European Union Import Demand for In-Shell Peanuts: The Source Differentiated AIDS Model[1]

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Abstract

This research estimates import demand elasticities for in-shell peanuts in the European Union from four different sources: China, the United States, South America, and Africa. The null hypothesis of aggregation over product sources is rejected at conventional levels of significance suggesting that peanuts from different sources are differentiated by EU consumers which might attributed to their different quality characteristics. Conditional expenditure elasticities for U.S. in-shell peanuts are larger than expenditure elasticities for Latin American, Chinese and African peanuts.

Keyword: In-Shell Peanuts, Nonlinear SAIDS, the European Union

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Introduction

The European Union (EU[2]) is the largest importer of peanuts in the world. In 2005, its peanuts imports accounted for around 40 percent of the world imports of this commodity (FAOSTAT database 2007). However, little economic research has been done on the EU markets for peanuts. To the best of our knowledge, our paper is the first study analyzing the EU import demand for peanuts differentiated by source of production.

The EU countries import peanuts mainly from China, the US, Latin America and Africa. Whereas the demand for peanuts in Europe has been steady, the export shares among exporting countries have changed. In the last decade, the U.S. share of the total import quantity of in-shell peanuts in the EU has declined whereas China, Africa and Latin America have increased their export shares. China has replaced the US as the main exporter of in-shelled peanuts to the region.

The principal objective of this study is to analyze the EU demand for imported peanuts and to estimate price and expenditure elasticities that can be used for policy analysis. The second objective of this study is to test product aggregation to see whether U.S. peanuts are differentiated from other countries because peanuts from different sources may be different quality characteristics. We hypothesize that EU import demand for peanuts is differentiated by region of origin.

The study of European Union (EU) markets for peanuts might be useful to peanut exporters, but especially the U.S. The recent US farm policy changes in 2002 that

[2] The countries included in the European Union members are Austria, Belgium, Germany, Denmark, Spain, Finland, France, United Kingdom, Greece, Ireland, Italy, Luxemburg, Netherlands, Portugal, and Sweden. It can be called EU15.

replaced the quota system by the Marketing Loan Program have affected not only US peanut production but also US export peanut supply. Therefore, the results from this study can be used to better understand the changes in the demand for peanuts in the world market. Policy makers and economists could also use these results, for example, to analyze and quantify the potential impacts of federal promotion programs on the EU demand for U.S. peanuts.

The EU countries import two types of peanuts: 1) in-shell peanuts and 2) shelled peanuts. Both types are completely different because in-shell peanuts are consumed directly by consumers but shelled peanuts are imported by processors to produce peanut butter, candy, snacks, etc. In this study, we only focus on the imported demand for in-shell peanuts.

General Information on the U.S. Peanut Markets

Peanuts in the United Sates can be classified into four basic types: Runner, Virginia, Spanish, and Valencia. Each of type of peanuts can be distinguished by its size, flavor, and nutritional composition and purpose of use. Virginia peanuts are mainly used for roasted peanuts or to be sold as peanuts in shell. Spanish peanuts are primarily utilized to make peanut candy and peanut oil. Valencia peanuts are sweet and excellent to make fresh make fresh boiled peanuts which are sold in the shell.

Virginia peanuts are the main source of in shell peanuts for domestic use and export. Virginia peanuts are grown mainly in southeastern Virginia and northeastern North Carolina. After the elimination of the peanut quota program in 2002 and due to high cost of productions, there has been a significant move away from peanut production in Virginia and North Carolina. Peanuts acreage in these two states has declined over time from 197.5 thousand acres in 2001 to 118 thousand acres in 2005 and the production has decreased from 591,225 thousand pounds in 2001 to 354,000 thousand pounds in 2005 (NASS[3] database). Peanut production has beginning to move to the Southeast where farms are more productive, have higher yields and where Runner peanuts are mainly planted.

The volume of peanut exports in the U.S. depends on the U.S. production because their production has to match with domestic consumption first before exports. The decline in production of Virginia peanuts in favor of Runner peanuts has also weaken export of in shell peanuts in U.S. Moreover, changes to the peanut program in the 2002 may have further diminished export incentives, as domestic producers who formerly produced additional peanuts for export can now market their peanuts domestically.

Background Information on World Peanut Trade

According to the Production, Supply, and Distribution (PSD online) database of the Foreign Agricultural Service of the USDA, the main suppliers of peanuts to the world peanut market are Argentina, China and U.S. which account for 70 percent of total quantity exports. In 2005, the world total quantity export of peanuts was 2,005 thousand metric tons. Out of this total amount, Argentina exported 400 thousand metric tons, China exported 784 thousand metric tons, and the U.S. exported 223 thousand metric tons.

