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The Elasticity of Substitution in Demand for Non-Tradable Goods in Costa Rica

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Abstract[1]

Using quarterly (annual) information on consumption and prices of non-tradable goods for the period 1980-2002 (1981-2001), this paper estimates the elasticity of substitution in demand for non-tradable goods in Costa Rica. The unit root and cointegration properties of the time series are tested, and then controlling for exogenous variables, the elasticity of substitution belonging to the interval [1.46, 2.14] ([0.22, 0.28]) is estimated. These results are statistically robust.

[1] The authors would like to thank Enrique Mendoza, Arturo Galindo and Alejandro Izquierdo as well as the rest of the participants in the IADB discussion seminar, for valuable comments. Furthermore, the authors thank Henry Vargas, Carlos Carrillo and William Calvo from the Central Bank of Costa Rica for providing valuable data.

1. Introduction

This paper estimates the elasticity of substitution in the demand for non-tradable goods in Costa Rica, with research in two main dimensions. The first is to describe and analyze the structure of Costa Rica's national accounts and other available information, examining particular features in order to obtain insights on the tradable and non-tradable sectors. The second dimension is the use of formal econometric methods to estimate the elasticity of substitution in the demand for non-tradable goods in Costa Rica. The lessons extracted from these two dimensions are likely to be important because Costa Rica is one of the most stable and open economies in Latin America.

Within the context of the region, estimating the elasticity of substitution for non-tradable goods in Costa Rica is particularly interesting for several reasons. First, Costa Rica is one of the many small economies of the region with characteristics very different from those of the more traditionally studied large economies. For instance, Costa Rica is among the first Latin American countries to open its economy unilaterally to the rest of the world. Second, Costa Rica represents a pleasant exception in Latin America (most notably in Central America), because it has implemented a democratic system with strong implications for its relative economic success.

A third reason for studying the case of Costa Rica is the absence of sharp external sector crises in the last two decades, in contrast to several transitional economies. It is possible that this relative external stability is associated with important changes in the tradable and non-tradable sectors. Related to the last point, a fourth reason to study Costa Rica's experience is the widespread belief within the country that the country's economic problems are largely due to the economy's increasing interaction with the rest of the world.

Finally, Costa Rica has a large amount of available information related to the tradable and non-tradable sectors, and the lifespan of the country's institutions makes available a complete data set on tradable and non-tradable goods. This feature facilitates the application of econometric methods.

The estimation of the elasticity of substitution in demand for non-tradable goods in Costa Rica was constructed using two alternative data sets. First, quarterly information was used for Real Private Consumption of Non-Tradable and Tradable Goods and CPI Prices of Tradable and Non-Tradable Goods for the 1980-2002 period. The Real Private Consumption of Non-Tradable and Tradable Goods series in quarters was constructed using annual Real Private Consumption of Final Goods by economic sector and the quarterly Real Gross Domestic Product by economic

sector, both constructed by the Costa Rican Central Bank. Thus, after the properties of the time series are studied, and controlling for exogenous variables, the elasticity belonging to the [1.46, 1.66] interval is estimated; results are statistically robust at 10 percent.

Second, annual data on Real and Nominal Private Consumption of Final Goods by economic sector constructed by the Central Bank are used. Thus, once a set of consumption and price vectors of non-tradable and tradable goods, consistent with alternative z-thresholds, is constructed, an elasticity of substitution between 0.22 and 0.28 is found. The results are also statistically robust. Additionally, for consistency the elasticity of substitution for the 1991-2002 quarterly subsample is computed. The results show greater coefficients (from 2.22 to 2.47), although they are statistically insignificant and the R-squares are poorer.

The elasticity of substitution with other procedures cannot be estimated, however, because it was not possible to construct the Nominal Private Consumption data. Specifically, it was not possible to set up the Nominal Consumption of Tradable and Non-Tradable Goods at a quarterly frequency for the period 1980-1990 and at an annual frequency for the period 1965-1990.

In the first case, the research team and the support personnel provided by the Central Bank tried to estimate the Nominal Private Consumption of Non-Tradable and Tradable Goods on a quarterly basis without success. Although Nominal Consumption of Non-Tradable and Tradable Goods was available on an annual basis, the Nominal GDP by economic sector was not available on a quarterly basis for the period 1980-1990.

In the second case, a problem originated in the Investment time series. Investment by economic sector was available from 1965 to 2002. However, when this information was combined with exports and imports data, the results of Private Consumption by Economic Sector were inconsistent with the 1978-1994 annual Private Consumption series.

Finally, another methodological problem was related with the Terms of Trade (TOT) series. Even though the Central Bank calculates the TOT data, the methodology of construction is inadequate and the movements in TOT are completely uncorrelated (or erroneously associated) with the dynamics of the trade balance. Therefore, it was not possible to use this series in the estimations, and a TOT proxy was constructed in order to provide an alternative. However, the inclusion of this proxy variable in the elasticity of substitution estimations greatly distorted the results, and this variable was dropped from the computations.

1.1 National Literature Review

The literature on the elasticity of substitution in demand for non-tradable goods in Costa Rica is nonexistent. However, after an intense search, two works were identified related to tradable and non-tradable goods and the elasticity of demand for imported goods and elasticity of supply for exported goods.

In the first, Monge and Gonzalez (1994) calculated for Costa Rica the price elasticity of the demand of imports and the price elasticity of the supply of exports. These estimations were used to measure the potential welfare gains of opening the country to foreign trade. In the second, Murillo, Laverde and Duran (2002) estimated short-run and long-run coefficients of exchange rate pass-through into the prices of tradable and non-tradable goods in Costa Rica. According to OLS estimations, the short-run pass-through coefficients were 13 percent and 10 percent for tradable and non-tradable goods, respectively, and the corresponding long-run coefficients were 68 percent and 52 percent in the same order; a second-stage pass-through of 7 percent is included in the long-run coefficient for non-tradable goods. The dynamic analysis shows that the adjustment process of prices, as a result of an exchange rate shock, takes 17 months for tradable goods and 27 months for non-tradable goods.

The remainder of the paper has the following objectives. The first is to describe the basic theoretical model that supports the study. A second objective is to describe the available data and the three procedures used to estimate the price and consumption of Non-Tradable and Tradable Goods, followed by a detailed description of the empirical methodology used to set up the price and consumption vectors of non-tradable and tradable goods. Finally, the paper presents an overview of the econometric strategy and the results of the elasticity of substitution, followed by the summary and conclusions.

2. A Basic Model

Consider an open economy with constant-elasticity-of-substitution preferences with respect to consumption of tradables and non-tradables: $U(C(CT,CN))$ where $U(.)$ could be the standard constant-relative-risk-aversion utility function in terms of the composite good $C(.)$, and $C(.)$ is a CES aggregator of CT and CN of the form:

$$C(C_t^T, C_t^N) = [\omega\,(C_t^T)^{-\eta} + (1-\omega)\,(C_t^N)^{-\eta}]^{-1/\eta}$$

The parameter η determines the elasticity of substitution between consumption of tradable goods and consumption of non-tradable goods, which is given by $v = 1/(1+\eta)$, and ω is the standard CES weighing factor.

