Import demand of bananas in the European Union

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The EU banana market has been of enormous interest for researchers for a long time. Prior to the policy unification brought by the Common Market Organization for Bananas (CMOB), many authors studied the implications of the multi policy scheme prevalent before 1993. This interest derived from the distorting effects of those import policies not only within the EU but also in the world banana market. The interest for studying the EU banana situation increased with the CMOB. Several factors contributed to this but probably the main reason was the adverse reactions generated by this policy in different sectors.

For example, some argue the EU protected certain low-income countries to the detriment of other developing nations that were also highly dependent on banana trade. Additionally, the aid system that accompanied the import regime was highly inefficient. Only a small proportion of the money intended to compensate preferred suppliers for any loss derived from the import system actually reached its target. The issue about the EU banana market became even more complicated when the interests of US multinational fruit companies entered the scenario. The interest for the European Union banana market resumed with the endorsement of the banana agreement between the EU and the United States in 2002.

What is interesting about the many analyses of this market is that the conclusions reached by them vary considerably. Divergences in the results are found not only in the magnitude of the effects but also in the way the involved parties have been affected by the alternative import policies. One of the main reasons for those discrepancies is that for each evaluation, a different set of demand parameters has been used. A common denominator to the estimations used is that the general demand restrictions necessary to make them consistent with

economic theory has not been incorporated. Table 1 summarizes a few of the demand elasticity set ups and the welfare effects that some authors have estimated for the EU banana market.

It is obvious from those results that demand parameters highly affect the results obtained from the welfare analysis. Now, that a new banana import agreement has emerged in the EU, an adequate estimation of its import demand becomes relevant from a policy analysis perspective. The objective of this project is to estimate a well-defined demand system to generate reliable elasticities to facilitate future welfare analysis of the EU banana market. Simulations to calculate preliminary welfare effects of the new import regime on Latin American producers and on EU consumers of bananas from this region are also performed.

The paper is organized in two main sections. Section one presents the methodology used to estimate the import demand elasticities for bananas in the EU. The results obtained are summarized and discussed. Section two deals with the welfare estimations for the new import regime that the EU intends to bring in January 2006. The welfare analysis centers on the Latin American region, therefore, just changes in the wellbeing of producers from that region and in EU consumers of Latin American bananas are estimated.

Table 1. Summary of some demand elasticities and welfare analysis of previous evaluations of the EU banana market.

Source	Method for calculating elasticities	Comparison period	Welfare cost for EU consumers[(a)]
Borell and Yang (1990)	Elasticities assumed	Before 1993	693
Matthews (1992)	Elasticities assumed based on prior studies	Before 1993	579
Borell and Cuthbertson quoted in Matthews 1992	Elasticities assumed	Before 1993	1438
Borell and Yang (1992)	Elasticities assumed	Before 1993	1610
McInerney and Person (1992)		Before 1993	1600
Read (1994)	Unpublished	Before 1993	642
Borell (1994)	Elasticities assumed	After 19993	2300
Euro PA (1995)	Same as Borell (1994)	After 19993	800-1000

Source: H. Kox,

(a) Million US$

Banana import demand elasticities in the European Union

Initially, two different models were estimated for determining whether a regular o an inverse demand system better fitted the way the EU banana market behaves. The first corresponded to the almost ideal demand system (AIDS), under the usual assumption that quantities imported are determined by the import price. This is the demand definition used by most researchers. The second model corresponded to the inverse almost ideal demand system (IAIDS) which assumes that prices adjust to quantities. This assumption was reasonable under the current import scheme, when imports are limited by quotas. However, with the forthcoming elimination of all quotas in January 2006, that will not longer be the case.

Total supply of bananas en the EU is decomposed into four components, each representing a different supplier region. The first corresponds to Latin America, the main supplier of the EU. The second is composed of the countries from Africa, the Caribbean and Pacific that has traditionally enjoyed preference access to the EU market. The third region comprises the communitarian countries, which are mainly overseas territories of Greece, Spain, France and Portugal. Finally, the last exporting region comprises all other countries (rest of the world).

