A CASE STUDY OF U.S. FRESH TOMATO TRADE AMONG NAFTA COUNTRIES

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Abstract
U.S. consumption of fresh-market tomatoes has been increasing steadily over the last 10 years despite a recent declining trend in domestic production. The international market plays a key role in meeting U.S. consumers' demand for fresh tomatoes. Over the last ten years, in volume terms, U.S. imports accounted for about 50% of the U.S. consumption. Our U.S. NAFTA partners are our main trade markets for fresh tomatoes. This study analyzes the U.S. principal supply sources of five tomato cultivars (greenhouse, cherry, grape, roma, and other) and estimates source-differentiated Marshallian and Hicksian price and expenditure elasticities. The study explores if U.S. consumers' preferences for these five tomato varieties are heterogeneous and if source of origin is an intrinsic quality attribute. Our results mostly indicated heterogeneous elasticity estimates and source of origin not been an intrinsic quality attribute for U.S. fresh-market tomato importers; but at the same time Mexico and Canada are the preferred sources, which suggests effective adaptation of NAFTA and the importance of market proximity in fresh-market tomato trade.

Key words: Elasticities, imports, SDAIDS, tomatoes, varieties

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Introduction

Tomatoes are the fourth most consumed vegetable in the U.S. (USDA-ERS, 2012). U.S. consumption of fresh-market tomatoes has been increasing steadily over the past several years (figure 1 and table 1) despite recent declining trends in U.S. fresh-market tomatoes area planted, area harvested, production, and yield (figures 2 and 3, and table 2). The international market plays a key role in meeting U.S. consumers' demand for fresh-market tomatoes as U.S. imports account for about 50% of the U.S. consumption in volume terms (table 1, top section) and for about 60% of the U.S. consumption in terms of value (table 1, bottom section). Given these trends, U.S. tomato growers, importers, and exporters would benefit from an import demand analysis for fresh-market tomatoes that identifies substitution patterns by tomato type and source.

For more than twenty years now, the main destinations for U.S. exports and source of U.S. imports for the various types of fresh-market tomatoes have consistently been Canada and Mexico (tables 3, 4, 6, 7, 8, 9, and 10). Over the last ten years, U.S. exports to Canada and Mexico account for 77% and 20% respectively (table 3) while U.S. imports from the same countries account for 10% and 89% respectively (table 4). From 2005 to 2010, U.S. exports of fresh-market tomatoes to Canada declined from 130,501 metric tons to 87,610 metric tons while from 2005 to 2009 exports to Mexico increased from 13,591 metric tons to 57,722 metric tons (table 3). For the next four or five years, from 2011 to 2014, exports of fresh-market tomatoes to Canada remained at about 90,800 metric tons, while from 2009 to 2014 exports to Mexico declined to 14,200 metric tons (table 3). In the case of imports (table 4), from 2005 to 2014, fresh-market

tomatoes imports from Mexico have been increasing, from 801,408 metric tons to 1,389,334 metric tons, while imports from Canada have remained at about 135,000 metric tons.

Table 5 and figures 4 and 5 identify trends in fresh-market tomatoes by type. In particular, since the late 1990s imports of greenhouse and roma tomatoes have been rapidly increasing, while grape and cherry tomatoes have remained at about the same level, but imports of all other tomatoes have been decreasing (figures 4 and 5). The increasing trend for fresh-market greenhouse tomato imports is likely to be the result of the increasing interest of growing tomatoes in greenhouses, partially driven by the need to grow fresh tomatoes yearlong in response to an increasing market demand; but also because it is easier to control tomato quality in greenhouses, and distributors and ultimately consumers prefer value-added fresh-market tomatoes, free of bruises, scratches, etc. Therefore, and not surprisingly, greenhouse tomatoes are priced higher (table 5). This means, the increasing import demand for fresh-market greenhouse tomatoes is not being driven by low prices, but also by quality and the ability to supply the market (i.e., the time component of utility marketing) among other factors such as population growth, economic growth, and free trade agreements. Greenhouse tomatoes accounted for 43%, on average, of the U.S. imports from 2005 to 2014 (table 5).

In addition to being the main export destinations, Mexico and Canada are also the main source of U.S. imports of fresh-market greenhouse tomatoes (2005-2014 shares of 96.78% and 1.69%, respectively), roma tomatoes (99.63% and 0.31%, respectively), cherry tomatoes (93.09% and 5.82%, respectively), and all other tomatoes (96.78% and

1.69%, respectively) (table 8). In the case of grape tomatoes, 1.25% comes from Dominican Republic in addition to 98.58% coming from Mexico and 0.14% from Canada. Clearly, the U.S. NAFTA partners, Mexico and Canada, are the main sources of fresh-market tomatoes; which also suggests an effective adaptation of NAFTA.

This study contributes to the existing literature by estimating recent and disaggregaed import elasticities while incorporating the principal supply sources, and by assessing whether fresh tomatoes are perceived as homogenous, and can therefore be aggregated into one category. The study employs a source differentiated almost ideal demand system (SDAIDS) to estimate the U.S. import demand for Canadian and Mexican fresh-market tomatoes. It also explores if source of origin is an intrinsic quality attribute and whether consumers' preferences for tomato varieties are heterogeneous.

Methods and Procedures

Various demand systems have been used to analyze the demand for fresh fruits and vegetables, including the Rotterdam model (e.g., Seale, Zhang, and Traboulsi 2013), the Almost Ideal Demand System (AIDS) (e.g., Lopez and Peckham 2016; Lopez and Davis 2015; Thompson 2003), the linear approximation of the AIDS (LA/AIDS) (e.g., Padilla and Acharya 2000; Naanwaab and Yeboah 2012), the quadratic AIDS (QAIDS) (e.g., Thompson 2003), first difference version of the AIDS (FDAIDS) (e.g., Jung, VanSickle, and Seale 2005), the inverse AIDS (e.g., Grant and Foster 2005), and source differentiated almost ideal demand system (SDAIDS) (Henneberry, Piewthongngam, and Qiang 1999). This study follows Henneberry and Mutondo (2009) and Yang and Koo

(1994) and employs a source SDAIDS to estimate the U.S. import demand for fresh-market tomatoes from Canada, Mexico, and the rest of the world.

Deaton and Muelbauer's (1980) AIDS model is considered an arbitrary first order approximation of any demand system. It satisfies the axioms of choice and aggregates perfectly over consumers up to a market demand function without invoking parallel linear Engel curves. The functional form can be used to test the properties of homogeneity and symmetry through linear restrictions on fixed parameters, and is not difficult to estimate. Following Henneberry and Mutondo (2009) and Yang and Koo (1994), the SDAIDS model is specified as:

$$(1) \qquad w_{i_h} = \alpha_{i_h} + \sum_j \sum_k \gamma_{i_h j_k} \ln(p_{j_k}) + \beta_{i_h} \ln\left(\frac{E}{P}\right) + \varepsilon_{i_h},$$

where subscripts i and j indicate goods ($i, j = 1, 2, \ldots n$) and h and k indicate source of origin; w_{i_h} is the import expenditure share for good i from source h; p_{j_k} is the price of good j from source k (with j including i and k including h); E is U.S. total expenditure on all goods included in the demand system; α_{i_h}, $\gamma_{i_h j_k}$, and β_{i_h} are parameters; ε_{i_h} is a random term of disturbances; and P is the nonlinear price index.

The demand theory properties of adding-up, homogeneity and symmetry are imposed on the system of equations by restricting parameters in the model as follows:

$$(2) \qquad \text{Adding-up: } \sum_i \sum_h \alpha_{i_h} = 1, \sum_j \sum_h \gamma_{i_k j_h} = 0, \text{ and } \sum_i \sum_h \beta_{i_h} = 0;$$

$$(3) \qquad \text{Homogeneity: } \sum_i \sum_h \gamma_{i_h j_k} = 0;$$

$$(4) \qquad \text{Symmetry: } \gamma_{i_h j_k} = \gamma_{j_k i_h};$$

where subscripts i and j indicate goods (i, j = 1, 2, …n) and h, and k indicate source of origin.

The parameter estimates and the mean expenditure shares are used to estimate the Marshallian (uncompensated) and the Hicksian (compensated) price elasticities as well as the expenditure elasticities. Following Green and Alston (1990), the elasticities are estimated as follow.

(5) Marshallian Price Elasticity: $e_{i_h j_m} = \frac{\gamma_{i_h j_m}}{w_{i_h}} - \frac{\beta_{i_h}}{w_{i_h}}\left(\alpha_{i_h} + \sum_l \sum_k \gamma_{l_k j_m} \ln(p_{l_k})\right) - \delta_{i_h j_m}$;

(6) Hicksian Price Elasticity: $e^c_{i_h j_m} = e_{i_h j_m} + w_{j_m} e_{i_h}$;

(7) Expenditure Elasticity: $e_{i_h} = 1 + \frac{\beta_{i_h}}{w_{i_h}}$;

where subscripts i and j indicate goods (i, j = 1, 2, …n) and h, k, and m indicate source of origin; and $\delta_{i_h j_m}$ is the Kronecker delta, which is equal to 1 if $i_h = j_m$ and equal to 0 if otherwise.

The equation holding the smallest budget share equation is usually omitted from the demand system estimation. However, after the estimation of the demand system, the parameters of the omitted equation are recovered using equations (2) through (4).

Data and Procedures

Annual data on U.S. imports in volume and value by country for the period 1999-2014 were obtained from the United States International Trade Commission (USITC) Interactive Tariff and Trade DataWeb Version 3.1.0. All data are for fresh or chilled tomatoes on a fresh-weight basis. The study has the advantage that it works with annual data; and therefore, there is no need to account for seasonality from biological lags within

the crop or calendar year, which may subsequently reflect on import/trade seasonality within the crop or calendar year. The annual data used in the estimation of the demand system revealed little (if any) evidence of import patterns reflective of seasonality (e.g., figures 4 and 5).

Due to space limitations, tables 6 through 10 only report data for the period 2004-2014. Due to the small volume and expenditure shares for all other countries (tables 6 through 10), only the U.S. NAFTA partners were analyzed. For the same reason, the five fresh-market tomatoes (greenhouse, roma, grape, cherry, and other) reported in the USITC Interactive Tariff and Trade DataWeb were combined into three categories from Mexico (greenhouse, roma, and other), two categories from Canada (greenhouse and other), and two categories from the rest of the world (ROW) (greenhouse and other).