In this environment, utility maximization by households subject to a standard budget constraint yields the following optimality condition for the allocation of consumption across *CT* and *CN*:

$$p_t = ((1- \omega)/ \omega)[C_t^T / C_t^N]^{1+\eta}$$

where p is the relative price of non-tradable goods in units of tradables (i.e., $p = PN/PT$). This optimality condition can be re-written as:

$$[C_t^T / C_t^N] = [(\omega /(1- \omega)) p_t]^v$$

This is the key relationship that must be used to produce the estimates of ν. The relationship may seem ad hoc to the extent that it has been derived without a full characterization of the model into which the utility function with this CES aggregator is entered. It should be noted, however, that the same optimality condition is a feature of a large class of neoclassical and neo-Keynesian intertemporal equilibrium models for open economies. Using logarithms and the variables defined previously, the above condition reduces to the following log-linear testable relationship:

$$ln(RCN_t/RCT_t) = \alpha_0 + \alpha_1 \, ln(p_t)$$

where

$$\alpha_0 = -v \, ln((1- \omega)/ \omega) \text{ and } \alpha_1 = -v.$$

3. Available Data

This section describes the main sources of information, its availability and access.

3.1.National Accounts Procedure

The National Accounts (NA) information system in Costa Rica makes it possible to decompose the components of aggregate supply and demand into the nine main economic sectors. These sectors are the following: Agriculture (A), Mining (M), Construction (C), Manufacturing (MF),

Utilities (U), Commercial Services (CS), Transportation Services (TS), Financial Services (FS), and Personal Services (PS).

Specifically, the Central Bank of Costa Rica (BCCR) constructs the Gross Domestic Product (GDP) by adding up the value added of twelve sectors: Agriculture, Forestry and Fishing, Mining, Manufacturing, Construction, Electricity and Water, Commercial Services; Transportation and Communications, Financial Services, Real Estate, Administration of Government, and Personal Services.

GDP information by industries (in real and nominal *colones*[2]) can be obtained annually starting in 1950 and quarterly starting in 1980. Table 1 presents the basic statistics of the first differences of ten sectors composing the GDP.[3]

Table 1. Gross Domestic Product by Industry

Series	Statistics (First Differences, Quarterly Data 1980-1995)		
	Mean	Std	Std/Mean
Agriculture	0.0073	0.1365	18.5835
Manufacturing	0.0062	0.0931	15.1091
Commerce	0.0083	0.0930	11.1486
Construction	-0.0053	0.1272	24.0576
Transportation Services	0.0130	0.0383	2.9520
Electricity	0.0137	0.0375	2.7436
Financial Services	0.0134	0.0556	4.1605
Real Estate	0.0049	0.0050	1.0074
Governmental Services	0.0031	0.0047	1.5024
Personal Services	0.0073	0.0101	1.3919
Total GDP	**0.0072**	**0.0520**	**7.2429**

[2] One dollar was equal to 380 *colones* at the time of the study.
[3] The Statistics in Table 1 were calculated using real industrial GDP (in *colones* of 1966).

Also, the National Institute of the Census and Statistics (INEC) estimates total imports and their decomposition into the following categories: (a) Raw Materials; (b) Consumption Goods; (c) Capital Goods; (d) Construction Materials; (e) Combustibles and Lubricants; and (f) Others.

It is important to note that it is possible to disaggregate each of these six categories into the four-digit International Standard Industrial Classification (ISIC). In short, INEC provides monthly disaggregated data on imports starting in 1986. In this way, it is possible to gain some degrees of freedom by performing a finer aggregation of the nine main economic sectors. Table 2 presents the period for which information is available, the frequency of information and annual basic statistics for the imports during the period 1956-2002 (first differences).

Table 2. Imports Data

Series	Period	Frequency			Statistics (First Differences)		
		Annual	Quarterly	Monthly	Mean	Std	Std/Mean
Total Imports	**1956-2002**	**All Period**	**1980-2002**	**1986-2002**	**0.0949**	**0.1236**	**1.3023**
Raw Materials	1956-2002	All Period	1980-2002	1986-2002	0.1117	0.1328	1.1885
For Manufacturing and Mining	1956-2002	All Period	1980-2002	1986-2002	*0.1187*	*0.1383*	*1.1649*
Perfecc. Activos Industries	*1983-2002*	*All Period*	*1983-2002*	*1986-2002*	*0.0732*	*0.1763*	*2.4076*
Zona Franca Industries	*1983-2002*	*All Period*	*1983-2002*	*1986-2002*	*0.3566*	*0.2949*	*0.8270*
Other Industries	*1983-2002*	*All Period*	*1983-2002*	*1986-2002*	*0.0690*	*0.0937*	*1.3583*
For Agriculture	1956-2002	All Period	1980-2002	1986-2002	*0.0694*	*0.2275*	*3.2761*
Consumption Goods	1956-2002	All Period	1980-2002	1986-2002	0.0802	0.1724	2.1499
Non-Durables	*1956-2002*	*All Period*	*1980-2002*	*1986-2002*	*0.0786*	*0.1461*	*1.8579*
Durables	*1956-2002*	*All Period*	*1980-2002*	*1986-2002*	*0.0836*	*0.2782*	*3.3273*
Capital Goods	1956-2002	All Period	1980-2002	1986-2002	0.0896	0.1991	2.2233
For Manufacturing and Mining	*1956-2002*	*All Period*	*1980-2002*	*1986-2002*	*0.0960*	*0.2335*	*2.4330*
Zona Franca Industries	*1983-2002*	*All Period*	*1983-2002*	*1986-2002*	*0.2542*	*0.2333*	*0.9179*
Other Industries	*1983-2002*	*All Period*	*1983-2002*	*1986-2002*	*0.0889*	*0.1723*	*1.9385*
For Agriculture	*1956-2002*	*All Period*	*1980-2002*	*1986-2002*	*0.0645*	*0.2217*	*3.4381*
For Transportation	*1956-2002*	*All Period*	*1980-2002*	*1986-2002*	*0.0761*	*0.2544*	*3.3438*
Construction Materials	1956-2002	All Period	1980-2002	1986-2002	0.0692	0.2164	3.1292
Fuels	1956-2002	All Period	1980-2002	1986-2002	0.0955	0.2681	2.8077

INEC likewise publishes statistics on exports in the following categories: Coffee, bananas, meat, sugar, other agricultural and sea products, manufacturing, and export processing zones. As in the case of imports, it is possible to classify exports using the four-digit ISIC.

The Central Bank has reported these export statistics on an annual basis since 1950. Nonetheless, the four-digit ISIC decomposition is calculated since 1986 on a monthly basis.

Table 3 shows the basic statistics on exports and their components for Costa Rica between 1950 and 2002, or the period for which data are available.

