**U.S. Demand for Fresh Fruit Imports**

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**Abstract**

Over the last three decades, U.S. imports of fresh fruits have been constantly increasing at an annual average growth rate of 7% (USITC, 2016). Fresh fruits make up 9% of the total U.S. food imports (UN Database, 2016) with the top seven fruits accounting for 82% of the value of the U.S. fresh fruit imports and Canada and Mexico (NAFTA countries) as the most important trade partners (USITC, 2016). This study analyzes the main U.S. markets and supply sources of the top imported fresh fruits and estimates a Source-Differentiated Almost Ideal Demand System model (SDAIDS) using time-series data, with North American Free Trade Agreement (NAFTA) countries and the rest of the world (ROW) as import sources. Our results suggest that source of origin is an intrinsic quality attribute for most of the fresh fruits analyzed. More specifically, the study found that most uncompensated own-price elasticities are inelastic, most cross-price elasticities are positives indicating that the fruits imported from given sources are net substitutes, and that statistically significant expenditure elasticities are positive implying that the quantity imported of all the fresh fruit analyzed increases as real expenditure for those fruits rises. The results of this study will be useful to policy-makers in regulating the international market of fresh fruits, setting optimal import taxes and price floors, and predicting likely scenarios of imports from Canada and Mexico.

**Introduction**

In the last three decades, U.S. imports[1] of fresh fruits have been increasing constantly at an annual average growth rate of 7% and make up on average 9% of the total U.S. food imports (UN Database, 2016). For many decades, tropical fruits and counter-seasonal temperature fruits have dominated the U.S. Imports of fresh fruits (Huang, 2014). Seven fresh-fruits (bananas and plantains, nuts, berries, avocadoes, grapes, melons, and pineapples) in 2015 accounted for 82% of the total value of all fresh fruit imports. The breakdown of the U.S. fresh-fruits imports for the years from 2005 to 2015 is presented in in the Figure 1 below (USITC, 2016).

Despite the fact that the proportions and ranks of these fruits have changed throughout the years, the fruits were the same for the period 2005-2015. For instance, the proportion of grape has reduced from 18% to 11%, while the proportions of avocadoes and berries have increased from 6% to 13% and 15% respectively (USITC, 2016). In addition, Figure 2 below reports the percentage change in import value of these fresh fruits from 2005 to 2015, measured in 2015 U.S. Dollars (USD).

While imports of berries and avocadoes have increased by approximately five and four times respectively, the other categories less than doubled (Figure 2). Furthermore, in volume terms, none of the fresh-fruit imports has decreased. Figure 3 below summarizes the structure and overall trend in U.S. fresh fruit imports for the period 2005-2015. Overall, the value of the U.S. fresh fruit imports (in 2015 USD) increased by 93% (Figure 2 and Figure 3).

The main trading partners of the U.S. are the member countries of the NAFTA, the Southern Common Market (MERCOSUR), Dominican Republic-Central America Free Trade Agreement (CAFTA-DR), as well as countries having bilateral free trade agreements (FTA) with the U.S. The top exporters of fresh fruits to the U.S. are Mexico, Chile, Guatemala, Costa Rica,

[1] Here and for the rest of this paper, the term import refers to the imports for consumption.

Vietnam, Peru, Ecuador, Honduras, and Canada (Figure 4). Clearly, the main U.S. partners for the fresh fruit imports are Mexico (NAFTA), Chile (bilateral FTA), Guatemala and Costa Rica (CAFTA-DR), Vietnam, Peru (bilateral FTA ), Ecuador, Honduras(CAFTA-DR), and Canada (NAFTA) (Figure 4).

This study is mainly focused on the performance of the North American Free Trade Agreement (NAFTA) countries, Mexico and Canada, and estimates a Source-Differentiated Almost Ideal Demand System (SDAIDS) using time-series data, with NAFTA countries and the rest of the world (ROW) as import sources.

The North American Free Trade Agreement was signed in 1992 and became effective in 1994. The agreed date of finalizing the gradual duty phase-out was 2008 (15 years). During the period from 2005 to 2015, the NAFTA countries accounted from 25% (minimum, in 2005) to 41% (maximum, in 2015) of fresh fruit exports to the US, making the agreement as the main fresh fruit trade partner for the U.S (USTR, 2016). In 2015, the net import value of fresh fruits imported from the NAFTA countries has amounted 5081.5 million USD, 95% of which comes from Mexico and 5% from Canada (USITC, 2016). As we will see in the further analysis, the U.S. imports from these countries exhibit highly seasonal patterns, and these sources often substitute each other in the U.S. market.

Considerable research effort has been devoted to the estimation of U.S. demand for fresh fruits at the retail (e.g. Durham 2006) and import levels (e.g. Nzaku et al. 2010). However, the previous studies do not consider the source of origin as a quality attribute for the imported fruits. Thus, the present study is rather different from the previous studies as it estimates the demand elasticities considering the source of origin as a quality attribute for the selected fresh fruit categories. The study is mainly concerned with two strategically important import sources:

Mexico and Canada (the NAFTA countries), so, in a sense, this is a study of international trade relationships among the NAFTA countries in terms of exporting fresh fruits to the U.S. market.

The main objective of this paper is to estimate a system of U.S. demand equations for the most important fresh fruits while taking into account source of origin. The specific objectives are to identify trends in the U.S. Fresh fruit trade in the global market; to estimate a Source-Differentiated Almost Ideal Demand System for berries, grapes, apples, and avocadoes; and to estimate and interpret own- and cross-price and expenditure elasticities of demand. The study will help to better understand the structure of the U.S. fresh-fruits imports; provide insight of the demand behavior of the U.S. for specific fresh fruit coming from specific import sources; be useful to policy-makers in regulating the international market of fresh fruits, setting optimal import taxes and price floors, and predicting likely scenarios of imports within the North American Free Trade Agreement.