[3] National Agricultural Statistics Service, United States Department of Agricultural

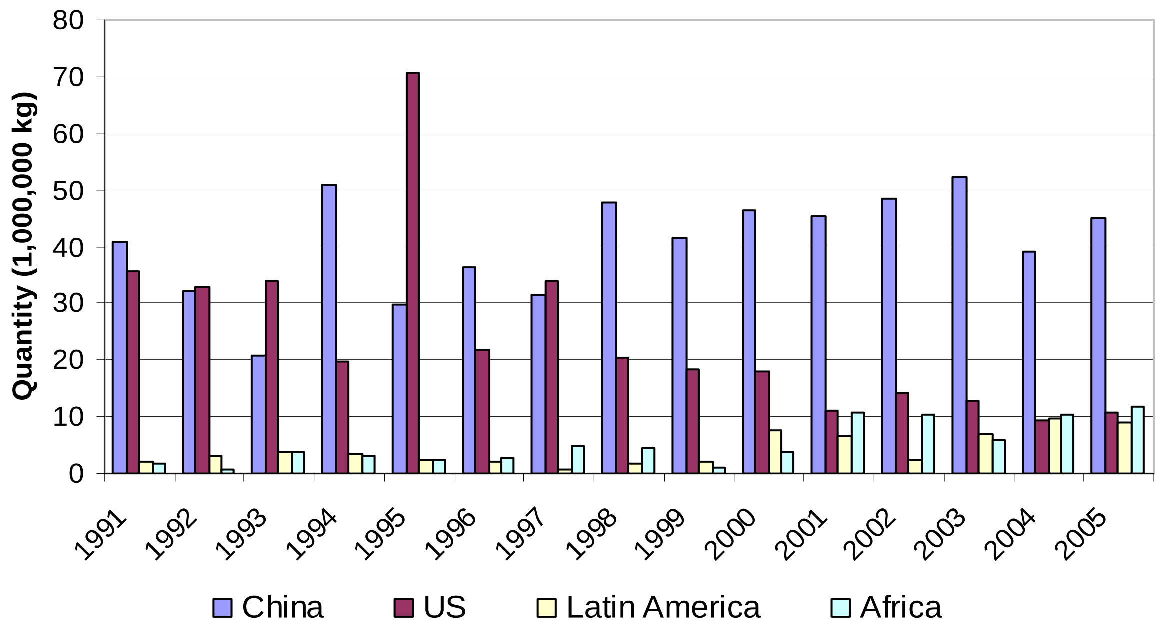
The main importers of peanuts in the world are Canada, the EU, Japan and Mexico. These four importers account for more than 60 percent of total imports. In 2005, Canada, Japan and Mexico each accounted for about 7 percent of total world import quantities and the EU accounted for around 40 percent. Hence, the EU is the largest importer of peanuts by quantity and value.

China, the U.S., Latin America, and Africa are the major exporters of in-shell peanuts to the EU. They accounted for more than 96% of the total value and quantity of EU in-shell peanut imports between 1995 and 2005 (EUROSTAT). Whereas the demand for peanuts in Europe has been steady, the competition among exporters has changed. China is still the main dominant exporter of peanuts. Both Africa and Latin American countries have increased their export share while the US export share for peanuts has decreased over time (Figure 1).

In the early 90s, the U.S. and China were the main exporters of in-shell peanuts to the EU. For example, in 1991 the US and Chine exported to the EU 35.62 and 40.90 million kilograms (kg) of in-shelled peanuts, respectively. The U.S. exports of peanuts peak in 1995 reaching a level of exports of 70.53 million kg followed by China (29.75 million kg), Latin American (2.54 million kg), and Africa (2.52 million kg). In 1996, China became the most dominant exporter of in-shell peanuts to the EU markets exporting 36.51 million kg, followed by the US (21.77 million kg), Africa (2.73 million kg), and Latin America (1.96 million kg).

The U.S. share of the total import quantity of in-shell peanuts in the EU declined from 66.66% in 1995 to 13.91% in 2005. The Chinese share of total import quantity increased from 28.12% in 1995 to 57.40% in 2005. The South America's share of total import quantity increased from 2.40% in 1995 to 11.38% in 2005 and the Africa's share of total import quantity also increased from 2.36% in 1995 to 14.84% in 2005.

