Dynamic Estimation of U.S. Demand for Fresh Vegetable Imports

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Selected Paper prepared for presentation at the Agricultural & Applied Economics Association 2009 AAEA & ACCI Joint Annual Meeting, Milwaukee, Wisconsin, July 26-29, 2009

Introduction:

The demand for fresh vegetables and for fresh produce in general continues to rise in the U.S., as consumers increasingly recognize that eating more fresh produce is healthy and consumer incomes rise. Americans have been consuming consistently more fresh fruits and vegetables over the last three decades. In 2005, per capita total fruit and vegetable consumption (fresh and processed) reached 687 pounds, up 110 pounds (19 percent) since 1970 (Wells and Buzby 2008). Per capita disappearance of fresh vegetables increased substantially from 123.2 pounds in 1983-85 to 151.9 pounds in 1993-95, and to 173.5 pounds in 2003-2005, based on U.S. Department of Agriculture reports (Huang and Huang 2007). The increases in per capita consumption of fresh vegetables were broad-based and ranged from onions, tomatoes, romaine and other leaf lettuces to sweet corn, bell peppers, cucumbers, broccoli, squash, garlic, snap beans, spinach, asparagus, and others. The steady and rapid increase of an immigrant population, especially Asians and Hispanics who are accustomed to a culture of fresh produce in meals, has also positively impacted the U.S. demand for fresh vegetables.

Despite a positive response to the growth in demand for fresh vegetables by U.S. producers, climatic factors impose seasonality in production and marketing seasons, hence tempering the continuous supply of fresh vegetables. Consequently, the growth in the production of fresh vegetables in the U.S. has not been as high as the growth in demand. Because the demand for fresh vegetables is continuous, this leads to counter-cyclical importation of fresh vegetables into the U.S. to satisfy demand during winter months. Other factors, such as the labor-intensive nature of fresh vegetable production, shortage of domestic farm workers in the U.S., high farm labor costs (Martin and Thompson 1992; Cook 2001), and the creation of more free trade agreements, particularly the North American Free trade Agreement (Huang and Huang 2007), have all increasingly favored imports. Between 1990-92 and 2004-06, annual U.S. imports of fresh vegetables and fruits together rose from US$2.7 billion to US$7.9 billion (Huang and Huang 2007), and the import share of fresh vegetable consumption over the decade grew from 9.3 percent in 1983-85 to 15.3 percent in 2003-05.

Since the 1990s, the increases in import shares have been across the board. However, at the top of the list of the major U.S. imports of fresh vegetables are tomatoes, cucumbers and gherkins, asparagus, and peppers. Between 1993-95 and 2003-05, the import shares of total consumption rose for tomatoes from 24.2% to 35,2% , for fresh peppers from 17.1% to 29.5%, for cucumbers from 38.1% to 49%, and for asparagus from 48.1% to 66.2% (Huang and Huang 2007). Of the four top fresh vegetable imports, three fresh vegetables (tomatoes, peppers, and cucumbers), constitute 60% of the increase in the value of U.S. fresh vegetable imports (Huang and Huang 2007; U.S. Department of Agriculture 2008).

Proximity to the U.S. greatly controls access to the U.S. market for fresh vegetables and the fresh vegetable import supply is dominated by NAFTA trade partners due to high transport costs, the perishable nature of fresh produce commodities, and sanitary and phytosanitary (SPS) controls (U.S. Department of Agriculture 2008a; U.S. Department of Agriculture 2008b). NAFTA (mainly Mexico) accounts for 82.9 percent of total U.S. fresh vegetable imports, with the remainder coming from the rest of the world (Huang and Huang 2007; U.S. Department of Agriculture 2007).