Although the results of this study are useful and valuable, it has its limitations. First, the estimated system of equations omits the domestic production data, which technically can be considered as another source for the selected fresh fruits categories. Second, the study does not consider the full list of the fresh fruits that can be complements or substitutes for the selected categories. Third, fresh fruits imports are highly seasonal, which implies that for some periods data is completely absent. As a result, a problem of unobserved prices arises. If for some reason the U.S. does not purchase any of the selected categories from any of the selected source of origin, we have no information about the import quantity and import price. Two simple and yet popular approaches to deal with this problem are (1) to discard all missing observations and use the remaining data to estimate the population parameters; or (2) to use simple zero-order methods that are commonly accepted in cross-sectional data analysis (Cox, 1986). The second approach assumes finding valid proxies for the missing observations. Since missing prices are mostly related to seasonal variations, i.e. prices are missing when there were no imports, this study uses an overall weighted monthly average import price for missing prices.

**Model**

The Almost Ideal Demand System (AIDS) model was first introduced by Deaton and Muelbauer in 1980 (Deaton, 1980). Since then the model has gained wide popularity, and many authors have used its varieties, making the model more flexible and applicable. Being developed from the price-independent generalized logarithmic (PIGLOG) model, the AIDS model ideally satisfies the axioms of choice and the conditions for exact aggregation over the consumers. At each level of utility, the AIDS model assumes that the consumers minimize expenditure to realize the given utility (Deaton, 1980)). In this study, a Source-Differentiated AIDS model is used to estimate nine expenditure share equations. The SDAIDS model considers fruits from different sources of origin as different categories.

The AIDS model is based on the PIGLOG class preferences. The expenditure function denoted by c has the following functional form:

$$\log c(p,u) = (1-u)\log(\mathrm{a(p)}) + u\log\big(\mathrm{b(p)}\big), \tag{1}$$

where

$$log\, a(p) = \alpha_0 + \sum_k \alpha_k \log(p_k) + 0.5 * \sum_k \sum_j \gamma_{kj}^* \log(p_k)\log(p_j) \tag{2}$$

and

$$log\, b(p) = log\, a(p) + \beta_0 \prod_k p_k^{\beta_k}. \tag{3}$$

With α, β, and γ as parameters; u is the utility index taking values 0 for the subsistence and 1 for the bliss (with some exceptions), so that a(p) can be considered as the cost of subsistence and b(p) as the cost of bliss.

Then, the AIDS cost function can be written as:

$$\log c(p,u) = \alpha_0 + \sum_k \alpha_k \log(p_k) + 0.5 * \sum_k \sum_j \gamma_{kj}^* \log(p_k) \log(p_j) + u * \beta_0 \prod_k p_k^{\beta_k} \quad (4)$$

Shepard's Lemma (a special case of Envelope theorem) can be used to get the quantity demanded, $q_i$ by taking the derivative of the expenditure function ( $\log c(p,u)$ )with respect to the $p_i$.

$$\frac{\partial c(p,u)}{\partial p_i} = q_i \quad (5)$$

Thus, taking the derivative of $\log c(p,u)$ with respect to $\log(p_i)$ will yield the expenditure share of the good *i* through the following relation

$$\frac{\partial\, log\, c(p,u)}{\partial\, log(p_i)} = \frac{p_i q_i}{c(p,u)} = w_i. \quad (6)$$ [2]

Therefore, the logarithmic differentiation of (4) with respect to the $\log(p_i)$ results in budget shares

$$w_i = \alpha_i + \sum_j \gamma_{ij} \log(p_j) + \beta_i(\log x - \log P), \quad (7)$$

Where

$$\gamma_{ij} = 0.5 * (\gamma_{ij}^* + \gamma_{ji}^*)$$

$$x = \sum_{i=1}^{n} p_i q_i$$

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[2] The step by step procedure is as follows:

$$\frac{\partial \log c(p,u)}{\partial \log(p_i)} = \frac{\partial \log c(p,u)}{\partial \log(p_i)} * \frac{\partial(p_i)}{\partial(p_i)} = \frac{\partial \log c(p,u)}{\partial(p_i)} * \frac{\partial(p_i)}{\partial \log(p_i)} = q_i * \frac{1}{c(p,u)} * \frac{1}{\frac{\partial \log(p_i)}{\partial(p_i)}} = \frac{p_i q_i}{c(p,u)} = w_i$$

$P$ is a nonlinear price index defined as

$$\log(P) = \alpha_0 + \sum_k \alpha_k \log(p_k) + 0.5 * \sum_j \sum_k \gamma_{ij} \log(p_k) \log(p_j) \tag{8}$$

Equation (7) is the AIDS demand function in expenditure share form. The price index shown in equation (8) is applied to deflate the logarithm of expenditure. The following are the restrictions for the parameters of the AIDS model:

$$\sum_{i=1}^{n} \alpha_i = 1, \qquad \sum_{i=1}^{n} \gamma_{ij} = 0, \qquad \sum_{i=1}^{n} \beta_i = 0, \tag{9}$$

$$\sum_j \gamma_{ij} = 0 \text{, and} \tag{10}$$

$$\gamma_{ij} = \gamma_{ji}. \tag{11}$$

The AIDS model estimates a large number of parameters that are used in the calculation of the elasticities of demand. Following Green and Alston, the Marshallian (uncompensated) price elasticities are calculated as:

$$\varepsilon_{ij} = -\delta_{ij} + \frac{\gamma_{ij} - \beta_i(\alpha_j + \sum_{k=1}^{n} \gamma_{jk} \log(p_k))}{w_i} \tag{12}$$

where $\delta_{ij}$ is the Kronecker delta with $\delta_{ij} = 1$ if $i = j$ (the own-price elasticity) and $\delta_{ij} = 0$ if $i \neq j$ (the cross-price elasticity).

