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US–Mexico fresh vegetable trade: the effects of trade liberalization and economic growth

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Abstract

Studies of US–Mexico vegetable trade have generally emphasized the importance of US tariffs in determining the competitive advantage of US producers. Even so, research has identified at least four factors related primarily to the different levels of economic development in the US and Mexico that also have important effects on US–Mexico agricultural trade in general and fresh vegetable trade in particular. These include the differential growth rates of US and Mexican real wages, production technology (yields), and per capita income as well as cyclical movements in the real Mexican Peso/US Dollar exchange rate. This study examines the relative contribution of NAFTA and the development-related factors to likely future changes in US fresh vegetable imports from Mexico. The analysis employs an econometric simulation model of US and Mexican markets for five fresh vegetables (tomatoes, cucumbers, squash, bell peppers, and onions) accounting for 80% of US fresh vegetable imports. The results suggest that the 1994–1995 Peso devaluation rather than NAFTA was primarily responsible for the sharp increase in US imports of Mexican vegetables observed in the first years following the implementation of NAFTA. Over time, however, the results suggest that differences in the growth rates of US and Mexican production yields and, to a lesser extent, of US and Mexican real incomes and/or real wage rates could plausibly contribute more to the future growth of US tomato, squash, and onion imports from Mexico than the trade liberalizing effects of NAFTA.

JEL classification: Q17-agriculture in international trade; O13 economic development; Agriculture

Keywords: NAFTA; Vegetables; Trade liberalization; Mexico

1. Introduction

Since discussions began on a North American Free Trade Agreement (NAFTA) in the early 1990s, free trade proponents have contended that such an agreement between Mexico and its more developed neighbors to the north would expand trade and thereby boost economic growth and employment in all three countries (Williams and Rosson, 1992; Gould, 1998). In Mexico, initial support for NAFTA in the agriculture sector during the negotiations faded to skepticism in the first year of the agreement (1994) as the Mexican agricultural trade deficit with the US deepened and then to outright opposition in the following year when a severe economic recession slashed real incomes and boosted the already high level of unemployment. In the US, the intense NAFTA debate which framed the 1992 presidential election has faded to passive acceptance over much of the agriculture sector as US agricultural exports to Mexico have generally increased

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but not at the explosive rates that some might have expected.

The reaction to NAFTA in both the US and Mexican vegetable sectors, however, has been exactly the opposite as the competition faced by US growers from imports of Mexican fresh vegetables has intensified. Even though controversy and keen competition have characterized US–Mexico fresh vegetable trade for at least four decades (Schmitz et al., 1981; Zepp and Simmons, 1979; Bredahl et al., 1983; Mares, 1987; VanSickle et al., 1994; Fuller et al., 1996), NAFTA is often cited as the primary contributor to the recent growth in US imports of fresh vegetables. Concerned about the impact of the phase-out of US tariffs under NAFTA, US vegetable growers have sought relief from Mexican imports through various formal and informal NAFTA trade dispute mechanisms (USDA, 1999).

Studies of US–Mexico vegetable trade have generally emphasized the importance of US import tariffs in determining the competitive advantage of US producers (Hammig and Mittelhammer, 1982; Buckley et al., 1986; VanSickle et al., 1994; Fuller et al., 1996; Marchant and Nanga, 1996). Over the years, however, several studies have identified at least four factors other than US tariffs that have important effects on US–Mexico agricultural trade in general and fresh vegetable trade in particular. Related primarily to the different levels of economic development in the US and Mexico, these other factors include the differential growth rates of US and Mexican wages (Simmons and Pomareda, 1975; Zabin, 1997), technological change (i.e., production yields) (Bredahl et al., 1983; Taylor and Wilkowske, 1984; Cook, 1992), and per capita income (Schwedel, 1992; Schulthies and Williams, 1992) as well as cyclical movements in the real Mexican Peso/US Dollar exchange rate (Schuh, 1987; Fuller et al., 1991; Love and Lucier, 1996; VanSickle et al., 1996).