Figure 1: EU15 Imports of In-Shell Peanut by Different Sources



Source: EUROSTAT database

The Source Differentiated AIDS Model

The Source-differentiated AIDS Model (SAIDS) was first specified by Yang and Koo (1994). The SAIDS model allows for source differentiation and it closely follows the derivation of the AIDS model proposed by Deaton and Muellbauer (1980). This model has been previously used in Yang and Koo (1994), and Carew, Florkowski and He (2004). The SAIDS model also allows disaggregating and differentiating products by source.

The SAIDS model is derived from a price independent generalized logarithmic expenditure function which accounts for the importer's behavior that differentiates goods from different origins. Even though tariff and quota on import peanuts and peanut products have become negligible in the EU, food safety issues are still a concern among EU consumers, especially the level of aflatoxins. Given this concern, the degree of food safety could become, to some extent, a source of product differentiation. Since peanuts from different sources have different quality attributes (Bliss, 2005), it is important to recognize quality differences among peanut exporters when analyzing the EU peanut import demand.

Applying Shephard's lemma to the expenditure function, the source-differentiated AIDS for one product (in shell peanuts from different origins in this case) can be written as:

$$(1) \qquad w_i = \alpha_i + \sum_{j \in g} \gamma_{ij} \ln p_j + \beta_i \ln(x_g / P_g)$$

where $\ln P_g = \alpha_0 + \sum_{k \in g} \alpha_k \ln p_k + 1/2 (\sum_{k \in g} \sum_{l \in g} \gamma_{kl} \ln p_k \ln p_l)$ is a price index, g represents the group, x_g $(= \sum_{i \in g} p_i q_i)$ is total expenditure on in shell peanuts from countries $i \in g$ (= China, U.S., Latin America, Africa or ROW), p_i and q_i are the price and quantity of shelled peanuts from countries i, $w_i = p_i q_i / x_g$ is the conditional budget share of shelled peanuts from all the imported sources.

Previous studies using the SAIDS have used the Stone price index as a proxy for the price index derived analytically from the AIDS cost function; however, several studies on consumer demand have showed that the Linear Almost Ideal Demand System could produce biased estimates of demand elasticities (Buse, 1994; Moschini, 1995; Chen, 1998). Therefore, the SAIDS model should be estimated as a nonlinear model (NLSAIDS) instead of using its linear approximation because policy evaluations and simulations require reliable estimates of demand responsiveness to prices and expenditure.

Consistent with demand theory, the demand restrictions are adding up ($\sum_{i=1}^{g}\alpha_i = 1$, $\sum_{i=1}^{g}\gamma_{ij} = 0$, $\sum_{i=1}^{g}\beta_i = 0$), homogeneity ($\sum_{j\in g}\gamma_{ij} = 0$), and symmetry ($\gamma_{ij} = \gamma_{ji}$, $\forall\ i, j \in g$).

To test the hypothesis of product aggregation, the AIDS model which does not differentiate the product by origins can be estimated. Estimation of the AIDS model corresponds to the following restrictions on the SAIDS model (Hayes, Wahl and Williams, 1990):

$$\alpha_i = \alpha_g, \qquad \forall\ i \in g,$$

$$\gamma_{ij} = \gamma_g, \qquad \forall\ i,\ j \in g,$$

$$\beta_i = \beta_g, \qquad \forall\ i \in g.$$

These restrictions imply that the price and expenditure coefficients from the different sources are equal.

The estimated parameters from equation (1) are utilized to compute income, own-price, and cross-price elasticities. The formulas of income elasticities, Marshallian price elasticities, and Hicksian price elasticities for the nonlinear SAIDS model are presented as equations (2), (3) and (4), respectively.

(2) $\eta_i = 1 + (\beta_i / w_i)$

(3) $\varepsilon_{ij} = -\delta_{ij} + (\gamma_{ij} - \beta_i \ln(x_g / P_g)) / w_i$

(4) $\varepsilon_{ij}^* = \varepsilon_{ij} + w_j \eta_i$,

where $\delta_{ij} = 1$ if $i = j$ and $\delta_{ij} = 0$ if $i \neq j$.

To identify whether the goods are substitutes or complements, the Morishima elasticities were calculated using the following equation (Blackorby and Russell, 1989):

(5) $M_{ij} = \varepsilon_{ij}^* - \varepsilon_{ii}^*$

These elasticities measure the percentage change in the consumption ratio $h_i(p,u)/h_j(p,u)$ due to a one percent change in the corresponding ratio p_i / p_j. Morishima elasticities of substitution are very natural measure of substitutability, because by focusing on price and quantity ratios they reflect the curvature of indifference curves. If the Morishima elasticities are positive, the goods are considered to be substitutes.