The almost ideal demand system can be obtained from an indirect utility function, V(p,m), of the form shown in (1):

$$V(p,I) = \frac{\ln(I) - \ln a(p)}{\ln b(p)} \tag{1}$$

Where

$$\ln a(p) = \alpha_0 + \sum_{i=1}^{n} \alpha_i \ln(p) + 0.5 \sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ij}^{*} \ln p_i \ln p_j \tag{2}$$

$$\ln b(p) = \beta_0 \prod p_j^{\beta_j} \tag{3}$$

And i,j represents the various banana producing regions (e.g. Latin America, ACP, Others, EU); **p** is a price vector containing import prices from each exporting region i; I is total expenditure in imported bananas in the EU; α_0, α_i, γ_{ij} and β_i are the parameters estimated.

Solving for I we can got the following expenditure function:

$$E(p,u) = b(p)^u a(p) \tag{4}$$

Where b(p) and a(p) correspond to the definitions previously given and u is utility level. By Shephard's lemma, differentiating the log of this function with respect to the log of each price, we got a share compensated equation (w_i) of EU imports from each region. These equations are of the form shown in (5),

$$w_i = \alpha_i + \sum_{i=1}^{n} \gamma_{ij} \ln p_j + \beta_i U \beta_0 \prod p_i^{\beta_i} \tag{5}$$

After solving equation 0 for u and plugging the solution back in the compensated share equation, we obtained uncompensated share equations, which compose the system that we estimated. See equation 0.

$$w_i = \alpha_i + \sum_{i=1}^{n} \gamma_{ij} \ln p_j + \beta_i (\ln M - \ln a(p)) \tag{6}$$

Derivation of the uncompensated share equations with respect to the appropriate variable let us derive uncompensated price (ε_{ij}) and income (ε_{im}) elasticities. They are of the form depicted in equations 0 and 0 respectively.

$$\varepsilon_{ij} = \frac{\gamma_{ij} - \beta_i (\alpha_i + \sum_{i=1}^{n} \gamma_{ij} \ln p_j)}{w_i} - \delta_{ij} \tag{7}$$

$$\varepsilon_{im} = \frac{\beta_i}{w_i} - 1 \qquad (8)$$

Where δ_{ij} is the Kronecker delta, which takes a value of 1 when i=j and zero otherwise.

Compensated elasticities are derived from the above elasticities from the following relationship:

$$\varepsilon_{ij}^{c} = \varepsilon_{ij} - w_j \varepsilon_{iM} \qquad (9)$$

These elasticities are meaningful since they are a pure representation of the substitution relationships between exporting regions. They allows us to exactly determine whether imports from the different regions are either complementary or substitutes. Finally, to be consistent with the general demand restrictions, adding up, homogeneity and symmetry were imposed to the system[1].

Data

The data comprise annual observations for the period 1964 to 1999. Trade flows (value and quantity) are decomposed by exporter country. These data were obtained from the World Trade Annual of the United Nations. Due to the way the data are reported, it is not possible to

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[1] $\sum_{i=1}^{n} \alpha_i = 1, \quad \sum_{i=1}^{n} \beta_i = 0, \quad \sum_{i}^{n} \gamma_{ij} = 0$ (adding up)

$\sum_{j}^{n} \gamma_{ij} = 0$ (homogeneity)

$\gamma_{ij} = \gamma_{ji}$ (symmetry)

determine the country where the trade flows within the EU come from. Therefore, statistics for the communitarian suppliers include two different flows. One corresponds to the domestic from Portugal, Spain, Greece and France. The other constitutes re-exports within the EU countries. As a result, imports statistics from the EU might be over estimated.

Statistics of the gross domestic product (GDP), commodity price index (CPI) and population were obtained from the International Financial Statistics of the International Monetary Fund. Domestic prices of bananas from France, Italy and Greece were obtained from the Food and Agricultural Organization (FAO) web site. Nominal prices were converted to real values using 2002 as the base year.

The descriptive statistics for the data are shown in Table 2. It can be seen that Latin American is by any means the main supplier of bananas to the EU. Per capita imports from this region averaged 5 kg a year during the period 1969 – 2002. Those flows had also the greater variability, which might be a result of the different import regimes that has ruled the EU during the analyzed period and that usually target imports from Latin America.

In the case of the quantities exported to the EU by the ACP and the EU regions, are about the same. However, exports from the ACP seem more stable over time. An explanation for the behavior of the EU flows might be due to the re-exports portion of these flows, which started to being allowed in 1993. Bananas from Latin America are also the cheapest and its prices present less variability. As is has been mentioned in existent literature, bananas from communitarian countries are the most expensive, followed by the ACP. Import prices from other suppliers are lower than from those regions but still are not competitive in relation to Latin America.