Unfortunately, the question of the relative importance of trade liberalization and the four development-related factors in the current and future potential performance of Mexican fresh vegetable exports to the US market, however, remains unanswered. Given that NAFTA is alternately blamed or credited for the recent performance of the fresh vegetable trade between the two countries, a comprehensive analysis of the contribution of NAFTA relative to that of the four development-related factors impacting that trade is warranted. Consequently, the objective of this study is to empirically measure the relative effects of the primary economic forces affecting US–Mexican fresh winter vegetable trade over the 10-year period during which US tariffs on Mexican vegetable imports are being eliminated under NAFTA. The trade liberalizing effects of NAFTA are compared to those of the 1994–1995 Mexican Peso devaluation and of other development-related factors, including the differences in the expected growth in US and Mexican real wage rates, real per capita incomes, and production yields. The analysis is facilitated through the use of a non-spatial, price equilibrium econometric simulation model of the US and Mexican tomato, cucumber, dry onion, squash, and bell pepper industries. These crops represent over 80% of the US fresh vegetable imports from Mexico in the winter season and were identified during the NAFTA negotiations as the US crops most sensitive to Mexican imports (Love and Lucier, 1996).

After presenting some background on US–Mexico fresh vegetable trade to frame the analysis and discussion, the analytical methodology, supporting data, and econometric results are discussed. A forecast simulation analysis then compares the impact of the NAFTA tariff elimination on US–Mexico fresh winter vegetable trade to those of relative US and Mexican wage rates, changes in yield-enhancing technology, and income growth and the effect of the 1994–1995 devaluation of the Peso. The final section provides conclusions and implications of the analysis for decision makers in both the US and Mexico.

2. Background

Fresh vegetable markets are important, dynamic components of both the US and Mexican agricultural sectors (Málaga and Williams, 1996). Between 1994 and 1998, US fresh vegetable production averaged nearly $7 billion in cash receipts while US fresh vegetable imports averaged about $1.4 billion. Leading imports over that period included fresh tomatoes ($0.70 billion), cucumbers ($0.14 billion), onions ($0.15 billion), bell peppers ($0.22 billion), and squash ($0.10 billion) (USDA, ERS). Mexico supplies about 96% of US tomato imports and 80–90% of US cucumber, onion, bell pepper, and squash imports (Calvin and Lucier, 1997). The majority of

Mexican vegetables enter the US market during the winter season when most US production is located in Florida. Before the implementation of NAFTA in January 1994, the ad valorem equivalent tariff was about 9% for tomato imports during the winter season and about 20, 10, 7, and 5% for cucumber, onions, bell peppers, and squash, respectively. Under NAFTA, all US vegetable tariffs are being phased out over a 10-year period except those for cucumbers which are scheduled for a 15-year phase-out.

In Mexico, vegetables comprise about 15% of total agricultural production and employ nearly 18% of the agricultural labor force (Málaga, 1997). Fresh vegetables are the leading Mexican agricultural export to the US, growing by nearly 120% since the early 1970s and now accounting for 40% of the value of all Mexican agricultural exports. Favorable winter weather and significantly lower labor costs have made the Mexican state of Sinaloa a natural supplier of the US winter vegetable market. Sinaloa has developed a modern fresh vegetable industry, adapting US technologies for use almost exclusively on irrigated, middle-sized, and large private farms. Sinaloan vegetable producers apply modern marketing and management techniques and have developed strong financial and commercial ties with US distributors. As a result, the Mexican vegetable export industry has developed into a highly efficient producer of high quality vegetables that often command premiums in the US market (Málaga et al., 1997).

3. Methodology and data

Analysis of the relative likely effects of NAFTA and four development-related factors on US imports of fresh vegetables from Mexico over the 1994–2004 period of scheduled tariff phase-out under NAFTA is based on a non-spatial, price equilibrium, econometric simulation model of US and Mexican markets of five fresh vegetables (tomatoes, cucumbers, squash, bell peppers, and onions). A two-country framework is employed for the analysis given that more than 90% of the US–Mexico trade of the five vegetables is bilateral. Although two-country models have frequently been utilized for analyses of US–Mexico trade in fresh vegetables, previous studies have tended to focus on only one vegetable such as tomatoes (Hammig and Mittelhammer, 1982; Gutierrez, 1983; Salcedo Baca, 1990) or onions (Fuller et al., 1991, 1996). In contrast, the model utilized for this analysis allows for the simultaneous determination of US and Mexican supplies, demands, prices, and trade of five vegetables comprising 80% of US vegetable imports from Mexico and accounts for the effects of key exogenous factors affecting those markets including tariffs, exchange rates, labor costs, US and Mexican yields, per capita incomes, and population. Three of the vegetables in the model (cucumbers, squash, and bell peppers) have never been considered in any previous empirical analysis of US and Mexico fresh vegetable trade.