Greenhouse tomatoes from Mexico, Canada and the ROW include Harmonized Tariff Schedule (HTS) commodities 0702002010, 0702004010, and 0702006010. Roma tomatoes from Mexico include HTS commodities 0702002060, 0702002065, 0702004060, 0702004065, 0702006060, and 0702006065. Other tomatoes from Mexico include grape tomatoes (HTS commodities 0702002045, 0702004045, 0702004046, and 0702006045), cherry tomatoes (HTS commodities 0702002030, 0702002035, 0702004030, 0702004035, 0702006030, and 0702006035), and other tomatoes (HTS commodities 0702002090, 0702002095, 0702002099, 0702004090, 0702004098, 0702004099, 0702006090, 0702006095, 0702006099). Other tomatoes from Canada and the ROW include Roma tomatoes (HTS commodities 0702002060, 0702002065, 0702004060, 0702004065, 0702006060, and 0702006065) grape tomatoes (HTS

commodities 0702002045, 0702004045, 0702004046, and 0702006045), cherry tomatoes (HTS commodities 0702002030, 0702002035, 0702004030, 0702004035, 0702006030, and 0702006035), and other tomatoes (HTS commodities 0702002090, 0702002095, 0702002099, 0702004090, 0702004098, 0702004099, 0702006090, 0702006095, 0702006099). Imports were converted from kilograms to metric tons. Table 11 summaries the resulting U.S. import volume, value, and expenditure shares for the period 1999-2014.

Results

The SDAIDS model was estimated for seven fresh-market tomatoes categories using an iterated seemingly unrelated regression (ITSUR) procedure in SAS version 9.3. The theoretical neoclassical restrictions, equations (2) through (4), were incorporated in estimation of the model, equation (1). The expenditure shares for these seven fresh-market tomato categories are depicted in figure 6 and summarized in table 11. At ITSUR iteration 401 the convergence criterion of 0.00001 was met. Table 12 reports the SDAIDS model parameter estimates as well as some goodness of fit measures.

Of the forty one parameter estimated (α_{i_h}, $i_h = 1, \ldots, 7$; $\gamma_{1_h j_m}, j_h = 1, \ldots, 7$; $\gamma_{2_h j_m}, j_h = 2, \ldots, 7$; $\gamma_{3_h j_m}, j = 3, \ldots, 7$; $\gamma_{4_h j_m}, j = 4, \ldots, 7$; $\gamma_{5_h j_m}, j = 5, \ldots, 7$; $\gamma_{6_h j_m}, j = 6, 7$; $\gamma_{7_h j_m}, j = 7$; and β_{i_h}, i = 1, …, 6), twenty two were significant at the 5% probability level, two at the 10% probability level, and seventeen were not significant (table 12). In terms of goodness of fit, the SDAIDS model explained about 90% or more of the total variation in the expenditure shares for other tomatoes and greenhouse tomatoes from Mexico; more than 70% for two roma tomatoes from Mexico and greenhouse tomatoes from the rest of

the world (ROW); about 59% for roma tomatoes from Canada; and about 21% for greenhouse tomatoes from Canada (table 12, bottom section).

The Marshallian (uncompensated) price elasticity estimates are reported on table 13. All Marshallian own-price elasticity estimates have the expected negative sign, except for the own-price elasticity estimate of other tomatoes from the ROW ($\hat{e}_{7_3 7_3}$). Excluding the latter elasticity, this study's own-price elasticity estimates range from -2.9441 ($\hat{e}_{6_3 6_3}$) to -0.1137 ($\hat{e}_{1_1 1_1}$). Compared to previous studies (table 16), the own-price elasticities of greenhouse tomatoes from the ROW, -2.9441 ($\hat{e}_{6_3 6_3}$), is relatively more elastic, which suggests importation of greenhouse tomatoes from the ROW is very responsive to price changes of greenhouse tomatoes, possibly because Mexico and Canada are the preferred sources. Excluding this latter elasticity, all other Marshallian own-price elasticity estimates fall within or close to the range reported by previous studies, -1.5400 to -0.0100, excluding the own-price elasticity estimate for cherry tomatoes reported by Thompson (2003) since he obtained an unexpected positive sign.

The Hicksian (compensated) own-price elasticity estimates from this study are reported on table 14. Similar to the Marshallian own-price elasticity estimates, all have the expected negative sign, except again for the own-price elasticity estimate of other tomatoes from the ROW ($\hat{e}^c_{7_3 7_3}$). This unexpected positive sign may be the result of combining small-share tomato varieties into the other tomato category. For example, due to small volume and budget shares, this study combined roma tomatoes, grape tomatoes, cherry tomatoes, and other tomatoes from the ROW into one category (other tomatoes from the ROW). Own-price elasticities measure how U.S. fresh-market tomato importers

respond to a 1% change in the own-price of fresh-market tomatoes, ceteris paribus. For example, a 1% increase in the import price of greenhouse tomatoes from Mexico is expected to decrease the quantity imported of greenhouse tomatoes from Mexico by 0.79%, ceteris paribus (table 14). Similarly, a 1% increase in the import price of greenhouse tomatoes from the ROW is expected to decrease the quantity imported of greenhouse tomatoes from the ROW by 2.98% (table 14). Similar to the Marshallian own-price elasticity estimates, excluding the own-price elasticity estimate of greenhouse tomatoes from the ROW -2.9799 ($\hat{e}^{c}_{6_3 6_3}$), our Hicksian own-price elasticity estimates, which range from -0.0093 ($\hat{e}^{c}_{3_1 3_1}$) to -0.7878 ($\hat{e}^{c}_{2_1 2_1}$), fall close or within the range reported by previous studies, which is -0.0300 to -0.5317 (table 16). The inelastic elasticity coefficients may reflect the U.S. reliance of imported fresh-market tomatoes to meet the U.S. increasing demand.

Excluding the own-price elasticities, there were slightly more positive Hicksian cross-price elasticity estimates than there were negatives. Positive cross-price elasticity estimates suggest imports of the two tomato types are positively associated when the price of one of the tomato types changes (i.e., cases of substitutes) while negative cross-price elasticity estimates suggest imports of the two tomato types are negatively associated when the price of one of the tomato type changes (i.e., cases of complements), which in this study may be either from the same or different sources of origin. For example, roma tomatoes from Mexico and greenhouse tomatoes from Canada are (gross and net) substitutes. If the import price of greenhouse tomatoes from Canada increases by 1%, the quantity imported of roma tomatoes from Mexico is expected to increase by

0.46% (table 14). Similarly, roma tomatoes from Mexico and other tomatoes from Canada or the ROW are (gross and net) complements. If the import price of other tomatoes from Canada increases by 1%, the quantity imported of roma tomatoes from Mexico is expected to decrease by 0.16% if coming from Canada and by 0.13% if coming from the ROW (table 14). More positive than negative Hicksian cross-price elasticities seem to suggest that source of origin is not an intrinsic quality attribute for U.S. fresh-market tomato importers.

The Marhallian and Hicksian own-price elasticity of greenhouse tomatoes from the ROW ($\hat{e}_{6_3 6_3}$ and $\hat{e}^{c}_{6_3 6_3}$) had relatively larger values than all other price elasticity coefficients. However, relatively large coefficients are not unusual in disaggregated demand studies (Lopez et al. 2012; Chidmi and Lopez 2007; Nevo 2001). It suggests that the quantity imported of greenhouse tomatoes from ROW is very responsive to the price of greenhouse tomatoes from the ROW.

Table 15 reports the expenditure elasticity estimates. Three expenditure elasticity estimates were positive and statistically significant at the 5% significant level ($\hat{e}_{2_1}, \hat{e}_{3_1}, \hat{e}_{4_2}$), two were negative and statistically significant at the 10% and 5% levels respectively ($\hat{e}_{1_1}, \hat{e}_{6_3}$), and two were negative and not statistically significant ($\hat{e}_{5_2}, \hat{e}_{7_3}$). When an expenditure elasticity estimate is greater than zero; the imported fresh-market tomato is considered a "normal good", in the sense that when U.S. expenditures on imported fresh-market tomatoes increase, the quantity imported of that fresh-market tomato is expected to increase. When an expenditure elasticity estimate is less than zero; the imported fresh-market tomato is considered an "inferior good", in the sense that if

U.S. expenditures on imported fresh-market tomatoes increase, the quantity imported of that fresh-market tomato is expected to decrease. The expenditure elasticity estimates suggests that as the U.S. economy grows and consumer expenditures on fresh-market tomatoes increases, the U.S. is expected to import more greenhouse tomatoes from Mexico and Canada, and roma tomatoes from Mexico. In addition, the expenditure elasticity estimate for greenhouse tomatoes from Mexico is more elastic than the estimate for greenhouse tomatoes from Canada, which is consistent with Seale, Zhang, and Traboulsi (2013). Previous expenditure elasticity estimates for fresh-market tomatoes are reported on table 16. This study is the first to report such estimates at the disaggregated level.

In the case of fresh-market tomatoes coming from the rest of the world, if U.S. expenditures on all imported tomatoes increase by 1%, the quantity imported of fresh-market tomatoes from the ROW is expected to decrease. Similarly, if U.S. expenditures on all imported tomatoes increase by 1%, the quantity imported of other tomatoes from Mexico, Canada, and the ROW is expected to consistently decrease. Negative expenditure elasticities may be the result of the predominantly and rapidly increasing trend of imported greenhouse tomatoes (figure 4).

Conclusion

Greenhouse tomatoes can be grown yearlong and allow growers to better control for quality (e.g., keep tomatoes free of bruises, scratches, etc.). Since the late 1990's imports of greenhouse and roma tomatoes have been rapidly increasing while all other tomatoes have either remained constant or decreased. From 2005 to 2014, greenhouse and roma

tomatoes accounted for 43% and 37% of the U.S. fresh-market tomato imports (table 5). This increasing import demand for fresh-market greenhouse tomatoes is not driven by low prices, but rather by quality, the ability to supply the market, and other factors such as population growth, economic growth, and free trade agreements. Our expenditure elasticity estimates suggests that as the U.S. economy grows, the U.S. is expected to import more greenhouse tomatoes from Mexico and Canada, and roma tomatoes from Mexico.

