mexican producing regions; $f(f=1,2\ldots3=F)$ Canadian producing regions; $m(m= 1,2\ldots7=M)$ U.S. ports of entry for imports from the rest of the world; $n(n=1=N)$ Mexican ports of entry for imports from the rest of the world; $r(r=1,2=R)$ Canadian entry ports for imports from the rest of the world; and $t(t=1,2\ldots T=12)$ time periods, then the objective function can be represented as follows:

$$
\begin{aligned}
(1)\quad Max\ NSW = & \sum_{t=1}^{T}\sum_{j=1}^{J}\left[\lambda_{jt}\,y_{jt}+\frac{1}{2}\omega_{jt}\,y_{jt}^{2}\right]+\sum_{t=1}^{T}\sum_{d=1}^{D}\left[\lambda_{dt}\,y_{dt}+\frac{1}{2}\omega_{dt}\,y_{dt}^{2}\right] \\
& +\sum_{t=1}^{T}\sum_{h=1}^{H}\left[\lambda_{ht}\,y_{ht}+\frac{1}{2}\omega_{ht}\,y_{ht}^{2}\right]-\sum_{t=1}^{T}\sum_{i=1}^{I}\left[\nu_{it}\,x_{it}+\frac{1}{2}\eta_{it}\,x_{it}^{2}\right] \\
& -\sum_{t=1}^{T}\sum_{s=1}^{S}\left[\nu_{st}\,x_{st}+\frac{1}{2}\eta_{st}\,x_{st}^{2}\right]-\sum_{t=1}^{T}\sum_{f=1}^{F}\left[\nu_{ft}\,x_{ft}+\frac{1}{2}\eta_{ft}\,x_{ft}^{2}\right] \\
& -\sum_{t=1}^{T}\sum_{m=1}^{M}\left[p_{mt}\,x_{mt}\right]-\sum_{t=1}^{T}\sum_{n=1}^{N}\left[p_{nt}\,x_{nt}\right]-\sum_{t=1}^{T}\sum_{r=1}^{R}\left[p_{rt}\,x_{rt}\right] \\
& -\sum_{t=1}^{T}\sum_{i=1}^{I}\sum_{j=1}^{J+1}\left[p_{ijt}\,x_{ijt}\right]-\sum_{t=1}^{T}\sum_{i=1}^{I}\sum_{d=1}^{D}\left[p_{idt}\,x_{idt}\right]-\sum_{t=1}^{T}\sum_{i=1}^{I}\sum_{h=1}^{H}\left[p_{iht}\,x_{iht}\right] \\
& -\sum_{t=1}^{T}\sum_{s=1}^{S}\sum_{j=1}^{J}\left[\left(p_{sjt}+a_{sjt}\right)x_{sjt}\right]-\sum_{t=1}^{T}\sum_{s=1}^{S}\sum_{d=1}^{D+1}\left[p_{sdt}\,x_{sdt}\right] \\
& -\sum_{t=1}^{T}\sum_{f=1}^{F}\sum_{j=1}^{J}\left[p_{fjt}\,x_{fjt}\right]-\sum_{t=1}^{T}\sum_{f=1}^{F}\sum_{h=1}^{H+1}\left[p_{fht}\,x_{fht}\right] \\
& -\sum_{t=1}^{T}\sum_{m=1}^{M}\sum_{j=1}^{J}\left[p_{mjt}\,x_{mjt}\right]-\sum_{t=1}^{T}\sum_{n=1}^{N}\sum_{d=1}^{D}\left[p_{ndt}\,x_{ndt}\right]-\sum_{t=1}^{T}\sum_{r=1}^{R}\sum_{h=1}^{H}\left[p_{rht}\,x_{rht}\right]
\end{aligned}
$$