Expenditure elasticities are calculated as

$$\varepsilon_{ix} = 1 + \frac{\beta_i}{w_i}. \tag{13}$$

Using Slutsky equation, compensated (Hicksian) elasticities are calculated as (Green, 1990)

$$e_{ij} = \varepsilon_{ij} + w_i * \varepsilon_{ix} \tag{14}$$

**Data**

For this study, the NAFTA countries have been selected because their combined exports of fresh fruits to the U.S. are highest among all the U.S. import sources. Gathered data includes the import quantity and value (USD) for berries imported from Canada, Mexico and the rest of the world (ROW), apples imported from Canada and ROW, grapes imported from Mexico and ROW, and avocadoes imported from Mexico and ROW. The selected fruit categories combine all the fruit subcategories (including organic and non-organic fruits) coming from the selected import sources. For example, the category of berries includes blackberries, raspberries, blueberries, strawberries etc. The above-listed fruit categories are selected according to their share in overall U.S fresh fruit imports as well as their shares in fresh fruit exports of the source countries.

This study analyzes the United States International Trade Commissions' (USITC) reported monthly import values and quantities for 11 years (2005-2015), ranging from January 2015 to December 2016. The prices are adjusted by inflation (2015 is the base year), using the consumer price index reported by the U.S. Bureau of Labor Statistics. This study uses the U.S. gross domestic product data reported by the U.S. Department of Commerce. Table 1 reports descriptive statistics using annual data. Annual data, instead of the monthly data, was used in the calculation of the descriptive statistics since the high level of seasonality causes monthly averages to be less relevant (USITC, 2016).

According to the Figure 5, the share of berries imported from Canada decreased during the period from 2012 to 2013 while the share of berries imported from Mexico increased. Figure 5 also reveals highly seasonal import patterns from the selected sources. As the Figure 5 reveals, the imports from the rest of the world and imports from Mexico exhibit somewhat similar seasonal patterns, most probably determined by the climate conditions of the exporting countries. In addition, Figure 5 shows that the imports from Mexico roughly reach their maximum when the imports from Canada and ROW reach their minimum and vice versa. This implies that at the country level these sources are likely import substitutes with respect to each other. A significant role in determining the relationships of the sources of origin quantified by the cross-price elasticities discussed further in this study plays the fact that the fruit categories include various fruit types of the same category, and the proportions of those categories can be different depending on the source of origin.

Figure 6 displays expenditure shares of avocadoes and grapes from Mexico and the ROW. Again, a highly seasonal pattern is observed, accompanied with somewhat symmetric seasonal import substitution between the selected sources for each of the fruit categories.

This study accounts for seasonality by estimating seasonal trigonometric variables applied in each share equation as explained in the next section.

## Estimation Procedure and Results

To accomplish the objectives of this study, a Source Differentiated Almost Ideal Demand System was estimated for the four fresh fruit categories imported from three different sources of origin using an Iterated Seemingly Unrelated Regression procedure (ITSUR) and Statistical Analysis System (SAS) software, version 9.3. To capture hypothesized seasonality in the estimated model, seasonal trigonometric variables were applied in each share equation (harmonic regression method) (Nzaku, 2010). The expenditure share equations have the following generalized form[3]

$$w_i = \alpha_i + \sum_j \gamma_{ij} \log(p_j) + \beta_i \log\left(\frac{x}{P}\right) + S_i Sin + C_i Cos \quad (15)$$

[3] In this form, the share equations are not corrected for endogeneity yet.

In addition to the restrictions discussed above, the coefficients of the trigonometric functions applied to the share equations also were restricted to sum up to zero. The model includes nine expenditure share equations (instead of 12) because some of the selected fresh fruits are imported only from two of the three selected sources of origin. Those nine equations are estimated for berries from Mexico, Canada, and ROW, apples from Canada and ROW, grapes from Mexico and ROW, avocadoes from Mexico and ROW. The ninth equation (avocadoes from ROW) was left out from the estimation to avoid the singularity of the variance-covariance matrix of error terms, arising from the requirement of summing the budget shares to unity, which is one of the key properties of the AIDS model. The parameter estimates of the last equation was recovered relying on the adding up, homogeneity, and symmetry restrictions imposed by the AIDS model (Deaton, 1980). The coefficient of determination ($R^2$) was recovered by squaring the coefficient of correlation between the predicted and actual expenditure shares of the last equation, while the Durbin-Watson statistic was estimated by the ratio of the squared difference of the residuals and their firs lag to the squared residuals of ninth equation, a procedure described (Durbin, 1951). Since the total expenditure is defined as the sum of individual expenditures, a simultaneity problem may arise. To correct this issue, a set of instrumental variables has been introduced for the total expenditure (including the real GDP and lags of all prices present in the model). Following Berndt and Savin (Berndt, 1975), a first-order autoregressive procedure was used to address the problem of serial correlation[4]. In this study, all statistical tests were conducted using 5% level of significance.

Table 2 reports the estimated statistically significant gamma-coefficients, p-values, coefficients of determinations and Durbin-Watson statistics associated with the estimated nine equations.

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[4] This problem was first considered by Arnold Zellner in 1962 (Zellner, 1962).

Accompanied with the statistical significance of the rho coefficient, the Durbin-Watson statistics for the estimated equations, ranging from 1.596 to 2.404, indicate that the problem of serial correlation has been successfully addressed in the model (Table 2).

The uncompensated (Marshallian) own-price elasticities, compensated (Hicksian) cross-price elasticities, and the expenditure elasticities are reported in the Table 3. All elasticity estimates were calculated at sample means.

All Marshallian price elasticities (Table 3) obtained, have the expected negative sign, which is consistent with the demand theory. Al other factors held constant, if the price of an import category changes, on average, the quantity of it demanded changes in the opposite direction. More specifically when the prices increase by 1%, the quantity demanded is expected to decrease on average by 0.9% for berries imported from Mexico, 1.2% for berries from Canada, 0.6% for berries from ROW, 0.9% for apples from Canada, 0.6% for apples from ROW, 0.7% for grapes from ROW, and 1.2% for avocadoes from Mexico. As the estimated elasticities suggest, the demand is found to be elastic for the berries imported from Canada and avocadoes imported from Mexico. This elastic demand may be partly explained by the relatively larger share that these two categories have in the total expenditure.