The US–Mexico model of fresh vegetable markets includes 36 behavioral equations and 140 parameters estimated using the three stage least squares estimator. Goodness-of-fit measures (R^2) ranged between 0.45 and 0.97 with all estimated parameters having the expected signs, 74 of which are significant at the 0.05 level. Winter season data were used for parameter estimation for all vegetables except onions. Annual data were used for onions because, unlike the other vegetables in the model, onions can be stored from one season to the next. The limited availability of Mexican data restricted the regression period to 1974 through 1993. US data sources included several US Department of Agriculture agencies (USDA) (Agricultural Market Service, the National Agricultural Statistics Service, and the Economic Research Service) and the Bureau of the Census of the US Department of Commerce. Mexican data sources included the Secretaría de Agricultura y Desarrollo Rural (SAGAR), the Bank of Mexico, the International Financial Statistics (IMF), and unpublished data collected by the authors in cooperation with researchers at the Autonomous University of Chapingo.

Consistent with previous research (e.g., Gutierrez, 1983; Salcedo Baca, 1990; Buxton, 1992), the supply specification for each vegetable in each country in the model is based on the Nerlovian distributed lag concept with static price expectations (Eq. (1) in Table 1). In this case, however, harvested area is the behavioral variable rather than supply. The supplies of each of the five vegetables in the model are calculated as products of the respective harvested areas and yields (Eq. (2) in Table 1). Also, unlike previous studies, the Mexican supplies of the five fresh vegetables are subdivided into export-oriented supplies from Sinaloa

Table 1
US–Mexico fresh vegetable conceptual model[a]

US supply of vegetable i	
$USha_i = f(USfp_{i-1}, USha_{i-1}, USlc)$	(1)
$USS_i = USy_i \times USha_i$	(2)
US per capita demand for vegetable i	
$USd_i = f(USrp_i, USrp_j, USI)$	(3)
$USfp_i = f(USrp_i)$	(4)
Mexican export sector supply of vegetable i	
$MXXha_i = f(MXbp_{i-1}, MXXha_{i-1}, MXlc)$	(5)
$MXXS_i = MXXha_i \times MXXy_i$	(6)
Mexican domestic sector supply of vegetable i	
$MXDha_i = f(MXbp_{i-1}, MXDha_{i-1}, MXlc)$	(7)
$MXDS_i = MXDha_i \times MXDy_i$	(8)
Mexican per capita demand for vegetable i	
$MXd_i = f(MXrp_i, MXrp_j, MXI)$	(9)
$MXrp_i = f(MXbp_i, RER)$	(10)
Price transmission for vegetable i	
$MXbp_i = f\ (USrp_i, UST_i)$	(11)
US–Mexico market clearing conditions for vegetable i	
$USED_i = USd_i \times USPOP - USS_i - USMo_i - USX_i$	(12)
$MXES_i = MXXS_i + MXDS_i - MXd_i \times MXPOP$	(13)
$USED_i = MXES_i$	(14)

[a] Subscripts i and j stand for: tomatoes, cucumber, bell peppers, onions, and squash. All variables are assumed to be subscripted with t for the current time period, unless indicated by -1 for period $t-1$. USd_i: US per capita demand; $USrp_i$: US own retail price; $USrp_j$: US cross retail price; USI: US per capita income; USPOP: US population; $USha_i$: US harvested acreage; $USfp_i$: US farm price; USlc: US labor cost; USS_i: US supply; USy_i: US yield; MXd_i: Mexican per capita demand; $MXrp_i$: Mex own retail price; $MXrp_j$: Mexican cross retail price; MXI: Mexican per capita income; MXD_i: MXPOP: Mexican population; $MXbp_i$: Mexican border price; RER: real exchange rate Peso/Dollar; $MXXha_i$: Mexican export states harvested acreage; MXlc: Mexican labor cost; $MXXS_i$: Mexican export states supply; $MXXy_i$: Mexican export states yield; $MXDha_i$: Mexican domestic harvested acreage; $MXDS_i$: Mexican domestic supply; $MXDy_i$: Mexican domestic yield; $MXbp_i$: Mexican border price; UST_i: US real tariff; $USED_i$: US excess demand; $USMo_i$: US imports from other countries; USX_i: US exports; $MXES_i$: Mexican excess supply.

and Baja California (Eqs. (5) and (6) in Table 1) and domestic-oriented supplies from all other Mexican states (Eqs. (7) and (8) in Table 1) to better reflect the growing interaction between the Mexican vegetable export and domestic markets.