where:
λ_{jt} = Demand function intercept in region *j* during month *t*;
y_{jt} = Volume of tomatoes consumed in region *j* during month *t*;
ω_{jt} = Slope of the tomato demand function in region *j* during month *t*;
λ_{dt} = Demand function intercept in region *d* during month *t*;
y_{dt} = Volume of tomatoes consumed in region *d* during month *t*;
ω_{dt} = Slope of the tomato demand function in region *d* during month *t*;
λ_{ht} = Demand function interception in region *h* during month *t*;
y_{ht} = Volume of tomatoes consumed in region *h* during month *t*;
ω_{ht} = Slope of the tomato demand function in region *h* during month *t*;
ν_{it} = Supply function interception in region *i* during month *t*;
x_{it} = Volume of tomatoes produced in region *i* during month *t*;
η_{it} = Slope of the tomato supply function in region *i* during month *t*;
ν_{st} = Supply function interception in region *s* during month *t*;
x_{st} = Volume of tomatoes produced in region *s* during month *t*;
η_{st} = Slope of the tomato supply function in region *s* during month *t*;
ν_{ft} = Intercept of the supply function in region *f* during month *t*;
x_{ft} = Volume of tomatoes produced in region *f* during month *t*;
η_{ft} = Slope of the tomato supply function in region *f* during month *t*;
p_{mt} = Tomato import price at port *m* during month *t*;
x_{mt} = Tomato import from the rest of the world through port *m* during month *t*;
p_{nt} = Tomato import price at port *n* during month *t*;
x_{nt} = Tomato imports from the rest of the world through port *n* during month *t*;
p_{rt} = Tomato import price at port *r* during month *t*;
x_{rt} = Tomato imports from the rest of the world through port *r* during month *t*;
p_{ijt} = Cost of tomato transportation from region *i* to region *j* by truck during month *t*;
x_{ijt} = Volume of tomatoes shipped from region *i* to region *j* by truck during month *t*;
p_{idt} = Cost of tomato transportation from region *i* to region *d* by truck during month *t*;
x_{idt} = Volume of tomatoes shipped from region *i* to region *d* by truck during month *t*;
p_{iht} = Cost of tomato transportation from region *i* to region *h* by truck during month *t*;
x_{iht} = Volume of tomatoes shipped from region *i* to region *h* by truck during month *t*;
p_{sjt} = Cost of tomato transportation from region *s* to region *j* by truck during month *t*;
a_{sjt} = Import tariff on tomatoes shipped from region *s* to region *j* during month *t*;
x_{sjt} = Volume of tomatoes shipped from region *s* to region *j* by truck during month *t*;
p_{sdt} = Cost of tomato transportation from region *s* to region *d* by truck during month *t*;
x_{sdt} = Volume of tomatoes shipped from region *s* to region *d* during month *t;*
p_{fjt} = Cost of tomato transportation from region *f* to region *j* by truck during month *t*;
x_{fjt} = Volume of tomatoes shipped from region *f* to region *j* by truck during month *t*;
p_{fht} = Cost of tomato transportation from region *f* to region *h* by truck during month *t*;
x_{fht} = Volume of tomatoes shipped from region *f* to region *h* during month *t;*
p_{mjt} = Cost of tomato transportation from port *m* to region *j* during month *t*;
x_{mjt} = Volume of tomatoes shipped from port *m* to region *j* during month *t;*
p_{ndt} = Cost of tomato transportation from port *n* to region *d* during month *t*;
n_{ndt} = Volume of tomatoes shipped from port *n* to region *d* during month *t;*
p_{rht} = Cost of tomato transportation from port *r* to region *h* during month *t*;
x_{rht} = Volume of tomatoes shipped from port *r* to region *h* during month *t;*

The objective function is subject to the following set of restrictions:

(2) $x_{it} \geq \sum_{j=1}^{J+1}[x_{ijt}] + \sum_{d=1}^{D}[x_{idt}] + \sum_{h=1}^{H}[x_{iht}]$

(3) $x_{st} \geq \sum_{j=1}^{J}[x_{sjt}] + \sum_{d=1}^{D+1}[x_{sdt}]$

(4) $x_{ft} \geq \sum_{j=1}^{J}[x_{fjt}] + \sum_{h=1}^{H+1}[x_{fht}]$

(5) $x_{mt} \geq \sum_{j=1}^{J}[x_{mjt}]$

(6) $x_{nt} \geq \sum_{d=1}^{D}[x_{ndt}]$

(7) $x_{rt} \geq \sum_{h=1}^{H}[x_{hdt}]$

(8) $\sum_{i=1}^{I}[x_{ijt}] + \sum_{s=1}^{S}[x_{sjt}] + \sum_{f=1}^{F}[x_{fjt}] \geq y_{jt}$

