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EXPLAINING THE EXCHANGE RATE IN THE EURO ZONE THROUGH NON-TRADABLE GOODS AND THE INCOME EFFECT

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ABSTRACT

This paper shows those fundamental macroeconomics variables which explain the behaviour of the real exchange rate (RER) in the Euro Zone, with special emphasis in tariff rates. Diminishing tariffs on imports affect tradable and non-tradable sectors depending on substitution or income effects. When the substitution effect prevails, lower tariffs increase imports and the demand for foreign currency depreciates the euro. When the income effect is stronger, lower tariffs increase demand for goods in both tradable and non-tradable sectors. It boosts productivity and increases relative prices in the non-tradable sector.

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INTRODUCTION

Researchers, policymakers and business executives have been debating about internal and external imbalances of countries in the global economy. In academia, governments, central banks, firms and international organizations, several studies have focused on the main domestic macroeconomic variables such as economic growth or inflation and their links to international variables such as balance of payments or exchange rates. In these debates, distortions in current and capital accounts produced jointly with real exchange rates (RER) misalignments are a common idea. In order to understand RER misalignments, it is need to recall two basic concepts in international economics: real exchange rate (RER) and real exchange rate in equilibrium (RERe). The RER is equal to the nominal exchange rate multiplied by foreign prices and divided by domestic prices when RERe is determined by fundamental variables and estimated with econometric techniques. Finally, the RER misalignment is the difference between the RER and the RERe. The behaviour of the RERe of the euro and its determinants has been the subject of a large number of studies but there is not previous literature which take into account real variables beyond terms of trade, public expenditure, net foreign assets, balance of trade or productivity. The contribution of this paper is based in the inclusion of the variable tariffs as one of the fundamentals of the real exchange rate in equilibrium. Therefore, this research links tariffs with the real exchange rate in the Euro Zone. In previous literature, Samuelson (1964) and Balassa (1964) criticise the purchasing power parity (PPP) theory and they highlight the relationship between productivity and currency overvaluations. These authors explain that increasing salaries rise non-tradable goods prices and produce currency misalignments but they assume not commercial restrictions in the tradable sector such as tariffs on imports. In 1996, Obstfeld and Rogoff formalized the relationship between RER and productivity through a dynamic partial equilibrium model which explains the Balassa - Samuelson effect. Edwards (1988a - 1988b) redefines the theory of the international economy equilibrium explaining the connections between domestic and foreign markets by including tariffs as one of the determinants of the real exchange rate. According to his research, tariff rates has an influence on the real exchange rate through a monetary mechanism but it is not related to the Balassa - Samuelson effect.

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Moreover, Nicita (2012) examines the relationship between exchange rate misalignments and international trade policies and finds that countries with overvalued exchange rates tend to protectionism and are less likely to open up to the international market. Devereux and Connolli (1996) also relate the RER with terms of trade and trade policies. Although they do not find a direct relationship between the real exchange rate and the terms of trade, they find indirect relationships between import liberalization and real exchange rates through the non-tradable goods prices. International negotiations have reduced tariffs on imports from most of the participating countries in the General Agreement on Tariffs and Trade (GATT). Since the Dillon Round until the Uruguay Round, there have been proposed different mechanisms and formulas to modify the level of tariffs consecutively. While the last Doha trade talks have not had the expected success to achieve a further trade openness, previous meetings and unilateral reductions have decreased applied tariffs in countries with different levels of growth and markets with dissimilar degrees of protection. In fact, since a year after the World Trade Organization (WTO) officially commenced in 1995 until the year 2010, the Euro Zone has reduced the simple average of its applied tariffs under the most favoured nation principle in 56,93%. The United Nations Conference on Trade and Development (UNCTAD) publications and the WTO reports have also confirmed the European Union trend to reduce tariff rates (see Millet (2001), Messerlin (2006), Evenett (2007) and Bouët and Laborde (2008) for further references).

This decrease in tariffs on imports have affected the behaviour of the real exchange rate as much as other real variables have been affecting it, such as terms of trade, public expenditure, net foreign assets, balance of trade or an improvement in technological innovations. This relationship between tariffs and the real exchange rate in the Euro Zone has not been explored deeply in the literature. From a methodological point o view, this paper is based on literature by Dickey - Fuller (1979 and 1981) on stationarity; research by Engle and Granger (1987) on co integration; Johansen procedures (1988 and 1991) to evaluate cointegration using autoregressive vectors; MacKinnon critical values (1991) to contrast stationarity; and the contribution by Pesaran et al. (2000) to test cointegration with different specifications of intercept and trend. Recent studies which present developments in econometric techniques have also been considered such as Carrion-i-Silvestre et al. (2004), Breitung and Das (2005), Pesaran (2007), Chiu et al. (2010), Shin and Park (2010), Chang et al. (2010), Su et al. (2012), Liu et al. (2012), Chang et al. (2012) and Chang (2012). However, these authors do not stress the relevance of real variables as fundamental determinants of the real exchange rate neither they consider tariff reductions with special emphasis in the Euro Zone.

As mentioned before, the aim of this paper is to present those structural variables which explain the behaviour of the RER in the Euro Zone with special emphasis on the evolution of the tariff rates (see Figure 1). Figure 1 shows RER and tariffs (TAR) in the Euro Zone. The RER times series is calculated multiplying the euro-dollar nominal exchange rate by the Monetary Union consumer price index over the consumer price index of United States and it is based in information from the International Finances Statistics published by the International Monetary Fund (IFS-IMF). The variable TAR is the simple average of the applied custom rate of the ad valorem tariffs on imports according to the principle of Most Favoured Nation (MFN), it has been quarterized with the time series of imports unit value and it is obtained from the Trade Analysis Information System (TRAINS) through the software World Integrated Trade Solution (WITS) developed by the World Bank with close collaboration with the United Nations Conference on Trade and Development (UNCTAD). In Figure 1, it can be observed a negative relationship between RER and TAR in the short term because the real exchange rate is counter cyclical with respect to the tariff rate. The exchange rate increases when tariffs decreases. However, there is also a positive relationship between both variables in the long run. Real exchange rate and tariffs rise their values until they reach a pick in 2000:Q4 and 2003:Q4 respectively, and they both decrease randomly after the highest observation to follow a negative trend. Graphically, it seems that diminishing tariffs are related with RER depreciation in the short term and RER appreciation in the long run.