Despite the growing importance of imports in the consumption of fresh vegetables in the U.S. over the past two decades, few studies have attempted to analyze the demand for fresh vegetable imports. Most of the publicly available studies have focused on the competitiveness of U.S. farm produce within the country (Cook 1990, 2001; Dimitri, Tegene, and Kaufman 2003; You, Epperson, and Huang 1996; Huang and Lin 2000), and among the major destinations of U.S.

fruit and vegetable produce (Andayani and Tilley 1997; Feleke 2006; Lee, Seale, and Jierwiriyapant 1990; Sparks 1992), with little reference to fresh vegetable importation. Some of the available literature have studied demand for imported fruit juices (Fonsah and Muhammad 2008) while others have examined the overall demand for fruits and vegetables (Arnade, Pick, and Gehlhar 2004, 2005; You, Epperson, and Huang 1998). One of the major constraints to studying the demand for fresh vegetables, as is the case with most fresh farm produce, is the chronic and widespread lack of consistent data, particularly on consumption.

This paper analyzes the demand for the fastest growing fresh vegetable imports in the U.S., namely fresh tomatoes, cucumbers, peppers and asparagus. The objectives of the study are to determine the competitiveness of the major fresh vegetable imports and to estimate the long-run and short-run elasticities of demand for these fresh vegetable imports. The remainder of the paper is organized as follows. A brief review of the literature on estimation approaches is presented in the next section, followed by a detailed description of the data used in this analysis. This is followed by a presentation of the results of the analysis and, finally, the conclusions and implications drawn from the study.

Methodology

Common approaches to import demand analysis involve the use of consumer demand theory or production theory. The consumer demand theory approach treats imports as final products that directly enter a consumer’s utility function (Schmitz and Seale 2002), while production theory treats imports as inputs (Washington and Kilmer 2002). The consumer demand theory approach enables the derivation of traditional consumer demand and labor supply functions from utility maximization. On the other hand, both input demand and output supply functions from profit maximization or cost minimization can be obtained from the production theory approach.

The literature on applications of the consumer approach to import demand analysis is extensive. Notable empirical models include the Armington model (Armington 1969), the Almost Ideal Demand System, or AIDS, model (Deaton and Muellbauer 1980), and the Rotterdam model (Theil 1980). However, the literature also cautions against treating imports as final goods (Lee, Seale, and Jierwiriyapant 1990; Seale, Sparks, and Buxton 1992), because, in international trade, most goods are intermediate commodities that require some processing or repackaging before final distribution to the end consumer (Washington and Kilmer 2002; Muhammad, Jones, and Hahn 2007). Under such circumstances, a production approach is considered by many to be better placed to estimate the import demand. However, we anticipate that, in case of fresh vegetables, the imported products are distributed to consumers by and large in their fresh form and very little value-added processing, if any, is involved. The imports can therefore be justifiably classified as final goods and the AIDS model is deemed appropriate for our purposes.

Following Deaton and Muellbauer (Deaton and Muellbauer 1980; U.S. Department of Agriculture 2008), the AIDS model can be expressed as follows:

$$w_i = \alpha_i + \sum \gamma_{ij} \log p_j + \beta_i \log(y/P) + u_i \qquad (1)$$

where w_i is the expenditure share of good *i*, *y* is total expenditure, and u_i denotes the disturbance term. P is a price index defined as

$$\log p = \alpha_0 + \sum_k \alpha_k \log p_k + \frac{1}{2} \sum_k \sum_j \gamma^*{}_{ij} \log p_i p_j \qquad (2)$$

The intercept α_i represents the estimated budget share of commodity i when all logarithmic prices and real expenditures are zero, interpreted as the subsistence consumption of commodity *i*. The β_i 's are real expenditure coefficients and represent the change in commodity i 's expenditure share with respect to change in total outlay, *ceteris paribus*. If $\beta_i > 0$, then good i is a luxury, and a necessity when $\beta_i < 0$. Thus the expenditure share w_i increases with an increase in real expenditure if $\beta_i > 0$ and decrease if $\beta_i < 0$. The price coefficients, γ_{ij}, represent the change in the i th budget share with respect to a percentage change in the j th price with real expenditures held constant. If $\gamma_{ij} > 0$, goods i and j are substitutes and if $\gamma_{ij} < 0$, they are complementary goods.