All estimated supply coefficients have the expected signs and most are statistically significant at the 0.20 level of significance or better. All own-price elasticities of supply are within reasonable expected ranges (from 0.07 for tomatoes to 0.21 for onions) and notably consistent with the results of previous studies (Table 2). The similarity between the elasticities estimated by this and previous studies is particularly striking for the US supply of tomatoes and onions. The estimated price elasticities of US cucumber and squash supply are between those estimated for tomatoes and onions. In Mexico, farmers producing tomatoes for the domestic market appear to be more responsive to short-run price changes than their US counterparts, but no more so with those producing tomatoes for export to the US market. Mexican own-price elasticities of cucumber and squash supply are generally of the same order of magnitude as those for tomatoes although their export supplies are somewhat more price responsive. Mexican onion and bell pepper supplies, however, appear to be much less responsive to price.

On the demand side of the model, a complete demand system approach was initially used following Mittelhammer (1978) and Scott (1991) for both countries (see Málaga and Williams, 2000 for details). Using the Barten approach, the Rotterdam demand system formulation was found to be the most appropriate for both countries. Reasonable own-price elasticities were found for the US with less satisfying results for Mexico. The Rotterdam demand system was used to test for weak separability of onion demand based on previous research suggesting that onions may not belong to the group of "salad"vegetables (Mittelhammer, 1978). The test failed to reject the null hypothesis of weak separability of onions at the 0.05 significance level of the χ^2 distribution. Consequently, a separate US–Mexico onion component of the model was estimated using annual data.

When the demand systems and supply blocks of the four salad vegetables (tomatoes, cucumbers, squash, and bell peppers) were integrated for both countries and linked together in a US–Mexico trade model framework, however, simulation of the resulting model produced solutions not consistent with either a priori expectations or economic theory. The problem was related to the prevalence of estimated negative Marshallian cross-price elasticities (gross complementarities) where positive Marshallian cross-price elasticities (gross substitutabilities) were expected, a common occurrence for parameters estimated in complete demand systems. As Pindyck and Rubinfeld

Table 2
Estimated fresh vegetable elasticities: US and Mexico[a]

Vegetable/study	Demand elasticities			
	Own-price		Income[b]	
	US	Mexico	US	Mexico
Tomatoes	**−0.55***	**−0.27*****	**0.95***	**0.11**
Simmons and Pomareda (1975)	–[c]	−0.50	–	–
Mittelhammer (1978)	−0.42	−0.40	0.23	–
Norton and Duloy (1983)	–	–	–	0.40
Gutierrez (1983)	−0.44	–	1.47	–
Salcedo Baca (1990)	−0.31	−0.10	2.68	0.29
Huang (1993)	−0.62	–	*0.92*	–
Cucumbers	**−0.41***	**−0.97*****	**0.59***	**1.54***
Mittelhammer (1978)	−0.54	–	0.23	–
Squash	**−0.66***	**−1.40***	**2.24***	**0.48**
Bell peppers	**−0.13*****	–	**2.05***	–
Mittelhammer (1978)	−0.22	–	0.43	–
Onions	**−0.20***	**−0.15****	**0.36****	**0.41**
Norton and Duloy (1983)	–	−0.20	–	0.59
Huang (1993)	−0.21	–	*0.08*	–
Fuller et al. (1996)	−0.20	–	–	–
	Supply: own-price			
	US	Mexico		
Tomatoes — domestic market	**0.07**	**0.21***		
Hammig and Mittelhammer (1982)	0.37	–		
Gutierrez (1983)	0.06	–		
Buxton (1992)	0.03	–		
Tomatoes — export market (Mexico only)	–	**0.19***		
Hammig and Mittelhammer (1982)	–	0.58		
Gutierrez (1983)	–	0.49		
Salcedo Baca (1990)	–	0.09		
Cucumbers — domestic market	**0.14**	**0.15****		
Cucumbers — export market (Mexico only)	–	**0.27***		
Squash — domestic market	**0.12*****	**0.29*****		
Squash — export market (Mexico only)	–	**0.36***		
Bell peppers — domestic market	**0.12*****	–		
Bell peppers — export market (Mexico only)	–	**0.08**		
Onions — total (domestic and export market)	**0.21***	**0.05*****		
Buxton (1992)	0.21	–		
Ornellas and Shumway (1993)	0.22	–		