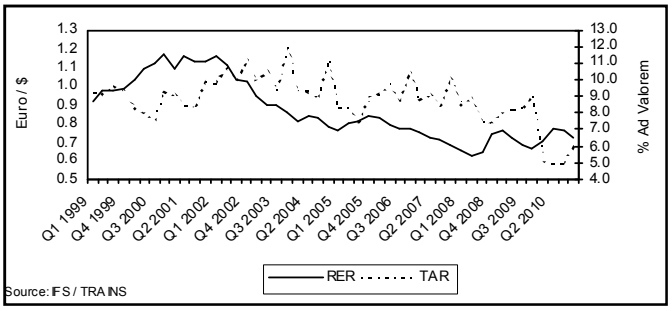
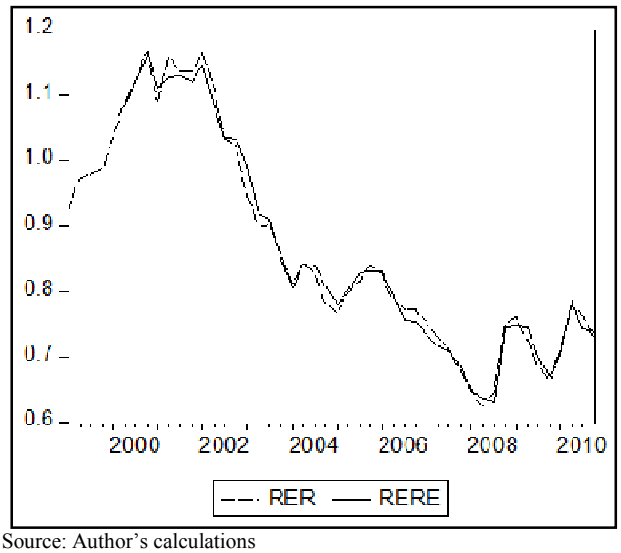


Figure 1. Real exchange rate and tariffs- Eurozone



Source: Author's calculations

Figure 2. Short term model adjustment in the Euro Zone

This paper shows that there is a link between tariff rates and RER. Theoretically, this research explains the mechanism of the influence of diminishing tariffs on the RER behaviour through income and substitution effects, thereby taking into account not only tradable goods but also non-tradable goods. Empirically, this research shows the evidence about the above mentioned relationship in both the short and long terms for the Euro Zone. A first approach to explain the relationship between RER and TAR focuses on the substitution effect. When the substitution effect prevails, lower tariffs increase imports. The demand for foreign currency to buy foreign goods depreciates both the nominal and the real exchange

rates.[1] A second approach to explain the relationship between RER and TAR is based on the income effect and the relative prices of non-tradable goods across countries. When the income effect is stronger, lower tariffs increase income and the demand for good and services in both tradable and non-tradable sectors. If a higher demand boost productivity, the productivity in the capital intensive sector (tradable goods) will be higher than the productivity in the labour intensive sector (non-tradable goods). Therefore, salaries and prices in the non-tradable sector will increase in terms of salaries and prices in the tradable sector. Reduced tariffs will affect the RER through prices of non-tradable goods. In the latest effect, tariffs appreciate the RER through the Balassa-Samuelson mechanism. In other words, according to the Balassa - Samuelson effect, productivity affects the exchange rate through the relationship between tradable and non-tradable markets across countries. Assuming that the production of tradable goods are capital intensive and the production of non-tradable goods are labour intensive, the Balassa - Samuelson effect suggests that improvements in productivity are faster in the tradable sector than those in the non-tradable sector, thereby increasing salaries and prices in the non-tradable sector with respect to salaries and prices the tradable sector. Diminishing tariffs augments non-tradable goods prices and it appreciates the RER.

An empirical model estimates the RERe between the dollar and the Euro. Through real macroeconomic variables, it can be found both long and short term relationships between the real exchange rate and its determinants. Cointegration techniques are used to establish the long run relationship when the method of ordinary least squares (OLS) with error correction mechanism (ECM) contrasts the short term relationship.
The next chapter describes the theoretical mechanism. Methodology and econometric techniques are specified in chapter 3. Data, empirical results and conclusions are presented in chapters 4, 5 and 6, respectively.

Theoretical framework

The Balassa-Samuelson effect: Widely debated by Edwards (a1988 - b1988) and formalized by Obstfeld and Rogoff (c1996) through a dynamic partial equilibrium model, the Balassa-Samuelson effect shows that the behaviour of the RERe is not explained only by monetary variables but also by real variables. This means that changes in the RER are not transitory but they fluctuate permanently on time according to its fundamental determinants. In this model, there are two countries with tradable and non-tradable goods with competitive labour markets for each country. The tradable goods sector presents higher relative productivity, and workers mobility in both productive tradable and non-tradable sectors is perfect. Purchasing power parity (PPP) is valid only for tradable goods but non-tradable goods prices are different across countries. There is perfect mobility of capital. Tradable and non-tradable production functions $Y_T = A_T F(K_T, L_T)$ and $Y_{NT} = A_{NT} F(K_{NT}, L_{NT})$, satisfying the following conditions:

a) Constant returns to scale in F(.): Multiplying each input K and L by λ, obtains: $AF(\lambda K, \lambda L) \rightarrow \lambda AF(K, L)$ for all $\lambda > 0$. Where K is capital, L is labour, A is technology or total factor productivity (TFP) and λ is a constant.