The expenditure elasticity estimates (Table 3) summarize the relationships between the overall change in expenditure on the selected group of fruit categories and the relative shares of each of those categories. All the estimated statistically significant expenditure elasticities have the expected positive sign, implying that all other factors held constant, the quantity demanded of all fruit types is expected to increase when the real expenditure on them as a whole increases. More specifically, as the overall expenditure increases by 1%, on average, the expenditure share increases by 1.1% for berries from Mexico, 1.2% for berries from ROW, 0.4% for apples from

Canada, 1.4% for apples from ROW, 2.2% for grapes from Mexico, 0.7% for grapes from ROW, and 1.2% for avocadoes from Mexico.

The Hicksian cross-price elasticity estimates (Table 3) reveal the economic relationships of each of the fresh fruit categories by sources of origin with the other categories. The negative (positive) cross-price elasticity implies that when the price of the given fruit from the given source increases by one percent, the quantity demanded of a different fruit category from the same or different source decreases (increases), which in its turn implies that the categories are complement (substitute).

All other factors held constant, if the average price of berries imported from Mexico increases by 1%, the quantity demanded is expected to increase by 0.3% for grapes from Mexico, 0.6% for avocadoes from Mexico, and 0.3% for avocadoes from ROW. On the other hand, the quantity of apples demanded from ROW is expected to fall by 0.5%. If the price of berries imported from Canada increases by 1%, the quantity demanded is expected to increase by 0.2% for berries from ROW, 0.5% for apples from ROW, and 0.7% for avocadoes from Mexico. On the other hand, the quantity of grapes demanded from Mexico is expected to fall by 0.4%.  If the average price of berries imported from ROW increases by 1%, the quantity demanded is expected to increase by 0.2% for berries from Canada, 0.1% for apples from Canada, 0.2% for apples from ROW, and 0.3% for grapes from Mexico. If the average price of apples imported from Canada increases by 1%, the quantity of berries demanded from ROW is expected to increase by 0.5%.If the average price of apples imported from ROW increases by 1%, the quantity demanded is expected to increase by 0.2% for berries from Mexico, 0.6% for berries from Canada, 0.2% for berries from ROW, and 0.4% for grapes from ROW. If the average price of grapes imported from Mexico increases by 1%, the quantity demanded is expected to increase by 0.4% for berries from Mexico and 0.2% for berries from ROW. On the other hand, the quantity demanded is expected to decrease by 0.3% for berries from Mexico, 0.6% for grapes from ROW and 0.5% for avocadoes from ROW. If the average price of grapes imported from ROW increases by 1%, the quantity demanded is expected to increase by 0.1% for apples from ROW, 0.4% for avocadoes from Mexico, and 0.2% for avocadoes from ROW. On the other hand, the quantity demanded is expected to decrease by 0.3% for grapes from Mexico. If the average price of avocadoes imported from Mexico increases by 1%, the quantity demanded is expected to increase by 0.4% for berries from Mexico, 0.3% for berries from Canada, and 0.3% for grapes from ROW. If the average price of avocadoes imported from ROW increases by 1%, the quantity demanded is expected to increase by 0.7% for berries from Mexico and 0.7% for grapes from ROW. On the other hand, the quantity demanded is expected to decrease by 0.8% for grapes from Mexico.

**Conclusion**

During the period from 2005 to 2015, the top fruit categories imported by the U.S. were bananas, nuts, berries, avocadoes, grapes, melons, and pineapples. These seven fresh fruits accounted for 82% of total fruits trade value. The main trading partners of the U.S. are the member countries of the preferential agreements NAFTA, MERCOSUR, CAFTA-DR, as well as countries having bilateral free trade agreements (FTA) with the U.S.

This study was focused on the performance of the North American Free Trade Agreement (NAFTA) countries, namely – Mexico and Canada, and the analysis was aimed at estimating a Source-Differentiated Almost Ideal Demand System (SDAIDS) using time-series data, with NAFTA countries and the rest of the world (ROW) as import sources.

The study reported that all the statistically significant uncompensated own-price elasticities are inelastic except for the own-price elasticity of avocadoes imported from Mexico and berries imported from Canada.  In addition, 65% of the statistically significant cross-price elasticities have positive sign indicating that the fruits imported from given sources are net substitutes. The remaining 35% indicate that the source of origin can be considered as important quality attribute for the given fruit categories.  All the statistically significant expenditure elasticities are positive implying that the quantity demanded of all fruit types increased as real expenditure for those fruits rose with all other factors held constant. This study can be a valuable base for making political decisions aimed at efficiently allocating the state resources (such as customs incentives) among different fresh fruit categories from each of the sources respectively.

As noted earlier, the study does not consider the domestic production and its impact on the imports, thus the future research might further focus on the estimation of the demand equations considering the domestic production as an additional source. Second, more source-countries or preferential trade agreements may be considered, such as CAFTA-DR, MERCOSUR etc. Third, depending on the source-countries, the fruit categories may be enlarged. Nevertheless, despite the limitations, this study is a solid contribution to analyzing the U.S. demand for the fresh fruit imports.

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## Tables

*Table 1 Descriptive statistics, 2005-2015*

| Fruit category | Source of origin | Units | n | Mean | Standard deviation |
|---|---|---|---|---|---|
| Berries | Mexico | kg | 11 | 170057.0 | 80919.7 |
| | Canada | kg | 11 | 71745.3 | 19321.3 |
| | ROW | kg | 11 | 51599.2 | 22395.3 |
| Apples | Canada | kg | 11 | 27638.8 | 7217.4 |
| | ROW | kg | 11 | 144151.7 | 28885.7 |
| Grapes | Mexico | $m^3$ | 11 | 359.3 | 46.5 |
| | ROW | $m^3$ | 11 | 1162.5 | 104.5 |
| Avocadoes | Mexico | kg | 11 | 357561.8 | 211630.6 |
| | ROW | kg | 11 | 95491.0 | 28024.7 |
| Berries | Mexico | USD/kg | 11 | 3.5 | 0.4 |
| | Canada | USD/kg | 11 | 2.3 | 0.4 |
| | ROW | USD/kg | 11 | 4.7 | 0.6 |
| Apples | Canada | USD/kg | 11 | 1.0 | 0.2 |
| | ROW | USD/kg | 11 | 1.2 | 0.1 |
| Grapes | Mexico | USD/$m^3$ | 11 | 755.5 | 78.7 |
| | ROW | USD/$m^3$ | 11 | 714.5 | 63.0 |
| Avocadoes | Mexico | USD/kg | 11 | 2.2 | 0.2 |
| | ROW | USD/kg | 11 | 1.4 | 0.2 |