To be consistent with consumer demand theory, we must ensure that the demand system satisfies adding-up, homogeneity in prices and income and slutsky symmetry conditions hold as follows:

$\Sigma\alpha_k = 1$, $\Sigma_k \gamma_{kj} = 0$, and $\Sigma_k \beta_k = 0$ (adding-up property)

$\Sigma_j \gamma_{kj} = 0$: (homogeneity property), and

$\gamma_{kj} = \gamma_{jk}$: (symmetry property)

The AIDS model can be further modified for use when dealing with goods from different origins as in our case of fresh vegetables. Following Yang and Koo (1994), a source-differentiated specification (SDAIDS) of the AIDS model can be specified:

$$w_{ih} = \alpha_{ih} + \sum_j \sum_k \gamma_{ihJk} \ln(p_{jk}) + \beta_{ih} \ln(E / P^*) \qquad (3)$$

$$h = 1, 2, 3, ..., m \text{ and } k = 1, 2, 3, ..., n$$

where i and j represent commodities, and h and k indicate countries of origin for the goods. Commodity i may be imported from m different sources, and j may be from n different sources. w_{i_h} is the budget share of good i imported from source h, and p_{j_k} is the price of good j imported from source k; α_i is the subsistence expenditure share of good i and β_i is the expenditure coefficient for commodity i . Term E denotes the total expenditure on all the goods in the demand system, while $P*$ is a price index and is defined as:

$$\ln p^* = \alpha_0 + \sum_i \sum_h \alpha_i \ln(p_{i_k}) + \frac{1}{2}\sum_i \sum_h \sum_j \sum_k \gamma^*{}_{i_h j_k} \ln(p_{i_h})\ln(p_{j_k}) \quad (4)$$

As in the AIDS model, the index $P*$ is nonlinear, which makes the SDAIDS model nonlinear. To mitigate the possible estimation difficulties associated with the nonlinear price index, we adopt the geometrically weighted average index, as suggested by Moschini (1995):

$$\ln P = \sum_{ih}^{n} w_{ih}^0 \log(p_{ih}) \quad (5).$$

The Marshallian elasticities of demand are then calculated, as in Andayani and Tilley (1997), using the following formulae:

$$\in_{i_h i_h} = 1 + \frac{\gamma_{i_{hh}}}{w_{i_h}} - \beta_{i_h} \quad \text{(own price elasticity)},$$

$$\in_{i_h i_k} = \frac{\gamma_{i_{hh}}}{w_{i_h}} - \beta_{i_h}\left(\frac{w_{i_k}}{w_{i_h}}\right) \quad \text{(cross-price elasticities of fresh product } i \text{ among sources)},$$

$$\in_{i_h j} = \frac{\gamma_{i_{hh}}}{w_{i_h}} - \beta_{i_h}\left(\frac{w_{i_k}}{w_{i_h}}\right) \quad \text{(cross-price elasticity among fresh produce and sources), and}$$

$$\eta_{i_h} = 1 + \frac{\beta_{i_h}}{w_{i_h}} \quad \text{(expenditure elasticities).}$$

We further take note of the time series properties of data and that the model introduced thus far assumes that consumers are always in equilibrium. In reality, habit persistence, adjustment costs, imperfect information and incorrect expectations interfere with instant expenditure adjustment to prices and income changes. When working with time series data, it is advisable to undertake stationarity and contegration tests to determine if the data at hand are nonstationary and cointegrated. Nonstationarity in variables and the presence of contegration in the equations will jeopardize the consistency of the parameters. If this be the case, as it is with our data, a dynamic version of the SDAIDS model is more suitable. We thus modify the model to an Error Correction Model version, following Banerjee, Dolado, and Smith (1986), Karagiannis, Katranidis, and Velentzas (2000) and Kremers, Ericsson, and Dolado (1992) as follows:

$$\Delta w_{i_k} = \delta_{i_k} \Delta w_{i_k t-1} + \sum_{j} \sum_{k}^{n} \gamma_{i_k j_k} \Delta \ln p_{j_k} + \beta_i \Delta \ln(E / P^*) + \lambda_{i_k} u_{i_k t-1} \qquad (5)$$

where Δ denotes the difference operator, $u_{i_k t-1}$ are the lagged estimated residual from cointegration equations. The term δ_{i_k} is the deviation of actual budget shares in the previous period, $w_{i_k t-1}$. The ECM-SDAIDS is then estimated by iterated seemingly unrelated regression (ISUR). Adding-up and symmetric conditions are expected to hold, just as in the AIDS model.