(9) $\sum_{i=1}^{I}[x_{idt}] + \sum_{s=1}^{S}[x_{sdt}] \geq y_{dt}$

(10) $\sum_{i=1}^{I}[x_{iht}] + \sum_{f=1}^{F}[x_{fht}] \geq y_{ht}$

(11) $x_m = \sum_{t=1}^{T} x_{mt}$

(12) $x_n = \sum_{t=1}^{T} x_{nt}$

(13) $x_r = \sum_{t=1}^{T} x_{rt}$

(14) $y_{jt}, y_{dt}, y_{ht}, x_{it}, x_{st}, x_{ft}, x_{mt}, x_{nt}, x_{rt}, x_{ijt}, x_{idt}, x_{iht}, x_{sjt}, x_{sdt}, x_{fjt}, x_{fht}, x_{mjt}, x_{ndt}, x_{rht} \geq 0$

Following Takayama and Judge, the objective function (equation (1)), maximizes the NSW for the North American tomato sector by subtracting the areas below the supply curves and the costs of transportation from producing regions and from ports of entry to consuming regions from the areas below the demand curves. Transportation costs are subtracted from the areas under the demand curves because domestically produced and imported tomatoes are shipped at a cost to the consuming regions for human consumption in each country.

The objective function is subject to various restrictions (equations (2) to (14)). The first restriction (equation 2) states that tomato production in a given U.S. producing region *i* during month *t* should be higher or equal to the total volume shipped by truck from that region to the demand regions *j, d*, and *h*. Note that only *J=12* consumer regions for the U.S. are include in the model. Region *J+1* corresponds to the consuming region in the rest of the world which is the recipient of exports from U.S. producing regions *i*. Equations (3) and (4) for Mexico and Canada, respectively, are similar to (2) for the United States. Again, regions *D+1* and *H+1* correspond to consuming regions in the rest of the world (ROW) which receive some exports from producing regions *s* and *f*, respectively. The three ROW regions are included to account for the small volume that each of the three NAFTA countries export to non-member countries.

The model restriction given as equation (5) requires that tomato imports from non-NAFTA countries (the Rest of the World) to the U.S. through a given port of entry *(m)* during month *t* must be greater than or equal to sum of the shipments from that port of entry to all consuming regions *j*. Equations (6) and (7) are similar restrictions for imports from non-NAFTA countries to Mexico and Canada, respectively.

Equation (8) requires that for a given U.S. consuming region *j* during month *t*, the amount of tomatoes consumed (y_{jt}) must be less than or equal to the volume of tomatoes received by that region from producing regions *i, s* and *f* through ports *m.* This restriction indicates that the monthly tomato consumption of U.S. region *j* must be supplied by tomatoes from the producing regions in the three NAFTA countries and from imports from non-NAFTA countries. Equations (9) and (10) are similar restrictions for tomato consumption in Mexico and Canada, respectively.

Because only a small portion of the tomato consumption by the three NAFTA countries is supplied by imports from non-NAFTA countries, imports from those countries enter the model exogenously as indicated in equations (11), (12), and (13). Equation (11) requires that the annual total of tomato imports from non-NAFTA countries through port *m* (x_m) must equal the sum of the monthly tomato imports from those countries through that port. Equations (12) and (13) are similar restrictions for ports *n* and *r*. Equation (14) is the non-negativity condition for all volumes produced, consumed, and shipped.

To evaluate the effects of the NAFTA-required elimination of tomato tariffs on the flow of tomatoes between Mexico and the U.S., the quadratic programming model presented above is first validated. The NAFTA tariff levels for the average year of 1999-2001 during the November 15 to February 28 window (window 1) and the March 14 to July 14 window (window 2) are assumed to be in force in the base model. The tariffs in place in those years during the July 15 to August 31 window (window 3) and the March 14 to July 14 window (window 4) are set to zero because they were eliminated in 1998. Importantly, the model does not include the effects of the safeguard quotas established under NAFTA because during most of the years of analysis, tomato exports from Mexico to the U.S. largely surpassed the safeguard quota levels.

Data

A large amount of information was required to support the quadratic programming model. To obtain a solution from the base model, the data required to estimate tomato supply and demand functions for all three countries and all producing and consuming regions were collected along with data for the monthly international prices at ports of entry for imports originating outside the three NAFTA countries, trucking transportation costs from all producer regions and all ports of entry to all consuming regions.

