Fundamentals of Equilibrium Real Exchange Rate
Juan Benítez, Gabriela Mordecki
Revista de Economía y Estadística | Vol. L | N° 1 | (2012) | pp. 59 - 92 | ISSN 0034-8066
Instituto de Economía y Finanzas | Facultad de Ciencias Económicas | Universidad Nacional de Córdoba
http://www.revistas.unc.edu.ar/index.php/REyE

Fundamentals of Equilibrium Real Exchange Rate

Fundamentos del Tipo de Cambio Real de Equilibrio

Juan Benítez
Facultad de Ciencias Económicas y de Administración,
Universidad de la República.
jotabepe@gmail.com

Gabriela Mordecki
Instituto de Economía
de la Facultad de Ciencias Económicas y de Administración,
Universidad de la República.
gabriela@iecon.ccee.edu.uy

Abstract

This paper examines the evolution of price competitiveness of Uruguayan economy, assessing the presence of "Balassa-Samuelson Effect" and a change in the economy's international integration, in a context of income and aggregate expenditure growth, through Johansen methodology. We found a long-term relationship between RER, the differential in labor productivity between Uruguay and U.S., extra-regional exports and total consumption. Furthermore, we found that the elasticities of RER to its long-term fundamentals are in line with the theory. We conclude that the decline in the equilibrium real exchange rate in the last two decades is due to the movement of its fundamentals.

Keywords: Real Exchange Rate, Cointegration, Fundamentals.

JEL Code: C32, F31, F41.

Resumen

Este trabajo examina la evolución de la competitividad-precio de la economía Uruguaya, evaluando la presencia del "Efecto Balassa-Samuelson" y un cambio en la inserción internacional de la economía, a través de la

metodología de Johansen. Se encontró una relación de cointegración entre el TCR, el diferencial de la productividad laboral entre Uruguay y EE.UU., las exportaciones extra-regionales y el consumo total. Además se halló que la elasticidad del TCR a sus fundamentos está en línea con la teoría. Así se concluye que la disminución del TCR de equilibrio en las dos últimas décadas se debe al movimiento de sus fundamentos.

Palabras Clave: Tipo de Cambio Real, Cointegración, Fundamentos.

Código *JEL*: C32, F31, F41.

I. INTRODUCTION

The Uruguayan economy has undergone an important growth process in recent years, together with the real appreciation of the domestic currency. Between the first quarter of 2004 and first quarter of 2012 Gross Domestic Product (GDP) grew at an annual accumulative average rate of 5.6%, while in the same period the RER fell annually 5.9% in average, or 8.6% if only the Extra-regional RER are considered.[1] Meanwhile, in the same period the ratio of tradable and non-tradable goods prices fell 2.1% per year considering the Consumer Price Index (CPI).[2]

In the two decades before the 2002 crisis, the Uruguayan economy was hit by regional shocks. The evolution of the relative prices of the two largest trading partners: Argentina and Brazil, and the weight they have on Uruguayan foreign trade, has meant that Real Exchange Rate (RER),[3] as amended TP/NTP, experienced great changes. These phenomena have been widely discussed in various studies related to the Uruguayan economy. However in recent years the region has lost relative weight in foreign trade, to the point that since 2003 over 70% of exports of goods are directed to the extra-region. This is also associated with the strong increase in commodity prices of Uruguayan exports (mainly products of agricultural origin) as well as its imports (mainly oil and oil products), that may have identified a number of changes in the fundamentals of RER that must be analyzed to understand the phenomenon of appreciation of the domestic currency in recent years.

1. In this paper we consider the region: Argentina and Brazil, and extra-region: NAFTA, Euro zone, UK and China.

2. When we refer to tradable and non-tradable goods we are always including goods and services.

3. Masoller (1998) quantifies the importance of regional shocks on GDP and relative prices, stating that "regional instability was the main source of external shocks faced by the Uruguayan economy during 1974-1997". Beside there are the Brazilian exchange rate devaluation in 1999 and in Argentina in 2001 which ended in the 2002 Uruguayan crisis.

This work aims to investigate as to whether the fall of RER verified in the Uruguayan economy in recent years is a long term trend originated from a change in the fundamentals of the equilibrium RER, in particular, productivity, aggregate spending and extra-regional trade. Thus, we examine the evolution of the competitiveness of the economy in light of the possible presence of "Balassa-Samuelson Effect"[4] and a change in the pattern of the economy's international insertion, in a context of income and aggregate expenditure growth. In particular, we aim to distinguish if the recent appreciation of the domestic currency reflects a cyclical phenomenon, or whether on the contrary, responds to a change in the evolution of the long-term fundamentals of the RER, the latter being the research hypothesis of this paper.

II. Real Exchange Rate and resource allocation

II.1 Real Exchange Rate definition

In this paper we define RER as the relative price of tradable goods, which prices are assumed to be given and determined in the international market, and non-tradable good prices (produced and consumed internally), which are determined by domestic supply and demand. Accordingly, the RER is defined as:

$$RER = \frac{TP}{NTP} \qquad (1)$$

Where TP is the price index of tradable goods and NTP that of non-tradable goods. Under this definition, a RER increase represents a real depreciation of the domestic currency and a decline in the relative price implies a real appreciation.