b) Positive and diminishing returns to private inputs: Calculating derivatives of F(.) with respect to each input:

$$\partial F / \partial K = r > 0, \partial^2 F / \partial K^2 < 0$$

$$\partial F / \partial L = w > 0, \partial_2 F / \partial L^2 < 0$$

Where r is the marginal product of capital and w is the marginal product of labour.

c) Inada condition: In the limit, the first derivatives of F(.) with respect to each input satisfying the following conditions:

$$Lim_{K \rightarrow 0} (\partial F / \partial K) = lim_{L \rightarrow 0} (\partial F / \partial L) = \infty$$

$$Lim_{K \rightarrow \infty} (\partial F / \partial K) = lim_{L \rightarrow \infty} (\partial F / \partial L) = 0$$

Note that the marginal product of each input depends on the capital-labour ratio k=K/L. Moreover, $Y = AF(K,L) \rightarrow Y = ALF(K/L,L/L) \rightarrow Y = ALF(K/L,1) \rightarrow Y = ALF(k,1) \rightarrow Y = ALf(k) \rightarrow Y = ALf(K/L)$

$$\partial Y / \partial K = \partial ALf(K/L) / \partial K = A[Lf'(K/L) * (1/L)] = A(L/L)f'(K/L) = Af'(K/L) = Af'(k) \quad \text{.....(1)}$$

$$\partial Y / \partial L = \partial ALf(K/L) / \partial L = A[(1 * f(K/L)) + Lf'(K/L) * ((0*L-K*1)/L2) = A[f(K/L) + (L/L)f'(K/L) * (-K/L)] = A[f(K/L) - f'(K/L)(K/L)] = A[f(k) - f'(k)k] \quad \text{……(2)}$$

The firm maximization problem is the following:

Maximize profit $(\pi) = \Sigma_t^{\infty} (1 / (1+z))^t [P * AF(K,L) - wL - rK]$, such that conditions A, B and C are satisfied. Where z is the discount factor, P is the goods and services prices, w are the wages to workers, r is the capital price and, it is assumed for simplicity, that capital depreciation is equal to zero.

Rewriting equation (1) and equation (2), first order conditions are the following:

$$\partial \pi / \partial K = 0 \rightarrow P * Af'(k) - r = 0 \rightarrow r = P * Af'(k) \quad \text{.....(3)}$$

$$\partial \pi / \partial L = 0 \rightarrow P * A[f(k) - f'(k)k] - w = 0 \rightarrow w = P * A[f(k) - f'(k)k] \quad \text{…….(4)}$$

Tradable goods sector:

$$r = P_T * A_T f'(k)$$

$$w = P_T * A_T [f(k) - f'(k)k]$$

Non-tradable goods sector:

$$r = P_{NT} * A_{NT} f'(k)$$

$$w = P_{NT} * A_{NT} [f(k) - f'(k)k]$$

Where T is tradable goods and NT are non-tradable goods. It is assumed that the level of prices is defined in geometric averages with weights equal to γ and 1-γ for tradable goods prices and non-tradable goods prices, respectively.

$$PD = PD_T^{\gamma} * PD_{NT}^{1-\gamma} \quad \text{.....(5)}$$

$$PE = PE_T^{\gamma} * PE_{NT}^{1-\gamma} \quad \text{……(6)}$$

Where PD is goods and services at domestic prices and PE is goods and services at foreign prices.

[1] The effect of tariffs on the RER depends on the elasticity of imports demand.

Taking into account the perfect mobility of labour in between both tradable and non-tradable productive sectors, the following is obtained for each country:

$$PD_T * AD_T[d(k) - d'(k)k] = w = PD_{NT} * AD_{NT}[d(k) - d'(k)k] \quad \text{..... (7)}$$

$$PE_T * AE_T[g(k) - g'(k)k] = w = PE_{NT} * AE_{NT}[g(k) - g'(k)k] \quad \text{.....(8)}$$

Where D is the domestic country and E is the foreign country. Without losing generalization, tradable goods prices can be equal to the numeraire ($PD_T = PE_T = 1$) [2]. Rewriting equation (5) and equation (6):

$$PD = (1)^{\gamma} * PD_{NT}^{1-\gamma} = PD_{NT}^{1-\gamma} \quad \text{.....(9)}$$

$$PE = (1)^{\gamma} * PE_{NT}^{1-\gamma} = PE_{NT}^{1-\gamma} \quad \text{……(10)}$$

Real exchange rate is defined as: $RER = c_1 * [(NER * PE) / PD]$. Where NER is the nominal exchange rate. Using the PPP assumption in the tradable goods competitive market [$NER = c_2 * (PD_T / PE_T)$] and substituting the numeraire:

$$PD_T = (NER * PE_T) / c_2 \rightarrow 1 = (NER * 1) / c_2 \rightarrow NER = c_2$$

Finally, $RER = (c_1 * c_2) [PE / PD]$

.....(11)

Substituting equation (7) and (8) in equation (9), (10) and (11), the Balassa–Samuelson effect can be obtained (see appendix for details):

$$RER = c_3 * \left[\frac{AE_T[g(k) - g'(k)k] / AE_{NT}[g(k) - g'(k)k]}{AD_T[d(k) - d'(k)k] / AD_{NT}[d(k) - d'(k)k]} \right]^{1-\gamma}$$