[a] Measured at the means of the data. Significance levels provided only for estimates from present study which are given in bold.
[b] Numbers in italics are expenditure elasticities.
[c] No estimate available or not relevant.
*Significant at 0.05.
**Significant at 0.10.
***Significant at 0.20.

(1991, p. 337) pointed out, modeling typically involves tradeoffs. In this case, the tradeoff involved substituting a set of conventional linear demand equations (Eqs. (3) and (9) in Table 1) for which only the homogeneity restriction was imposed for the theoretically more rigorous demand system specification in each country to produce a simulation model of US–Mexico fresh vegetable trade that tracks the historical data extremely well.

As with the vegetable supply equations, the signs of the estimated coefficients in the conventional linear demand equations are consistent with a priori expectations and most are statistically significant. Also, the associated price elasticities are quite similar to those estimated in previous studies, ranging from −0.13 for bell peppers to −0.66 for squash in the US and from −0.15 for onions to −1.40 for squash in Mexico (Table 2). Income elasticities of US vegetable demand range more widely from 0.59 for cucumbers to 2.24 for squash, while those for Mexico range from 0.11 for tomatoes to 1.54 for squash. For Mexico, the own-price elasticity of tomato demand is smaller than that for the US, consistent with the results of Salcedo Baca (1990). On the other hand, the estimated own-price elasticities of Mexican cucumber and squash demand are considerably higher than their US counterparts. The own-price elasticity of US onion demand estimated in this study (−0.21) is nearly identical not only to those estimated for the US by Huang (1993) and Fuller et al. (1996) but also to those estimated in this study and by Norton and Duloy (1983) for Mexico. Cross-price elasticities of demand were generally found to be either not statistically significant or small for both countries, again suggesting that a compete demand system may not be the appropriate approach for the study of fresh vegetable demands.

Standard price margin equations connect farm and retail prices within each country (Eqs. (4) and (10) in Table 1). Prices among countries are linked with standard price transmission equations following Bredahl et al. (1979) with tariffs and exchange rates included as separate explanatory variables as suggested by Chambers and Just (1979) (Eq. (11) in Table 1). Market clearing conditions require equality of supply and demand in each country and of Mexican exports and US imports of each vegetable in each time period (Eqs. (12)–(14) in Table 1).

4. Model validation [1]

A within-sample validation of the model was conducted through historical simulation and sensitivity analysis. The root mean square percent (RMS%) errors were relatively small with the endogenous price variables among those with the highest errors, a typical result for models with inelastic demands. Theil inequality coefficients (U2) were all also relatively small while decomposition of the Theil coefficients did not indicate the presence of systematic error (bias) for any endogenous variable. Finally, calculation of the dynamic multipliers associated with four key exogenous variables showed the model to be stable. All endogenous variables changed in the expected directions and returned to equilibrium between the fourth and tenth years following one-time shocks of 10% in each of the four key exogenous variables. Thus, the estimated model was both dynamically stable and replicated the historical data extremely well providing confidence for use of the model in forecast simulation analysis (see Málaga et al., 1997 for more details).

5. Forecast simulation analysis

The first step in the analysis of the relative effects of NAFTA and other development-related factors on US imports of Mexican fresh vegetables was to establish a baseline forecast of the endogenous variables in the model from 1996 through 2004 when the NAFTA tariff phase-out will be completed. The exogenous variables were first projected through the year 2004 using FAPRI forecasts to represent the most plausible values of most macroeconomic variables in both countries over the forecast period, including income growth, exchange rates, general price indexes, and wage rates (FAPRI, 1995). [2] Trend growth rates over the previous decade were used as the most plausible values for US and Mexican vegetable production yield levels over the forecast period. US fresh vegetable import tariffs were assumed to be phased-out

[1] Due to space limitations, the full model, all data used, and all estimated parameters and associated regression statistics are not presented here but are available in Málaga et al. (1997).