*Source:* USITC (2016)

*Table 2 Coefficients of AIDS, p-values, $R^2$'s and DW statistics (n=132)*

| **Category - source (equation number)** | **$R^2$** | **DW** |
|---|---|---|
| Berries - Mexico (1) | 0.613 | 1.596 |
| Berries - Canada (2) | 0.695 | 2.404 |
| Berries - ROW (3) | 0.859 | 2.326 |
| Apples - Canada (4) | 0.677 | 1.811 |
| Apples - ROW (5) | 0.679 | 2.297 |
| Grapes - Mexico (6) | 0.450 | 1.797 |
| Grapes - ROW (7) | 0.826 | 2.149 |
| Avocadoes - Mexico (8) | 0.492 | 1.740 |
| Avocadoes - ROW (9) | 0.464 | 1.775 |
| **Parameter** | **Coefficient** | **p-value** |
| $g_{15}$ | -0.081 | 0.000 |
| $g_{18}$ | 0.049 | 0.008 |
| $g_{19}$ | 0.038 | 0.004 |
| $g_{22}$ | -0.179 | 0.000 |
| $g_{23}$ | 0.031 | 0.002 |
| $g_{24}$ | -0.012 | 0.000 |
| $g_{25}$ | 0.072 | 0.001 |
| $g_{26}$ | 0.138 | 0.002 |
| $g_{27}$ | -0.099 | 0.015 |
| $g_{28}$ | 0.100 | 0.005 |
| $g_{29}$ | -0.054 | 0.018 |
| $g_{33}$ | 0.025 | 0.000 |
| $g_{34}$ | 0.006 | 0.000 |
| $g_{38}$ | -0.044 | 0.001 |
| $g_{46}$ | 0.010 | 0.003 |
| $g_{47}$ | -0.007 | 0.013 |
| $g_{49}$ | -0.006 | 0.030 |
| $g_{68}$ | -0.076 | 0.020 |
| $g_{78}$ | 0.060 | 0.030 |
| rho | 0.327 | 0.000 |

*Notes:*
1. *Due to limited space, the table includes only those estimates that are statistically significant at 5% significance level.*
2. *The subscripts of the estimated parameters correspond to the equation numbers listed in parentheses above. For example, g12 shows the effect of the price of berries imported from Canada on the quantity demanded of berries imported from Mexico.*
3. *Rho refers to the estimated autocorrelation coefficient.*

*Table 3 Marshallian, Hicksian, and expenditure elasticities.*

| | **Berries Mexico** | **Berries Canada** | **Berries ROW** | **Apples Canada** | **Apples ROW** |
|---|---|---|---|---|---|
| **Berries Mexico** | -0.9385* | -0.0389 | 0.0054 | 0.0157 | -0.4516* |
| **Berries Canada** | -0.0661 | -1.1608* | 0.1723* | -0.0122 | 0.4736* |
| **Berries ROW** | 00000 | 0.2030* | -0.6299* | 0.0773* | 0.181* |
| **Apples Canada** | 0.2097 | -0.0963 | 0.5164* | -0.8729* | -0.0569 |
| **Apples ROW** | 0.2497* | 0.6325* | 0.2051* | -0.0096 | -0.6115* |
| **Grapes Mexico** | 0.3828* | -0.3303* | 0.202* | 0.0039 | 0.0862 |
| **Grapes ROW** | 0.0703 | 0.0179 | 0.0491 | 0.0003 | 0.1113* |
| **Avocadoes Mexico** | 0.3674* | 0.2544* | -0.0674 | 0.0161 | 0.0232 |
| **Avocadoes ROW** | 0.6766* | 0.2835 | -0.1337 | -0.0226 | 0.1613 |