Table 2. Data's descriptive statistics

Variable	Mean	St. Deviation	Variance	Minimum	Maximum
Prices					
Latin America	0.292	0.227	0.052	0.000	0.706
ACP	0.321	0.269	0.072	0.000	0.725
EU	0.356	0.289	0.084	0.026	0.884
Others	0.299	0.280	0.078	0.006	0.912
Quantities					
Latin America	5.077	2.005	4.020	0.000	8.491
ACP	1.429	0.456	0.208	0.000	2.348
EU	1.352	0.647	0.418	0.048	2.864
Others	0.206	0.228	0.052	0.009	0.702
Expenditure	3.038	3.057	9.342	0.007	8.601

(1) Prices are US$/kg.
(2) Quantities are expressed in per-capita kg

Results

Table 3 presents the parameters obtained from the estimation of the AIDS model. All the parameters directly obtained from the model were significant at a 5% confidence level, which makes the elasticity estimated highly reliable. Based on the demand restrictions previously imposed to the system, values for the eliminated parameters were recovered. These are the values for which the standard error and the T-ratios are not reported.

Table 3. Parameter estimated from the AIDS model for the EU import demand of bananas

Parameter	Coef.	St. Error	T-Ratio	Parameter	Coef.	St. Error	T-Ratio
α_0	-4502.50	46.68	-96.45	γ_{23}	0.81	0.17	4.80
α_1	43.02	10.64	4.04	γ_{24}	-0.52	0.07	-7.16
α_2	24.79	1.73	14.33	γ_{34}	2.89	0.61	4.75
α_3	-151.30	19.03	-7.95	α_4	84.49		
β_1	-0.01	0.00	-3.90	β_4	-0.02		
β_2	-0.01	0.00	-13.52	γ_{11}	-0.31		
β_3	0.03	0.00	7.65	γ_{22}	-0.01		
γ_{12}	-0.28	0.08	-3.66	γ_{33}	-5.06		
γ_{13}	1.37	0.56	2.46	γ_{44}	-1.59		
γ_{14}	-0.78	0.27	-2.86				

Uncompensated and income elasticities are shown in Table 4. Income elasticities indicate that bananas from the Latin America and the ACP regions can be considered normal goods. However, demand for bananas from these regions increases less than proportionally than the income of the EU population. Communitarian bananas on the other hand are luxury goods since their consumption increases more than proportionally than increases in income. Finally, the income elasticity for the demand from other sources is the close to zero, which makes bananas from the rest of the world an inferior good for the EU consumers.

The four own price elasticities have the expected negative sign. An important conclusion that can be drawn from them is that the EU demand for bananas from all regions is relative inelastic. Import demand from ACP is the least elastic (-0.224), followed by the EU

(-0. 627) and other suppliers (-0.778). Import demand from Latin America is the most sensitive to own price changes (-0.843).

Table 4. Uncompensated and Income Elasticities from the AIDS model

Prices/Quantities	Latin America	ACP	EU	Others
Latin America	-0.843	-0.274	-0.512	1.666
ACP	-0.073	-0.224	-0.188	-2.322
EU	-0.104	-0.161	-0.627	1.349
Others	0.035	-0.308	0.135	-0.778
Income	0.985	0.967	1.192	0.084

To determine whether bananas from the four different sources are complements or substitutes, compensated price elasticities were calculated. The advantage of this procedure is that the income effect is eliminated, letting us to analyze the pure price effect and categorize the goods as q-net complements or q-net substitutes.

Compensated elasticities are summarized in Table 5. EU import demand from all regions but ACP and other suppliers are substitutes. In the case of Latin America, its demand is most sensitive to price changes of ACP bananas, which makes sense since those two regions are the main suppliers of the EU. On the other hand, bananas from the ACP and other sources are complements.

It would be interesting to compare these estimates to those used by other authors on their analysis. However, as shown in Table 1, most of the demand parameters used are either hypothetical or not reported.

Table 5. Compensated Elasticities from the AIDS model

	Latin America	ACP	EU	Others
Latin America	-0.2261	0.3515	0.3212	1.5020
ACP	0.0898	-0.0077	-0.0331	-2.4184
EU	0.0874	-0.0352	-0.4653	1.4781
Others	0.0489	-0.3086	0.1771	-0.5617

II. Welfare Analysis

The new import policy proposed by the EU for the import of bananas corresponds to the second stage of the signed agreement between the EU and the United States. In this stage, which will come into effect in 2006, exporters will compete on the basis of differentiated tariffs and all regional or country-specific quotas will be eliminated. The EU has proposed a new tariff level of 230 euros for Latin America, for example.