Table 3. Exports Data

Series	Period	Frequency			Statistics (First Differences)		
		Annual	Quarterly	Monthly	Mean	Std	Std/Mean
Total Exports	**1950-2002**	**All Period**	**1980-2002**	**1986-2002**	**0.1135**	**0.2064**	**1.8178**
Coffee	1950-2002	All Period	1980-2002	1986-2002	0.1369	0.7475	5.4605
Banana	1950-2002	All Period	1980-2002	1986-2002	0.1143	0.4210	3.6843
Meat	1950-2002	All Period	1980-2002	1986-2002	0.2011	0.7091	3.5257
Sugar	1950-2002	All Period	1980-2002	1986-2002	0.2129	0.7338	3.4471
Others	1950-2002	All Period	1980-2002	1986-2002	0.1598	0.2692	1.6853
Agricultural and Sea Products	*1978-2002*	*All Period*	*1980-2002*	*1986-2002*	*0.1770*	*0.4911*	*2.7748*
Industrials	*1978-2002*	*All Period*	*1980-2002*	*1986-2002*	*0.1517*	*0.4696*	*3.0955*
Perfeccionamiento Activo	*1983-2002*	*All Period*	*1983-2002*	*1986-2002*	*0.1817*	*0.5171*	*2.8461*
Zonas Francas	*1986-2002*	*All Period*	*1986-2002*	*1986-2002*	*0.3980*	*0.3378*	*0.8488*

3.1.1 INTEL and Costa Rican National Accounts

It is important to mention the effect of the establishment of Intel on the country's economy and national accounts since the company first opened a plant in Costa Rica in 1997 to manufacture microchips under the Export Processing Zones regime. Given the large scale of Intel's operations compared to the size of the country, Intel has had a great impact on the value added national accounting figures.

Although the BCCR does not disclose specific production data for Intel and its effect on National Accounts, Rodríguez-Clare, Saenz and Trejos (2002) created a methodology permitting the decomposition of Intel's share of economic activity. To illustrate further the importance of Intel, it is sufficient to observe that 50 percent of Costa Rica's economic growth in 1999 (8.2 percent) was explained by the production growth of Intel in the country. Moreover, Intel has accounted for on average 25 percent of total exports in the last five years, and Intel has bought 17 percent of the national total of imports. Therefore, given the economic significance of Intel

for Costa Rica, it is necessary to exclude Intel figures in order to avoid a bias in calculating the elasticity of substitution between tradable and non-tradable goods.

3.2. Simplified National Accounts Procedure

In Costa Rica, the Central Bank reports the private (household) consumption by product. As is shown in Table 4, private consumption is divided among 23 products. Thus, it is possible to distinguish between tradable and non-tradable goods and services through a simple aggregation in line with Central Bank definitions. In this case, there is a problem with the frequency and extension of the series, since data are available for the 1991-2002 period.

Table 4. Private (Household) Consumption by Product

Series	Statistics		
	Mean	**Std**	**Std/Mean**
1. Foods, beverages, tobacco and other products	0.2266	0.0104	0.0459
1. Agricultural Foods	*0.0334*	*0.0031*	*0.0928*
2. Manufactured Foods	*0.1677*	*0.0068*	*0.0408*
3. Beverages	*0.0143*	*0.0007*	*0.0492*
a. Alcoholic	*0.0079*	*0.0008*	*0.1000*
b. Non-Alcoholic	*0.0064*	*0.0005*	*0.0795*
4. Tobacco	*0.0111*	*0.0016*	*0.1482*
5. Other Non-Human Foods	*0.0001*	*0.0000*	*0.0654*
2. Textile and Leather Products	0.0369	0.0049	0.1323
1. Textiles	*0.0315*	*0.0030*	*0.0941*
2. Leathers	*0.0012*	*0.0010*	*0.8015*
3. Others	*0.0042*	*0.0013*	*0.3090*
3. Wood and Wood Products	0.0023	0.0004	0.1798
1. Furniture and Accessories	*0.0013*	*0.0003*	*0.2096*
2. Other Industrial Wood Products	*0.0011*	*0.0002*	*0.1657*
4. Paper and Paper and Cardboard Products	0.0164	0.0025	0.1541
1. Newspapers, Magazines and Other Printed Products	*0.0116*	*0.0018*	*0.1563*
2. Other Paper and Cardboard Products	*0.0048*	*0.0009*	*0.1787*

Table 4., continued

Series	Statistics Mean	Std	Std/Mean
5. Chemical Products	0.0675	0.0037	0.0555
1. Medical and Pharmaceutical Products	*0.0064*	*0.0010*	*0.1539*
2. Fuels	*0.0271*	*0.0046*	*0.1715*
3. Other Chemical Products	*0.0341*	*0.0014*	*0.0414*
6. Glass, Stoneware, Clay, and Porcelain Products	0.0018	0.0002	0.1350
7. Industrial Metallic Products	0.0001	0.0000	0.7662
8. Metallic, Machinery and Equipment Products	0.0136	0.0012	0.0916
9. Other Manufactured Products	0.0071	0.0009	0.1246
10. Small Industry Products	0.0471	0.0078	0.1655
11. Electricity and Water	0.0192	0.0007	0.0385
12. Restaurant and Hotel Services	0.0380	0.0021	0.0562
13. Transport and Communication Services	0.0673	0.0050	0.0738
1. Transport	*0.0494*	*0.0011*	*0.0230*
2. Transport-Related Services	*0.0018*	*0.0002*	*0.1302*
3. Communication	*0.0161*	*0.0046*	*0.2842*
14. Financial and Insurance Services	0.0067	0.0005	0.0795
15. Real Estate and Rent Services	0.0708	0.0068	0.0967
16. Other Professional Services	0.0039	0.0003	0.0882
17. Government Services	0.0008	0.0001	0.0786
18. Education Services	0.0131	0.0011	0.0857
19. Health Services	0.0099	0.0010	0.0983
20. Other Social, Community and Personal Services	0.0628	0.0027	0.0426
21. Imported Consumption Goods	0.1872	0.0261	0.1396
22. Consumption and Selective Taxes	0.0635	0.0006	0.0090
23. Others	0.0376	0.0050	0.1339

Surprisingly, however, the National Accounts Department of the Central Bank has tabulated the Private Consumption of Final Goods (in real and current *colones*) by product since 1978 with an annual frequency. The methodology to the estimation of the Private Consumption of Final Goods was developed by Castro (1984) and adopted by the Central Bank, who constructed this figure from 1978 to 1994. Table 5 presents the basic statistics of the Real Private Consumption of Final Goods by economic sector from 1980-2002 (in real *colones*). The Real

Consumption for the 1995-2002 period was constructed from the Table of Supply and its Uses (TSU). This table, calculated by the Central Bank of Costa Rica, provides information on the origin and uses of 121 goods and services. Table 7 shows a subset of the TSU for 1991. (Section 4 provides further details on the TSU).

Table 5. Basic Statistics of Real Consumption of Final Goods (1980-2002)

	Mean	Volatility	Min	Max	Std/Mean	Autocorrelation
Agriculture	897.885	184.151	655.700	1257.627	0.205	0.995
Manufacturing	3068.221	557.837	2154.000	3975.458	0.182	0.984
Electricity	157.855	56.517	71.708	271.390	0.358	0.995
Transportation Services	938.726	387.002	520.600	1831.375	0.412	0.985
Real Estate	472.858	63.228	381.600	595.796	0.134	0.961
Financial Services	180.358	54.887	86.665	262.082	0.304	0.987
Commerce	231.366	38.384	177.400	320.352	0.166	0.981
Governmental Services	15.098	5.311	9.486	28.334	0.352	0.992
Personal Services	680.501	164.510	464.814	940.393	0.242	0.989
Total	6642.868	1493.773	4599.500	9482.807	0.225	0.992

Using Private Consumption data, it was possible to construct private consumption by economic sector with a quarterly frequency (see Section 4).