The estimation of the standard errors of the elasticities in the non-linear SAIDS is complicated by the fact that these elasticities are non-linear function of several parameter estimates. To conduct statistical tests on the elasticities, two types of approaches can be applied to obtain the standard errors. The first method is the delta method which is based on a Taylor series approximation (Greene, 2003). The second approach is the blocks moving bootstrap method for time series data as outlined in Goncalves and White (2005). Both methods are utilized and compared in this paper.

Data and Procedures

The data used to estimate the model are quarterly data from 1991 to 2005 providing a total of 60 observations. The sources of origin of the EU imports of in-shell peanut considered in this study are China, U.S., Latin America, Africa, and rest of the world. The data were obtained from the EUROSTAT database. The quantity of imports from each source is measured in 100,000 kg, and the value of imports is measured in 1,000 EUROS. Since import price data is difficult to obtain, unit prices[4] are used as approximate of import price.

The EU countries grow a trivial amount of peanut plant because the weather in Europe is unsuitable to grow peanuts. Their peanut production is infinitesimal relative to the amount of their peanut imported[5]. Peanut consumption in the EU mainly depends on peanut imports from different sources. Therefore, domestic production can be ignored.

Empirical Estimation

The estimated system of equations is conditional on the EU total expenditure on imported in-shell peanuts. To make the estimation manageable, we assume that the EU consumers allocate total expenditure among groups of goods, in-shell peanuts being one. Preferences among these groups are weakly separable. For the allocation of expenditure for the in-shell peanut group, the EU consumers select imported in-shell peanuts from different sources (China, U.S., Latin America, Africa, and ROW).

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[4] Unit prices of imported in-shell peanut from each country are computed by dividing total value by total quantity of imports.
[5] The EU production is less than 0.0001 percent of total world production and is less than 0.01 percent of total EU import of peanuts. The data of EU and world peanut production are available at Production, Supply and Distribution (PSD online) from the FAS, USDA.

The conditional demand system contains five equations. The ROW equation for in-shell peanut is dropped to avoid singularity problems since the expenditure shares in the conditional demand system sum to one. The parameters of the unrestricted conditional demand system are estimated by using the iterated seemingly unrelated regression (ITSUR) method. The parameters of the restricted conditional demand system were estimated by the seemingly unrelated regression method (SUR) in order to take into account the cross-price effects on source-differentiated within a product.

Tests of homogeneity and symmetry were conducted in the unrestricted demand system, taking into account that cross price effects are source-differentiated within a product. The test of product aggregation was performed in the restricted demand system (Carew, Florkowski, and He, 2004). The MODEL procedure from SAS was used for estimation proposes.

Results

The null hypothesis of no autocorrelation was rejected in all of the models indicating that the data is serially correlated. The systems of demand equations were estimated and corrected for first-order autocorrelation. Since the model is a singular equation system, we follow the first-order autocorrelation correction procedure proposed by Berndt and Savin (1975). This approach assumes a constant autocorrelation coefficient in all the equations of the system of equations and zero cross equation autocorrelation. The estimated value of the first autocorrelation coefficient is 0.3092 which was significant at the 5 percent statistical level.

The results of the tests of the homogeneity and symmetry restrictions in the SAIDS model after correction for the first autocorrelation are presented in table 1. The null hypothesis that symmetry or homogeneity or symmetry and homogeneity restrictions are satisfied is not rejected. Likelihood ratio tests were used to test the restrictions.

The results of the test of product aggregation are showed in table 1. A Wald F-test was used for this purpose. The null hypothesis of product aggregation which maintains that in-shell peanuts from different production sources are perfect substitutes is rejected. These results suggest that in-shell peanuts from different sources are differentiated by EU consumers which might be attributed to their different quality characteristics.

Results of Parameter Estimates

Estimation results of the nonlinear SAIDS model after the correction of autocorrelation are shown in table 2. Dummy variables measuring the effects of seasonality show that imported demand for U.S. and African in-shell peanuts is high during the October-December season which coincides with the harvesting season of peanuts in the U.S. and the higher consumption demand of the product during the holiday season. The seasonal dummy variables also show that imported demand for Chinese in-shell peanuts does not coincide with the harvesting season. This indicates that in China some in-shell peanuts are stored and sold during off season. All of the seasonal dummy variables are significant for China and U.S. but they are not significant for Latin America.