If improvements in productivity of tradable goods relative to non-tradable goods are higher in the domestic economy than those in the foreign economy, the RER decreases and appreciates. In other words, assuming a non-tradable sector intensive in labour and a tradable sector intensive in capital, the Balassa-Samuelson effect explains that domestic economic growth increases technological progress and improves tradable goods productivity levels relative to non-tradable goods productivity. This productivity improvement in the domestic economy, relative to the foreign economy, decreases the RER. Note that rewriting equation (7) and equation (8), it can be obtained:

$$PD_{NT} = AD_T[d(k) - d'(k)k] / AD_{NT}[d(k) - d'(k)k] \quad \text{.....(7')}$$

$$PE_{NT} = AE_T[g(k) - g'(k)k] / AE_{NT}[g(k) - g'(k)k] \quad \text{.....(8')}$$

Substituting equation (7') and (8') in equation (11), the RER is the following:

$$RER = (c_1 * c_2) [PE_{NT} / PD_{NT}]^{1-\gamma}$$

[2] As it has been explained by Egert et al. (2006), there is a component of prices of tradable goods that can be considered as exogenous and determined on the international market.

Levels of productivity have an effect on tradable and non-tradable sectors, thereby also affecting relative non-tradable good prices across countries and the RER. This non-monetarist approach argues that the nominal exchange rate does not offset changes on relative prices across countries to maintain the RER constant.

The tariffs mechanism

Recalling the definition of the RER and equations (5), (6), (7'), and (8'), there are:

$RER = c_1 * [(NER * PE) / PD]$

RER definition

$$PD = PD_T^{\gamma} * PD_{NT}^{1-\gamma} \quad \text{.....(5)}$$

$$PE = PE_T^{\gamma} * PE_{NT}^{1-\gamma} \quad \text{……(6)}$$

$$PD_{NT} = AD_T[d(k) - d'(k)k] / AD_{NT}[d(k) - d'(k)k] \quad \text{…….(7')}$$

$$PE_{NT} = AE_T[g(k) - g'(k)k] / AE_{NT}[g(k) - g'(k)k] \quad \text{.....(8')}$$

Diminishing tariffs in tradable goods affect the RER through two different effects: the substitution effect and the income effect. If the substitution effect is stronger than the income effect, lower tariffs increase imports and the nominal exchange rate (NER). The domestic demand for foreign currency to buy foreign goods depreciates both the nominal and the real exchange rates.

↓ TAR → ↑ Imports (tradable goods) → ↑ NER → ↑ RER (negative relationship between tariffs and the RER).

When the income effect is stronger than the substitution effect, diminishing tariffs increases income and the domestic demand for both tradable and non-tradable goods. It boosts productivity, specially in the tradable sector, and increases salaries and relative prices in the non-tradable sector. Reduced tariffs appreciate the RER through prices of non-tradable goods.

↓ TAR → ↑ Consumption (tradable and non-tradable goods) → ↑ Productivity (AD_T relative to AD_{NT}) → ↑ Salaries and PD_{NT} → ↓ RER (positive relationship between tariffs and the RER).

Both substitution and income effects have an impact on the RER but only the latest takes into account the Balassa - Samuelson effect.

MATERIALS AND METHODS

Basically, there are three econometrics procedures. The first procedure performs the augmented Dickey-Fuller test to find unit roots. The optimum lags order is calculated running the Schwarz information criterion, and the critical values are based in MacKinnon to 1%, 5% and 10%. This time series analysis through stationarity tests takes into account structural breaks in three different cases: without intercept or trend, with intercept and with intercept and trend. The Chow test evaluates the structural breaks. If there are permanent changes in the real exchange rate time series found by the stationarity test, it is

convenient to define the reasons behind these variations. In order to show how determinants affect the real exchange rate, there are two models: a long run model and a short-term model. The second procedure is the Johansen method to find the number of co-integration vectors. This econometric technique establishes relationships in the long term under unrestricted intercept and restricted trend assumptions according to the Pesaran et al. criteria (2000). Finally, the third procedure is an algorithm to minimize the