3.3. CPI Approach

In Costa Rica the Central Bank reports two types of price indices associated with the consumption of goods and services. The first is the CPI (Consumer Price Index), which is divided into five categories and eight groups. The second is the SPI (Services Price Index), which includes four sectors: Transportation, Communications, Water and Electricity, and Social Services. The five classifications of the CPI are: General, Regulated Goods and Services, Non-Regulated Goods and Services, Tradable Goods, and Non-Tradable Goods. Table 6 presents the frequency, number of periods, source and basic statistics (for the period 1.1987-12.2002) of the CPI for tradable and non-tradable goods.

Table 6. CPI Data

Series	Frequency	Period	Source	Statistics (Growth Rate)	
				Std	Autocorrelation
CPI Non-Tradable Goods	Monthly	1975-2003	Central Bank of Costa Rica	0.0245	0.3459
CPI Tradable Goods	Monthly	1975-2003	Central Bank of Costa Rica	0.0192	0.0627

Likewise, the eight groups with data on consumption prices are: Foods, Drinks and Tobacco; Apparel and Shoes; Housing; Furniture and Accessories; Medical Care; Transportation, Entertainment and Education; and Other Goods and Services. To complete the series required for the estimation of the elasticity of substitution, a series of durable goods and services was used as a proxy for the consumption of tradable and non-tradable goods.

4. Empirical Methodology

The objective of this section is to describe the empirical methodology followed to estimate the elasticity of substitution of non-tradable goods, and the estimation of the elasticity of substitution using the CPI Procedure is presented. Concretely, the CPI prices of Non-Tradable and Tradable Goods and the Real Private Consumption of Non-Tradable and Tradable Goods at a quarterly frequency from 1980 to 2002 (92 observations) are used. As noted above, it was not possible to set up quarterly data for the Nominal Consumption of Tradable and Non-Tradable Goods for the period 1980-1990 and at an annual frequency for the period 1965-1990.

4.1. Data Description

The real consumption of non-tradable and tradable goods is generated from quarterly National Accounts information on the real Gross Domestic Product and private consumption. In addition, the price of non-tradable goods in terms of tradables is constructed using the Consumer Price Index of tradable and non-tradable goods. Moreover, a data set is constructed from the following exogenous variables: prime interest rate (six months), government expenditure, terms of trade, Gross Domestic Product and trade balance of the United States, and petroleum prices. The properties of these time series are then studied to determine the optimal combination of the data and using control variables to estimate the elasticity of substitution.

In Costa Rica, the National Accounts Department of the Central Bank has constructed the Private Consumption of Final Goods by product since 1978. In short, the Central Bank reports the household consumption divided by 23 products. Hence, it was possible to establish a mapping from the private consumption by product set to the private consumption by economic sector set. This information was reconstructed on an annual basis.

The Central Bank has also provided the expenditure side of the GDP on a quarterly basis since 1980. The estimate of private consumption by economic sector on a quarterly basis was made in the following manner. Starting with the information of the annual private consumption for each of the economic sectors, each sector's share in total annual consumption was calculated. Afterwards, with the quarterly GDP information by economic sector, the share of each sector in the quarter was estimated. Then, each sector's share in quarterly GDP was multiplied by each sector's corresponding share of annual consumption (normalized to 1). In this way, a vector for quarterly private consumption was obtained.

With this information, the consumption of non-tradable and tradable goods was computed on a quarterly basis. That is, by measuring the share of exports plus imports in the GDP of the sector, it was determined whether a sector's consumption component was tradable or non-tradable. Thus, to classify a particular economic sector as tradable or non-tradable, the importance of foreign trade for each economic sector was computed. The Central Bank of Costa Rica calculates the Table of Supply and its Uses (TSU), which contains information on the origin and uses of 121 goods and services. Table 7 displays a subset of the TSU for 1991.

Table 7. Origin and Uses Table (1991)

		ITEM		
		TOTAL	Total	
			Coffee	Bananas
Production Value		1,534,993.50	26,762.59	43,100.99
Taxes	**Consumption**	39,643.13	-	-
	Others	15,302.40	-	10,876.32
Subsidies		16,875.46	-	5,760.61
Imports	**Goods**	263,855.05	-	-
	Services	61,671.96	-	-
	Total	325,527.01	-	-
Import Taxes		32,288.63	-	-
Commercial and Transport Markup		0.00	-	2,568.34
Exchange Rate Differential Adjustment		-	-	-
Supply		**1,930,879.20**	**26,762.59**	**50,785.03**
Intermediate Consumption			25,598.77	2,373.12
Final Consumption Expenditure	**Households**	633,691.13	-	334.27
	Government	117,173.74	-	-
	Total	750,864.87	-	334.27
Investment		156,309.89	-	-
Existences Changes		965.65	1,163.82	-
Exports of Goods and Services	**Goods**	233,948.51	-	48,077.65
	Services	60,348.66	-	-
	Total	294,297.16	-	48,077.65
Uses		**1,930,879.20**	**26,762.59**	**50,785.03**

After distributing the products to each of the ten economic sectors, the value of exports and imports by economic sector was calculated. The sum of exports and imports was then divided by GDP. The results of these estimations are included in Table 8. As can be seen, in addition to the thresholds recommended by the IDB research team (z = 0.01, 0.05 and 0.10), a further threshold (z = 0.25) was included.

The Costa Rican economy is highly open to foreign trade. Therefore, to determine whether a sector belongs to a set of tradable or non-tradable goods, the thresholds of z = 0.01, 0.05, 0.10 and 0.25 were considered. In this way, five sectors are categorized as tradable and five sectors as non-tradable. These results can be seen in Table 9 for z = 0.25.

Table 8. Classification of Tradable (T) and Non-Tradable (NT) Goods

Sector	(X+M)/GDP	Thresholds (z)			
		0.01	0.05	0.1	0.25
Agriculture	1.333	T	T	T	T
Industry	0.915	T	T	T	T
Electricity	0.008	NT	NT	NT	NT
Commerce+Restaurants+Hotels	0.233	T	T	T	NT
Transportation	0.751	T	T	T	T
Financial Services	0.084	T	T	NT	NT
Real Estate	0.002	NT	NT	NT	NT
Services to Firms	1.009	T	T	T	T
Government	0.051	T	T	NT	NT
Other Services	0.030	T	NT	NT	NT

Table 9. Tradable and Non-Tradable Goods for z = 0.25

Sector	
Tradable	**Non-Tradable**
Agriculture	Electricity
Industry	Financial Services
Transportation	Real Estate
Services to Firms	Government
	Other Services
	Commerce+Restaurants+Hotels

With this information in hand, the aggregation was undertaken of the private consumption of households among tradable and non-tradable goods, in quarters, for the period 1980:1 to 2002:4. Table 10 presents the associated statistics to this variable for each z threshold. Here, the consumption of non-tradable goods represents around 37 percent that of tradable goods.