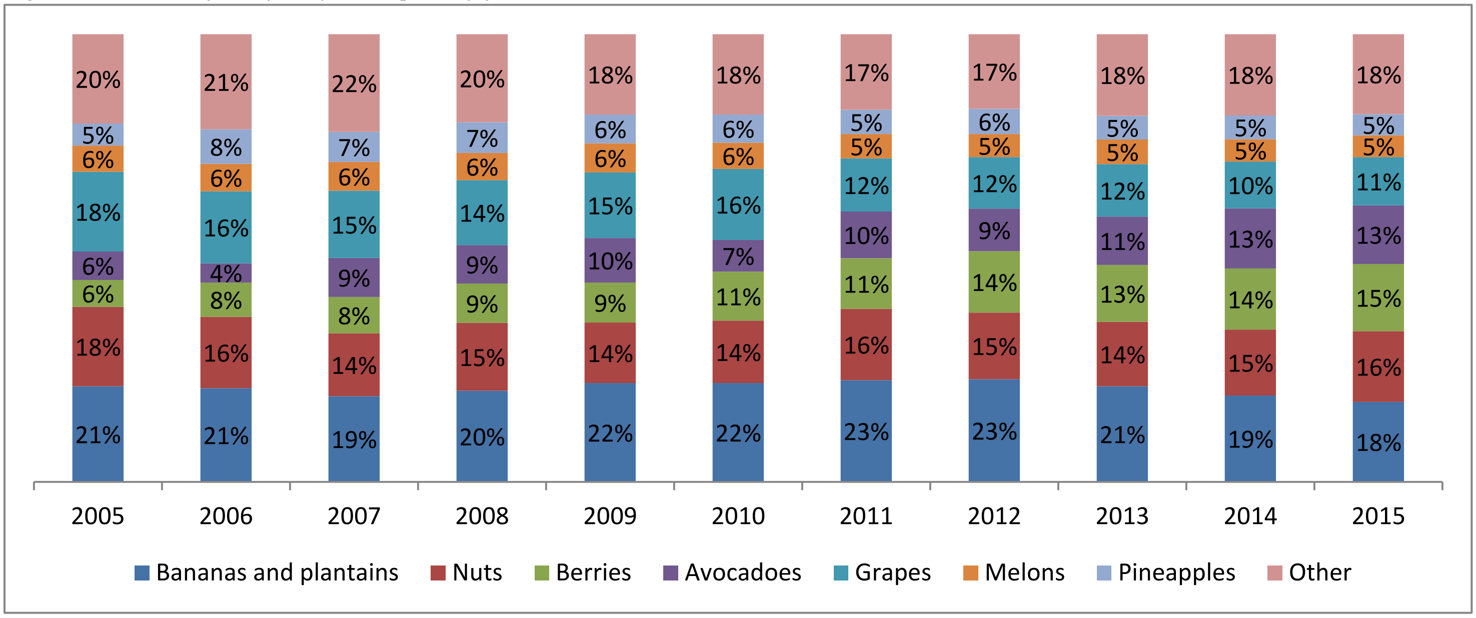
| ***Continued*:** | **Grapes Mexico** | **Grapes ROW** | **Avocadoes Mexico** | **Avocadoes ROW** | **Expenditure** |
|---|---|---|---|---|---|
| **Berries Mexico** | 0.2517* | 0.1000 | 0.6354* | 0.2606* | **1.0882*** |
| **Berries Canada** | -0.3694* | 0.0432 | 0.7482* | 0.1857 | **-0.1675** |
| **Berries ROW** | 0.2662* | 0.1401 | -0.2336 | -0.1032 | **1.2022*** |
| **Apples Canada** | 0.0347 | 0.0052 | 0.3720 | -0.1167 | **0.4311*** |
| **Apples ROW** | 0.1287 | 0.3596* | 0.0912 | 0.1412 | **1.3669*** |
| **Grapes Mexico** | 0.4051 | -0.6178* | 0.1502 | -0.4941* | **2.1913*** |
| **Grapes ROW** | -0.2856* | -0.7066* | 0.3940* | 0.1948* | **0.7383*** |
| **Avocadoes Mexico** | 0.0571 | 0.3240* | -1.1906* | -0.0758 | **1.1461*** |
| **Avocadoes ROW** | -0.8433* | 0.7190* | -0.3405 | -0.515 | **0.2588** |

*Notes: 1. Asterisk indicates the statistical significance at 5% level of significance.*

*2. Expenditure elasticities are bolded; the own-price elasticities are highlighted.*