Considerable efforts were made to develop the model and calculate the required parameters. For example, for each of the 19 consuming regions and the 17 producing regions in the model, the parameters for 12 inverse supply and demand functions had to be calculated using supply and demand price elasticity estimates, producer and consumer prices, and the quantities supplied and demanded (Alston, *et al.*, 1995; Kawaguchi *et al.*, 1997).

The price elasticities of demand obtained from Málaga (1997) who analyzed the effects of NAFTA on U.S.-Mexico fresh vegetable trade were -0.55 and -0.27 for the U.S. and Mexico, respectively, during the winter season months and -0.24 and -0.31 for the two countries during the summer season months. Given the high level of economic integration between the U.S. and Canada, Canadian price elasticities of demand were assumed equal to those of the U.S. Price elasticities of supply were also obtained from Málaga (1997) for both the U.S. (0.07 in the winter and 0.21 in the summer) and Mexico (0.19 throughout the year).

Data for all prices, quantities, and other exogenous and endogenous variables were collected for the 1999, 2000, and 2001 calendar years and then averaged to create a 1999/2001 "average year." To determine the annual U.S. production of tomatoes by region and month, the data for the annual tomato production by state were first obtained from USDA (1999 through 2001). Then, the monthly shipments of fresh produce reported by USDA (2000 and 2001) were used to calculate seasonal weights for the production in each state. The annual state-by-state production and the seasonal weights were then used to calculate seasonal production in each U.S. tomato producing region.

In the case of Mexico, state tomato production by season is available from the Mexican Ministry of Agriculture, Livestock, Social Development, Food, and Fisheries (SAGARPA). Because SAGARPA only reports total tomato production for both fresh consumption and processing, all production in Mexico was assumed to be for fresh consumption. Plunkett (1996) and USDA (1998) report that up to 300,000 mt of annual Mexican tomato production is destined for processing. However, reliable data on production of tomatoes for processing by state in Mexico are not available. Data on the annual distribution of consumption, which was assumed to be constant throughout the year, and the seasonal distribution of tomato shipments from Mexico to the U.S. were used to calculated the seasonal weights. In this way, the seasonal weights and the state-by-state seasonal production were used to calculate monthly tomato production in Mexico. Data on monthly tomato shipments from Mexico to the U.S. by port of entry were obtained from the U.S. International Trade Commission (USITC).

Monthly regional tomato production in Canada was calculated by subtracting the volume of tomatoes produced for processing from total Canadian tomato production. As in the case of Mexico, seasonal weights were calculated by using the data for Canadian tomato consumption and the volume of tomato shipments from Canada to the United States. The necessary data were obtained from Agriculture and Agri-Food Canada (2002) and the U.N. Food and Agriculture Organization (FAO). The data on monthly tomato shipments from Canada to the U.S. by port of entry were obtained from the U.S. International Trade Commission (USITC).

The process for calculating the monthly regional tomato consumption was similar for all three countries. First, the apparent national annual consumption was calculated by adding imports to national production and then subtracting national annual exports. For each country, the national annual per capita consumption was calculated by dividing the calculated apparent consumption level by the total population of the corresponding country. Regional consumption was calculated by multiplying the per capita consumption for each country by the population of the corresponding regions and assuming that consumption is constant in each region throughout the 12 months of the year. The data to calculate the monthly regional consumption were obtained from the USITC, the Mexican Ministry of Economics (Secretaría de Economía), the U.S. Department of Commerce, the Mexican National Institute of Statistics, Geography and Information of Mexico (INEGI), and Statistics Canada.

Tomato production unit values (the value of tomato production divided by the volume) were taken as the U.S. tomato producer prices and were calculated from data reported by USDA (1999 through 2001). In the case of Mexico, the producer price was calculated as the U.S. import unit values (the CIF import value divided by the volume of imports) for tomatoes imported from Mexico minus transportation and other marketing costs from U.S. ports of entry (Nogales, Arizona; San Diego, California; and Laredo, Texas) to Mexican tomato producing regions. This same process was used to calculate Canadian tomato producer prices. The data required for these calculations came from the USITC.

For all three countries, the wholesale tomato prices at arrival points in the principal cities were used as the prices faced by consumers. The required price data were obtained from USDA (2002a) in which the wholesale prices of the principal cities in the world, including those in the three NAFTA countries, are reported. A considerable effort was necessary to calculate monthly prices for each city because price data for tomatoes of different sizes and qualities over many days of each month are reported by USDA. The CIF import unit values were taken as the prices of imports from non-NAFTA countries at the principal ports of entry as reported by the USITC.