Data and Estimation Results

The data utilized for this study include monthly import quantities (metric tones) and import values (CIF) for select fresh vegetables that include tomatoes, cucumbers, peppers, asparagus, and all other fresh vegetable imports. The data are sourced from USDA’s Foreign Agricultural Statistics from January 1989 to December 2008. The data show that, other than the U.S. domestic supply, NAFTA (in particular, Mexico) is the sole supplier of these fresh vegetables; that is, 97%, 89%, and 98% for tomatoes, peppers and cucumbers, respectively, are NAFTA sourced. In fact, Mexico’s contribution is more than 70 percent for each commodity. This limits the extent to which the sources can be differentiated. We therefore differentiate fresh vegetable sources into two sources: imports (mainly NAFTA) and U.S. domestic supply.

The import values for each fresh vegetable group represent average commodity import expenditures for the period (month). Unit values of the imports are used as proxies for import prices and are measured by dividing the reported import values by the reported imported quantity. U.S. monthly consumption data for locally produced fresh vegetables is not available. To circumvent this limitation, we use monthly fresh vegetable shipment data from USDA's Agricultural Marketing Service as proxies for U.S. domestic fresh vegetable supply. U.S. prices for tomatoes, peppers, cucumbers, and asparagus are obtained from Vegetables and Melon Yearbooks. For each fresh vegetable and source, monthly expenditures are calculated from the quantities and prices, following which total expenditure and fresh vegetable expenditure shares are derived. In the event that some U.S. domestic prices are missing, world prices for the fresh vegetable are used. However, we note that using monthly shipments of fresh vegetables might introduce a bias because these shipments do not capture all the produce consumed and in some cases they include produce destined for the export market. We also introduced a dummy variable to capture the impact of NAFTA trade policy.

In total, we constituted nine (9) fresh vegetable equations: tomatoes imports, peppers imports, cucumbers imports, asparagus imports, all other fresh vegetables imports, US tomatoes, US peppers, US cucumbers, and US asparagus. Because we utilize monthly data, we conducted Philips-Perron tests for stationarity and cointegration in all the series and equations. Results are presented in Table 2, and they confirmed nonstationarity and presence of cointegration in the data.

Given the low power of cointegration tests, we also follow the suggested method of testing for cointegration of Banerjee, Dolado, and Smith (1986) and Kremers, Ericson and Dolado, (1992). They suggested formulating and estimating an ECM, and then testing for the significance of the error correction term. If the null hypothesis that the coefficient of the error correcting term is not significantly different from zero is not rejected, then the series is not cointegrated (Karagiannis and Mergos 2002), but if the null hypothesis is rejected, then the series is cointegrated. This approach also confirms that the series are cointegrated (Table 3). Notably, the error-correcting coefficient is negative and statistically significant at the 1 percent significance level in all the expenditure share equations, which meets our expectations.

The finding that the NAFTA trade block introduction had no significant role in fresh vegetable expenditures, however, is surprising. An explanation for this finding may be that U.S. fresh vegetable supply in respective monthly periods is either solely from domestic production or imports from Mexico, and so factoring in the trade block policy change does not influence demand significantly, since the U.S. fresh vegetable market is not open to other regions.

The uncompensated and compensated elasticities of demand are calculated at sample means and shown in Tables 4 and 5, respectively. The short-run expenditure elasticities of demand for all the fresh vegetables are positive and statistically significant with the exception of tomato imports (Table 5). U.S. asparagus and tomatoes appear to be luxury fresh vegetables, with expenditure elasticities greater than one. Other fresh vegetables are demonstrated to be necessities, as their short-run expenditure elasticities are less than one. However, demand for all the analyzed fresh vegetables significantly respond to changes in expenditures.