At this point, it is uncertain whether the new tariff level of 230 euros will materialize as Latin American countries consider the tax to be excessive and prohibitive. A panel formed by Ecuador, Costa Rica, and Colombia opened a consultation process in the WTO alleging that the new tariff violated GATT principles as it inhibits Latin American banana producers in their ability to compete with the ACP region. The EU, on the other hand, maintains that the proposed system is legal and, in fact, off the table for discussion as the tariff came about as a necessary feature in the 2002 agreement with the US.

Figure 1 presents a simple supply and demand analysis of the potential effect of tarrification. As shown in Figure 1, the analysis assumes that the initial EU market covered by Latin America is characterized by an equilibrium that takes place at point E, with P_1 and Q_1 being the respective equilibrium price and quantity. The demand curve is D and the supply curve is the line formed by the segments $Q_1E_1S_1$. The portion Q_1E_1 corresponds to the inelastic segment of the Latin American supply under the quota. That is, this is the price range where it is not profitable to export any quantity above the quota level because of the high tariff applied to those exports (680 euros per ton). Above P_1, exporters would be willing to export more than the 2.5 million-ton quota thus supply becomes upward sloping.

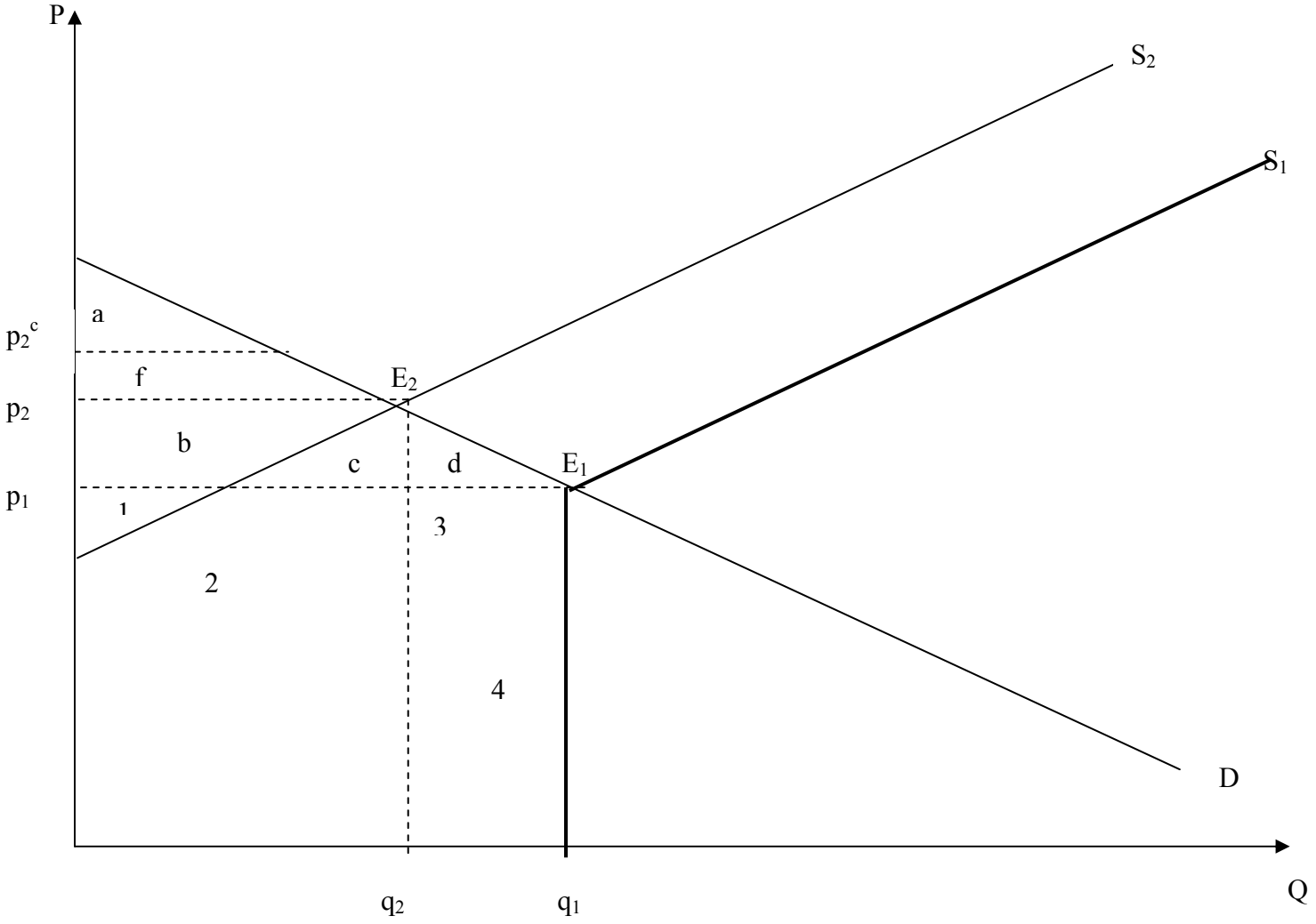
Once the new policy comes into effect, the inelastic portion of the supply curve disappears, replaced by a traditional, upward-sloping curve, given by P_0ES_1. However, the higher tariff will result in a decrease in the supply due to the portion of the tax assumed by the exporters. This tariff translates into a leftward shift of the supply curve resulting in the new equilibrium under the tariff, E_2, with P_2 and Q_2 being the new price and quantity levels.