Table 1. Data Euro Zone

Index 2005=100							
Year	RER	TT	PE	NFA	BT	TAR	PR
	NER*CPI/CPIUSA	(UVX/UVI)/GDP	PE/CPI	IR+Gold/CPIUSA	(M+X/GDP)	Applied MFN	(GDP/Nº of Em.)
Q1 1999	0.91908	0.01335	3613.88	4441.38011	1.8197	9.22826	0.000707
Q2 1999	0.97375	0.01283	3618.14	4207.91531	1.8671	9.12512	0.000705
Q3 1999	0.97833	0.01212	3657.29	4400.84388	1.8414	9.64092	0.000706
Q4 1999	0.98529	0.01171	3685.05	4336.96756	1.9989	9.39918	0.000713
Q1 2000	1.03343	0.01096	3721.05	4226.19972	1.9523	8.36174	0.000725
Q2 2000	1.08767	0.01076	3720.80	4197.33008	1.9672	8.07521	0.000722
Q3 2000	1.12053	0.01056	3742.65	4035.36354	1.9912	7.59812	0.000718
Q4 2000	1.16674	0.01034	3760.93	3949.74538	1.9936	9.29224	0.000719
Q1 2001	1.09161	0.01074	3802.12	3861.74133	1.9878	9.05781	0.000730
Q2 2001	1.15866	0.01046	3788.73	3825.19074	1.9971	8.52447	0.000725
Q3 2001	1.13562	0.01046	3829.58	3954.28597	1.9802	8.38611	0.000720
Q4 2001	1.13577	0.01033	3897.44	3812.37413	1.9555	9.92141	0.000721
Q1 2002	1.16413	0.01074	3907.03	3915.47173	1.9744	9.83620	0.000728
Q2 2002	1.10979	0.01058	3924.80	3975.18758	1.9690	10.58639	0.000726
Q3 2002	1.03279	0.01050	3978.93	4060.82453	1.9613	9.93639	0.000724
Q4 2002	1.02114	0.01032	3993.01	4138.66896	1.9547	11.12033	0.000725
Q1 2003	0.94554	0.01056	3986.00	3944.61484	1.9819	9.97628	0.000727
Q2 2003	0.89713	0.01047	4006.72	3961.97088	1.9645	10.48597	0.000720
Q3 2003	0.90275	0.01048	4087.81	4104.38258	1.9477	9.39773	0.000719
Q4 2003	0.85800	0.01028	4054.06	4097.85227	1.9327	11.94831	0.000726
Q1 2004	0.81142	0.01045	4074.77	3958.44071	1.9431	9.40932	0.000736
Q2 2004	0.84108	0.01022	4083.58	3793.69387	1.9569	9.34360	0.000730
Q3 2004	0.82661	0.01010	4097.75	3818.67048	1.9734	8.95639	0.000727
Q4 2004	0.78074	0.00994	4105.92	3919.37969	1.9710	11.05138	0.000729
Q1 2005	0.76428	0.01018	4137.25	3758.61379	2.0002	8.31164	0.000731
Q2 2005	0.79726	0.01003	4141.08	3665.44462	1.9908	8.32378	0.000728
Q3 2005	0.81602	0.01001	4168.46	3716.96909	1.9972	7.44237	0.000728
Q4 2005	0.83860	0.00980	4208.57	3726.16887	2.0117	8.99052	0.000732
Q1 2006	0.82547	0.00990	4230.41	3886.34881	2.0305	9.14120	0.000740
Q2 2006	0.78740	0.00966	4235.22	3974.32062	2.0215	9.66563	0.000737
Q3 2006	0.77247	0.00955	4241.23	3950.21781	2.0286	8.71513	0.000737
Q4 2006	0.77174	0.00928	4270.73	4155.35969	2.0081	10.34122	0.000743
Q1 2007	0.75316	0.00953	4316.00	4233.31117	2.0279	8.81054	0.000752
Q2 2007	0.72811	0.00926	4293.14	4131.40555	2.0353	9.11311	0.000745
Q3 2007	0.71281	0.00923	4329.64	4527.98509	2.0366	8.43621	0.000742
Q4 2007	0.67959	0.00902	4351.95	4759.97372	2.0515	10.08702	0.000746
Q1 2008	0.65392	0.00935	4366.31	5186.56924	2.0707	8.49664	0.000753
Q2 2008	0.62407	0.00926	4383.26	5020.95442	2.1074	8.92319	0.000744
Q3 2008	0.64359	0.00926	4390.87	4745.62912	2.1588	7.51717	0.000735
Q4 2008	0.75083	0.00915	4461.44	4773.15770	2.1407	7.43936	0.000728
Q1 2009	0.76039	0.00981	4559.32	4851.20854	2.1338	7.97433	0.000722
Q2 2009	0.72619	0.00974	4563.79	4914.54212	2.0996	8.24566	0.000718
Q3 2009	0.68413	0.00967	4629.33	5712.02203	2.0979	8.32956	0.000723
Q4 2009	0.66453	0.00953	4618.41	6018.25462	2.0966	8.96685	0.000726
Q1 2010	0.70648	0.00975	4618.40	6048.81579	2.1451	5.17853	0.000739
Q2 2010	0.77627	0.00956	4566.05	6410.36487	2.1699	4.99536	0.000740
Q3 2010	0.76196	0.00961	4585.68	6743.72409	2.1871	4.94734	0.000741
Q4 2010	0.72818	0.00938	4552.07	7044.00870	2.2080	5.99712	0.000744

Source: Author's calculations

The data

The theoretical model is applied to the euro-dollar relationship. The quarterly data starts in 1999:1 until 2010:4 for the Euro Zone (see Table 1). This frequency of the data is due to the fact that most of the "proxies" variables are published quarterly. For instance, one of the key variables to calculate some of the real determinants is the Gross Domestic Product (GDP). The GDP is published mostly on a quarterly basis.

The base year data is 2005 and the sources are the following:

1) The International Finances Statistics from the International Monetary Fund (IFS-IMF).
2) The macroeconomics data from the Statistical Office of the European Communities (Eurostat - European Commission) and from the European Central Bank (ECB).
3) The Trade Analysis Information System (TRAINS) through the software World Integrated Trade Solution (WITS) developed by the World Bank and the United Nations Conference on Trade and Development (UNCTAD).

Proxies of the variables are the following

Variable RER: The real exchange rate is calculated by multiplying the euro-dollar nominal exchange rate (NER) by the consumer price index of United States over the consumer price index in the Eurozone. The NER is defined in units of euros (home currency) per one unit of dollar (foreign exchange). RER = NER*CPIUSA/CPI.

Variable TT: The terms of trade are obtained from the ratio unit value exports over unit value imports divided by the Euro Area gross domestic product. TT = (UVX/UVI)/GDP.

Variable PE: The proxy of public expenditure is the Euro Area total current government expenditure deflated by the Monetary Union index of consumer prices. PE = PE/CPI.

Variable NFA: The net foreign assets are calculated dividing the euro area total international reserves plus gold, deflated by the consumer price index of the United States. NFA = IR+Gold/CPIUSA.

Variable BT: The balance of trade is the sum of the volume of exports plus the volume of imports divided by the Euro Area gross domestic product. BT = (M+X)/GDP.

Variable TAR: Tariffs are obtained from the harmonized system, by calculating the simple average of the applied custom rate at a national level of the ad valorem import tariff according to the principle of Most Favoured Nation (MFN). Some years have been completed using applied tariff under 6 digits. Annual data have been quarterized with the time series of imports unit value.