The uncompensated short-run, own-price price elasticities are negative and significant, except for U.S. peppers. The own-price elasticity for imported fresh cucumbers is -1.0987, slightly more than unitary, and that of imported asparagus is -0.9003. Short-run, own-price elasticities for tomatoes, peppers, and all the other imports are -0.5317, -0.6284, and -0.5197, respectively. Evidence shows that fresh vegetable imports are more price elastic compared to the U.S. fresh vegetable supply. For example, the own-price elasticity of demand for U.S. asparagus is -0.7084 compared to -0.9003 for imports. U.S. fresh cucumbers, on the other hand, are price inelastic (-0.2366) in the short run compared to -1.0987 for imports. Imported tomatoes also have a slightly higher own-price elasticity of -0.5317, compared to -0.4505 for U.S.-supplied tomatoes. Except for U.S. peppers, the results for own-price elasticities are comparable to those in the You, Epperson, and Huang (1996) study results in which they obtained -0.405, -0.5762, -0.2976, and -0.2472 for tomatoes, asparagus, cucumbers and peppers, respectively. Once more, it is clear that demand for the selected fresh vegetables, both imported and domestic, respond significantly to their respective own prices.

The estimated cross price elasticties show mostly expected relationships of the demand for pairs of fresh vegetables. Based on the negative sign and significant cross-price elasticity of demand, tomato imports are shown to be complementary goods with fresh peppers imports, asparagus imports, all other fresh vegetable imports, and U.S. cucumber. These findings appear to substantiate the common consumption habits for tomatoes, which are widely combined and consumed with a wide range of other fresh vegetables. Other complementary fresh vegetables include U.S. asparagus and all the other fresh vegetables imports.

Results also show that fresh vegetables imports are substitutes to U.S. supplied fresh vegetables, with the exception of asparagus. The cross-price elasticities of demand are positive and significant for domestically supplied fresh vegetables and fresh tomatoes imports, fresh pepper imports and U.S. peppers, and fresh cucumber imports and U.S. cucumbers. This finding puts into doubt the argument that imports of fresh vegetables in the U.S. complement domestic supplies by picking up supply in off-season months. Since almost all the imports originate from Mexico and the rest from Canada, which, with an exception of southern Mexico, share similar climate factors and seasons with the U.S, these imports are actually competing with U.S. fresh vegetables. Other fresh vegetables that are significant substitutes include U.S. tomatoes and fresh pepper imports, asparagus imports, cucumber imports, and all other fresh vegetable imports. Asparagus imports and cucumber imports, as well as U.S. imports of all other fresh vegetables are substitute goods, as are all the other fresh vegetable imports with pepper imports and asparagus imports.

Conclusions

We estimate a dynamic version of a source-differentiated AIDS model for selected fresh vegetables that include fresh tomatoes, peppers, cucumbers, and asparagus. The sources for these fresh vegetables are categorized into U.S. domestic source and total imports. Unit root and cointegration tests reveal that the series are nonstationary and cointegrated. An error-correction version of the Aids model is thus estimated, and results show that most fresh vegetable imports are more price elastic compared to domestic vegetables in the short run. Cucumbers and asparagus are found to be price elastic. Also, expenditure shares for all the fresh vegetables are responsive to changes in real expenditure and increase with an increase in expenditures.

From the study findings, we can also infer that most fresh vegetable imports into the U.S. compete significantly with domestic fresh vegetables, as is evidenced by the finding that all fresh vegetable imports significantly substitute for U.S. vegetables, as with tomatoes, peppers, and cucumbers. To the contrary, asparagus does not show any relationship between imports and local produce. NAFTA is shown to have had no significant impact on the selected fresh vegetable imports. However, we observe that the use of fresh vegetable shipments as a proxy for U.S. quantities is likely to introduce bias to our estimates, and this might be the reason our expenditure elasticities for U.S. vegetables are higher than those of imports. This study gives insights into the demand relationships of fresh vegetable imports and U.S. domestic produced fresh produce. Based on the findings, it might be beneficial to encourage more access to asparagus and cucumber imports and discourage fresh tomato imports through price incentives and tariffs. However, there is need for more research on how seasonality and country of origin effects impact the demand relationships for fresh vegetable imports.

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Appendix

Table 1. U.S. Domestic and Imported Fresh Vegetable Outlay Summary, 1989-2008.