Transportation costs from producing regions and from ports of entry to the various consuming regions were calculated using a cost function similar to that used by Cramer, Wailes, and Shui in which transportation costs (*ct*) are the dependent variable and distance (*km*) between different routes is the independent variable. The function includes a binary variable (*d*) with a value of 1 for routes less than 1,000 km and 0 for routes of more than 1,000 km. The data used in the calculation includes costs of transportation (in $US) and distances (in kilometers) from Florida, California, and Nogales to the cities of Atlanta, Chicago, Dallas, Denver, New York, Montreal, and Seattle. The application of OLS estimator to this model yielded the following results:

$$ct = \underset{(8.7)}{15.57} + \underset{(73.9)}{0.046} \cdot km - \underset{(-1.8)}{3.44} \cdot d \qquad (15)$$

$$R^2 = 0.91$$

where the numbers in parentheses are the student's t values. The transportation cost and distance data were obtained from USDA (2002b).

Model Validation

Because it is used to evaluate the effects of NAFTA on U.S.-Mexico tomato trade, the model was first validated for tomato consumption, production, and trade by port of entry. The solution of the base model, as well as the different scenarios using the model, were generated using the MINOS procedure written in GAMS (General Algebraic Modeling System) programming language.

Table 1 shows the base model results compared to actual data observations for the average year of 1999-2001. With few exceptions, the base model solutions are quite close to the actual levels observed for the corresponding variables in the analysis year. On the consumption side, with the exception of the Seattle region, the relative differences between the actual data and the base solutions were less than 10%. Although the model overestimates the Seattle region consumption, the effect on total consumption is minimal. On the production side, the base solution values for only South Carolina, New Jersey, and Michigan deviated by more than 10% from the actual data. Again, however, these deviations have a minimal effect on the base solutions for total U.S. and North American tomato production (Table 1).

Scenario Analysis

NAFTA called for the gradual, phased elimination of the year-round U.S. tariffs on tomato imports from Mexico. When NAFTA was implemented, the existing tariffs were 3.3 cents/kg for the periods of November 15 to February 28 (window 1) and July 15 to August 31 (window 3) and 4.6 cents/kg for the periods of March 14 to July 14 (window 2) and September 1 to November 14 (window 4). NAFTA required a gradual elimination of these tariffs in two phases. During the first phase , the tariffs for the second half of the year (July 15 through November 14) were to be gradually eliminated between 1994 and 1998. During the second phase, the tariffs for the rest of the year (November 15 through July 14) were to be gradually eliminated between 1998 and 2004. Consequently, by January 1, 2004, all U.S. tomato imports were to be free of any tariff or other import restrictions.

This section presents the results of using the model presented above and validated for the average year of 1999-2001 to conduct two sets of scenario analyses: (1) the first phase elimination of U.S. tomato import tariffs completed in 1998 and (2) the second phase elimination of the remaining U.S. tomato import tariffs completed in 2004.

Effects of the First Phase Elimination of U.S. Tomato Import Tariffs

Given that the model was validated for years 1999-2001, for this analysis the tariffs that were eliminated in the first phase (windows 3 and 4) were set back to their 1994 levels and a new