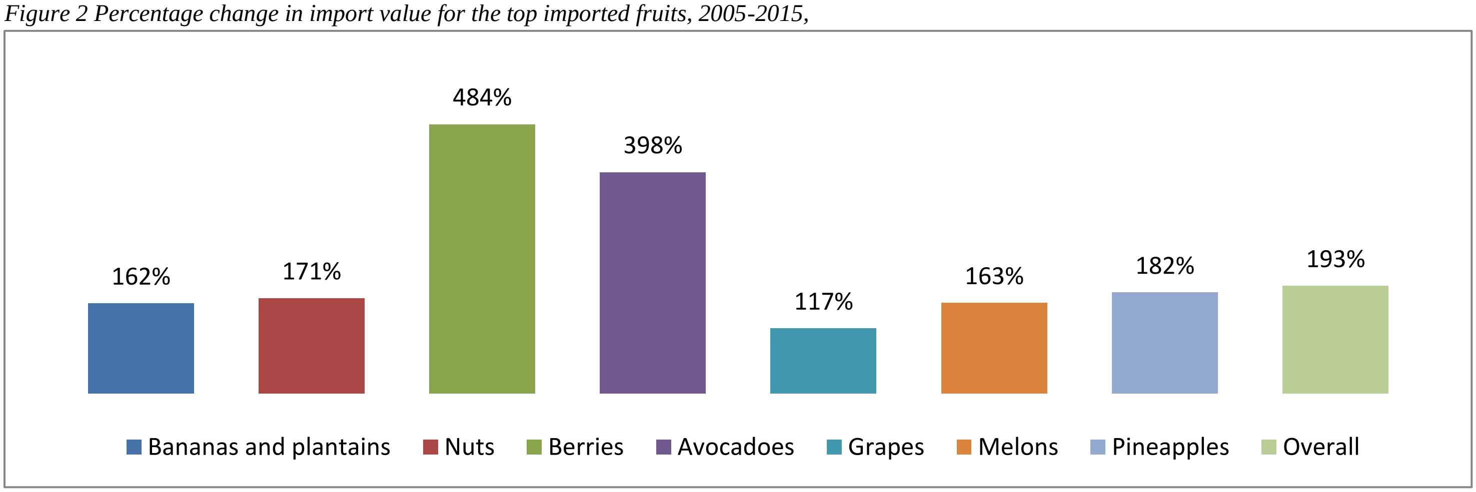
## Figures

*Figure 1 Structure of U.S. fresh fruits imports by fruit in 2005-2015*



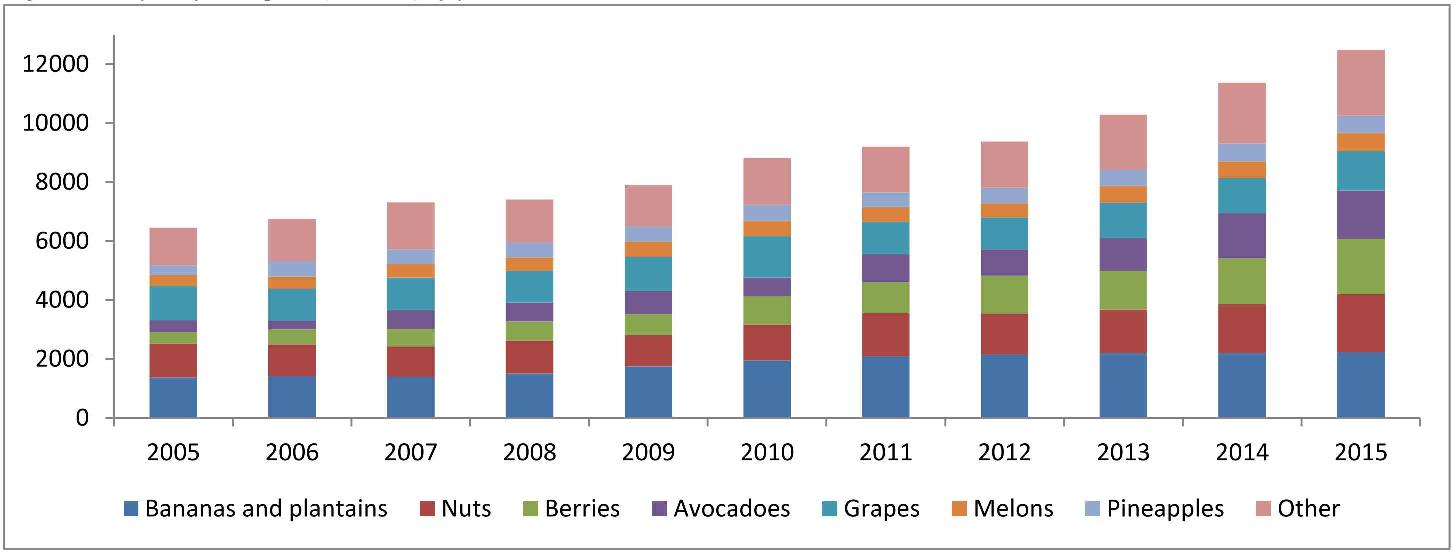

*Source:* USITC ( 2016)

*Figure 2 Percentage change in import value for the top imported fruits, 2005-2015,*



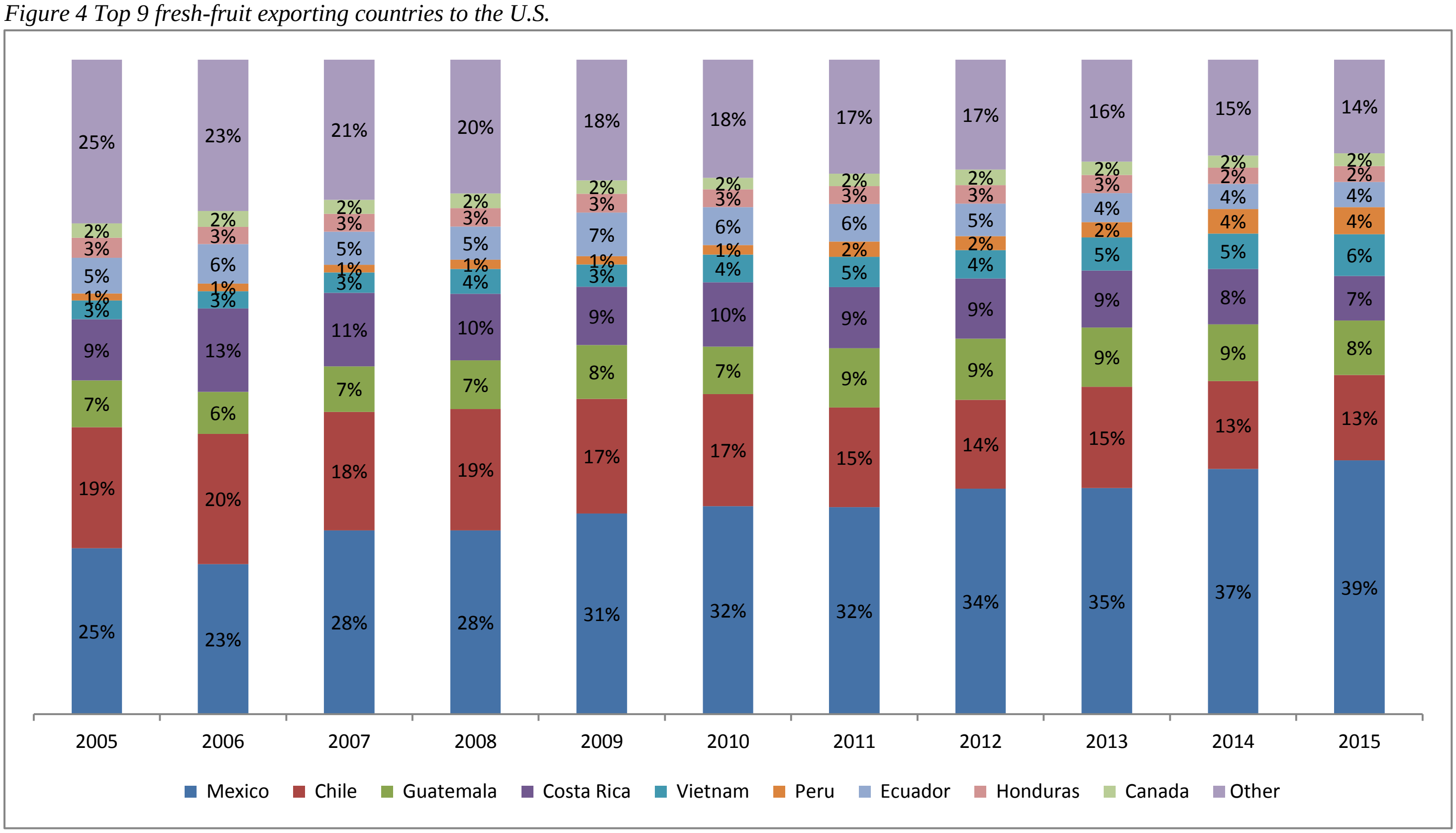

*Source:* USITC (2016)