Thus, the RER can be seen as the relative price of two markets: internal and external. It represents the balance between both markets, determining the allocation of resources for the economy's production of tradable and non-tradable goods. For this reason, the RER thus defined is called "internal

4. It is assumed that, with international prices given, a productivity increase in the tradable sector raises wages in this sector. Assuming that labor moves freely between the different productive sectors, wages in the non-tradable sector will tend to equalize to those in the tradable sector, which although does not raise unit labor costs in the sector exposed to international competition, it does in the sector which market is domestic, where it is assumed that productivity is lower. Under this assumption, prices in non-tradable sector and, as a result the general price-level, will be higher in economies experiencing higher rates of productivity growth in the tradable sector. The prices of tradable goods will not experience an increase since they are internationally given. Thus, the RER will fall as a result of productivity difference.

real exchange rate", to distinguish it from "external real exchange rate" or "border", defined as the price relationship between the economy and its commercial partners adjusted by nominal exchange rate.

II.2 Internal and external balance

The RER, along with the real interest rate, are the most relevant relative prices of a small open economy like Uruguay, since, in the absence of significant distortions, they determine the set of production decisions, investment, consumption and savings of domestic and foreign agents, and thus, the allocation of resources. In this sense, and according to Nurkse (1945), is defined as the equilibrium RER relative price that solves the external equilibrium, determined by the current account balance, and inner balance, determined by factors market consistent with potential output level. The "fundamentals" are therefore those variables that determine the equilibrium RER.

According to the Balassa-Samuelson hypothesis, in contexts of strong economic growth, the appreciation of the local currency is associated with productivity increases. For the Uruguayan economy in the period 1991-2010 goods and services production in the urban sector grew at an average rate of 4.1% per year, while the labor force grew at an annual average rate of 1.4% year. So, very roughly, one might assume a growth in labor productivity of 2.7% per year, calculated as the difference in growth between GDP and the number of employees. In the same period, the world economy has increased its activity level 3.4% per year, while developed economies did so at an average rate of 2.2% per year.[5]

The sharp increase in commodities demand since mid-2000s, as a result of strong growth of emerging economies demand like China and India, combined with international low interest rates have led investors to refuge in real assets. This process had a dual effect in economies like Uruguay, with an international trade insertion based on these products. On the one hand, the price growth stimulates the exports value growth with the consequent foreign exchange earnings. On the other hand, it raises some inputs prices, like oil, that the country imports, all of which results in RER changes.

In principle, it is presumed that positive international price shocks cause an expansion of tradable goods production and stimulate the search for

5. The data for the Uruguayan economy are from Uruguayan Central Bank (BCU) and for the world economy are from International Monetary Fund (IMF).

new markets driven by the presence of comparative advantages in these sectors. Hence, the interest in examining whether higher commodity prices stem from a gain of productivity in the economy, so the appreciation is originated in the "Balassa-Samuelson effect", concomitantly with a greater openness to markets where the country's production is more competitive.

Moreover, the growth rates of the so-called "emerging economies" have shown higher than in developed economies in the last years Therefore, assuming that real appreciation is stronger the higher the rate of growth, economies like Uruguay will continue to experience the fall of the RER, especially taking into account the virtual stagnation experienced by the U.S. and European economies.

Note that the primary products are the most sensitive to the RER incidence on the exporters' income. Consequently, the increase in international commodity prices plays a significant role in the growth of exports income, considering the composition of the exports basket of emerging economies.

III. Background

The dependent economy Salter-Swan model, with tradable and non-tradable goods, is a theoretical support to analyze the determinants of consumption decisions and resource allocation between domestic and foreign goods. In this sense, and according to Montiel (1999), the long run RER equilibrium, is the appropriate indicator to analyze these consumption and resource allocation decisions, while is also crucial in defining the set of fundamentals explaining the evolution of the relative price.

In recent decades, the analysis of local currencies over-valuation in emerging economies has been linked to the existence of a productivity growth differential between the tradable and the non-tradable sectors. On this subject, Valdés and Delano (1998) quantified with three different methodological approaches (a model directly linking productivity and RER, a model of fundamentals cointegrated variables, and panel data from 92 countries for the period 1960-1990) the effects that increases in the relative productivity of the tradable sector had over the Chile's RER between 1990 and 1997, and conclude that this phenomenon led to a real appreciation of between 0.7 and 0.9% per annum of the Chilean currency. Furthermore, empirical evidence allows the authors to assert that the fall of RER verified, is also explained by changes in the fundamentals, capital flows, government spending and the terms of trade.

Hausmann et al. (2005) explain the evolution of Uruguayan RER pursuant to regional economic trends. The authors argue that while the production of agricultural goods such as meat, soy, rice and forestry, generate investment opportunities to export to the world market destination whose profitability depends on international goods prices and the RER, Uruguayan economy is closely linked to its two large neighbors: Argentina and Brazil, which have a powerful influence on Uruguayan macroeconomic variables, in particular on the RER.