The dummy variable included to capture the 2002 Farm bill which eliminated the marketing quota system for peanuts was found to have a significant and negative effect on imported demand for US in shell peanuts as expected since the decline in the production of Virginia peanuts in the U.S. has weaken the export of in shell peanuts from the U.S. due to its high cost of production. This dummy variable also captures Nicaragua export of in shell peanuts significantly rising in the last three years. It has significant and a positive effect on imported demand for Latin American in shell peanuts. The change in farm policy in U.S. has not had any effect on in shell peanuts exported from China and Africa.

Result of Elasticities

Conditional expenditure elasticities are reported in table 3. Imported in shell peanuts from China, Latin American, and Africa are conditionally expenditure inelastic while imported in shell peanuts from the U.S. are conditionally elastic. These results suggest that, as peanuts imports increase, the EU imports more peanuts from the US than form other sources. This might be due to the fact that U.S. peanuts have better quality. The conditional expenditure elasticity from rest of the world is negative because most of in shell peanuts imported to the EU are mostly low quality peanuts from India.

Mashallian price elasticities showed in table 3 indicates that all conditional own price elasticities for in-shell peanuts from different sources are negative corresponding to the law of demand. The Marshallian own price elasticities of demand for U.S. in shell peanuts are -2.2952 and that for Chinese in shell peanuts -1.7787. They are conditionally highly elastic and significant. These results suggest that EU consumers respond more to price reductions for in shell peanuts imported from China and the US.

Latin American in shell peanuts are much less own price elastic. This indicates that EU consumers' demand for Latin American in shell peanuts is not that sensitive to own price changes. The Marshallian own price elasticities are only -0.4720. The Marshallian own price elasticities of in shell peanuts from Africa and the rest of the world are more elastic than Latin American in-shell peanuts but less elastic than US and Chinese in-shell peanuts. African in-shell peanuts have a Marshallian own price elasticity of -1.4935 which is very close to the own price elasticity of the rest of the world which is -1.4851. Something that is important to point out is the fact that only the own and cross price elasticities corresponding to the US and China were statistically significant.

The Morishima elasticities of substitution are utilized to identify whether goods are substitutes or complements and they are shown in table 3. The Morishima elasticities indicate that in-shell peanuts from China, Latin America, Africa, and the rest of the world are substitutes for U.S. in-shell peanuts. The Morishima elasticities also indicate that peanuts from China and the U.S. have a higher degree of substitutability than other countries probably because China and U.S. are the main exporters of in-shell peanuts to the EU markets. China has a lower degree of substitutability for in-shell peanuts from Latin American. The U.S. has lower substitutability for in-shell peanuts from Africa and Latin American.

The estimated standard errors of elasticities are also shown in table 3. Standard errors of elasticities are the values in parentheses. The first row of values in parentheses corresponds to standard errors calculated using the delta method and the second row of values in parentheses correspond to standard errors calculated using bootstrapping.

Statistical tests conducted using bootstrapping standard errors yielded a higher number of statistical significant elasticity estimates.

Summary and Conclusions

This research estimates import demand elasticities for in-shell peanuts in the European Union from four different sources: China, the United States, South America, and Africa. A source differentiated AIDS model was used for estimation of the demand parameters.

The null hypothesis of aggregation over product sources is rejected at conventional levels of significance suggesting that peanuts from different sources are differentiated by EU consumers which might attributed to their different quality characteristics. The expenditure elasticity is elastic for U.S. in-shell peanuts which might be associated with their higher quality. The results also indicate that own price elasticities for in shell peanuts from different sources are negative. The own price elasticities of demand for U.S. and Chinese in shell peanuts are more elastic than Latin American, African and the rest of the world in shell peanuts. These results suggest that EU consumers respond more to price reductions for in shell peanuts imported from China and the US. The Morishima elasticity results indicate that in shell peanuts from China, Latin America, Africa, and rest of the world are substitutes for U.S. in shell peanuts and also indicate that China and U.S. countries have a higher degree of substitutability than other countries.

Demand for peanuts in Europe has been steady, while competition among exporters has changed. The results of expenditure and price elasticities may help to evaluate policies that can be used by the US peanut exporters to maintain existing export markets in the face of increasing global competition. Maintaining strong export markets is an important priority for the U.S. peanut industry. For example, a policy issue that may be addressed with this research is the question in regards to allocating federal dollars for peanut export promotion into the EU. Promotion and advertising program will help boost the demand for U.S. in shell peanuts so that U.S. peanut industry can remain strong in a competitive market for peanuts.