*Figure 3 U.S. fresh fruit imports (million $) by fruit, 2005-2015*



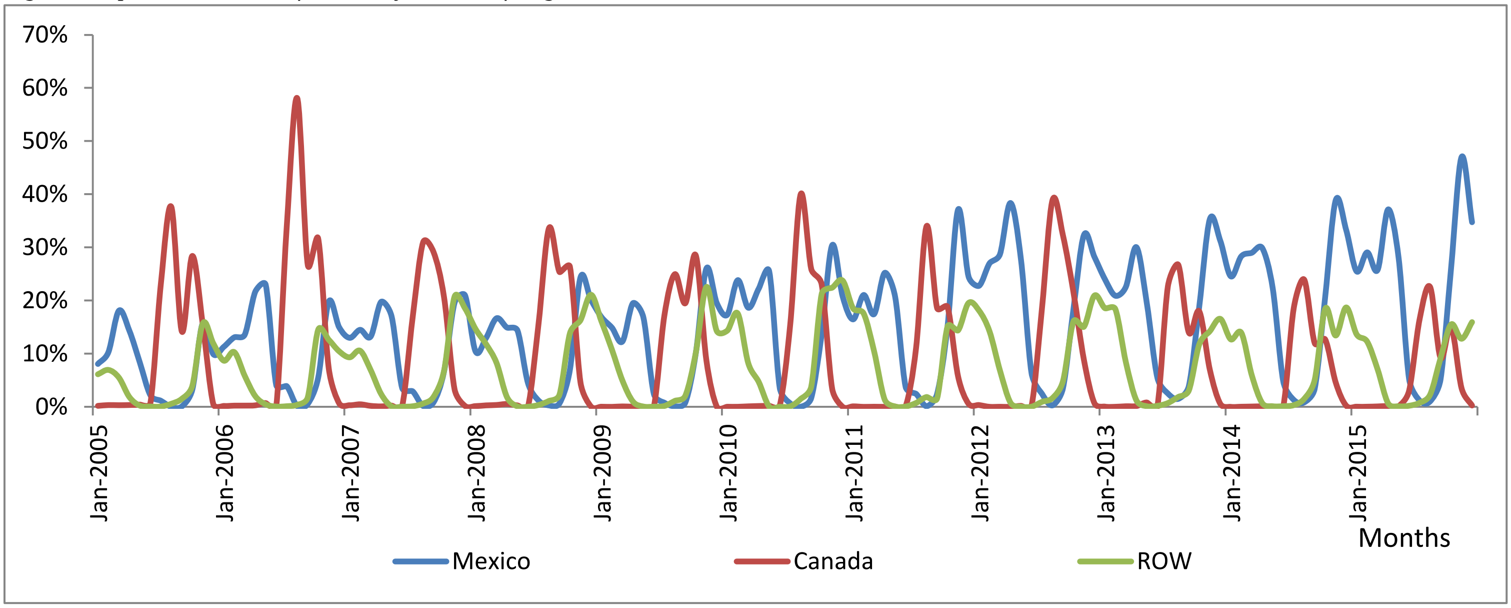

*Source:* USITC (2016)

*Figure 4 Top 9 fresh-fruit exporting countries to the U.S.*



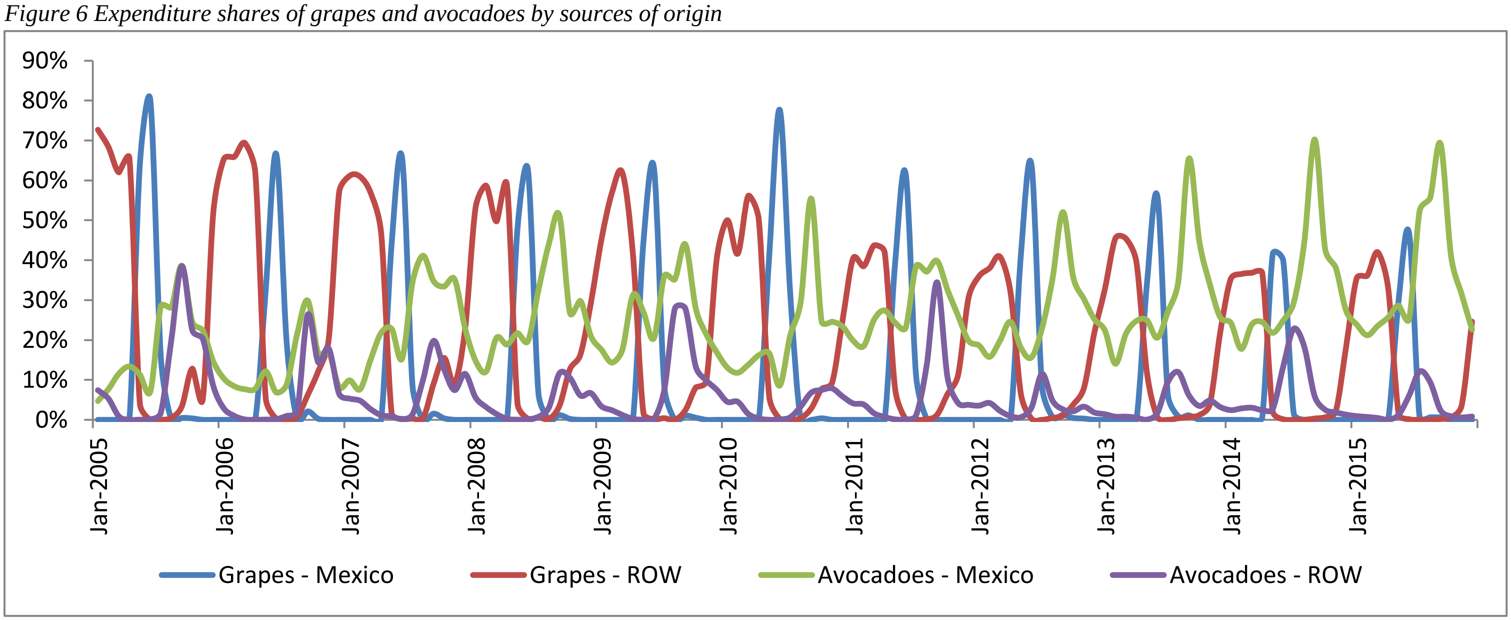

*Source:* USITC (2016)

*Figure 5 Expenditure shares of berries by sources of origin*




*Source:* USITC (2016)

*Figure 6 Expenditure shares of grapes and avocadoes by sources of origin*




*Source:* USITC (2016)