[2] FAPRI forecasts benefit from the macroeconomic forecasts of the WEFA Group.

over the forecast period as required by the negotiated NAFTA tariff schedules for each vegetable.

Given these assumptions on the exogenous variables, the validated model of US and Mexican fresh vegetable markets and trade was simulated over the 1996–2004 period to generate the baseline values of the endogenous variables in the model. The baseline forecast thus represents the scenario in which NAFTA is implemented, the 1994–1995 Mexican Peso devaluation occurs, and the levels of vegetable production technology, i.e., yields, real per capita income, and real wages, grow at their most plausible respective rates over the forecast period. Under these conditions, the model projects an impressive growth in US imports of all the Mexican fresh vegetables except onions between 1993, the last pre-NAFTA year, and 2004, the last year of NAFTA (Table 3). In the case of onions, a high estimated Mexican income elasticity of onion demand and a low Mexican elasticity of onion supply combined to reduce the Mexican export supply of onions over time. US supplies of tomatoes and squash were also forecast to increase over the same period but at a lower rate than the projected increase in imports. Consequently, the Mexican shares of the US tomato and squash markets were projected to increase by 6 percentage points and 3 percentage points, respectively. The US cucumber supply was forecast to grow sufficiently over time to just maintain its share of the US market. In contrast, Mexican imports of bell peppers and onions were projected to lose shares of their respective US markets in the baseline forecast.

Table 3
Baseline forecast: US fresh vegetable imports from Mexico, 1996–2004

Year	Forecast import level (1000 cwt)	Forecast growth since 1993	
		Imports (%)	Mexican share of US market (percentage points)
Tomatoes			
1996	8700	25	2
2000	9700	38	3
2004	11500	64	6
Cucumbers			
1996	5506	55	7
2000	5153	47	4
2004	4718	35	0
Squash			
1996	4046	74	6
2000	4134	80	3
2004	4494	96	3
Bell peppers			
1996	2087	16	2
2000	2079	15	−1
2004	2067	15	−3
Onions			
1996	2714	20.8	1
2000	2646	17.9	0.5
2004	1808	−19.0	−1

The model was then simulated again over the forecast period to analyze the likely relative contribution to the projected changes in US imports of Mexican fresh vegetables of NAFTA, the 1994–1995 Mexican Peso devaluation, and the other economic growth factors. In this simulation, US tariff levels were held constant at pre-NAFTA levels (no NAFTA) and the Peso was maintained at its real pre-devaluation level (no Peso devaluation) while US fresh vegetable yields, Mexican real per capita income, and the Mexican real wage rate were all set at their highest plausible levels relative to those in the other country to generate a model solution representing the lowest plausible level of US imports of Mexican fresh vegetables over the forecast period. For real per capita income, the projected difference in US and Mexican average annual growth rates was increased by 1 percentage point given the higher forecasted growth rate of Mexican per capita income in the baseline forecast. For real wage rates, the difference in US and Mexican average annual growth rates was reduced by about 1 percentage point. The differences in the average annual growth rates in US and Mexican yields were increased by about 1 percentage point for tomatoes and about 2.5 percentage points for cucumbers, squash, and bell peppers. The difference in the growth rates of US and Mexican onion yields was reduced by about 0.5 percentage points given the higher projected growth rate in Mexican onion yields.

The simulated differences between the values of the endogenous variables in the baseline forecast solution (the most plausible scenario) and those in the scenario representing the lowest plausible level of US fresh vegetable imports provide direct measures of the most likely effects of NAFTA, the Peso devaluation, and differences in US and Mexican development-related factors on US and Mexican fresh vegetable markets and trade over the forecast period. The results indicate that in the absence of both NAFTA and the Peso

Table 4
Estimated contribution of NAFTA and economic growth factors to US–Mexico fresh vegetable trade, 1996 and 2004