Table 1: Test Results for Demand Restrictions and Product Aggregation

	Nonlinear SAIDS	
	L.R. statistic	Pr>Chisq
System tests for homogeneity	8.86	0.0646
System tests for symmetry	7.24	0.2994
System tests for homogeneity and symmetry	10.06	0.4352
Product aggregation	Wald F-value 408.19	<.0001

Table 2: Parameter Estimates for the Restricted Conditional SAIDS Model of EU Import Demand for In-Shell Peanuts (Homogeneity and Symmetry imposed)

	China	U.S.	Latin American	Africa
Price effects (γ_{ij})				
China	-0.4406**			
	(0.1201)			
U.S.	0.4075**	-0.5447**		
	(0.1351)	(0.1958)		
Latin American	-0.0331	0.0525	0.0306	
	(0.0403)	(0.0438)	(0.0291)	
Africa	0.0685	0.0641	-0.0519*	-0.0701
	(0.0726)	(0.0893)	(0.0304)	(0.0736)
Rest of the World	-0.0023	0.0206	0.0019	-0.0106
	(0.0210)	(0.0225)	(0.0103)	(0.0152)
Expenditure effects	-0.0299	0.0960	-0.0086	-0.0441
	(0.0719)	(0.0700)	(0.0272)	(0.0432)
Trends	0.0006	-0.0022*	-0.0001	0.0018**
	(0.0013)	(0.0013)	(0.0005)	(0.0007)
Seasonal effects				
Quarter 1	0.1083**	-0.0771*	0.0003	-0.0354
	(0.0457)	(0.0438)	(0.0172)	(0.0278)
Quarter 2	0.1472**	-0.0976**	0.0244	-0.0731**
	(0.0459)	(0.0435)	(0.0174)	(0.0278)
Quarter 3	0.2370**	-0.1351**	0.0036	-0.1035**
	(0.0498)	(0.0466)	(0.0187)	(0.0305)
Farm Bill 2002	-0.0154	-0.1381**	0.0848*	0.0529
	0.0508	(0.0508)	(0.0192)	0.0318
R^2	0.6410	0.7565	0.5625	0.4895
Adjusted R^2	0.5772	0.7133	0.4847	0.3988
DW	2.0710	1.7377	1.6200	2.0405

Significance levels of 0.05 and 0.10 are indicated by ** and *, respectively

Table 3: Income Elasticities for the SAIDS model of In-Shell Peanuts

	Income Elasticity
	0.9433**
China	(0.1365)
	(0.1326)
	1.2929**
U.S.	(0.2135)
	(0.2671)
	0.8604*
LA	(0.4436)
	(0.4738)
	0.3781
Africa	(0.6091)
	(0.4849)
RW	-0.0274

	Marshallian Elasticities				
	China	U.S.	LA	Africa	RW
	-1.7787**	0.7026**	-0.0514	0.1751	0.0090
China	(0.2817)	(0.3152)	(0.2882)	(0.2794)	
	(0.2893)	(0.3062)	(0.0663)	(0.1340)	
	0.9450**	-2.2952**	0.1010	-0.0376	-0.0061
U.S.	(0.4209)	(0.5219)	(0.4488)	(0.4310)	
	(0.4921)	(0.5310)	(0.1455)	(0.1696)	
	-0.3982	0.6820	-0.4720	-0.7353*	0.0630
LA	(0.9334)	(1.0023)	(0.9377)	(0.9079)	
	(0.5698)	(0.7781)	(0.7837)	(0.5111)	
	1.5986*	0.1261	-0.6062*	-1.4935*	-0.0031
Africa	(1.3095)	(1.4071)	(1.2902)	(1.1963)	
	(0.9956)	(0.7841)	(0.4419)	(0.9611)	
RW	0.8720	0.2796	0.3486	0.0122	-1.4851

	Morishima Elasticities				
	CN	US	LA	AF	RW
CN	-	2.29	1.35	1.52	1.30
US	3.50	-	2.05	1.93	1.88
LA	0.47	1.38	-	-0.26	0.49
AF	3.26	1.72	0.88	-	1.49
RW	2.43	1.57	1.83	1.50	-

Significance levels of 0.05 and 0.10 are indicated by ** and *, respectively
The first row of values in parentheses corresponds to standard errors calculated using the delta method and the second row of values in parentheses correspond to standard errors calculated using bootstrapping.

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