Vegetable	Share Label	N	Mean	Std Dev	Minimum	Maximum
Tomato Imports	S1	240	0.1094	0.0623	0.0118	0.4270
Pepper Imports	S2	240	0.0637	0.0282	0.0104	0.1492
Cucumber Imports	S3	240	0.0300	0.0203	0.0023	0.0950
Asparagus Imports	S4	240	0.0214	0.0156	0.0000	0.0780
Other Veggies Imp	S5	240	0.1159	0.0498	0.0371	0.2826
US Tomato	S6	240	0.4943	0.1456	0.1289	0.7856
US Peppers	S7	240	0.1253	0.0631	0.0105	0.3752
US Cucumber	S8	240	0.0202	0.0155	0.0000	0.0822
US Asparagus	S9	240	0.0199	0.0288	0.0000	0.1878

Table 2. Unit root and Cointegration tests, U.S. fresh vegetable imports, 1989-2008.

Variable	**Label**	**Unit Root Test**	**Cointegration Test**
Tomato Imports Expenditure Share	S1	-7.5527	-7.6383
Pepper Imports Expenditure Share	S2	-7.8356	-8.4457
Cucumber Imports Expenditure Share	S3	-6.6846	-7.325
Asparagus Imports Expenditure Share	S4	-7.8676	-8.1438
Other Veggies Imp Expenditure Share	S5	-6.5903	-7.1294
US Tomato Expenditure Share	S6	-6.8856	-7.7257
US Peppers Expenditure Share	S7	-6.8384	-8.0945
US Cucumber Expenditure Share	S8	-7.8513	-9.1785
US Asparagus Expenditure Share	S9	-6.8432	-7.7741
Tomato Imports Price (log)	LNP1	-7.5527	
Pepper Imports Price (log)	LNP2	-15.682	
Cucumber Imports Price (log)	LNP3	-6.5258	
Asparagus Imports Price (log)	LNP4	-10.564	
Other Veggies Import Price (log)	LNP5	-9.8732	
US Tomato Price (log)	LNP6	-5.7621	
US Peppers Price (log)	LNP7	-4.6266	
US Cucumber Price (log)	LNP8	-10.132	
US Asparagus Price (log)	LNP9	-9.0932	
Real Expenditure (log)	LN E	-10.19	

Critical Values at 10% are -3.13 and -4.42 for unit root and cointegration tests, respectively

Table 3. Estimated coefficients of ECM-LA/AIDS for U.S. domestic and imported fresh vegetables, 1989–2008.