Variable PR: Productivity is obtained by dividing the Euro Area gross domestic product by the number of full time employees in the euro area. PR = (GDP/Nº of Em.).

The empirical evidence and results

In this section, the time series with unit roots tests are evaluated, the long run relationship between the cointegrating variables is found and the short term model with the ECM is built to estimate the relationship between the RER, the tariff rates and the rest of the real determinants.

Beside the variable tariffs, the econometric model includes other real determinants to get the following specification:

$$RERe = c_4TT + c_5PE + c_6NFA + c_7BT + c_8TAR + c_9PR \quad .....(i)$$

As mentioned before, TT is terms of trade, PE is public expenditure, NFA is net foreign assets, BT is Balance of trade, TAR is tariffs and, PR is productivity.

This study takes into account both the income effect and the substitution effect to relate the RERe with its fundamentals. Therefore, the parameters signs of the variables on the right side of the equation (i) are not established a priori (Tariffi, 2010).

Model (i) in the theoretical framework can be rewriting as:

$$RERe = f(t) + c_4TT + c_5PE + c_6NFA + c_7BT + c_8TAR + c_9PR + ECM + u_t \quad .....(ii)$$

Where f(t) could be zero (0), a constant (δ) or a constant and the trend ($\delta + \beta 0t$), "c" is equivalent to the parameters of the model, ECM is error correction mechanism and u_t are the regression errors.

Evaluating RER in levels for the Euro Zone, a stationarity test shows that the null hypothesis of the unit root cannot be rejected (see table 2). From figure 1, it is evident that the behaviour of the RER is not stationary in variance. In order to evaluate the stability, a Chow test was applied. Taking into account the financial crisis during the period 2007-2009, the breaking points correspond to the year 2009. When the Schwartz information criterion (SIC) calculates an optimal lag equal or greater than 4, the breaking points are established in 2008 (so that the corresponding number of observations is not insufficient). The existence of structural breaks is not found when stationarity in the RER variable is evaluated. Considering that there is no evidence of stationarity, the fact that the unit root null hypothesis can not be rejected justifies the next step in the methodological procedure: to find empirical determinants along the lines of the model (ii). All real determinants in the right side of the equation (ii) are I(1). In first differences, time series such as the terms of trade and productivity are stationary when the intercept and the trend in the model are included at 5 and 10%. Table 2 shows the SIC optimum levels of lags.

In order to find the long run relationship between variables RER, TT, PE, NFA, BT, TAR and PR in the Euro Zone, a VAR model of order 1 with unrestricted intercept and restricted trend was run. Table 3 shows the ratio of maximum likelihood with significance levels at 5 and 10%. The LR test based on trace finds 2 cointegrating vectors including the RER and all the real determinants in levels. Table 4 presents the VAR estimators for each variable in the model including the trend. Normalized estimators values are in between brackets. Cointegrating vectors are used to calculate both error correction mechanisms which are included in the short term model with one lagged period and a negative sign. In table 5, the time series in the short term model are I(0) because the variables are transformed to first differences.

Table 2. Eurozone Real exchange rate (RER) and real determinants (1999-2010)

Testing unit roots (Augmented Dickey - Fuller)
MacKinnon (1996) one-sided p-values

	No trends No intercepts	Intercepts	Trends Intercepts		No trends No intercepts	Intercepts	Trends Intercepts
Real exchange rate: Order of integration = 1							
In levels	-0.787	-0.658	-2.248	In 1st differences	-5.506	-4.389	-4.341
1% level	-2.615	-3.578	-4.171	1% level	-2.616	-3.585	-4.176
5% level	-1.948	-2.925	-3.511	5% level	-1.948	-2.928	-3.513
10% level	-1.612	-2.601	-3.186	10% level	-1.612	-2.602	-3.187
SIC (maxlag=9)	0	0	1	SIC (maxlag=9)	0	1	1
Structural breaks	No	No	No				
Chow p-value F	0.854	0.497	0.191				
Terms of trade: Order of integration = 1							
In levels	-0.878	-0.927	-2.568	In 1st differences	-4.693	-4.644	-4.114
1% level	-2.621	-3.597	-4.186	1% level	-2.621	-3.597	-4.192
5% level	-1.949	-2.933	-3.518	5% level	-1.949	-2.933	-3.521
10% level	-1.612	-2.605	-3.190	10% level	-1.612	-2.605	-3.191
SIC (maxlag=9)	5	5	4	SIC (maxlag=9)	4	4	4
Structural breaks	No	No	No at 1 y 5%				
Chow p-value F	0.586	0.406	0.095				
Public expenditure: Order of integration = 1							
In levels	4.546	-1.132	-2.398	In 1st differences	-5.016	-7.182	-7.251
1% level	-2.615	-3.578	-4.166	1% level	-2.616	-3.581	-4.171
5% level	-1.948	-2.925	-3.509	5% level	-1.948	-2.927	-3.511
10% level	-1.612	-2.601	-3.184	10% level	-1.612	-2.601	-3.186
SIC (maxlag=9)	0	0	0	SIC (maxlag=9)	0	0	0
Structural breaks	No	No	No				
Chow p-value F	0.480	0.125	0.198				
Net foreign assets: Order of integration = 1							
In levels	2.300	2.656	0.499	En 1ª diferencia	-4.715	-5.051	-6.115
1% level	-2.615	-3.578	-4.166	1% level	-2.616	-3.581	-4.171
5% level	-1.948	-2.925	-3.509	5% level	-1.948	-2.927	-3.511
10% level	-1.612	-2.601	-3.184	10% level	-1.612	-2.601	-3.186
SIC (maxlag=9)	0	0	0	SIC (maxlag=9)	0	0	0
Structural breaks	No at 1%	No	No				
Chow p-value F	0.011	0.340	0.117				
Balance of trade: Order of integration = 1							
In levels	1.784	-1.344	-2.755	In 1st differences	-8.428	-9.015	-8.912
1% level	-2.615	-3.578	-4.166	1% level	-2.616	-3.581	-4.171
5% level	-1.948	-2.925	-3.509	5% level	-1.948	-2.927	-3.511
10% level	-1.612	-2.601	-3.184	10% level	-1.612	-2.601	-3.186
SIC (maxlag=9)	0	0	0	SIC (maxlag=9)	0	0	0
Structural breaks	No	No	No				
Chow p-value F	0.416	0.109	0.148				
Tariffs: Order of integration = 1							
In levels	-1.151	0.389	-0.392	In 1st differences	-6.691	-6.830	-7.182
1% level	-2.619	-3.589	-4.181	1% level	-2.619	-3.589	-4.181
5% level	-1.948	-2.930	-3.516	5% level	-1.948	-2.930	-3.516
10% level	-1.612	-2.603	-3.188	10% level	-1.612	-2.603	-3.188
SIC (maxlag=9)	3	3	3	SIC (maxlag=9)	2	2	2
Structural breaks	No	No	No at 1%				
Chow p-value F	0.241	0.242	0.031				
Productivity: Order of integration = 1							
In levels	0.899	-1.695	-3.197	In 1st differences	-3.639	-3.745	-3.638
1% level	-2.621	-3.597	-4.212	1% level	-2.621	-3.597	-4.192
5% level	-1.949	-2.933	-3.530	5% level	-1.949	-2.933	-3.521
10% level	-1.612	-2.605	-3.196	10% level	-1.612	-2.605	-3.191
SIC (maxlag=9)	5	5	8	SIC (maxlag=9)	4	4	4
Structural breaks	No	No	No at 1%				
Chow p-value F	0.364	0.116	0.012				