Table 10. Basic Statistics RCN v RCT (1980-2002)

	RCN/RCT			
Statistic	**z = .01**	**z = .05**	**z = .10**	**z = .25**
Mean	0.106	0.247	0.294	0.356
Std	0.009	0.014	0.017	0.020
Max	0.127	0.281	0.339	0.406
Min	0.091	0.221	0.253	0.308
Std/Mean	0.082	0.056	0.057	0.056
Autocorrelation	0.267	0.118	0.135	0.098

In addition, using the monthly series of Consumer Price Index of tradable goods (PT) and non-tradable goods (PN) for the period 1976-2003, the quarterly series was calculated by taking the average of the months corresponding to each quarter. The statistics for the relation between PN and PT are presented in Table 11.

Table 11. Basic Statistics: Relationship between the Prices of Non-Tradable and Tradable Goods (1980:1 – 2002:4)

Statistic	**PN/PT**
Mean	0.9795
Std	0.1306
Max	1.2639
Min	0.7099
Std/Mean	0.1334
Autocorrelation	0.9881

5. Results: Quarterly Approach I

Once the series of real consumption of non-tradable goods in term of tradable goods was obtained, the elasticity of substitution of non-tradable goods was subsequently estimated. Using the relationship of CPI non-tradable to tradable goods, the effect was computed of a variation of this price on the consumption of non-tradable goods in terms of tradable.

For this estimation eight quarterly variables for the 1980:1–2002:4 period were used. Table 12 presents the name, source and frequency of each variable.[4]

Table 12. Variables Description

Descriptor	Variable	Source	Frequency
C	Real Consumption of Non-Tradables in Terms of Tradables Goods	Own	Annual Quarterly
P	CPI of Non-Tradables in Terms of Tradables Goods	Own	Annual Quarterly Monthly
GGOV	Government Expenditure as Percentage of GDP	Own	Annual Quarterly Monthy
R	Prime Interest Rate	Banco Central de Costa Rica	Annual Quarterly Monthy
TOTUS	Terms of Trade of United States	IMF Statistics and US Labor Department	Annual Quarterly
YUS	Real Gross Domestic Product of United States	IMF Statistics	Annual Quarterly
TBUS	Trade Balance of United States	IMF Statistics and US Labor Department	Annual Quarterly
PPET	Price of West Texas Intermediate Crude, NSA, Dollars Per Barrel	US Labor Department	Annual Quarterly Monthy

The basic statistics of these variables are presented in Table 13 using the original data and the logs and log differences transformations. It must be noted that the difference between YUS and GDPUS variables is that the first variable is the log difference of GDPUS inter-quarterly while GDPUS is the real GDP of the USA. In addition, Table 14 presents the correlation matrix.

Table 13. Basic Statistics

	Statistic					
Variable	**Mean**	**Volatility**	**Max**	**Min**	**Std/Mean**	**Autocorr**
Original Data						
P	0.979	0.131	1.264	0.710	0.133	0.988
C	0.356	0.020	0.406	0.308	0.056	0.098
GOV	0.117	0.011	0.143	0.096	0.095	0.846
RPRIME	9.524	3.274	20.323	4.417	0.344	0.946
TBUS	-123.877	114.225	3.300	-476.000	-0.922	0.987
PPET	23.672	6.939	39.500	12.870	0.293	0.914
TOTUS	0.984	0.039	1.053	0.852	0.040	0.915
YUS						
GDPUS	6,944.442	1,440.515	9,518.200	4,850.300	0.207	0.999

[4] Costa Rica's terms of trade are not included because, according to the National External Accounts Department of Costa Rica's Central Bank, this information is of poor quality and is not available on a quarterly basis. Work undertaken in the course of this project verified that the annual frequency of the data was inconsistent. Moreover, an attempt to construct a TOT yielded unsatisfactory results.

Table 13., continued

	Statistic					
Variable	**Mean**	**Volatility**	**Max**	**Min**	**Std/Mean**	**Autocorr**
Logs						
P	-0.013	0.058	0.102	-0.149	-4.547	0.986
C	-0.449	0.025	-0.392	-0.512	-0.055	0.086
GOV	-0.935	0.042	-0.844	-1.020	-0.044	0.853
RPRIME	0.956	0.137	1.308	0.645	0.144	0.961
TBUS						
PPET	1.356	0.126	1.597	1.110	0.093	0.902
TOTUS	-0.007	0.018	0.023	-0.070	-2.484	0.918
YUS						
GDPUS	3.832	0.090	3.979	3.686	0.024	0.999
Log Differences						
P	0.002	0.010	0.018	-0.033	6.370	0.263
C	0.000	0.033	0.084	-0.060	104.940	-0.175
GOV	-0.001	0.022	0.088	-0.039	-21.190	-0.119
RPRIME	-0.006	0.038	0.159	-0.148	-6.045	0.193
TBUS						
PPET	-0.001	0.056	0.170	-0.234	-48.622	0.138
TOTUS	0.001	0.007	0.017	-0.018	11.461	0.116
YUS	0.028	0.021	0.083	-0.029	0.747	0.866
GDPUS	0.003	0.003	0.010	-0.009	1.111	0.363

Table 14. Correlation Matrix

	P	**C**	**GOV**	**RPRIME**	**TBUS**	**PPET**	**TOTUS**	**GDPUS**
P	1.000	-0.252	-0.770	-0.711	-0.775	-0.361	0.465	0.943
C		1.000	0.395	0.122	0.198	0.101	0.105	-0.164
GOV			1.000	0.452	0.786	0.282	-0.428	-0.801
RPRIME				1.000	0.464	0.673	-0.729	-0.675
TBUS					1.000	0.035	-0.330	-0.768
PPET						1.000	-0.826	-0.383
TOTUS							1.000	0.513
GDPUS								1.000

5.1. Unit Root and Cointegration

The next step was to calculate whether these variables were stationary, expressed as I(0), or dynamic, expressed as I(1). For this analysis the Dickey-Fuller Test was used. Concretely, the Augmented Dickey-Fuller Test (ADF) was employed to control for serial correlation by adding

lagged first differences to the autoregressive equation. Of particular interest was computing whether a process of the form

$$y_t = \alpha + \delta t + \rho\, y_{t-1} + \zeta_1\, \Delta y_{t-1} + \zeta_2\, \Delta y_{t-2} + \ldots + \zeta_p\, \Delta y_{t-p} + \varepsilon_t$$

is I(0) or I(1), where y_t refers to the value of any variable y in the period t, (α, δ, ρ, ζ_1, ζ_2,...,ζ_p) is the vector of coefficients of the constant, time trend, and first lag, p represents first differences lags, and ε_t represents the error term.

The first step was to estimate the number of lags (p_{max}) associated with the first differences. For a sample with T observations,[5]

$$p_{max} = \text{integer part of } [12\ (T/100)]^{1/4}$$

The quarterly database used includes 92 observations, thus the associated p_{max} is equal to 11. Then, using the Sequential t (t-Rule) Akaike Information Criterion (AIC) and Bayesian (Schwarz) Information Criterion (BIC) rules, the optimal number of lags (p^*) was determined for each of the eight variables.[6] Using these tools, the ADF t-statistics associated with these variables were estimated.