	Tomatoes (%)		Cucumbers (%)		Squash (%)		Bell peppers (%)		Onions (%)	
	1996	2004	1996	2004	1996	2004	1996	2004	1996	2004
Change from 1993										
Baseline forecast	24.3	64.3	56.5	34.1	75.5	95.0	15.9	14.8	21.1	−19.3
Lowest plausible import level	−18.3	23.5	15.7	−2.8	24.5	58.3	−13.4	−13.3	−5.5	−57.1
Difference between baseline and lowest plausible import level	−34.3	−24.8	−26.1	−27.6	−28.9	−18.8	−25.3	−24.4	−22.0	−46.8
Share of import difference[a]										
NAFTA tariff elimination	6.0	12.7	13.8	30.0	1.7	9.5	21.2	46.5	7.2	17.7
1994–1995 Peso devaluation	87.1	28.3	84.0	39.8	95.6	59.6	74.4	24.2	73.0	8.7
Growth rate differential in productivity (yields)	3.3	38.0	1.2	7.1	1.3	15.9	3.0	16.6	14.4	39.7
Real incomes	3.4	18.9	0.7	19.0	0.4	5.7	1.0	9.1	3.4	16.5
Real wage rates	0.2	2.1	0.3	4.1	1.0	9.3	0.4	3.6	2.0	17.4
Total five factors	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] Calculated in each case as the change in imports as a percent of the total difference between the baseline and the lowest plausible import level.

devaluation and with the largest plausible differences between US and Mexican yields, real incomes, and real wage rates, US imports of all five vegetables over the forecast period could be as much as 20–45% lower than the baseline forecast (Table 4). In the case of cucumbers, bell peppers, and onions, the results indicate that imports not only could be lower than the baseline but also could plausibly decline over the forecast period from pre-NAFTA levels rather than experience the strong growth projected in the baseline forecast.

Next, the combined effects of NAFTA, the Peso devaluation, and the differences in the level of the US and Mexican development-related factors were decomposed into components representing their separate effects on the levels of US and Mexican fresh vegetable production, consumption, prices, and trade. The decomposition was accomplished by setting each factor (i.e., US import tariffs, the real Peso, and relative US and Mexican yields, real per capita incomes, and real wages) back to their baseline levels one at a time and re-simulating the model each time. The resulting changes in US imports of each vegetable from each simulation were calculated as percentages of the total effect of all factors combined.

The results indicate that NAFTA alone will likely be responsible for the largest part of the expected growth of only US bell pepper imports from Mexico over the forecast period and only a small part of the expected increase in US tomato, squash, and onion imports (Table 4). Over the short-run (1993–1996), the results clearly indicate that the Peso devaluation rather than NAFTA explains most (70–95%) of the projected change in imports. In other words, the devaluation was by far the most important factor determining the sharp increase in US imports of Mexican vegetables between 1993 and 1996. As NAFTA was being negotiated, the Mexican government intervened in its currency markets to stabilize an increasingly overvalued Peso. In late 1994, almost a year after NAFTA was implemented, however, the Mexican government could no longer keep the Peso supported and allowed its value to drop sharply against the US dollar by about 95% between December 1994 and 1995. The Peso devaluation altered an implicit assumption underlying the NAFTA negotiations that the Peso either was in equilibrium against the Dollar or, at least, would remain stable at pre-NAFTA levels. The Peso devaluation was accompanied by an unexpectedly large increase in US fresh vegetable imports from Mexico in 1995 and 1996. Faced with this unexpected onslaught of imports, US producers held NAFTA to blame while many producer groups filed actions and complaints through various NAFTA dispute resolution mechanisms seeking to reduce the competitive pressure of Mexican imports (USDA, 1999). The results of this study demonstrate, however, that the Peso devaluation and not NAFTA

was the main culprit in the sharp increase in US imports of Mexican vegetables during that period.

The results also indicate that differences in growth rates of production yields, real incomes, and real wages between the two countries played little role in what happened to US vegetable imports from Mexico during that early period except perhaps for onions. The share of the increase in all fresh vegetable imports in 1996 accounted for by differences in the US and Mexican levels of these three development-related factors was only 3% or less over all vegetables (Table 4). The only exception was for onions where the difference in US and Mexican production yields could plausibly account for no more than about 14% of the 1996 import increase.