Source: Author's Calculations
Breaking point 2009q3. SIC models lag equal o higer than 4: 2008q1. (Applied for pe, NFA y TAR)

Table 3. Euro Zone. Cointegration with unrestricted intercepts and restricted trends in the VAR cointegration LR test based om trace of the stachastic matriz

47 observations from 1999Q2 to 2010Q4. Order of VAR = 1.
List of variables included in the cointegrating vector:
RER TT PE NFA BT TAR PR Trend
List of eigenvalues in descending order:
.74269 .66541 .59322 .30352 .24794 .16321 .003421 .0000

Null	Alternative	Statistic	95% Critical value	90% Critical value
r = 0	r>= 1	196.4620	147.2700	141.8200
r<= 1	r>= 2	132.6610	115.8500	110.6000
r<= 2	r>= 3	81.2037	87.1700	82.8800
r<= 3	r>= 4	38.9285	63.0000	59.1600
r<= 4	r>= 5	21.9275	42.3400	39.3400
r<= 5	r>= 6	8.5355	25.7700	23.0800
r<= 6	r = 7	.16107	12.3900	10.5500

Note: This table is used to determine r (the number of cointegrating vectors).
Source: Author's calculations

Table 4. Euro Zone. Estimated Cointegrated vectors in Johansen estimation

Cointegration with unrestricted intercepts and restricted trends in the VAR

****

47 observations from 1999Q2 to 2010Q4. Order of VAR = 1, chosen r =2.

List of variables included in the cointegrating vector:

RER TT PE NFA BT TAR PR Trend

****

	Vector 1	Vector 2
RER	1.2897	-.10308
	(-1.0000)	(-1.0000)
TT	-55.3976	160.5473
	(42.9543)	(1557.4)
PE	-.6784E-3	-.0020929
	(.5260E-3)	(-.020302)
NFA	.9079E-4	.1885E-4
	(-.7040E-4)	(.1829E-3)
BT	-1.4373	1.8362
	(1.1145)	(17.8130)
TAR	.086886	.13584
	(-.067370)	(1.3178)
PR	.59126	-1.7134
	(-.45846)	(-16.6214)
Trend	.037742	.043865
	(-.029264)	(.42553)

****
Source: Author's calculations

Where D is first differences, the negative number between parentheses is the number of lags, SIC is the Schwarz information criterion, DW is the Durbin-Watson statistic, MCE is error correction mechanism, T is trend and S2 is a variable of seasonality for the second quarter. According to the economic theory, all the coefficients have right signs and they are statistically significant at different lags. The terms of trade is significant with 1, 2 and 4 lags and presents jointly positive signs all together. Public expenditure and balance of trade have been lagged once and three times, respectively. Net foreign asset is related to the RER in levels and after three periods of time. Productivity is significant only at 10%. If productivity in the domestic tradable sector is higher, the RER decreases, appreciating the national currency. The tariff rates (TAR) are significant at 5 and 10% and they are included in the model in levels and after a year. The relationship between these tariffs and the RER is inversely proportional jointly when the correspondent coefficients are summed. R^2 is around 86%, therefore the econometric model fits to the data.