A direct comparison of this study's elasticity estimates with previous study is not possible since previous studies have aggregated all fresh-market tomatoes into one category. In general though, our elasticity estimates are consistent with previous studies, in terms of the magnitude and sign of the coefficients. Our Hicksian cross-price elasticity estimates indicate that the main competitor of greenhouse tomatoes from Mexico is greenhouse tomatoes from the ROW rather than from Canada. The main competitor of roma tomatoes from Mexico is greenhouse tomatoes from Canada. The main competitor of greenhouse tomatoes from Canada and the ROW are roma and greenhouse tomatoes from Mexico, respectively. These results may be attributed to competitive advantages; which may include to some extent import logistics involved, and the ability to supply the market and meet the import specifications. In addition, slightly more positive Marshallian and Hiksian cross-price elasticities than negatives seems to suggest that source of origin is not an intrinsic quality attribute for U.S. fresh-market tomato importers, but at the same time Mexico and Canada are the preferred sources, which

suggests effective adaptation of NAFTA and the fact that proximity to the market is key to fresh-market tomato trade.

With U.S. fresh-market tomato production decreasing and U.S. consumption increasing, the international market is essential for meeting U.S. consumers' demand for fresh tomatoes. U.S. imports of fresh-market tomatoes accounts for about 50% of the domestic consumption in volume terms, with Mexico and Canada being the two main sources. Consequently, effective implementation of free trade agreements continues to be key in meeting the U.S. consumers' demand for fresh tomatoes.

This study employed a source differentiated almost ideal demand system (SDAIDS) to estimate the U.S. import demand for Canadian and Mexican fresh-market tomatoes. The study not only analyzed five disaggregated fresh-market tomato varieties but also considered the principal supply sources. The study estimated source-differentiated Marshallian and Hicksian price as well as expenditure elasticities. The study contributed to the existing literature by reporting and discussing recent U.S. import elasticity estimates by fresh-market tomato variety. The study may assist U.S. importers and growers in better understanding the substitution patterns among imported fresh-market tomatoes and emerging consumption trends. The study also highlights to U.S. policy makers that free-trade agreements with the U.S. are essential in meeting the increasing U.S. demand for fresh vegetables.

The elasticity estimates reported in this study could also be useful to decision makers in establishing U.S. fresh-tomato import taxes and price floors, and may also

assist growers in monitoring imports and implementing relevant marketing strategies. The elasticity estimates can also be used to project likely import scenarios among our NAFTA partners. Last, further research could use weekly or monthly data to assess if the import substitution patterns identified in this study are to some extend also attributed to seasonality.

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Table 1. Fresh-Market Tomatoes: U.S. Production, Exports, Imports, Apparent Consumption, Apparent Per-capita Consumption, and Ratio of Imports to Consumption, 2005-2014

Year	Production [a]	Exports [b]	Imports [b]	Apparent Consumption	Apparent Per-Capita Consumption	Ratio Imp. to Consum.
	Quantity (metric tons)				Quantity (kg/person)	(%)
2005	1,789,968	147,951	951,786	2,593,803	8.70	37
2006	1,645,363	144,184	992,339	2,493,519	8.29	40
2007	1,525,297	160,777	1,070,808	2,435,327	8.02	44
2008	1,412,352	170,132	1,116,335	2,358,556	7.69	47
2009	1,507,516	170,380	1,189,601	2,526,738	8.16	47
2010	1,268,291	120,752	1,532,489	2,680,028	8.58	57
2011	1,379,195	114,564	1,491,014	2,755,645	8.75	54
2012	1,299,997	117,329	1,532,162	2,714,831	8.55	56
2013	1,197,077	109,468	1,537,472	2,625,081	8.20	59
2014	1,237,401	112,830	1,550,475	2,675,047	8.29	58
	Value (1,000 $)				Value ($/person)	(%)
2005	1,637,394	166,131	1,075,119	2,546,381	8.54	42
2006	1,584,708	172,625	1,233,408	2,645,491	8.79	47
2007	1,168,693	191,866	1,220,498	2,197,325	7.23	56
2008	1,414,131	210,032	1,431,589	2,635,689	8.59	54
2009	1,344,217	212,122	1,403,583	2,535,677	8.19	55
2010	1,352,315	196,873	1,798,238	2,953,680	9.46	61
2011	1,291,875	184,930	2,137,870	3,244,815	10.30	66
2012	874,195	152,349	1,867,605	2,589,450	8.16	72
2013	1,177,592	156,275	1,979,770	3,001,087	9.38	66
2014	1,134,616	166,114	1,960,938	2,929,440	9.08	67

[a] From 2005 to 2010, cherry, grape, tomatillo, and greenhouse tomatoes are excluded.
[b] Data are for fresh or chilled tomatoes (Harmonized Tariff Schedule (HTS) subheadings 07020020, 07020040, and 07020060) on a fresh-weight basis.

Source: Production data from USDA-NASS (2015), USDA-NASS (2012), USDA-NASS (2009), USDA-NASS (2006), USDA-NASS (2003), and USDA-NASS (2000). Exports and imports data from USITC (2015). Population from IMF (2015).

Note: Production data are raw product intended for fresh-market sales only and were converted from pounds to metric tons. Exports and imports were converted from kilograms to metric tons. Apparent consumption equals production minus exports plus imports.

Table 2. Fresh-Market Tomatoes: U.S. Area Planted, Area Harvested, Production, and Yield, 2005-2014

Year	Area planted (acres) [a]	Area harvested (acres) [a]	Production (mt) [a]	Yield (mt/acre) [a]
2005	136,000	129,800	1,789,968	13.79
2006	125,300	120,200	1,645,363	13.69
2007	116,400	108,100	1,525,297	14.11
2008	109,200	105,250	1,412,352	13.42
2009	113,200	108,700	1,507,516	13.87
2010	107,700	103,000	1,268,291	12.31
2011	105,400	99,710	1,379,195	13.83
2012	104,500	101,000	1,299,997	12.87
2013	103,400	99,600	1,197,077	12.02
2014	101,800	97,600	1,237,401	12.68

[a] From 2003 to 2010, cherry, grape, tomatillo, and greenhouse tomatoes are excluded.

Source: Area planted, area harvested, and production data from USDA-NASS (2015), USDA-NASS (2012), USDA-NASS (2009), USDA-NASS (2006), USDA-NASS (2003), and USDA-NASS (2000).

Note: Production data are raw product intended for fresh-market sales only and were converted from pounds to metric tons. Yield data equals production divided by area harvested.

Table 3. All Fresh-Market Tomatoes: U.S. Exports of Domestic Merchandise, by Principal Markets, 2005-2014

Market	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Average 2005-14
	Quantity (metric tons)										
Canada	130,501	119,177	121,562	124,184	110,358	87,610	89,197	89,822	89,326	94,830	105,657
Mexico	13,591	19,691	34,827	43,746	57,722	29,007	23,272	22,363	15,368	14,200	27,379
Japan	1,713	3,769	2,911	392	491	1,229	45	987	1,582	693	1,381
Bahamas	887	958	760	755	703	873	688	839	787	1,103	835
Trin & Tobago	209	100	153	204	210	586	454	950	1,358	914	514
China	0	0	0	4	5	0	0	1,187	185	514	190
Korea	113	132	53	101	114	90	0	65	356	56	108
Bermuda	86	106	85	112	119	116	107	57	68	13	87
Barbados	87	39	57	129	46	96	58	60	36	97	71
Hong Kong	0	17	20	0	1	94	165	183	142	30	65
All other	765	195	350	504	611	1,051	580	815	260	381	551
Total	147,951	144,184	160,777	170,132	170,380	120,752	114,564	117,329	109,468	112,830	136,837
	Value (1,000 $)										
Canada	149,806	144,496	150,840	157,239	139,371	117,453	132,728	113,044	121,731	125,563	135,227
Mexico	7,758	20,928	34,614	49,353	68,669	72,046	48,924	31,986	26,615	33,333	39,423
Japan	5,177	4,860	3,945	469	897	2,704	94	1,227	2,549	1,608	2,353
Bahamas	1,171	1,300	1,230	1,275	1,145	1,401	1,148	1,369	1,561	2,275	1,388
Trin & Tobago	232	79	141	210	266	733	617	1,193	1,909	1,324	670
China	0	0	0	5	14	0	0	1,684	314	713	273
Bermuda	172	246	213	271	248	274	276	110	106	18	193
Korea	83	172	88	96	166	156	0	99	800	55	172
Cayman Is	0	21	0	79	462	325	105	94	131	149	137
Turks & Caic Is	95	71	56	187	124	301	157	70	85	191	134
All other	1,638	452	739	847	759	1,479	881	1,474	473	885	963
Total	166,131	172,625	191,866	210,032	212,122	196,873	184,930	152,349	156,275	166,114	180,932

Source: USITC (2015).

Note: Data are for fresh or chilled tomatoes (Harmonized Tariff Schedule (HTS) subheadings 07020020, 07020040, and 07020060) on a fresh-weight basis. Exports were converted from kilograms to metric tons.

Table 4. All Fresh-Market Tomatoes: U.S. Imports for Consumption, by Principal Sources, 2005-2014

Source	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Average 2005-14
	Quantity (metric tons)										
Mexico	801,408	844,343	949,486	987,914	1,046,869	1,380,111	1,327,309	1,379,519	1,381,306	1,389,334	1,148,760
Canada	141,642	135,141	111,723	119,385	130,310	142,590	141,349	139,311	140,240	146,534	134,823
Guatemala	0	4	252	1,155	2,762	5,408	17,351	8,937	12,088	10,308	5,827
EU-28											
Netherlands	6,249	6,148	5,171	3,445	5,308	863	308	351	339	254	2,844
Spain	275	2,141	480	1,035	93	0	0	0	0	8	403
Belgium	871	1,240	554	198	367	69	0	0	0	0	330
All other	23	294	19	6	0	34	1	0	0	5	38
Subtotal	7,419	9,823	6,224	4,684	5,768	965	309	351	339	268	3,615
Dominic Rep	857	2,422	2,650	2,853	2,862	2,172	4,162	3,224	3,202	3,924	2,833
Israel	348	570	241	221	195	360	104	369	0	37	244
All other	112	36	232	125	836	883	431	451	295	70	347
Total	951,786	992,339	1,070,808	1,116,335	1,189,601	1,532,489	1,491,014	1,532,162	1,537,472	1,550,475	1,296,448
	Value (1,000 $)										
Mexico	781,234	918,755	960,047	1,142,868	1,125,527	1,487,411	1,807,703	1,578,591	1,637,535	1,656,406	1,309,608
Canada	271,977	284,206	238,148	269,236	255,521	293,775	299,936	268,634	320,075	283,052	278,456
Guatemala	0	5	283	1,502	3,981	7,385	21,962	12,135	15,840	14,221	7,731
EU-28											
Netherlands	16,229	17,796	15,028	10,991	12,500	3,400	2,044	2,336	2,416	1,762	8,450
Spain	820	4,810	1,474	2,423	196	0	0	0	0	21	974
Belgium	2,167	2,652	1,110	534	672	312	0	0	0	0	745
All other	30	188	25	8	0	43	4	0	0	8	31
Subtotal	19,245	25,446	17,637	13,957	13,367	3,755	2,048	2,336	2,416	1,791	10,200
Dominic Rep	1,216	3,284	3,217	2,942	2,879	2,942	5,550	4,597	3,518	5,124	3,527
Israel	1,251	1,653	873	836	570	957	275	776	0	148	734
All other	195	60	294	248	1,737	2,013	396	536	386	195	606
Total	1,075,119	1,233,408	1,220,498	1,431,589	1,403,583	1,798,238	2,137,870	1,867,605	1,979,770	1,960,938	1,610,862

Source: USITC (2015).