Table 1: Tomato Model Validation

Region	Actual 1999-2001	Base Model Solution	Difference	Percent Difference	Region	Actual 1999-2001	Base Model Solution	Difference	Percent Difference
	------------ 1,000 mt		--------------	%		------------ 1,000 mt		--------------	%
Consumption					*Production*				
Los Angeles	304	278	-26	-8.5	California	582	574	-9	-1.5
Seattle	93	102	9	10.0	Florida	798	836	38	4.7
Detroit	136	133	-4	-2.8	Arkansas	24	24	0	1.8
Billings	24	26	2	9.7	Georgia	69	75	6	8.7
Dallas	277	270	-7	-2.6	N. Carolina	38	35	-3	-7.3
Omaha	114	109	-5	-4.4	S. Carolina	47	53	6	12.3
Minneapolis	56	57	1	2.2	Tennessee	42	39	-2	-5.7
Miami	141	143	2	1.5	Virginia	71	68	-4	-5.2
Atlanta	136	137	1	0.7	New Jersey	107	96	-11	-10.2
Chicago	398	407	10	2.5	Michigan	107	96	-11	-10.3
Washington	275	293	18	6.7	Baja Calif.	403	391	-12	-3.1
New York	525	557	32	6.0	Sinaloa	946	948	2	0.2
Tijuana	95	103	8	8.5	North Mexico	277	291	14	5.1
Culiacán	49	47	-2	-3.6	Central Mex.	612	655	44	7.1
Monterrey	286	277	-9	-3.3	East Canada	144	140	-4	-2.6
Mexico City	1,206	1,229	23	1.9	Cent. Canada	2	2	0	-2.5
Montreal	178	173	-5	-2.8	West Canada	35	34	-2	-4.4
Winnepeg	43	45	1	2.9					
Vancouver	34	37	3	8.1					
Country Consumption Totals					*Country Production Totals*				
U.S.	2,478	2,511	34	1.4	U.S.	1,886	1,896	11	0.6
Mexico	1,636	1,656	20	1.2	Mexico	2,238	2,286	47	2.1
Canada	255	254	-1	-0.4	Canada	182	177	-5	-3.0
Total	4,369	4,421	52	1.2	Total	4,306	4,359	53	1.2
Trade from Mexico to the United States									
San Diego	188	196	8	4.5					
Nogales & Laredo	440	469	29	6.5					
Total	628	665	37	5.9					

solution with the model was generated. The new solutions for quantities supplied and demanded are given in Table 2 along with the changes from the base solution values. Thus, the new model solutions indicate the levels of supply and demand in the respective producing and consuming regions that would have existed if the tariffs had not been eliminated. The changes from the base model solutions, then, represent how much more or less supply and demand would have been in the average year of 1999-2001 if NAFTA had not been implemented.

The scenario analysis results indicate that the phase 1 elimination of the U.S. tomato tariffs under NAFTA had little net effect on the levels of production and consumption in the North American market (Table 2). If the tariffs had not been eliminated, U.S. and Canadian tomato consumption and Mexican tomato production would have been marginally smaller while U.S. and Canadian tomato production and Mexican tomato consumption would have been marginally higher. On net then, tomato consumption and production in 1999-2001 across the three countries would have been virtually the same without a tariff reduction as what actually occurred when the phase 1 tariff reduction was completed.

The small changes in tomato production and consumption in the three NAFTA countries also resulted in some small changes in the flows of tomatoes among them. If the phase 1 tariff elimination had not been implemented, the scenario results indicate that U.S. tomato imports in 1999-2001 would have been only about 1% less than what actually occurred in that period.

The finding that the phase 1 elimination of tomato tariffs had little impact on tomato production, consumption, and trade across the three countries is not surprising. In the first place, the tariffs during those periods during the year when the tariffs were eliminated in the first phase of tariff reductions (windows 3 and 4) were already historically low. Secondly, the largest volume of U.S. imports of Mexican tomatoes occurs during windows 1 and 2 rather than during windows 3 and 4 for which the tariffs were eliminated. Finally, the price inelasticity that characterizes tomato demand and supply in both the U.S. and Mexico tends to minimize the response of supply and demand, and thus trade, to tariff changes.

Effects of the Second Phase Elimination of U.S. Tomato Import Tariffs

The second phase of the reduction of U.S. tomato tariffs under NAFTA occurred over the period of 1998 through 2003 so that U.S. imports of tomatoes would be completely free of tariffs on January 1, 2004. As indicated earlier, during the second phase, the tariffs for the period of November 15 through July 14 (windows 1 and 2) were gradually eliminated. Table 3 presents the results of assuming that the tariffs that still existed in 1999-2001 after completion of the first phase of tariff reductions were then subsequently eliminated. Thus, the scenario results in Table 3 indicate the levels of tomato production, consumption, and trade in the three NAFTA countries that would have occurred in 1999-2001 if the tariffs still in place for windows 1 and 2 (and due to be eliminated by 2004) had been eliminated during those years. In other words, the results indicate what tomato production, consumption, and trade would have been in 1999-2001 in the three countries under the conditions of completely free trade.