Table 5. Real exchange rate with respect to the dollar in the eurozone OLS with ECM model

Eurozone
Dependent variable: DEURRER
(Period: 1999:1 - 2010:4)

Variable	Coefficient	Stand. Er.	t: p-value
C	-1.0187	0.1029	0.0000
DEURRER(-3)	0.2143	0.0930	0.0288
DEURTT(-1)	56.6023	22.2068	0.0166
DEURTT(-2)	-71.3835	23.2934	0.0048
DEURTT(-4)	66.8292	18.7383	0.0013
DEURPE(-1)	0.0004	0.0001	0.0169
DEURNFA	0.0001	0.0000	0.0486
DEURNFA(-3)	0.0001	0.0000	0.0004
DEURBT(-3)	-0.3298	0.1519	0.0385
DEURTAR	-0.0219	0.0043	0.0000
DEURTAR(-4)	0.0076	0.0038	0.0546
DEURPR	-1537.7780	863.1196	0.0857
ECMFINAL1	-0.4403	0.0445	0.0000
T	-0.0006	0.0004	0.1095
S2	-0.0530	0.0148	0.0012
R^2			0.8575
SIC			-4.2032
DW			1.3784

Source: Author's calculations

The ECM coefficient of the first cointegration vector is statistically significant, is negative, and its values are between 0 and 1. In the regression, the model includes RER lags as a endogenous variable (right hand of the equation), to capture speculative adjustments of present RER from past RER effects after three quarters of year. The White heteroskedasticity test without cross terms shows a statistical test equal to 29.018 and an associated p-value to the statistic equal to 0.360. Because the p-value associated is higher than the significance level 1%, 5% and 10%, the null hypothesis of no heteroskedasticity cannot be rejected. Testing residual normality with the Jarque-Bera test, the p-value observed is 0.425. The null hypothesis of normal distribution in the errors with level of significance of $\alpha = 0.01$, 0.05 and 0.10 (see Fig. 7) cannot be rejected.

Conclusions

The unit roots test evaluates non-stationarity of RER time series in levels and contrasts empirically the relevance of the Balassa - Samuelson effect. According to this test, variables TT, PE, NFA, BT, TAR and PR are I(1). The cointegration test plotted 2 cointegrating vectors between the RER and the real determinants in the long-term model. The short-term econometric model is estimated and both cointegrating vectors are contrasted through the error correction mechanism. The OLS with ECM methodology estimated coefficients that are statistically significant. Including 48 observations in the regression, the model fits acceptably to the statistical data. Note that in Figure 2, the segmented line of the RER variable in levels (RER) and the continuous line of the RER adjusted (RERE) fluctuate in unison. In summary, the tariff levels and the intercept represent the most significant variables in the short term model. Tariffs show a negative sign jointly and have an influence on the behaviour of the real exchange in levels and after a year. The real exchange rate is also affected by the terms of trade (1, 2, and 4 lags), public expenditure (1 lag), net external assets (in levels and 3 lags), balance of trade (3 lags), productivity (in levels), a trend and a seasonally variable for the second quarter. In addition, the RER is related to itself when the dependent variable lags 3 periods of times. It can be observed that the coefficient of the productivity variable is negative and significant at 10%.

The main contribution of this study has been to explain not only how the RER is affected by real macroeconomics variables in the Euro Zone, but also to show the significant relationship between tariffs and the behaviour of the real exchange rate, thereby demonstrating the Balassa - Samuelson effect relevance in the international economics theory. This theoretical framework explains as the RER in equilibrium varies depending on fluctuations in the prices of the tradable and non-tradable goods ratio across countries. Therefore, the nominal exchange rate and internal and external prices do not necessarily counteract to maintain constant the RERe. In other words, the nominal exchange rate does not compensate for changes in tradable goods prices and non-tradable goods prices among different countries. Those variables which affect the tradable and non-tradable sectors, as tariffs, will affect relative prices between countries and the RERe. It can be observed in the Euro Area empirical evidence that real determinants have permanent impacts on RER changes. In order to find a well specified RER model taking into account the Balassa - Samuelson effect, the right side of the equation should include not only the technological innovations but also all variables that affect the ratio tradable and non-tradable goods across different economies. The terms of trade, the balance of trade and public expenditure are macroeconomic variables collecting exogenous factors especially in the short term. In addition, the RER itself lagged some periods as well as net foreign assets adjust the empirical model to expectations in the foreign exchange markets and to artificial interventions by government regulators. Therefore, the main contribution of this research in this context is the evidence obtained on the applied tariff rates. In particular, the results show that tariffs are fundamental variables to determine the real exchange rate. In the current international context of uncertainty with internal and external imbalances in the global economy, the level of competitiveness across countries -and therefore their economic growth- may be sustainable as long as the academia and policymakers comprehend that the RER is affected not only by monetary variables and artificial modifications of the nominal exchange rate but also by real variables including tariffs. In order to explain the behaviour of asset values, such as real

exchange rate, it is necessary to observe the characteristics that influence the core of asset prices.

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Appendix. The RER formula

Substituting equation (7) and (8) in equation (9), (10) and (11) the Balassa–Samuelson effect can be obtained:

a) The equation (11) is: $RER = (c_1 * c_2) [PE / PD]$

b) Substituting equation (9) and (10) in equation (11):

$$RER = (c_1 * c_2) [((1)^{\gamma} * PE_{NT}^{1-\gamma}) / ((1)^{\gamma} * PD_{NT}^{1-\gamma})];$$

$$RER = c_3 [PE_{NT}^{1-\gamma} / PD_{NT}^{1-\gamma}] = c_3 [PE_{NT} / PD_{NT}]^{1-\gamma}, \text{ where } c_1 * c_2 = c_3; \quad \text{.....(11')}$$

$$RER = c_3 * \left[\frac{PE_T * AE_T[g(k) - g'(k)k] / AE_{NT}[g(k) - g'(k)k}{PD_T * AD_T[d(k) - d'(k)k] / AD_{NT}[d(k) - d'(k)k]} \right]^{1-\gamma}$$

$$RER = c_3 * \left[\frac{PE_T}{PD_T} \right] \left[\frac{AE_T[g(k) - g'(k)k] / AE_{NT}[g(k) - g'(k)k}{AD_T[d(k) - d'(k)k] / AD_{NT}[d(k) - d'(k)k]} \right]^{1-\gamma}$$

If tradable goods prices can be equal to the numeraire ($PD_T = PE_T = 1$):

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