Table 15. ADF t-Tests

Variable	ADF t			
	Logs	I(1)	LogDiff	I(0)
C	***-6.25***		-26.35	***
P	-3.42	**	-10.06	***
GGOV	-2.12	***	-17.30	***
R	-0.82	***	-6.59	***
TOTUS	-3.98	*	-9.44	***
YUS			-5.66	***
TBUS	-0.10	***	***-0.10***	
PPET	-2.73	***	-8.06	***
GDPUS	-2.44	***	-7.99	***

* Significance at 10%
** Significance at 5%
*** Significance at 1%

[5] See Hayashi (2000, p. 595).
[6] Specifically, $p^* = max\ \{max\{p_{t\text{-}Rule}\}, min\{p_{AIC}\}\ , min\{p_{BIC}\}\}$.

As can be seen in Table 15, it was concluded from the ADF t-statistic that only consumption is stationary in the log series approach.[7] This restriction implies that it is not possible to estimate elasticity using the Vector Error Correction (VEC) procedure. However, all variables (except TBUS) are stationary under the log differences approach.

5.2. Estimations

To calculate the elasticity of substitution the private consumption of non-tradable and tradable goods was used, consistent with the four z-thresholds defined in Section 4. In the calculations that follow the threshold of z = 0.25 is used, and the results for the other three thresholds will be presented afterward. In first place, given that two equation systems ((1) and (2)) were available, OLS was first computed for the consumption and price equations and for the first log differences equations.

$$ln(RCN_t/RCT_t) = \alpha_{10} + \alpha_{11} ln(PN_t/PT_t) + \alpha_{12}\, z_t + \varepsilon_t \qquad (1)$$

$$ln\,(PN_t/PT_t) = \alpha_{20} + \alpha_{21} ln(RCN_t/RCT_t) + \alpha_{22}\, z_t + \varepsilon_t \qquad (2)$$

Table 16 presents the results. As expected, the relation between the consumption of non-tradable goods and its price is negative and significant, both in logs and log differences.

Table 16. OLS Estimations

Variable	Dependent			
	Price Non-Trad v Price Trad		Cons Non-Trad v Cons Trad	
	Logs	Log First Diff	Logs	Log First Diff
Constant	-4.358***	-0.009**	-2.848***	0.004
	(0.363)	(0.004)	(0.724)	(0.016)
P			-0.424***	-0.999***
			(0.135)	(0.387)
C	-0.241***	-0.072***		
	(0.077)	(0.028)		

[7] Appendix A presents the cointegration pairwise results and the LR test for cointegration of the seven I(1) variables.

Table 16., continued

Variable	Dependent: Price Non-Trad v Price Trad		Cons Non-Trad v Cons Trad	
	Logs	Log First Diff	Logs	Log First Diff
Interest Rate	-0.106***	-0.087***	-0.039	0.058
	(0.021)	(0.027)	(0.032)	(0.107)
US Terms of Trade	-0.499***	0.090	-0.248	-0.275
	(0.142)	(0.133)	(0.199)	(0.495)
US GDP	0.486	0.304***	0.213***	-0.113
	(0.037)	(0.110)	(0.082)	(0.426)
US Trade Balance	-0.0001**	-0.0000	0.0000	-0.0000
	(0.000)	(0.000)	(0.000)	(0.000)
R-squared	0.914	0.249	0.138	0.111
Adjusted R-squared	0.909	0.204	0.088	0.059
S,E, of regression	0.041	0.020	0.054	0.074
Sum squared resid	0.142	0.034	0.250	0.469
Log likelihood	167.15	229.81	141.26	110.58
Akaike Info Criterion	-3.503	-4.919	-2.941	-2.299
Schwarz Criterion	-3.339	-4.753	-2.776	-2.133
Durbin-Watson Stat	0.392	1.739	1.988	2.298

* Significant at 10%
** Significant at 5%
*** Significant at 1%

It should be noted that government expenditure (*GGOV*) and petroleum prices (*PPET*) were excluded because both individually altered the results significantly. The elasticity of substitution was then estimated using the following General Framework:

$$\Delta ln\,(RCN_t/RCT_t) = \alpha_{10} + \alpha_{11}\Delta ln(PN_t/PT_t) + \alpha_{12}\,\Delta \mathbf{z}_t + \varepsilon_t \qquad (3)$$

$$\Delta ln\,(PN_t/PT_t) = \alpha_{20} + \alpha_{21}\Delta ln(RCN_t/RCT_t) + \alpha_{22}\,\Delta \mathbf{z}_t + \varepsilon_t \qquad (4)$$

Given that all variables (except *TBUS*) in first differences are individually I(0), the last two equations can be consistently estimated using the generalized method of moments (GMM). Tables 18 and 19 present the estimation of the elasticity of substitution using the IV and 2SLS

specifications.[8] In both estimations the models described in Table 17 were used as control variables.

Table 17. Alternative Control Variables

Model	Control Variables
(1)	Interest Rate (DR)
(2)	Growth US GDP (YUS)
(3)	Interest Rate (DR) Growth US GDP (YUS)
(4)	Interest Rate (DR) US TOT (DTOTUS)
(5)	Interest Rate (DR) US TOT (DTOTUS) Growth US GDP (YUS)
(6)	Interest Rate (DR) US TOT (DTOTUS) Growth US GDP (YUS) Petroleum Prices (DPPET)

Table 18. Elasticity IV Estimations (standard errors in parentheses)

	Model					
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.007	0.004	0.006	0.008	0.007	0.006
	(0.009)	(0.010)	(0.008)	(0.009)	(0.008)	(0.008)
DP	-1.757	-0.884	-1.454	-2.015	-1.650*	-1.661*
	(-1.261)	(1.927)	(1.037)	(1.308)	(0.979)	(0.977)
R-squared	0.060	0.097	0.088	0.024	0.072	0.070
Adjusted R-squared	0.050					
		0.086	0.077	0.013	0.061	0.060
S,E, of regression	0.075	0.073	0.074	0.076	0.074	0.074
Durbin-Watson stat	2.191					
		2.322	2.248	2.137	2.212	2.210
J-statistic	0.000	0.000	0.001	0.002	0.004	0.010
N	91					

* Significant at 10%

[8] Corrected by White Test.

Table 19. Elasticity 2SLS Estimations (standard errors in parentheses)

	Model					
Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Constant	0.007	0.004	0.006	0.007	0.006	0.006
	(0.008)	(0.010)	(0.008)	(0.009)	(0.008)	(0.008)
DP	-1.757	-0.884	-1.465*	-1.904	-1.540*	-1.537*
	(1.252)	(1.996)	(0.827)	(1.227)	(0.819)	(0.819)
R-squared	0.060	0.097	0.087	0.041	0.081	0.082
Adjusted R-squared	0.050	0.086	0.077	0.030	0.071	0.071
S,E, of regression	0.075	0.073	0.074	0.075	0.074	0.074
Durbin-Watson stat	2.191	2.322	2.246	2.161	2.233	2.233
N	91					

* Significant at 10%

The elasticity of substitution belongs to the [-1.66, -1,46] interval. Consequently, a one percentage point change in the (log difference of) price of non-tradable goods in terms of tradable goods implies an average decrease of 1.56 percent in the (log difference of) private consumption of non-tradable goods in terms of tradables. These results are statistically significant at 10 percent and the associated R-square values are low.