Note: Data are for fresh or chilled tomatoes (Harmonized Tariff Schedule (HTS) subheadings 07020020, 07020040, and 07020060 on a fresh-weight basis. Imports were converted from kilograms to metric tons.

Table 5. Fresh-Market Tomatoes: U.S. Imports for Consumption, by Type, 2005-2014

Type	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Average 2005-14
	Quantity (metric tons)										
Greenhouse	293,359	321,332	368,854	419,948	484,907	580,620	667,385	728,052	771,214	882,951	551,862
Roma	358,635	373,148	424,610	420,604	439,697	612,022	546,600	555,581	533,014	470,016	473,393
Other	232,790	231,044	205,983	196,937	192,456	251,669	197,758	165,839	146,736	111,036	193,225
Grape	35,518	35,083	43,406	54,286	50,670	70,073	57,801	66,961	63,472	67,177	54,445
Cherry	31,484	31,732	27,955	24,561	21,871	18,104	21,471	15,729	23,035	19,295	23,524
Total	951,786	992,339	1,070,808	1,116,335	1,189,601	1,532,489	1,491,014	1,532,162	1,537,472	1,550,475	1,296,448
	Value (1,000 $)										
Greenhouse	476,816	552,384	639,473	715,493	760,105	979,239	1,233,718	1,216,202	1,275,758	1,318,654	916,784
Roma	301,087	331,650	302,140	372,784	354,880	454,652	556,985	417,347	427,487	379,051	389,806
Other	192,129	238,833	165,555	225,919	181,058	226,023	228,201	131,861	162,207	137,154	188,894
Grape	52,438	51,097	65,390	77,802	72,179	107,245	82,664	79,796	79,594	96,021	76,422
Cherry	52,650	59,444	47,939	39,592	35,362	31,079	36,302	22,399	34,723	30,057	38,955
Total	1,075,119	1,233,408	1,220,498	1,431,589	1,403,583	1,798,238	2,137,870	1,867,605	1,979,770	1,960,938	1,610,862

Source: USITC (2015).

Note: All data are on a fresh-weight basis. Data for fresh or chilled greenhouse tomatoes include Harmonized Tariff Schedule (HTS) commodities 0702002010, 0702004010, and 0702006010. Data for fresh or chilled Roma or other Roma tomatoes include HTS commodities 0702002060, 0702002065, 0702004060, 0702004065, 0702006060, and 0702006065. Data for fresh or chilled grape tomatoes include HTS commodities 0702002045, 0702004045, 0702004046, and 0702006045. Data for fresh or chilled cherry or other cherry tomatoes include HTS commodities 0702002030, 0702002035, 0702004030, 0702004035, 0702006030, and 0702006035. Data for fresh or chilled tomatoes or other tomatoes include HTS commodities 0702002090, 0702002095, 0702002099, 0702004090, 0702004098, 0702004099, 0702006090, 0702006095, 0702006099. Imports were converted from kilograms to metric tons.

Table 6. Fresh-Market Greenhouse Tomatoes: U.S. Imports for Consumption, by Principal Sources, 2005-2014

Source	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Average 2005-14
	Quantity (metric tons)										
Mexico	149,505	177,184	249,759	299,045	353,789	438,611	520,104	586,782	632,664	738,007	414,545
Canada	137,013	134,355	111,418	114,737	123,134	138,123	135,808	131,649	126,428	133,691	128,636
Guatemala	0	0	95	35	87	729	8,345	6,790	9,625	8,690	3,440
EU-28											
Netherlands	5,468	5,391	4,841	3,266	5,094	752	308	327	339	254	2,604
Spain	275	2,043	480	981	93	0	0	0	0	8	388
Belgium	704	1,103	549	198	367	69	0	0	0	0	299
All other	1	41	0	0	0	34	0	0	0	0	8
Subtotal	6,449	8,577	5,869	4,446	5,554	854	308	327	339	263	3,299
Dominic Rep	130	982	1,528	1,542	1,787	1,456	2,505	1,748	1,914	2,227	1,582
All other	262	234	185	143	556	847	315	755	244	72	361
Total	293,359	321,332	368,854	419,948	484,907	580,620	667,385	728,052	771,214	882,951	551,862
	Value (1,000 $)										
Mexico	194,730	244,021	382,330	437,986	496,549	679,687	924,111	940,729	958,414	1,035,204	629,376
Canada	264,018	283,398	237,914	262,258	247,108	290,548	293,133	259,788	299,429	266,383	270,397
Guatemala	0	0	111	41	108	900	10,360	9,299	12,777	12,136	4,573
EU-28											
Netherlands	14,471	15,721	13,956	10,305	11,885	3,071	2,040	2,150	2,416	1,762	7,778
Spain	820	4,538	1,474	2,330	196	0	0	0	0	21	938
Belgium	1,589	2,285	1,091	534	672	312	0	0	0	0	648
All other	4	23	0	0	0	43	0	0	0	0	7
Subtotal	16,885	22,568	16,521	13,169	12,752	3,426	2,040	2,150	2,416	1,784	9,371
Dominican Rep	130	1,471	1,870	1,453	1,986	2,401	3,704	3,015	2,413	2,902	2,134
All other	1,054	927	727	586	1,603	2,277	370	1,221	309	246	932
Total	476,816	552,384	639,473	715,493	760,105	979,239	1,233,718	1,216,202	1,275,758	1,318,654	916,784

Source: USITC (2015).

Note: Data are for fresh or chilled greenhouse tomatoes (Harmonized Tariff Schedule (HTS) commodities 0702002010, 0702004010, and 0702006010) on a fresh-weight basis. Imports were converted from kilograms to metric tons.

Table 7. Fresh-Market Roma Tomatoes: U.S. Imports for Consumption, by Principals Sources, 2005-2014

Source	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Average 2005-14
	Quantity (metric tons)										
Mexico	358,110	372,515	424,412	419,705	438,165	610,182	544,796	550,986	530,598	466,896	471,636
Canada	158	326	70	755	1,462	1,688	1,570	4,224	2,143	2,428	1,482
Dominican Rep	241	300	124	111	68	0	160	102	155	273	153
Guatemala	0	0	0	30	0	11	73	265	118	420	92
All other	127	8	4	3	3	141	0	5	0	0	29
Total	358,635	373,148	424,610	420,604	439,697	612,022	546,600	555,581	533,014	470,016	473,393
	Value (1,000 $)										
Mexico	300,307	330,981	301,952	371,779	352,736	453,151	555,324	411,782	424,836	376,516	387,936
Canada	115	296	41	814	2,034	1,304	1,265	4,772	2,360	2,081	1,508
Dominican Rep	321	342	120	145	98	0	238	224	43	132	166
Guatemala	0	0	0	34	0	16	158	555	248	321	133
All other	344	31	28	10	12	182	0	14	0	0	62
Total	301,087	331,650	302,140	372,784	354,880	454,652	556,985	417,347	427,487	379,051	389,806

Source: USITC (2015).

Note: Data are for fresh or chilled Roma or other Roma tomatoes (Harmonized Tariff Schedule (HTS) commodities 0702002060, 0702002065, 0702004060, 0702004065, 0702006060, and 0702006065) on a fresh-weight basis. Imports were converted from kilograms to metric tons.

Table 8. Fresh-Market Grape Tomatoes: U.S. Imports for Consumption, by Principal Sources, 2005-2014

Source	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Average 2005-14
	Quantity (metric tons)										
Mexico	35,467	34,940	43,077	53,341	49,793	69,470	56,575	65,712	62,452	65,914	53,674
Dominican Rep	29	140	329	890	837	588	946	1,159	862	1,011	679
Canada	21	0	0	48	21	3	203	91	146	216	75
All other	0	3	0	7	19	13	77	0	13	36	17
Total	35,518	35,083	43,406	54,286	50,670	70,073	57,801	66,961	63,472	67,177	54,445
	Values (1,000 $)										
Mexico	52,333	50,961	65,083	76,768	71,401	106,869	81,517	78,813	78,669	94,257	75,667
Dominican Rep	57	124	307	917	654	358	664	760	538	1,355	573
Canada	47	0	0	86	40	2	405	223	365	370	154
All other	0	12	0	31	84	16	78	0	22	40	28
Total	52,438	51,097	65,390	77,802	72,179	107,245	82,664	79,796	79,594	96,021	76,422

Source: USITC (2015).

Note: Data are for fresh or chilled grape tomatoes (Harmonized Tariff Schedule (HTS) commodities 0702002045, 0702004045, 0702004046, and 0702006045) on a fresh-weight basis. Imports were converted from kilograms to metric tons.