Table 2: Effects of NAFTA First Phase U.S. Tomato Tariff Elimination in 1999-2001

Region	Base Model Solution	Phase 1 Effect	Change	Percent Change	Region	Base Model Solution	Phase 1 Effect	Change	Percent Change
	------------ 1,000 mt	--------------		%		------------ 1,000 mt	--------------		%
Consumption					Production				
Los Angeles	277.9	277.3	-0.6	-0.2	California	573.8	574.8	1.0	0.2
Seattle	102.0	101.9	-0.1	-0.1	Florida	836.3	836.3	0.0	0.0
Detroit	132.5	132.3	-0.2	-0.1	Arkansas	24.0	24.0	0.0	0.0
Billings	26.0	25.9	0.0	-0.1	Georgia	75.3	75.3	0.0	0.0
Dallas	269.5	269.1	-0.4	-0.1	N. Carolina	35.2	35.2	0.0	0.0
Omaha	108.8	108.6	-0.2	-0.1	S. Carolina	53.3	53.3	0.1	0.1
Minneapolis	56.8	56.7	-0.1	-0.1	Tennessee	39.2	39.2	0.0	0.0
Miami	142.8	142.6	-0.2	-0.1	Virginia	67.6	67.6	0.0	0.0
Atlanta	137.3	137.1	-0.2	-0.1	New Jersey	96.1	96.1	0.0	0.0
Chicago	407.4	406.9	-0.5	-0.1	Michigan	95.7	95.7	0.0	0.0
Washington	293.5	293.2	-0.3	-0.1	Baja Calif.	390.8	390.4	-0.4	-0.1
New York	556.9	556.4	-0.5	-0.1	Sinaloa	948.2	947.4	-0.8	-0.1
Tijuana	103.3	103.4	0.1	0.1	North Mexico	291.3	291.1	-0.3	-0.1
Culiacán	47.1	47.2	0.1	0.2	Central Mex.	655.3	654.7	-0.6	-0.1
Monterrey	276.7	277.2	0.5	0.2	East Canada	140.4	140.5	0.1	0.1
Mexico City	1,228.7	1,230.6	1.9	0.2	Cent. Canada	2.2	2.2	0.0	0.0
Montreal	172.8	172.7	-0.2	-0.1	West Canada	33.9	33.9	0.0	0.1
Winnepeg	44.7	44.7	0.0	-0.1					
Vancouver	36.7	36.6	-0.0	-0.1					
Country Consumption Totals					Country Production Totals				
U.S.	2,511.3	2,508.1	-3.2	-0.1	U.S.	1,896.4	1,897.5	1.1	0.1
Mexico	1,655.7	1,658.3	2.7	0.2	Mexico	2,285.6	2,283.5	-0.2	-0.1
Canada	254.2	254.0	-0.2	-0.1	Canada	176.5	176.6	0.1	0.1
Total	4,421.2	4,420.4	-0.8	0.0	Total	4,385.5	4,357.7	-0.8	0.0
Trade from Mexico to the United States									
San Diego	196.4	193.7	-2.7	-1.4					
Nogales & Laredo	468.9	466.8	-2.0	-0.4					
Total	665.2	660.5	-4.7	-0.7					

Table 3: Effects of NAFTA Second Phase U.S. Tomato Tariff Elimination in 1999-2001