To simulate the market situation and changes depicted in Figure 1, the elasticities estimated from the AIDS model are used to define a system of demand and supply equations. From these, changes in producer and consumer surplus will be calculated for pre- and post-tariff scenarios under hypothetical market parameters. We presume that over small changes, the demand equations may be approximated using the function as the shown in equation 1.

$$Q_i = A_i \prod_{j=1} p_j^{\alpha_{ij}} I^{\varepsilon_i} \quad \forall \quad i, j = 1,..., N \tag{1}$$

Where i, j represent the various banana producing regions (e.g. Latin America, ACP, Others, EU); Q_i is the EU import demand for bananas from region i; A_i is a constant term for

Figure 1. EU Banana Market for the Latin American suppliers



the demand for bananas from region i, p_i represents the import price from region i; α_{ij} is the elasticity of the demand from region i with respect to j's import price; I represents the EU income level, and ε_i stands for the income elasticity of demand for bananas from region i.

In the case of the supply functions, due to the lack of complete information on supply, supply elasticities were not estimated. Instead, the welfare analysis was performed using different scenarios based on four alternative elasticity values (0.5, 1.0, 2.0, and 3.0). Like the demand equations, the supply curves are assumed to be of the constant-elasticity form shown in Equation 2.

$$S_i = B_i p_i^{\beta_i} \tag{2}$$

Where S_i is the supply of bananas from region i to the EU; B_i represents a constant term of region i's supply equation; p_i represents the export price from region i (same as import price) and β_i represents the price elasticity of region i's supply.

The constant terms of both demand and supply curves are used to calibrate the system to its initial values, where we have chosen the pre-tariff year of 2002 as the base year. Relevant variables from the AIDS model are quantities, prices and income and we refer to these using the following notation: Q_{io}, p_{io} and I_o. Using those values and the estimated demand elasticities, a constant term for each demand equation (A_i) is obtained by solving Equation 3.

$$A_i = Q_{io} \prod_{j=1} p_{jo}^{-\alpha_i} I_o^{-\varepsilon_i} \quad \forall \; i, j = 1,...N \tag{3}$$

A similar procedure is used to calibrate the supply equation for each exporting region. The value of the constant term, B_i, is obtained for each elasticity-value scenario by solving for this variable as shown in (4).

$$B_i = S_{io} p_{io}^{-\beta_i} \tag{4}$$

Since it is unclear how much the exported quantity from Latin America is going to decrease[2] under the new tariff level, the welfare analyses were performed under different scenarios with alternative quantity changes that range from -1% to -20%. Based on that new quantity, a new constant term for the supply curve from this region (B_{LA}') is calculated under each scenario. Then, the market clearing condition ($Q_i = S_i$) is imposed to solve for the new optimal price that is,

$$A_i p_i^{\alpha_i} M_i = B_i' p_i^{\beta_i} \tag{5}$$

Where:

$$M_i = \prod_{j=1}^{n-1} p_{jo}^{\alpha_i} I_o^{\tau_i} \tag{6}$$

Solving equation (5), the new equilibrium price is found as shown in Equation (7).

$$p_i = \left(\frac{A_i * M_i}{B_i'} \right)^{\left(\frac{1}{\beta_i - \alpha_i} \right)} \tag{7}$$