Table 9. Fresh-Market Cherry Tomatoes: U.S. Imports for Consumption, by Principal Sources, 2005-2014

Source	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Average 2005-14
	Quantity (metric tons)										
Mexico	31,244	31,119	27,349	24,416	21,485	18,006	21,108	15,139	15,225	13,891	21,898
Canada	0	0	0	17	339	0	160	381	7,639	5,155	1,369
Dominican Rep	104	207	535	17	11	0	72	75	167	241	143
All other	137	407	71	111	36	98	131	134	5	8	114
Total	31,484	31,732	27,955	24,561	21,871	18,104	21,471	15,729	23,035	19,295	23,524
	Value (1,000 $)										
Mexico	52,058	58,074	46,998	39,174	34,791	30,839	35,538	21,158	21,493	21,099	36,122
Canada	0	0	0	42	462	0	339	680	12,795	8,432	2,275
Dominican Rep	262	452	740	26	12	0	224	248	426	508	290
All other	330	918	201	351	97	240	202	313	9	17	268
Total	52,650	59,444	47,939	39,592	35,362	31,079	36,302	22,399	34,723	30,057	38,955

Source: USITC (2015).

Note: Data are for fresh or chilled cherry or other cherry tomatoes (Harmonized Tariff Schedule (HTS) commodities 0702002030, 0702002035, 0702004030, 0702004035, 0702006030, and 0702006035) on a fresh-weight basis. Imports were converted from kilograms to metric tons.

Table 10. Other Fresh-Market Tomatoes: U.S. Imports for Consumption, by Principals Sources, 2005-2014

Source	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Average 2005-14
	Quantity (metric tons)										
Mexico	227,081	228,585	204,889	191,407	183,637	243,842	184,727	160,900	140,367	104,626	187,006
Canada	4,450	460	235	3,828	5,354	2,776	3,609	2,966	3,885	5,045	3,261
Guatemala	0	4	157	1,090	2,675	4,655	8,752	1,759	2,328	1,159	2,258
EU-28											
Netherlands	672	666	312	132	194	110	1	24	0	0	211
All other	175	486	25	60	0	0	1	0	0	0	75
Subtotal	848	1,152	337	192	194	110	2	24	0	0	286
Dominican Rep	354	795	134	293	160	128	478	141	105	171	276
Costa Rica	36	36	214	84	357	90	16	43	52	0	93
All other	22	12	17	43	80	67	175	7	0	35	46
Total	232,790	231,044	205,983	196,937	192,456	251,669	197,758	165,839	146,736	111,036	193,225
	Value (1,000 $)										
Mexico	181,806	234,719	163,683	217,160	170,051	216,866	211,214	126,109	154,122	129,329	180,506
Canada	7,797	512	193	6,036	5,878	1,921	4,793	3,170	5,126	5,786	4,121
Guatemala	0	5	172	1,427	3,873	6,453	11,209	1,980	2,784	1,715	2,962
EU-28											
Netherlands	1,435	1,818	994	543	521	323	4	186	0	0	582
All other	552	795	44	102	0	0	4	0	0	0	150
Subtotal	1,987	2,613	1,038	645	521	323	8	186	0	0	732
Dominican Rep	447	894	180	400	129	184	720	350	99	227	363
Costa Rica	28	60	239	116	407	116	30	49	77	0	112
All other	64	31	50	133	199	161	227	16	0	97	98
Total	192,129	238,833	165,555	225,919	181,058	226,023	228,201	131,861	162,207	137,154	188,894

Source: USITC (2015).

Note: Data are for fresh or chilled tomatoes or other tomatoes (Harmonized Tariff Schedule (HTS) commodities 0702002090, 0702002095, 0702002099, 0702004090, 0702004098, 0702004099, 0702006090, 0702006095, 0702006099) on a fresh-weight basis. Imports were converted from kilograms to metric tons.

Table 11. Average Quantity, Value, and Expenditure Shares of Fresh-Market Tomato Imports from Mexico and Canada, 1999-2014

Fresh-Market Tomato	Quantity (metric tons)	Value ($)	Expenditure Share
MEXICO			
Other Tomatoes	321,893	309,680,762	0.2544
Greenhouse Tomatoes	231,773	349,466,942	0.2871
Roma Tomatoes	380,028	299,283,041	0.2459
CANADA			
Greenhouse Tomatoes	88,418	179,483,050	0.1474
Other Tomatoes	23,165	35,781,981	0.0294
ROW			
Greenhouse Tomatoes	9,935	19,701,436	0.0162
Other Tomatoes	13,900	23,927,030	0.0197

Source: USITC (2015).

Note: Greenhouse tomatoes from Mexico, Canada and the ROW include Harmonized Tariff Schedule (HTS) commodities 0702002010, 0702004010, and 0702006010. Roma tomatoes from Mexico include HTS commodities 0702002060, 0702002065, 0702004060, 0702004065, 0702006060, and 0702006065. Other tomatoes from Mexico include grape tomatoes (HTS commodities 0702002045, 0702004045, 0702004046, and 0702006045), cherry tomatoes (HTS commodities 0702002030, 0702002035, 0702004030, 0702004035, 0702006030, and 0702006035), and other tomatoes (HTS commodities 0702002090, 0702002095, 0702002099, 0702004090, 0702004098, 0702004099, 0702006090, 0702006095, 0702006099). Other tomatoes from Canada and the ROW include Roma tomatoes (HTS commodities 0702002060, 0702002065, 0702004060, 0702004065, 0702006060, and 0702006065) grape tomatoes (HTS commodities 0702002045, 0702004045, 0702004046, and 0702006045), cherry tomatoes (HTS commodities 0702002030, 0702002035, 0702004030, 0702004035, 0702006030, and 0702006035), and other tomatoes (HTS commodities 0702002090, 0702002095, 0702002099, 0702004090, 0702004098, 0702004099, 0702006090, 0702006095, 0702006099).

Table 12. U.S. Fresh-Market Tomato Imports: SDAIDS Model Parameter Estimates, 1999-2014

	MEXICO						CANADA				ROW			
	Other Tomato		Greenhouse		Roma Tomato		Greenhouse		Other Tomato		Greenhouse		Other Tomato	
Par.	Est.	Std Err	Est.	Std Err	Est.	Std Err	Est.	Std Err	Est.	Std Err	Est.	Std Err	Est.	Std Err
α_{i_h}	4.7241*	0.4877	-7.7695*	0.6922	1.5674*	0.2935	0.3974	0.6449	0.9824*	0.3683	0.8176*	0.1764	0.2806	0.2835
$\gamma_{i_h{}^1{}_k}$	-1.5327*	0.4317	3.0274*	0.6468	-0.5636*	0.1473	-0.1536	0.2558	-0.3691‡	0.1703	-0.3183*	0.0758	-0.0902	0.1191
$\gamma_{i_h{}^2{}_k}$	3.0274*	0.6468	-5.4188*	1.0424	0.7853*	0.2615	0.1322	0.4415	0.6881*	0.2717	0.6034*	0.1407	0.1825	0.1947
$\gamma_{i_h{}^3{}_k}$	-0.5636*	0.1473	0.7853*	0.2615	0.0580	0.0597	0.0478	0.0706	-0.1506*	0.0397	-0.1102*	0.0318	-0.0668‡	0.0303
$\gamma_{i_h{}^4{}_k}$	-0.1536	0.2558	0.1322	0.4415	0.0478	0.0706	0.0820	0.0857	-0.0714	0.0742	0.0019	0.0490	-0.0388	0.0455
$\gamma_{i_h{}^5{}_k}$	-0.3691‡	0.1703	0.6881*	0.2717	-0.1506*	0.0397	-0.0714	0.0742	-0.0286	0.0794	-0.0678*	0.0268	-0.0006	0.0424
$\gamma_{i_h{}^6{}_k}$	-0.3183	0.0758	0.6034*	0.1407	-0.1102*	0.0318	0.0019	0.0490	-0.0678*	0.0268	-0.1009*	0.0273	-0.0081	0.0191
$\gamma_{i_h{}^7{}_k}$	-0.0902*	0.1191	0.1825	0.1947	-0.0668‡	0.0303	-0.0388	0.0455	-0.0006	0.0424	-0.0081	0.0191	0.0220	0.0299
β_{i_h}	-0.3236*	0.0370	0.5809*	0.0517	-0.0908*	0.0211	-0.0181	0.0476	-0.0698*	0.0272	-0.0586*	0.0126	-0.0200	0.0208

Goodness of Fit														
	R^2	Adj. R^2	R^2	Adj. R^2	R^2	Adj. R^2	R^2	Adj. R^2	R^2	Adj. R^2	R^2	Adj. R^2	R^2	Adj. R^2
	0.8991	0.8559	0.9376	0.9109	0.5825	0.4036	0.2101	-0.1284	0.7010	0.5729	0.7360	0.6229	n.a.	n.a.

Note: Significant at the 0.05, 0.10, and 0.20 probability levels are indicated by asterisks (*), double daggers (‡), and daggers (†) respectively. Greenhouse tomatoes from Mexico, Canada and the ROW include Harmonized Tariff Schedule (HTS) commodities 0702002010, 0702004010, and 0702006010. Roma tomatoes from Mexico include HTS commodities 0702002060, 0702002065, 0702004060, 0702004065, 0702006060, and 0702006065. Other tomatoes from Mexico include grape tomatoes (HTS commodities 0702002045, 0702004045, 0702004046, and 0702006045), cherry tomatoes (HTS commodities 0702002030, 0702002035, 0702004030, 0702004035, 0702006030, and 0702006035), and other tomatoes (HTS commodities 0702002090, 0702002095, 0702002099, 0702004090, 0702004098, 0702004099, 0702006090, 0702006095, 0702006099). Other tomatoes from Canada and the ROW include Roma tomatoes (HTS commodities 0702002060, 0702002065, 0702004060, 0702004065, 0702006060, and 0702006065) grape tomatoes (HTS commodities 0702002045, 0702004045, 0702004046, and 0702006045), cherry tomatoes (HTS commodities 0702002030, 0702002035, 0702004030, 0702004035, 0702006030, and 0702006035), and other tomatoes (HTS commodities 0702002090, 0702002095, 0702002099, 0702004090, 0702004098, 0702004099, 0702006090, 0702006095, 0702006099).