Region	Base Model Solution	Phase 2 Effect	Change	Percent Change	Region	Base Model Solution	Phase 2 Effect	Change	Percent Change
	------------ 1,000 mt	--------------		%		------------ 1,000 mt	--------------		%
Consumption					Production				
Los Angeles	277.9	279.9	2.0	0.7	California	573.8	573.3	-0.5	-0.1
Seattle	102.0	102.3	0.3	0.3	Florida	836.3	833.0	-3.3	-0.4
Detroit	132.5	133.3	0.8	0.6	Arkansas	24.0	23.9	-0.1	-0.4
Billings	26.0	26.1	0.1	0.4	Georgia	75.3	75.0	-0.4	-0.5
Dallas	269.5	271.2	1.6	0.6	N. Carolina	35.2	35.2	0.0	0.0
Omaha	108.8	109.4	0.7	0.6	S. Carolina	53.3	52.9	-0.3	-0.6
Minneapolis	56.8	57.1	0.3	0.5	Tennessee	39.2	39.2	0.0	0.0
Miami	142.8	143.5	0.7	0.5	Virginia	67.6	67.6	0.0	0.0
Atlanta	137.3	138.0	0.7	0.5	New Jersey	96.1	96.1	0.0	0.0
Chicago	407.4	409.3	1.9	0.5	Michigan	95.7	95.7	0.0	0.0
Washington	293.5	294.6	1.1	0.4	Baja Calif.	390.8	392.1	1.4	0.4
New York	556.9	559.1	2.1	0.4	Sinaloa	948.2	952.3	4.1	0.4
Tijuana	103.3	102.8	-0.4	-0.4	North Mexico	291.3	292.7	1.4	0.5
Culiacán	47.1	46.8	-0.3	-0.7	Central Mex.	655.3	658.6	3.3	0.5
Monterrey	276.7	274.9	-1.7	-0.6	East Canada	140.4	140.1	-0.4	-0.3
Mexico City	1,228.7	1,222.6	-6.1	-0.5	Cent. Canada	2.2	2.2	0.0	-0.2
Montreal	172.8	173.8	1.0	0.6	West Canada	33.9	33.8	-0.1	-0.2
Winnepeg	44.7	45.0	0.2	0.5					
Vancouver	36.7	36.8	0.1	0.4					
Country Consumption Totals					Country Production Totals				
U.S.	2,511.3	2,523.7	12.4	0.5	U.S.	1,896.4	1,891.8	-4.6	-0.2
Mexico	1,655.7	1,647.1	-8.6	-0.5	Mexico	2,285.6	2,295.8	10.2	0.4
Canada	254.2	255.6	1.4	0.5	Canada	176.5	176.1	-0.4	-0.3
Total	4,421.2	4,426.4	5.2	0.1	Total	4,358.5	4,363.7	5.2	0.1
Trade from Mexico to the United States									
San Diego	196.4	198.8	2.5	1.2					
Nogales & Laredo	468.9	485.2	16.3	3.5					
Total	665.2	684.0	18.8	2.8					

The results suggest that the second phase elimination of U.S. tomato import tariffs that took place between 1998 and 2004 had only a marginally larger effect on tomato consumption, production, and trade in the three countries than was the case for the first phase elimination of tariffs. With tomato trade completely free of tariffs, the tomato consumption in the U.S. and Canada and the tomato production in Mexico in 1999-2001 would all have been only marginally higher than would have been the case had the tariffs not been removed. At the same time, tomato consumption in Mexico and tomato production in the U.S. and Canada all would have been only marginally smaller. Thus, the net impact of completely free trade in 1999-2001 on tomato production and consumption across the three countries would have been negligible.

The small shifts of tomato production to Mexico and of consumption to the U.S. and Canada would have generated a small increase in U.S. tomato imports, most of which would have moved over land through the Nogales and Laredo ports of entry and the reminder by sea through the port of San Diego. The reason that the majority of the small increase in U.S. tomato imports flows through the Nogales and Laredo rather than through San Diego is that the U.S. consumption regions that experience the greatest increases in demand are closer to the former than then to the latter ports of entry.

Conclusions

This study used a spatial and temporal equilibrium model of U.S., Mexico, and Canadian tomato markets to evaluate the effects of NAFTA on tomato production, consumption, and trade in the three NAFTA member countries. The results of the analysis indicate that the elimination of the U.S. tomato import tariffs as required by NAFTA has had a minimal impact on the level and pattern of tomato production, consumption, and trade in the U.S., Mexico, and Canada. The implication of this finding is that the strong growth in Mexican tomato exports to the U.S. since NAFTA was implemented must be due to factors other than the provisions of NAFTA - such as the devaluation of the Mexican peso against the U.S. dollar that occurred in late 1994 and early 1995. Other potential causes of the growth in U.S. tomato imports from Mexico include growing U.S. tomato demand and an increase in productivity in Mexican tomato producing regions.

In terms of winners and losers from free trade in North American tomato markets, although Mexican tomato producers and U.S. and Canadian consumers are the clear winners, their gain is minimal and only slightly outweighs the loss of U.S. tomato producers and Mexican consumers. An interesting observation from the analysis is the smaller negative impact of free trade in North America on Canadian tomato production in both an absolute and relative sense than on U.S. production. Most Canadian tomatoes are produced under hothouse conditions. Rapidly increasing Canadian yields as a result of new technology adoption is providing Canadian producers some protection from not only the weather but also the growing competitive threat of the Mexican tomato industry leaving U.S. producers to absorb the largest share of the negative impact of growing Mexican tomato exports.

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