In order to complete the analysis, the Model (6) estimation was replicated with each of the other three definitions of private consumption of non-tradable and tradable goods. Tables 20 and 21 present the IV and 2SLS estimations, respectively, of the elasticity of substitution.

Table 20. IV Estimation of Elasticity of Substitution by Threshold (t-values in parentheses)

Threshold	Variable	Coefficient
z = .01	Constant	0.004 (0.368)
	DP	-1.498 (-1.082)
	R-squared	0.103
	Adjusted R-squared	0.093
	S,E, of regression	0.093
	Durbin-Watson stat	2.353
	J-statistic	0.001
	N	91
z = .05	Constant	0.004 (0.430)
	DP	-1.222 (-1.181)
	R-squared	0.095
	Adjusted R-squared	0.085
	S,E, of regression	0.072
	Durbin-Watson stat	2.151
	J-statistic	0.010
	N	91
z = .10	Constant	0.005 (0.554)
	DP	-1.340 (-1.300)
	R-squared	0.097
	Adjusted R-squared	0.087
	S,E, of regression	0.072
	Durbin-Watson stat	2.143
	J-statistic	0.011
	N	91

Table 21. 2SLS Estimation of Elasticity of Substitution by Threshold (t-values in parentheses)

Threshold	Variable	Coefficient
	Constant	0.004
		(0.382)
	DP	-1.425
		(-1.384)
z = .01		
	R-squared	0.104
	Adjusted R-squared	0.094
	S,E, of regression	0.093
	Durbin-Watson stat	2.363
	N	91
	Constant	0.004
		(0.536)
	DP	-1.242
		(-1.552)
z = .05		
	R-squared	0.095
	Adjusted R-squared	0.085
	S,E, of regression	0.072
	Durbin-Watson stat	2.148
	N	91
	Constant	0.005
		(0.678)
	DP	-1.327
		(-1.654)
z = .10		
	R-squared	0.098
	Adjusted R-squared	0.087
	S,E, of regression	0.072
	Durbin-Watson stat	2.145
	N	91

6. Results: Quarterly Approach II

This section repeats the exercise of Section 5, but with the addition of a further variable: the current account balances of the main OECD countries for the period 1981-2001, provided by the IDB Research Department.[9] The introduction of this exogenous variable increased by 10 percent, on average, the elasticity of substitution. Thus, the elasticity of substitution was in the [1.25, 2.14] interval. Tables 22 to 27 present the main results of the estimations.

At this point it should be noted that the Central Bank calculates the terms of trade (TOT) faced by Costa Rica. The construction methodology of this index, however, is inadequate. As a result, TOT movements are not highly useful for forecasting changes in the Costa Rican trade balance, and this series could not be used in the estimations. However, as an alternative a TOT proxy was constructed using the prices of the main products that historically have affected the performance of Costa Rica's economy: bananas, coffee and petroleum. The TOT were thus redefined as the price of banana plus the price of coffee, weighted by their share in total particular exports, divided by the WTI petroleum price. However, the inclusion of this variable in the elasticity of substitution computations distorted the results, and it was dropped from the estimations.

[9] The countries included are the following: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States.

Table 22. Control Variables: IV Estimations

Model	Control Variables
(1)	Growth GDP US (YUS)
(2)	Current Account Balances of main OECD countries (OECD02) Interest Rate (DR)
(3)	Current Account Balances of main OECD countries (OECD02) Growth GDP US (YUS)
(4)	Interest Rate (DR) Growth GDP US (YUS) Current Account Balances of main OECD countries (OECD02)
(5)	Interest Rate (DR) US TOT (TOTUS) Growth GDP US (YUS) Current Account Balances of main OECD countries (OECD02)
(6)	Interest Rate (DR) US TOT (TOTUS) Growth GDP US (YUS) Petroleum Prices (DDPET) Current Account Balances of main OECD countries (OECD02)
(7)	US TOT (TOTUS) Growth GDP US (YUS) Petroleum Prices (DDPET) Current Account Balances of main OECD countries (OECD02)
(8)	US TOT (TOTUS) Growth GDP US (YUS) Petroleum Prices (DDPET) Current Account Balances of main OECD countries (OECD02)
(9)	US TOT (TOTUS) Growth GDP US (YUS) Petroleum Prices (DDPET) Current Account Balances of main OECD countries (OECD02)
(10)	Interest Rate (DR) US TOT (TOTUS) Current Account Balances of main OECD countries (OECD02)

Table 23. IV Estimation of Elasticity of Substitution (t-values in parentheses)

Item	Model									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Constant	0.004	0.006	0.003	0.010	0.010	0.009	0.005	0.004	0.004	0.005
	-0.716	-1.387	-0.88	-2.124	-2.087	-2.078	-1.474	-1.13	-1.038	-1.308
DP	-0.884	-1.145	-0.365	-1.768	-1.740	-1.706	-0.744	-0.611	-0.464	-1.118
	(-0.716)	(-1.699)	(-0.526)	(-3.846)***	(-3.792)***	(-3.733)***	(-1.199)	(-0.840)	(-0.698)	(-1.655)
R-squared	0.097	0.106	0.059	0.067	0.070	0.074	0.095	0.085	0.071	0.106
Adjusted R-squared	0.086	0.096	0.048	0.056	0.059	0.063	0.085	0.075	0.060	0.096
S,E, of regression	0.073	0.073	0.075	0.074	0.074	0.074	0.073	0.073	0.074	0.073
Durbin-Watson	2.322	2.302	2.307	2.222	2.227	2.232	2.318	2.317	2.313	2.304
J-statistic	0.000	0.044	0.009	0.040	0.046	0.050	0.039	0.040	0.013	0.049
N	88									

*** Significant at 1%

Table 24. IV Estimation of Elasticity of Substitution by Threshold (t-values in parentheses)

Threshold	Variable	Coeficient
	Constant	0.011
		(1.772)
	DP	-2.069
z = .01		(-3.460)***
	R-squared	0.095
	Adjusted R-squared	0.085
	S,E, of regression	0.093
	Durbin-Watson	2.268
	N	88
	Constant	0.009
		(1.926)
	DP	-1.655
z = .05		(-3.818)***
	R-squared	0.078
	Adjusted R-squared	0.067
	S,E, of regression	0.072
	Durbin-Watson	2.115
	N	88
	Constant	0.010
		(2.157)
	DP	-1.707
z = .10		(-3.975)***
	R-squared	0.081
	Adjusted R-squared	0.070
	S,E, of regression	0.072
	Durbin-Watson	2.109
	N	88

Table 25. Control Variables: TSLS Estimations

Model	Control Variables
(1)	Growth GDP US (YUS)
(2)	Current Account Balances of main OECD countries (OECD02) Growth GDP US (YUS)
(3)	Interest Rate (DR) US TOT (TOTUS) Growth GDP US (YUS) Petroleum Prices (DDPET) Current Account Balances of main OECD countries (OECD02)
(4)	US TOT (TOTUS) Growth GDP US (YUS) Petroleum Prices (DDPET) Current Account Balances of main OECD countries (OECD02)
(5)	US TOT (TOTUS) Petroleum Prices (DDPET) Current Account Balances of main OECD countries (OECD02)
(6)	US TOT (TOTUS) Growth GDP US (YUS) Current Account Balances of main OECD countries (OECD02)
(7)	Interest Rate (DR) US TOT (TOTUS) Current Account Balances of main OECD countries (OECD02)