Table 13. U.S. Fresh-Market Tomato Imports: SDAIDS Model, Marshallian Price Elasticity Estimates, 1999-2014

Marshallian Price Elasticity Estimates ($\hat{e}_{i_h j_m}$)							
	MEXICO			CANADA		ROW	
$i_h \backslash j_m$	Other	Greenhouse	Roma	Greenhouse	Other	Greenhouse	Other
MEXICO							
Other Tomatoes	-0.1137	0.3761	-0.0444	-0.0310	0.0168	-0.0264	0.0753
Greenhouse Tomatoes	-0.5317†	-1.6229*	-0.8097*	-0.5087†	0.0695	0.1740‡	-0.0562
Roma Tomatoes	-0.2758*	-0.1481	-0.1505	0.3538*	-0.1826*	0.0909†	-0.1436‡
CANADA							
Greenhouse Tomatoes	-0.3444	-0.1960	0.4898‡	-0.4386	-0.3149	0.1203	-0.2036
Other Tomatoes	6.3156	1.5694†	-0.8806†	-1.1165	-0.4487	-0.0167	0.6430
ROW							
Greenhouse Tomatoes	0.0401	3.1657*	-0.4439	1.2374	-0.0041	-2.9441*	0.5121
Other Tomatoes	1.0675	0.0620	-1.8407†	-1.6833	1.2722	0.6292	0.6248

Note: Significant at the 0.05, 0.10, and 0.20 probability levels are indicated by asterisks (*), double daggers (‡), and daggers (†) respectively. Greenhouse tomatoes from Mexico, Canada and the ROW include Harmonized Tariff Schedule (HTS) commodities 0702002010, 0702004010, and 0702006010. Roma tomatoes from Mexico include HTS commodities 0702002060, 0702002065, 0702004060, 0702004065, 0702006060, and 0702006065. Other tomatoes from Mexico include grape tomatoes (HTS commodities 0702002045, 0702004045, 0702004046, and 0702006045), cherry tomatoes (HTS commodities 0702002030, 0702002035, 0702004030, 0702004035, 0702006030, and 0702006035), and other tomatoes (HTS commodities 0702002090, 0702002095, 0702002099, 0702004090, 0702004098, 0702004099, 0702006090, 0702006095, 0702006099). Other tomatoes from Canada and the ROW include Roma tomatoes (HTS commodities 0702002060, 0702002065, 0702004060, 0702004065, 0702006060, and 0702006065) grape tomatoes (HTS commodities 0702002045, 0702004045, 0702004046, and 0702006045), cherry tomatoes (HTS commodities 0702002030, 0702002035, 0702004030, 0702004035, 0702006030, and 0702006035), and other tomatoes (HTS commodities 0702002090, 0702002095, 0702002099, 0702004090, 0702004098, 0702004099, 0702006090, 0702006095, 0702006099).

Table 14. U.S. Fresh-Market Tomato Imports: SDAIDS Model, Hicksian Price Elasticity Estimates, 1999-2014

Hicksian Price Elasticity Estimates ($\widehat{ec}_{i_h j_m}$)							
	MEXICO			CANADA		ROW	
$i_h \setminus j_m$	Other	Greenhouse	Roma	Greenhouse	Other	Greenhouse	Other
MEXICO							
Other Tomatoes	-0.1789	0.3119	-0.1077	-0.0716	0.0077	-0.0322	0.0708
Greenhouse Tomatoes	0.3170	-0.7878†	0.0138	0.0187	0.1872	0.2492*	0.0020
Roma Tomatoes	-0.1110	0.0140	-0.0093	0.4561	-0.1598	-0.0763	-0.1323‡
CANADA							
Greenhouse Tomatoes	-0.1152	0.0296	0.7122*	-0.2962	-0.2831	0.1406	-0.1879
Other Tomatoes	6.0708	1.3285	-1.1182*	-1.2686	-0.4147	-0.0384	0.6262
ROW							
Greenhouse Tomatoes	-0.3637	2.7684*	-0.8357	0.9865	-0.0601	-2.9799*	0.4845
Other Tomatoes	1.0335	0.0286	-1.8737‡	-1.7045	1.2674	0.6262	0.6225

Note: Significant at the 0.05, 0.10, and 0.20 probability levels are indicated by asterisks (*), double daggers (‡), and daggers (†) respectively. Greenhouse tomatoes from Mexico, Canada and the ROW include Harmonized Tariff Schedule (HTS) commodities 0702002010, 0702004010, and 0702006010. Roma tomatoes from Mexico include HTS commodities 0702002060, 0702002065, 0702004060, 0702004065, 0702006060, and 0702006065. Other tomatoes from Mexico include grape tomatoes (HTS commodities 0702002045, 0702004045, 0702004046, and 0702006045), cherry tomatoes (HTS commodities 0702002030, 0702002035, 0702004030, 0702004035, 0702006030, and 0702006035), and other tomatoes (HTS commodities 0702002090, 0702002095, 0702002099, 0702004090, 0702004098, 0702004099, 0702006090, 0702006095, 0702006099). Other tomatoes from Canada and the ROW include Roma tomatoes (HTS commodities 0702002060, 0702002065, 0702004060, 0702004065, 0702006060, and 0702006065) grape tomatoes (HTS commodities 0702002045, 0702004045, 0702004046, and 0702006045), cherry tomatoes (HTS commodities 0702002030, 0702002035, 0702004030, 0702004035, 0702006030, and 0702006035), and other tomatoes (HTS commodities 0702002090, 0702002095, 0702002099, 0702004090, 0702004098, 0702004099, 0702006090, 0702006095, 0702006099).

Table 15. U.S. Fresh-Market Tomato Imports: SDAIDS Model, Expenditure Elasticity Estimates, 1999-2014

i_h	Expenditure Elasticity Estimates ($\hat{e}_{i_h}$)
MEXICO	
Other Tomatoes	-0.2526†
Greenhouse Tomatoes	3.2855*
Roma Tomatoes	0.6376*
CANADA	
Greenhouse Tomatoes	0.8875*
Other Tomatoes	-0.9479
ROW	
Greenhouse Tomatoes	-1.5631*
Other Tomatoes	-0.1317

Note: Significant at the 0.05, 0.10, and 0.20 probability levels are indicated by asterisks (*), double daggers (‡), and daggers (†) respectively. Greenhouse tomatoes from Mexico, Canada and the ROW include Harmonized Tariff Schedule (HTS) commodities 0702002010, 0702004010, and 0702006010. Roma tomatoes from Mexico include HTS commodities 0702002060, 0702002065, 0702004060, 0702004065, 0702006060, and 0702006065. Other tomatoes from Mexico include grape tomatoes (HTS commodities 0702002045, 0702004045, 0702004046, and 0702006045), cherry tomatoes (HTS commodities 0702002030, 0702002035, 0702004030, 0702004035, 0702006030, and 0702006035), and other tomatoes (HTS commodities 0702002090, 0702002095, 0702002099, 0702004090, 0702004098, 0702004099, 0702006090, 0702006095, 0702006099). Other tomatoes from Canada and the ROW include Roma tomatoes (HTS commodities 0702002060, 0702002065, 0702004060, 0702004065, 0702006060, and 0702006065) grape tomatoes (HTS commodities 0702002045, 0702004045, 0702004046, and 0702006045), cherry tomatoes (HTS commodities 0702002030, 0702002035, 0702004030, 0702004035, 0702006030, and 0702006035), and other tomatoes (HTS commodities 0702002090, 0702002095, 0702002099, 0702004090, 0702004098, 0702004099, 0702006090, 0702006095, 0702006099).

Table 16. Marshallian and Hicksian own-price and expenditure elasticity estimates for U.S. fresh-market tomatoes in previous studies

Study	Model	Period	Tomato Type	Market	Marshallian Own-Price		Hicksian Own-Price		Expenditure	
					Estimate	Sig.	Estimate	Sig.	Estimate	Sig.
Naanwaab and Yeboah (2012)	LA/AIDS	1970-2010	Tomatoes	U.S.	-0.5970	n.a.	-0.4430	n.a.	0.7330	n.a.
Nzaku and Houston (2009)	LA/AIDS	1989-2008	Tomatoes	Imported	-0.5438	n.a.	-0.5317	n.a.	0.1111	n.a.
Jung, VanSickle, and Seale (2005)	double-log	1990-2001	Tomatoes	U.S. & Imp.	-0.6140	**	-0.1136	n.a.	0.7702	**
Jung, VanSickle, and Seale (2005)	Rotterdam	1990-2001	Tomatoes	U.S. & Imp.	-0.8468	**	-0.1530	**	1.0640	**
Jung, VanSickle, and Seale (2005)	FD/AIDS	1990-2001	Tomatoes	U.S. & Imp.	-1.1967	**	-0.2192	**	1.5047	**
Seale, Zhang, and Traboulsi (2013)	Rotterdam	1989-2009	Tomatoes	Imp. Mexico	n.a.	n.a.	-0.0300	n.a.	1.1800	n.a.
Seale, Zhang, and Traboulsi (2013)	Rotterdam	1989-2009	Tomatoes	Imp. Canada	n.a.	n.a.	-0.3700	n.a.	0.7800	n.a.
Thompson (2003)	QAIDS	1997-1999	Regular	Dallas, TX	-0.7890	n.a.	n.a.	n.a.	n.a.	n.a.
Thompson (2003)	QAIDS	1997-1999	Greenhouse	Dallas, TX	-0.4800	n.a.	n.a.	n.a.	n.a.	n.a.
Thompson (2003)	QAIDS	1997-1999	On the Vine	Dallas, TX	-0.0100	n.a.	n.a.	n.a.	n.a.	n.a.
Thompson (2003)	QAIDS	1997-1999	Roma	Dallas, TX	-1.5400	n.a.	n.a.	n.a.	n.a.	n.a.
Thompson (2003)	QAIDS	1997-1999	Cherry	Dallas, TX	0.0500	n.a.	n.a.	n.a.	n.a.	n.a.
Henneberry, Piewthongngam, and Qiang (1999)	LA/AIDS	1970-1992	Tomatoes	U.S.	-0.2300	**	-0.1100	n.s.	n.a.	n.a.

Note: Significance at the 0.01, 0.05, and 0.10 probability levels are indicated by triple asterisks (***), double asterisks (**), and single asterisks (*), respectively. The abbreviations n.a. and n.s. stand for not available and not significant, respectively.