In the case of Latin American producers, since their exports are taxed, this expression represents the producer price. It is assumed that the cost of the tariff is completely transferred to consumers. The way consumer and producer prices are related is shown in Equation (8):

$$p_{LA}^c = p_{LA}(1 + \varsigma)$$

Based on the new price and quantity, one can integrate over the supply curve from the old equilibrium price and quantity (p_{io} and Q_{io}) to the new equilibrium price and quantity (p_i'

[2] Latin American exporters argue that they are going to be entirely left out of the market (La Nación. Economía en América. January 13, 1995) while EU authorities maintain that this region will keep its access unaltered (La Nación. February 4, 1995).

and $Q_i^{'}$) to obtain the change in producer surplus (Alston et al. 1997). This change is given by equation (9).

$$\Delta PS_{LA} = \frac{p_i^{'}Q_i^{'} - p_{io}Q_{io}}{1+\beta} \tag{9}$$

The change in consumer surplus is given by (10):

$$\Delta CS = \int_{p_{io}}^{p_i^{c'}} Mp^{\alpha_i}\, dp \tag{19}$$

Results

Table 6 presents the results of the welfare analysis for the several market scenarios analyzed. It can be seen that for small quantity changes, the elasticity of supply does not have much effect on the new equilibrium price. For example, for a 1% quantity decrease in the imports from 3,366 tones to 3,332 tones in the EU, the differences in the equilibrium price at alternative elasticity levels are less than 0.2%. However, for the scenarios when the quantity decreases were bigger, equilibrium prices vary more widely depending on the elasticity level used in the analysis. For instance, if the exported quantity decreases by 20%, the new equilibrium price would be $0.66 if the supply elasticity were 0.5. Meanwhile, if the value of this parameter is changed to 3.00, the new price would be $0.59, which represents a difference of more than 10% in the price Latin American producers would receive.

The analysis of welfare changes indicates that both EU consumers of Latin American bananas and producers from this region would be made worse off with the new import regime. In the case of consumers, they would purchase a lower quantity at a higher price, although, as shown in table 1, differences in the consumer surplus change as result of a 1% and a 20%

quantity decrease range from 12% and 23% depending on the supply elasticity. For example, losses are of around $1,725 when the quantity imported decreases 1% from 2002 levels for an elasticity of 1. If the quantity decrease were of 20%, those loses would rise to $2,067.

The same can not be said for producers' welfare changes. The welfare lost for Latin American producers would increase from $4,330 to $90,507 depending on whether quantity decreases by 1% or 20%, respectively.

A sensitivity analysis to determine the behavior of consumer and producer surplus changes with respect to elasticity values not only supports those findings but also gives other interesting results. Figure 2 shows how the change in consumer surplus changes as the supply elasticity increases. As supply becomes more elastic, the change in consumers' surplus due to a 1% quantity decrease decreases at a decreasing rate. The same behavior is observed for any quantity change.

In the case of producers, the degree of surplus loss from the supply being more elastic depends on the magnitude of the elasticities. For low values, the change in welfare lost increases as the supply becomes more elastic. However, after attaining a supply elasticity of one, this relationship reverses and the change in producers' surplus losses become lower as their supply gets more elastic (note, these are changes in producer surplus, not the level of surplus).

Table 6. Results from the Welfare Analysis of the EU import tariff to Latin American suppliers

Latin American supply	Percentage change in LAT imports						
	-1.0%	-3.0%	-5.0%	-7.5%	-10.0%	-15.0%	-20.0%
New producer price ($/kg)							
0.50	0.564	0.573	0.582	0.593	0.606	0.632	0.661
1.00	0.563	0.569	0.576	0.584	0.593	0.612	0.632
2.00	0.562	0.566	0.570	0.575	0.581	0.593	0.606
3.00	0.561	0.564	0.567	0.571	0.575	0.584	0.593
New consumer price ($/kg)							
0.50	0.809	0.8178	0.827	0.838	0.851	0.877	0.906
1.00	0.808	0.8143	0.821	0.829	0.838	0.857	0.877
2.00	0.807	0.8110	0.815	0.821	0.826	0.838	0.851
3.00	0.806	0.8094	0.812	0.816	0.821	0.829	0.838
Change in Consumer surplus from Latin American banana imports (2002 US$)							
0.50	-1728.50	-1766.47	-1805.34	-1855.27	-1906.77	-2014.85	-2130.45
1.00	-1725.71	-1757.99	-1791.02	-1833.42	-1877.13	-1968.78	-2066.69
2.00	-1722.06	-1746.89	-1772.28	-1804.86	-1838.42	-1908.71	-1983.67
3.00	-1719.77	-1739.95	-1760.57	-1787.03	-1814.26	-1871.26	-1931.99
Change in LAT Producers surplus (2002 US$)							
0.50	-4322.20	-13038.22	-21852.29	-33012.67	-44337.91	-67512.03	-91438.18
1.00	-4330.20	-13046.99	-21840.83	-32945.03	-44178.06	-67051.54	-90506.91
2.00	-3779.31	-11372.40	-19012.47	-28630.58	-38326.78	-57964.91	-77951.86
3.00	-3227.18	-9704.17	-16211.98	-24391.32	-32621.72	-49242.82	-66090.72