	TOMATO$_{IM}$	PEPPER$_{IM}$	CUCUM$_{IM}$	ASPARA$_{IM}$	OTHER$_{IM}$	TOMATO$_{US}$	PEPPER$_{US}$	CUCUM$_{US}$	ASPAR$_{US}$
	Δs_1	Δs_2	Δs_3	Δs_4	Δs_5	Δs_6	Δs_7	Δs_8	Δs_9
Δs_{it-1}	0.1596	0.1392	-1.5427	0.3564	0.1332	0.1629	0.1036	0.2678	0.2199
	0.0242	0.0327	0.1480	0.0402	0.0265	0.0212	0.0220	0.0423	0.0334
$\Delta \ln p_1$	0.0393								
	0.0075								
$\Delta \ln p_2$	-0.0127	0.0196							
	0.0029	0.0024							
$\Delta \ln p_3$	-0.0060	-0.0048	-0.0039						
	0.0028	0.0022	0.0065						
$\Delta \ln p_4$	-0.0117	-0.0016	0.0037	0.0017					
	0.0018	0.0012	0.0019	0.0014					
$\Delta \ln p_5$	-0.0283	-0.0002	0.0045	0.0082	0.0423				
	0.0047	0.0028	0.0047	0.0020	0.0063				
$\Delta \ln p_6$	0.0332	-0.0003	0.0069	0.0014	-0.0018	0.0273			
	0.0108	0.0049	0.0048	0.0026	0.0088	0.0261			
$\Delta \ln p_7$	-0.0067	-0.0016	-0.0028	-0.0055	-0.0144	-0.0701	0.1136		
	0.0060	0.0031	0.0027	0.0018	0.0049	0.0117	0.0096		
$\Delta \ln p_8$	-0.0072	-0.0001	0.0061	0.0022	0.0000	-0.0113	-0.0039	0.0149	
	0.0023	0.0014	0.0018	0.0011	0.0022	0.0035	0.0024	0.0017	
$\Delta \ln p_9$	0.0002	0.0017	-0.0036	0.0015	-0.0103	0.0146	-0.0086	-0.0008	0.0054
	0.0038	0.0021	0.0022	0.0014	0.0033	0.0068	0.0042	0.0017	0.0040
$\Delta \ln E$	-0.0972	-0.0465	-0.0189	-0.0174	-0.0686	0.2500	-0.0012	-0.0104	0.0103
	0.0112	0.0049	0.0040	0.0023	0.0087	0.0237	0.0115	0.0032	0.0065
u_{t-1}	-0.5122	-0.5556		-0.7480	-0.5664	-0.5293	-0.5157	-0.7257	-0.4890
	0.0285	0.0368		0.0453	0.0302	0.0237	0.0260	0.0529	0.0293
Nafta	0.0023	0.0010		-0.0002	0.0006	-0.0032	-0.0007	-0.0003	0.0004
	0.0026	0.0011		0.0005	0.0020	0.0055	0.0027	0.0007	0.0015
R-Sq.	0.5252	0.4702		0.5653	0.4743	0.5061	0.5218	0.4283	0.2126
D-W	1.6896	1.3430		1.7374	1.3551	1.4090	1.7428	1.8802	1.4657
LogL	5366.35								

Below the parameters are the respective estimated standard errors. IM = Imports. US = U.S. Domestic Supply.

Table 4. Uncompensated Elasticities for LA/AIDS for U.S. fresh vegetable imports and domestic supply, 1989–2008.

	$TOMATO_{IM}$	$PEPPER_{IM}$	$CUCUM_{IM}$	$ASPARA_{IM}$	$OTHER_{IM}$	$TOMATO_{US}$	$PEPPER_{US}$	$CUCUM_{US}$	$ASPAR_{US}$
$TOMATO_{IM}$	**-0.5438**	-0.0600	-0.0285	-0.0879	-0.1553	0.7428	0.0498	-0.0477	0.0194
	0.0670	0.0266	0.0257	0.0164	0.0435	0.1184	0.0578	0.0211	0.0349
$PEPPER_{IM}$	-0.1203	**-0.6455**	-0.0538	-0.0092	0.0812	0.3565	0.0671	0.0133	0.0415
	0.0452	**0.0371**	0.0348	0.0197	0.0444	0.0893	0.0503	0.0223	0.0325
$CUCUM_{IM}$	-0.1322	-0.1203	**-1.1100**	0.1364	0.2212	0.5393	-0.0150	0.2140	-0.1082
	0.0913	0.0727	**0.2178**	0.0625	0.1524	0.1645	0.0932	0.0595	0.0718
$ASPARA_{IM}$	-0.4588	-0.0221	0.1986	**-0.9042**	0.4812	0.4703	-0.1571	0.1214	0.0862
	0.0821	0.0581	0.0886	**0.0664**	0.0921	0.1369	0.0879	0.0509	0.0656
$OTHER_{IM}$	-0.1789	0.0357	0.0565	0.0837	**-0.5672**	0.2771	-0.0500	0.0119	-0.0773
	0.0401	0.0244	0.0404	0.0171	**0.0535**	0.0883	0.0442	0.0191	0.0285
$TOMATO_{US}$	0.0118	-0.0328	-0.0012	-0.0079	-0.0623	**-1.1948**	-0.2050	-0.0329	0.0195
	0.0214	0.0099	0.0097	0.0054	0.0179	**0.0607**	0.0247	0.0072	0.0138
$PEPPER_{U}$	-0.0526	-0.0118	-0.0222	-0.0440	-0.1140	-0.5553	**-0.0913**	-0.0309	-0.0684
	0.0473	0.0243	0.0219	0.0147	0.0393	0.1068	**0.0792**	0.0193	0.0338
$CUCUM_{US}$	-0.3003	0.0287	0.3181	0.1226	0.0601	-0.3049	-0.1288	**-0.2463**	-0.0318
	0.1110	0.0694	0.0899	0.0541	0.1093	0.1966	0.1227	**0.0849**	0.0847
$ASPAR_{US}$	-0.0468	0.0539	-0.1994	0.0645	-0.5825	0.4813	-0.4986	-0.0531	**-0.7385**
	0.1881	0.1033	0.1098	0.0710	0.1672	0.3920	0.2206	0.0865	**0.2012**