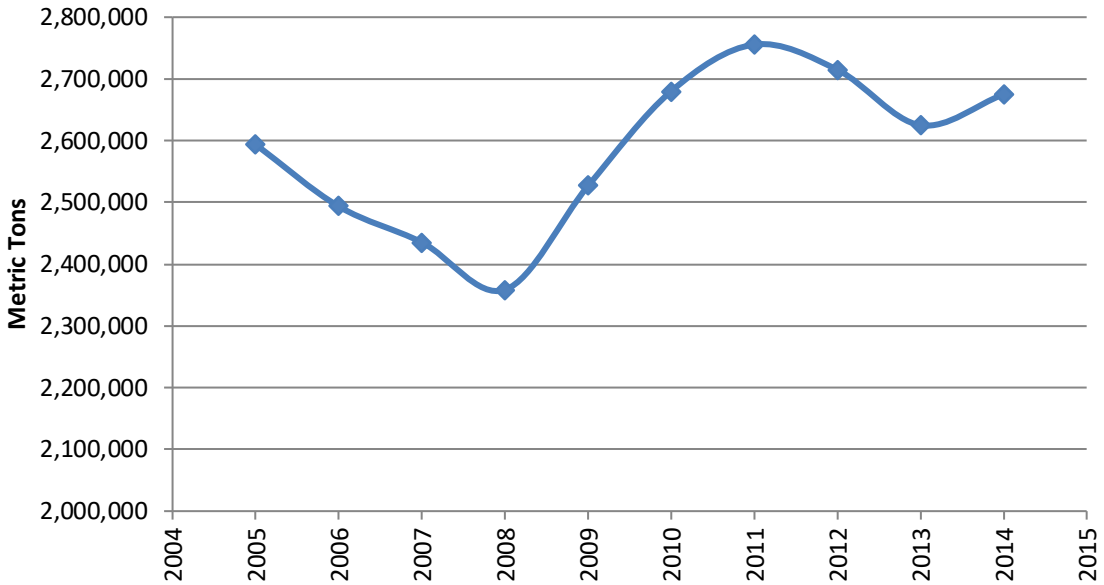

Figure 1. Fresh-market tomatoes: U.S. apparent consumption

Source: Production data from USDA-NASS (2015), USDA-NASS (2012), USDA-NASS (2009), USDA-NASS (2006), USDA-NASS (2003), and USDA-NASS (2000). Exports and imports data from USITC (2015).

Note: Apparent consumption equals production minus exports plus imports. Production data were converted from pounds to metric tons using a factor of 2,204.62 pounds per metric ton. Exports and imports were converted from kilograms to metric tons.

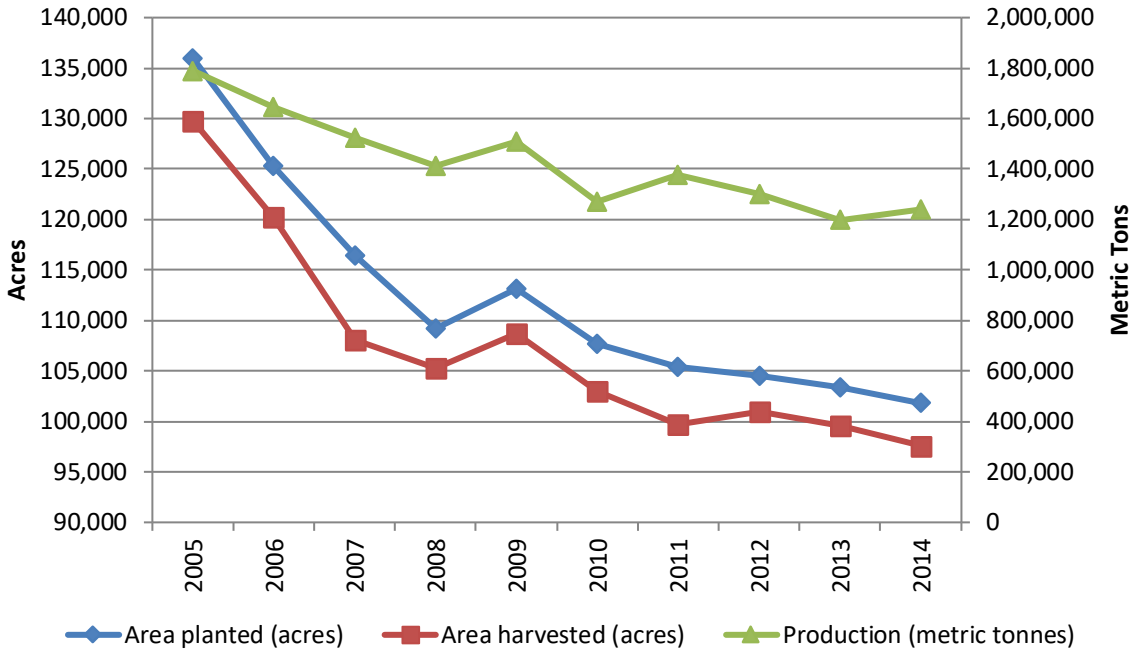

Figure 2. Fresh-market tomatoes: U.S. area planted, area harvested, and production, 2005-2014

Source: Area planted, area harvested, and production data from USDA-NASS (2015), USDA-NASS (2012), USDA-NASS (2009), USDA-NASS (2006), USDA-NASS (2003), and USDA-NASS (2000).

Note: Production data are raw product intended for fresh-market sales only and were converted from pounds to metric tons using a factor of 2,204.62 pounds per metric ton.

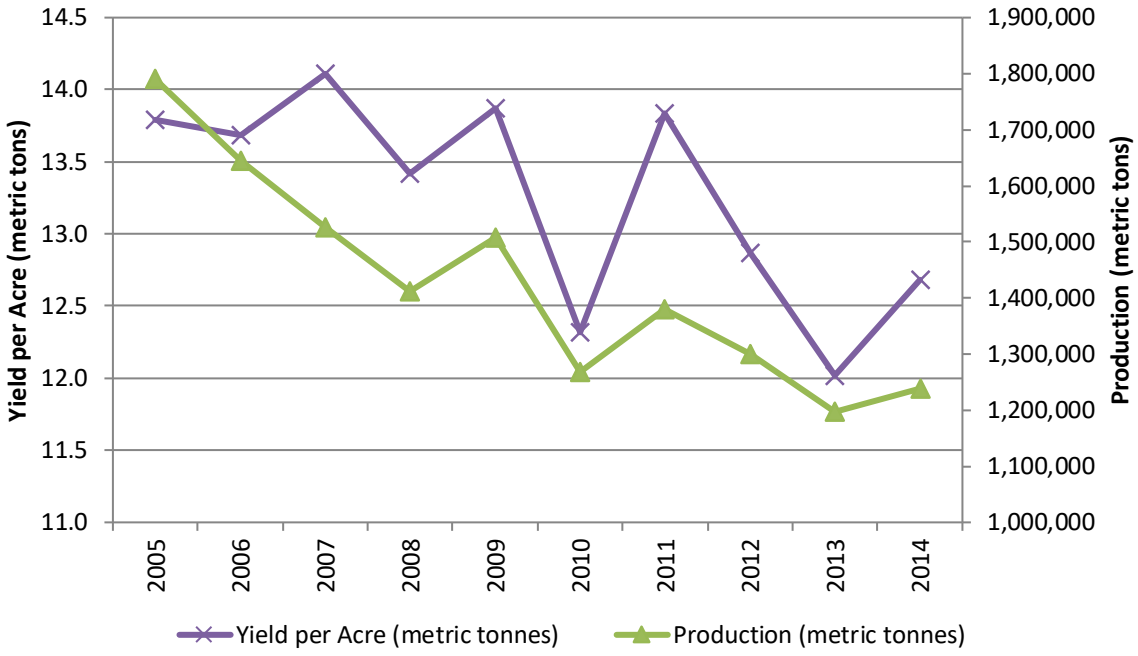

Figure 3. Fresh-market tomatoes: U.S. production and yield, 2005-2014

Source: Production data from USDA-NASS (2015), USDA-NASS (2012), USDA-NASS (2009), USDA-NASS (2006), USDA-NASS (2003), and USDA-NASS (2000).

Note: Production data are raw product intended for fresh-market sales only and were converted from pounds to metric tons. Yield data equals production divided by area harvested.

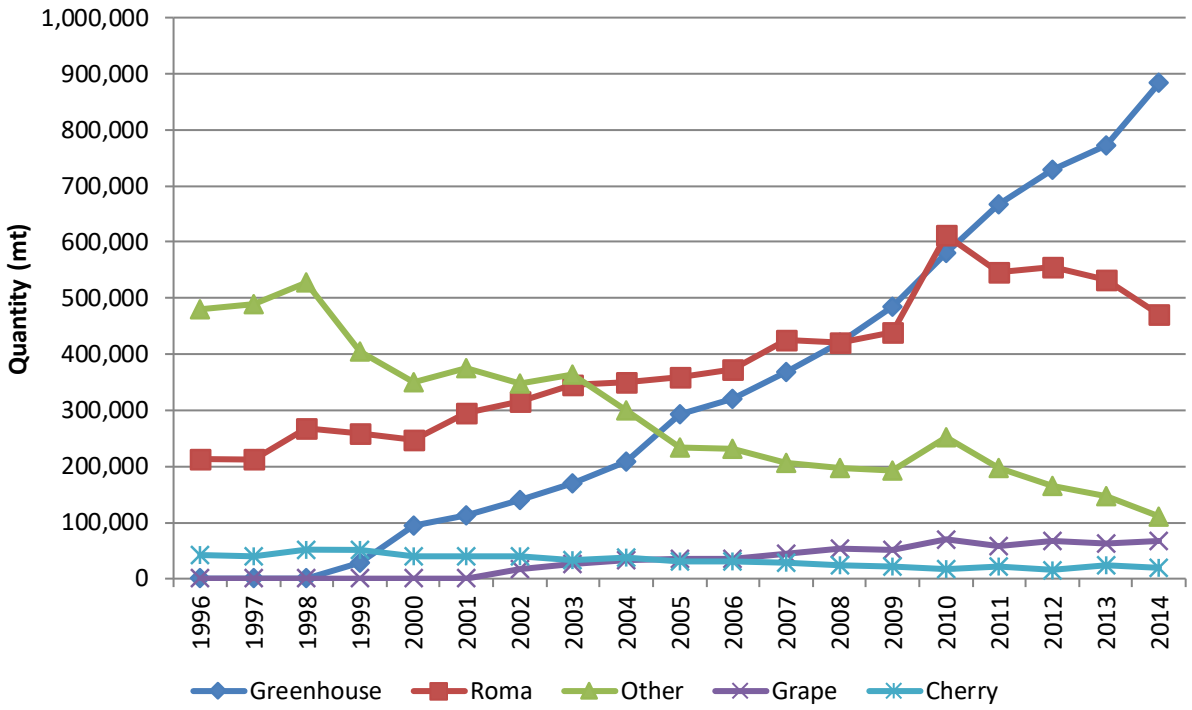

Figure 4. Fresh-market tomatoes: U.S. imports (metric tons) for consumption by type, 1996-2014

Source: USITC (2015).