Figure 2. Change in consumer surplus at alternative supply elasticity values (Change in LA quantity=-1%)

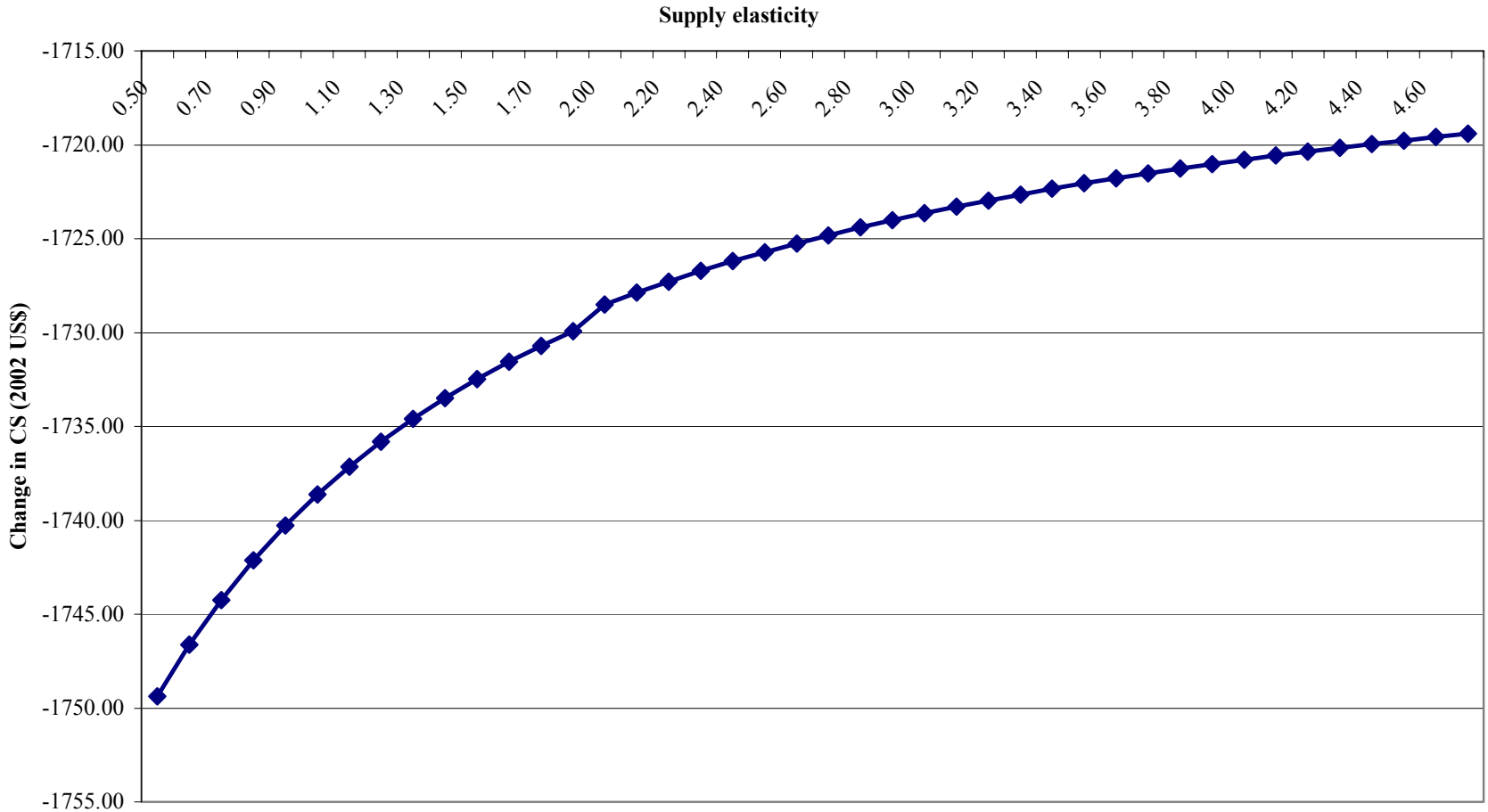
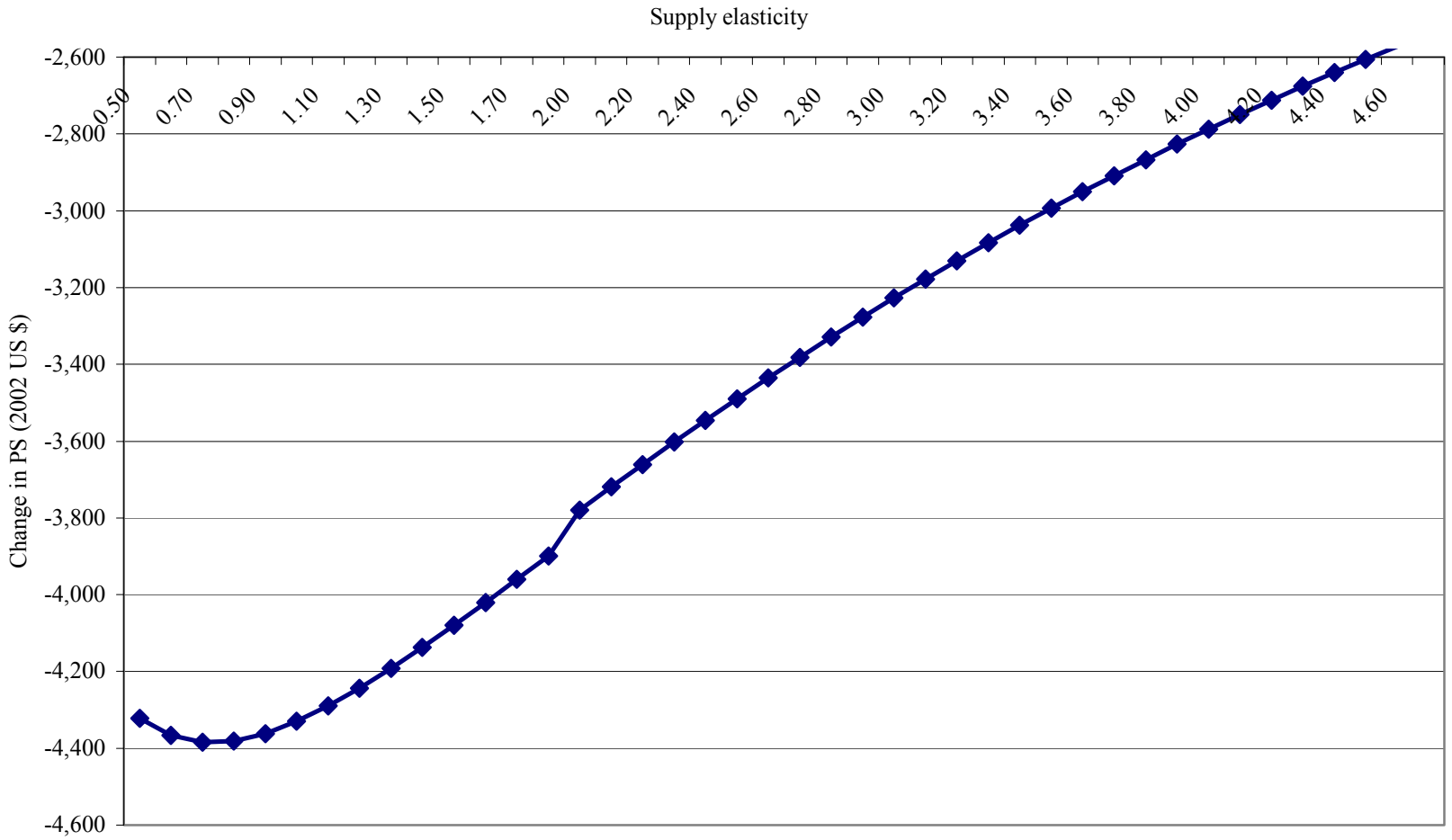


Figure 3. Change in producer surplus at alternative elasticity values (% change in LA quantity=-1%)



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