Below the estimated elasticities, are the respective standard errors. IM = Imports. US = U.S. Domestic Supply.

Table 5. Expenditure and Compensated Elasticities for ECM-LA/AIDS for U.S. domestic and fresh vegetables imports, 1989 – 2008.

	$TOMATO_{IM}$	$PEPPER_{IM}$	$CUCUM_{IM}$	$ASPAR_{IM}$	$OTHER_{IM}$	$TOMATO_{US}$	$PEPPER_{US}$	$CUCUM_{US}$	$ASPAR_{US}$	REAL Expenditure
$TOMATO_{IM}$	**-0.5317**	-0.0529	-0.0251	-0.0856	-0.1424	0.7978	0.0637	-0.0455	0.0216	0.1111
	0.0689	0.0267	0.0255	0.0162	0.0432	0.0987	0.0552	0.0208	0.0347	0.1022
$PEPPER_{IM}$	-0.0908	**-0.6284**	-0.0457	-0.0035	0.1125	0.4896	0.1007	0.0187	0.0468	**0.2692**
	0.0459	**0.0375**	0.0347	0.0196	0.0447	0.0765	0.0483	0.0221	0.0324	**0.0762**
$CUCUM_{IM}$	-0.0912	-0.0965	**-1.0987**	0.1444	0.2647	0.7246	0.0319	0.2215	-0.1008	**0.3749**
	0.0925	0.0732	**0.2166**	0.0624	0.1544	0.1581	0.0904	0.0596	0.0718	**0.1315**
$ASPARA_{IM}$	-0.4386	-0.0103	0.2041	**-0.9003**	0.5026	0.5615	-0.1340	0.1251	0.0898	**0.1844**
	0.0833	0.0584	0.0882	**0.0662**	0.0927	0.1239	0.0856	0.0508	0.0656	**0.1071**
$OTHER_{IM}$	-0.1342	0.0617	0.1806	0.0924	**-0.5197**	0.4791	0.0011	0.0201	-0.0692	**0.4086**
	0.0407	0.0245	0.2367	0.0170	**0.0540**	0.0759	0.0423	0.0190	0.0284	**0.0750**
$TOMATO_{US}$	0.1765	0.0631	0.0442	0.0242	0.1125	**-0.4505**	-0.0166	-0.0027	0.0493	**1.5056**
	0.0218	0.0099	0.0096	0.0053	0.0178	**0.0527**	0.0237	0.0071	0.0138	**0.0480**
$PEPPER_{US}$	0.0557	0.0513	0.0077	-0.0228	0.0010	-0.0656	**0.0326**	-0.0110	-0.0488	**0.9905**
	0.0483	0.0246	0.0218	0.0146	0.0393	0.0937	**0.0769**	0.0191	0.0337	**0.0923**
$CUCUM_{US}$	-0.2476	0.0594	0.3327	0.1329	0.1161	-0.0664	-0.0684	**-0.2366**	-0.0223	**0.4825**
	0.1133	0.0701	0.0895	0.0540	0.1095	0.1736	0.1188	**0.0846**	0.0845	**0.1608**
$ASPAR_{US}$	0.1194	0.1506	-0.1536	0.0969	-0.4062	1.2325	-0.3085	-0.0226	**-0.7084**	**1.5193**
	0.1920	0.1043	0.1094	0.0707	0.1666	0.3438	0.2130	0.0858	**0.2006**	**0.3271**

Below the estimated elasticities, are the respective standard errors. IM = Imports. US = U.S. Domestic Supply.