Note: All data are on a fresh-weight basis. Data for fresh or chilled greenhouse tomatoes include Harmonized Tariff Schedule (HTS) commodities 0702002010, 0702004010, and 0702006010. Data for fresh or chilled Roma or other Roma tomatoes include HTS commodities 0702002060, 0702002065, 0702004060, 0702004065, 0702006060, and 0702006065. Data for fresh or chilled grape tomatoes include HTS commodities 0702002045, 0702004045, 0702004046, and 0702006045. Data for fresh or chilled cherry or other cherry tomatoes include HTS commodities 0702002030, 0702002035, 0702004030, 0702004035, 0702006030, and 0702006035. Data for fresh or chilled tomatoes or other tomatoes include HTS commodities 0702002090, 0702002095, 0702002099, 0702004090, 0702004098, 0702004099, 0702006090, 0702006095, 0702006099. Imports were converted from kilograms to metric tons.

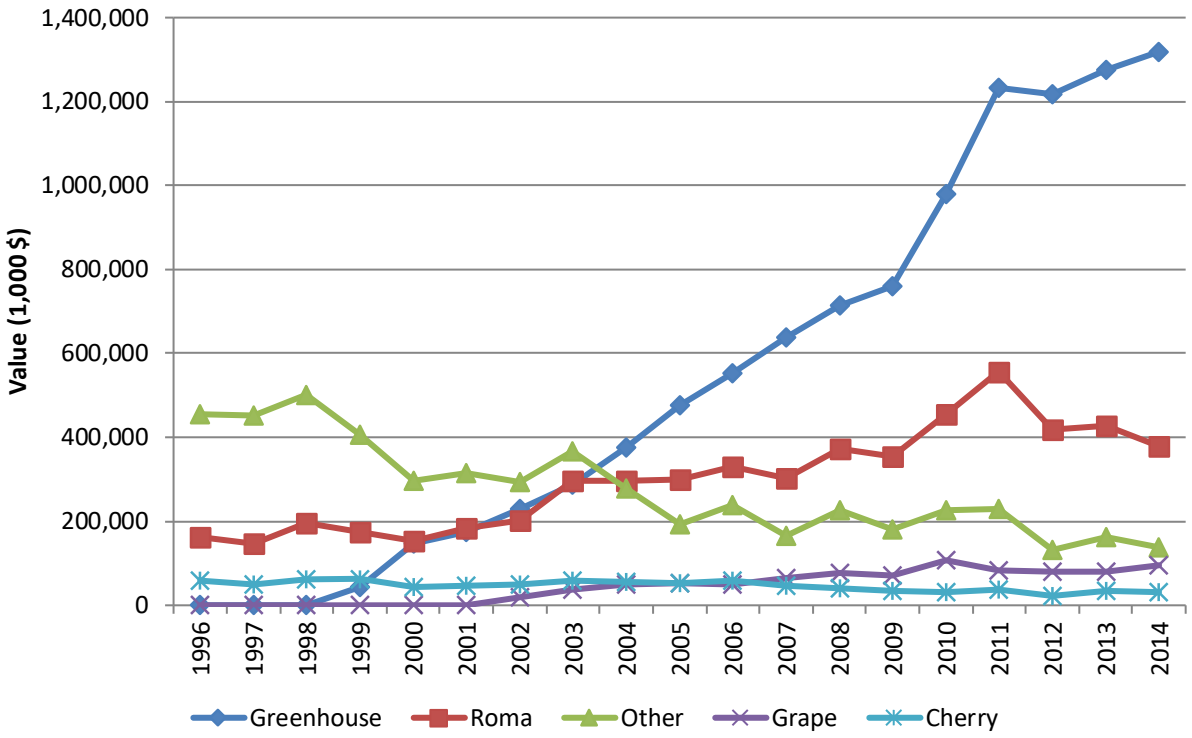

Figure 5. Fresh-market tomatoes: U.S. imports ($) for consumption by type, 1996-2014

Source: Data retrieved by author from the USITC Interactive Tariff and Trade DataWeb, Version 3.1.0, of the United States International Trade Commission (USITC).

Note: All data are on a fresh-weight basis. Data for fresh or chilled greenhouse tomatoes include Harmonized Tariff Schedule (HTS) commodities 0702002010, 0702004010, and 0702006010. Data for fresh or chilled Roma or other Roma tomatoes include HTS commodities 0702002060, 0702002065, 0702004060, 0702004065, 0702006060, and 0702006065. Data for fresh or chilled grape tomatoes include HTS commodities 0702002045, 0702004045, 0702004046, and 0702006045. Data for fresh or chilled cherry or other cherry tomatoes include HTS commodities 0702002030, 0702002035, 0702004030, 0702004035, 0702006030, and 0702006035. Data for fresh or chilled tomatoes or other tomatoes include HTS commodities 0702002090, 0702002095, 0702002099, 0702004090, 0702004098, 0702004099, 0702006090, 0702006095, 0702006099. Imports were converted from kilograms to metric tons.

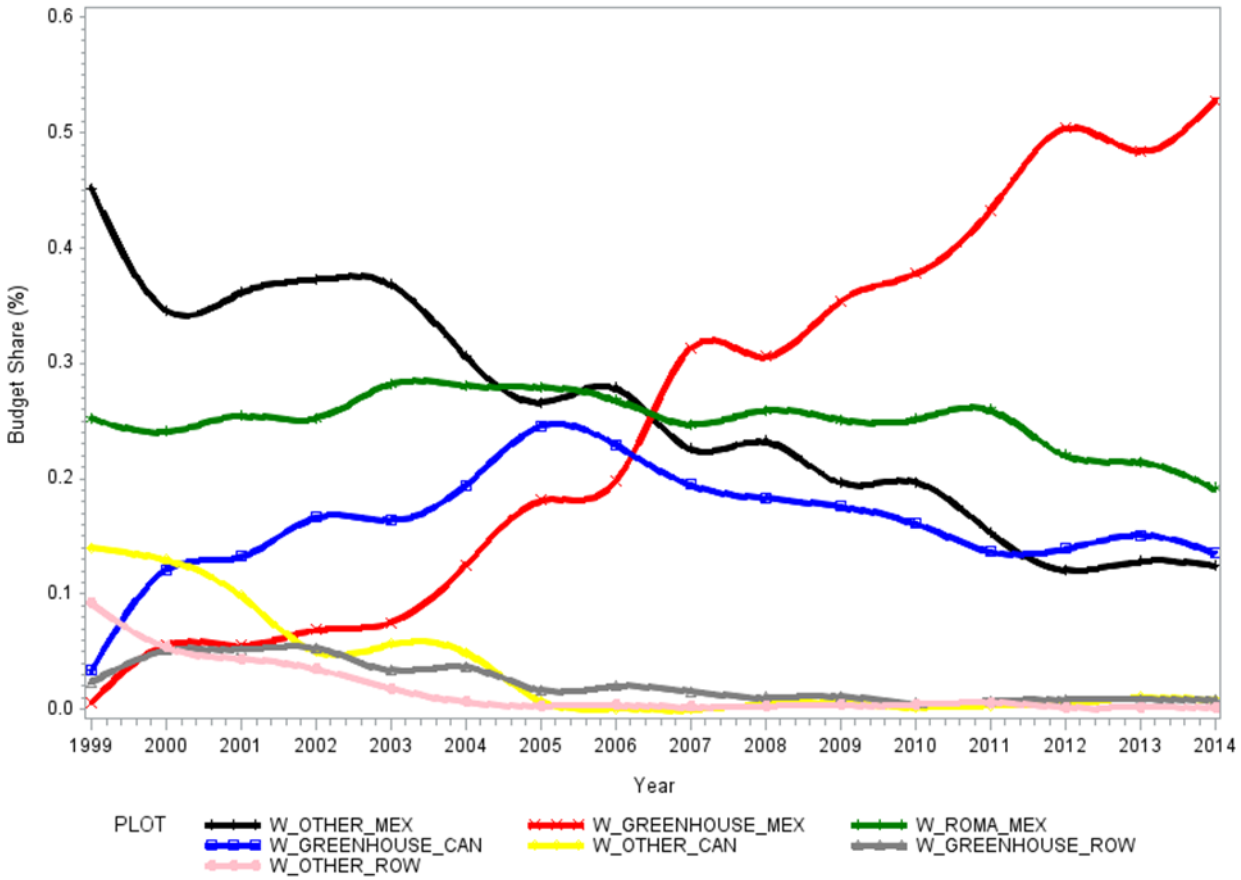

Figure 6. Expenditure shares of fresh-market tomato imports from Mexico and Canada, 1999-2014

Note: Greenhouse tomatoes from Mexico, Canada and the ROW include Harmonized Tariff Schedule (HTS) commodities 0702002010, 0702004010, and 0702006010. Roma tomatoes from Mexico include HTS commodities 0702002060, 0702002065, 0702004060, 0702004065, 0702006060, and 0702006065. Other tomatoes from Mexico include grape tomatoes (HTS commodities 0702002045, 0702004045, 0702004046, and 0702006045), cherry tomatoes (HTS commodities 0702002030, 0702002035, 0702004030, 0702004035, 0702006030, and 0702006035), and other tomatoes (HTS commodities 0702002090, 0702002095, 0702002099, 0702004090, 0702004098, 0702004099, 0702006090, 0702006095, 0702006099). Other tomatoes from Canada and the ROW include Roma tomatoes (HTS commodities 0702002060, 0702002065, 0702004060, 0702004065, 0702006060, and 0702006065) grape tomatoes (HTS commodities 0702002045, 0702004045, 0702004046, and 0702006045), cherry tomatoes (HTS commodities 0702002030, 0702002035, 0702004030, 0702004035, 0702006030, and 0702006035), and other tomatoes (HTS commodities 0702002090, 0702002095, 0702002099, 0702004090, 0702004098, 0702004099, 0702006090, 0702006095, 0702006099).