Over time, however, the effects of the devaluation dissipate and the other factors exhibit greater impacts on the behavior of US fresh vegetable imports from Mexico. Interestingly, however, NAFTA becomes the dominant factor affecting behavior by the end of the forecast period only in the case of bell peppers, accounting for up to 47% of the plausible increase in bell pepper imports in the year 2004 (Table 4). For tomatoes, squash, and onions, the results suggest that differences in US and Mexican production technology could plausibly contribute more to the growth of Mexican vegetable imports than the elimination of tariffs under NAFTA. Even for bell peppers, however, differences in yield growth in the two countries could plausibly account for 17% of the increase in US imports in 2004. At the same time, differences in US and Mexican real income growth and/or real wage rates could also plausibly be as or more important than NAFTA in the future behavior of US tomato, squash, and onion imports from Mexico. In the case of cucumbers and bell peppers, differences in US and Mexican real income growth could plausibly account for up to nearly 20 and 10% of US imports in 2004.

6. Conclusions and implications

In discussions of US–Mexico agricultural trade, the effects of trade liberalization under NAFTA are generally highlighted and often credited or blamed for most of the recent changes observed in that trade. In the US at least, much of the continuing debate over NAFTA has focused on fresh vegetables, one of the few agricultural commodities for which NAFTA is expected to boost US imports. This study examines the contribution of NAFTA to the likely future changes in US fresh vegetable imports from Mexico compared to that of other key factors more related to economic development, such as differences in the growth rates of US and Mexican real per capita incomes, real wages, and production yields. The analysis employs an econometric simulation model of US and Mexican markets for five fresh vegetables (tomatoes, cucumbers, squash, bell peppers, and onions) accounting for 80% of US fresh vegetable imports.

The analytical results provide empirical support for the prediction of Williams and Rosson (1992) that economic growth would be more likely than NAFTA to bring about changes in future US–Mexico agricultural trade. Indeed, the results suggest that NAFTA alone will likely be responsible for the largest part of the future US imports of only bell peppers among the five major vegetable imported from Mexico. Between 1993 and 1996, the results clearly suggest that the Peso devaluation rather than NAFTA or economic development was primarily responsible for the sharp increase in US imports of Mexican vegetables observed during that period. Over time, differences in the growth rates of US and Mexican production yields and, to a lesser extent, of US and Mexican real incomes and/or real wage rates could plausibly contribute more to the future growth of US tomato, squash, and onion imports from Mexico than the trade liberalizing effects of NAFTA. Even in the cases of bell peppers and cucumbers, factors other than NAFTA could plausibly account for a large share of the behavior of US imports from Mexico.

Among the implications of these results for policy makers and decision makers at all levels are the following:

- Trade agreements not only have a direct effect on the levels of trade among member countries through the elimination of trade barriers but also indirect effects as more open borders allow the relative rates of economic growth among member countries to impact the level of trade.
- The indirect effects of the relative rates of economic growth among participants in trade agreements as evidenced by relative rates of growth in real incomes, real wages, and productivity may be more

important in determining the behavior of trade among countries over time than the direct effects of trade liberalization.

- Changes in implicit assumptions underlying trade agreements, such as the assumed current and future level of the rate of exchange, can lead to unexpected changes in trade which may be ascribed mistakenly to the effects of the particular provisions of the trade agreement.
- Of particular importance to the performance of trade among countries under a trade agreement is the relative levels of production technology as evidenced by the relative rates of productivity growth over time in each country. In the case of US imports of fresh vegetables from Mexico under NAFTA, this study suggest that the level of imports and the US producer share of the US fresh vegetable market, especially for tomatoes, could plausibly depend more on relative yield performance than tariff elimination. Given that NAFTA has already been implemented and is well on its way to eliminating US vegetable tariffs, perhaps the most important issue for US vegetable producers now is to maintain or increase the differential between US and Mexican yields through investment in new yield-enhancing technologies. The return to US vegetable producers from public and private investments in such technology could be relatively high in terms of the limitation on imports and the maintenance of market share that such investments might induce.
- Promotion of the economic development of underdeveloped trading partners is in the best interest of US agricultural producers. Again, in the case of fresh vegetables and NAFTA, the simulation results imply that both public and private development assistance in Mexico would likely help limit the growth in the available export supply of most Mexican fresh vegetables to the US.

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