Table 26. TSLS Estimation of Elasticity of Substitution (t-values in parentheses)

Item	Model						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Constant	0.007	0.004	0.010	0.006	0.006	0.005	0.006
	(0.590)	(0.432)	(1.134)	(0.695)	(0.616)	(0.567)	(0.763)
DP	-1.394	-0.697	-2.141	-1.233	-1.221	-0.949	-1.256
	(-0.623)	(-0.477)	(-2.718)***	(-1.029)	(-0.733)	(-0.70)	(-1.556)
R-squared	0.099	0.092	0.012	0.105	0.105	0.104	0.104
Adjusted R-squared	0.088	0.081	0.000	0.094	0.095	0.094	0.094
S,E, of regression	0.073	0.073	0.076	0.073	0.073	0.073	0.073
Durbin-Watson	2.278	2.318	2.152	2.295	2.296	2.314	2.293
N	88						

*** Significant at 1%

Table 27. TSLS Estimation of Elasticity of Substitution by Threshold (t-values in parentheses)

Threshold	Variable	Coeficient
	Constant	0.010
		(0.946)
	DP	-2.361
z = .01		(-2.437)***
	R-squared	0.071
	Adjusted R-squared	0.061
	S,E, of regression	0.094
	Durbin-Watson	2.228
	N	88
	Constant	0.009
		(1.077)
	DP	-2.049
z = .05		(-2.682)***
	R-squared	0.022
	Adjusted R-squared	0.011
	S,E, of regression	0.074
	Durbin-Watson	2.046
	N	88
	Constant	0.010
		(1.199)
	DP	-2.127
z = .10		(-2.767)***
	R-squared	0.020
	Adjusted R-squared	0.008
	S,E, of regression	0.075
	Durbin-Watson	2.041
	N	88

7. Results: Annual Approach

This section presents the estimations of the elasticity of substitution using annual data from 1981 to 2001. Hence, a Simplified National Accounts Procedure is developed. As mentioned above, the Central Bank of Costa Rica estimates the Private (Household) Consumption by economic sector. Thus, it is relatively easy to aggregate the consumption of tradable and non-tradable goods.

It was surprising to find that under this approach, and consistently with the quarterly data, the consumption variable (*RCN/RCT*) is not I(1).[10] Therefore, the GMM procedure must be used to estimate the elasticity of substitution using the same control variables as described in Section 6.

In this case the elasticity of substitution belonged to the [0.22, 0.28] range. Table 28 presents the basic statistics on consumption (RCN/RCT) according to different z thresholds, and Tables 30 to 32 present estimations of elasticity.

8. Summary and Conclusions

Using quarterly information on consumption and prices of non-tradable goods for the period 1980-2002, this paper estimated the elasticity of substitution in demand for non-tradable goods in Costa Rica. After testing for unit root and the cointegration properties of the time series and then controlling for exogenous variables, an estimation of the elasticity of substitution was obtained belonging to the [1.46, 2.14] interval using quarterly information. However, with annual data the estimation yields values in the [0.22, 0.28] interval. The results are statistically robust.

[10] See Table 29.

Table 28. Basic Statistics Annual Data (1981-2001)

	RCN/RCT			
Statistic	**z = .01**	**z = .05**	**z = .10**	**z = .25**
Mean	0.107	0.245	0.291	0.353
Std	0.005	0.008	0.013	0.013
Max	0.120	0.259	0.307	0.377
Min	0.099	0.226	0.253	0.319
Std/Mean	0.051	0.031	0.043	0.038
Autocorrelation	0.742	0.507	0.807	0.709

	PN/PT			
Statistic	**z = .01**	**z = .05**	**z = .10**	**z = .25**
Mean	1.060	1.526	1.499	1.451
Std	0.101	0.322	0.322	0.329
Max	1.185	2.004	2.000	1.987
Min	0.781	0.924	0.910	0.866
Std/Mean	0.096	0.211	0.215	0.226
Autocorrelation	0.693	0.962	0.963	0.962

Table 29. ADF t-Test (Annual Data)

	Logs	**I(1)**	**Other**	**I(1)**
C (z=.25)	***-4.803***			
P (z=.25)	-4.317	**		
R	-3.477	*		
TOTUS	-3.395	*		
TOTCR	-1.554	***		
PPET	-1.916	***		
CABOECD			-1.699	***

* Significant at 10%
** Significant at 5%
*** Significant at 1%

Table 30. Alternative Control Variables

Model	Control Variables
(1)	Growth GDP US (YUS)
(2)	Current Account Balances of main OECD countries (CABOECD)
(3)	Interest Rate (DR) Growth GDP US (YUS)
(4)	Interest Rate (DR) Growth GDP US (YUS) Petroleum Prices (DDPET)
(5)	Interest Rate (DR) US TOT (TOTUS) Growth GDP US (YUS) Petroleum Prices (DDPET)

Table 31. IV Estimation of Elasticity of Substitution (t-values in parentheses)

Item	Model (1)	(2)	(3)	(4)	(5)
Constant	0.005 (1.408)	0.011 (0.483)	0.005 (1.143)	0.005 (1.201)	0.005 (1.282)
DP	-0.220 (-3.217)***	-0.353 (-0.353)	-0.279 (-4.985)***	-0.282 (-4.982)***	-0.276 (-6.464)***
R-squared	0.513	0.333	0.472	0.469	0.478
Adjusted R-squared	0.487	0.302	0.444	0.441	0.451
S,E, of regression	0.018	0.023	0.019	0.019	0.018
Durbin-Watson	2.011	2.085	2.018	2.020	2.030
J-statistic	0.000	0.000	0.123	0.130	0.132
N	21				

*** Significant at 1%

Table 32. TSLS Estimation of Elasticity of Substitution (t-values in parentheses)

Item	Model				
	(1)	(2)	(3)	(4)	(5)
Constant	0.005	0.004	0.006	0.006	0.006
	(1.262)	(0.191)	(1.495)	(1.494)	(1.492)
DP	-0.220	-0.183	-0.269	-0.269	-0.268
	(-2.997)***	(-0.173)	(-3.820)***	(-3.817)***	(-3.821)***
R-squared	0.513	0.498	0.488	0.488	0.489
Adjusted R-squared	0.487	0.471	0.461	0.461	0.462
S,E, of regression	0.018	0.018	0.018	0.018	0.018
Durbin-Watson	2.011	1.937	2.040	2.040	2.040
N	21				

*** Significant at 1%

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APPENDIX A

Table A1. Pairwise Cointegration Matrix

	LC	LP	LGOV	LPPET	LR	TBUS	YUS
LC	-						
LP	-	-					
LGOV	-	Yes	-				
LPPET	-	No	No	-			
LR	-	No	No	No	-		
TBUS	-	No	No	No	No	-	
YUS	-	Yes	Yes	Yes	Yes	Yes	-