In the 80s and early 90s, the external debt crisis precipitated real depreciation of regional countries domestic currencies, while for most of the 90s regional picture showed sharp currencies appreciation. Thus, after the crisis of the "*tablita*" in 1982 in our country,[6] the RER was relatively stable until the late 80s. In the 90s, a new economic policy was implemented which again led to the currency real appreciation and ended dramatically with the 2002 crisis. While in the region similar trends were verified, the authors argue that Argentina and Brazil evidenced greater volatility than the Uruguayan economy. However, during the 90s bilateral RERs with Argentina and Brazil were relatively stable, which in the opinion of the authors, created incentives for the production of goods and services destined to the regional market, displacing the international tradable markets, in parallel with a significant participation of MERCOSUR in the Uruguayan trade.

That pattern was broken in January 1999 with the Brazilian devaluation and in 2001 with the end of Argentina convertibility. The abrupt change in relative prices, concomitantly with a significant decline of our two large neighbors' aggregate demand, implied adjustments in the Uruguayan economy that required a large depreciation of the domestic currency, while profitability conditions were restored for the internationally tradable sector.

There are several papers addressing issues concerning the equilibrium or long term RER for the Uruguayan economy, both from the perspective of two goods models as proposed in the theoretical framework of this study, as of three goods, which highlights regional influence in determining the relative prices of our economy.

6. The so called "tablita" regime was a monetary and exchange rate policy that pre-announced daily the dollar equivalence in pesos. The objective of this policy was to control inflation. It started in 1978, but the Central Bank couldn't afford this policy and abandoned it in November 1982. At the same time, a similar policy was adopted by Argentina, but abandoned at the end of 1981.

The most relevant theoretical framework to analyze the determinants of relative prices incorporating the region as a relevant area is the model that includes tradable, non-tradable and regional goods, is the work of Bergara et al. (1995), where they identified as "booming sector" the sector that produces regional tradable goods and services, so its price is endogenously determined. The analysis of demand shocks and regional and international capital flows effects reflect an increase in the profitability of the sector that produces regional tradable goods and services and their prices relative to tradable production sector, resulting in a reallocation of resources , which the authors call "deindustrialization", as well as changes in the current account composition.

In the same line, Capurro et al. (2006) study through the Johansen methodology, the determinants of relative prices for the Uruguayan economy. The authors conclude that in the long run, the relative price, defined as the ratio between tradable and non-tradable goods' prices, is determined by regional demand, by the ratio consumption/GDP and by productivity differentials in the tradable sector relative to other sectors. Meanwhile, the relative price, defined by the relationship between regional and tradable goods' prices in the long-run is determined only by regional demand. Moreover, the paper shows that in the short term only relative prices are adjusted upon the occurrence of shocks in one of its fundamentals. Finally, based on the empirical analysis the authors conclude that there is a long-term relationship between the determinants of the relative prices of Argentina and Uruguay that verify compliance with the Purchasing Power Parity (PPP) between the two economies.

Furthermore, in the dependent model economy framework of two goods: tradable and non-tradable, Aboal (2002), using the Johansen cointegration methodology estimates the equilibrium real exchange rate explained by productivity, government consumption and total consumption. Regarding the long-term RER, he finds a negative relationship with the first two variables and a positive one with the last one.

Along the same line of Aboal (2002), but using the Engle-Granger methodology, Gianelli and Mednik (2006) find a long-term relationship between the RER and the average productivity of the economy, the interest rate differential, the terms of trade and government expenditure/GDP ratio, while the dynamic adjustment to equilibrium in the short run is determined by the terms of trade, government spending, the interest rate differential,

the productivity average, domestic inflation and changes in the Nominal Exchange Rate (NER).

Fernandez et al. (2005), using a model of PPP with annual data for the period 1913-2004 found that "*despite the different regimes applied in Uruguay over the years, there are certain fundamentals or economic forces that make to store RER equilibrium path in the long term". Furthermore, using quarterly data for 1980-2005 as a medium-term approach, they conclude that "Uruguayan RER is determined by RERs of Argentina and Brazil*." [7]

IV. THEORETICAL FRAMEWORK

The PPP is a basic model for determining the real exchange rate, which in its weak version states that inflation differentials are neutralized by adjustments in the NER. Thus the impact of relative price shocks should be transitory, so the RER should return to its long-term trend. Instead, if shocks are permanent, the PPP is not satisfied.

The approach developed by Balassa (1964) and Samuelson (1964), establishes a relationship between the evolution of productivity and RER and constitutes an explanation for RER misalignments relative to the PPP. The difference of productivity growth of tradable and non-tradable sectors, leads to a real appreciation phenomenon, which is a determining factor in the allocation of resources in the local economy and internationally price competitiveness. An increase in RER means that production of traded goods is relatively more profitable than the production of non-tradable and therefore provides an incentive for the reallocation of resources from the non-tradable sector to the tradable. Taking international prices as given, the real exchange rate is also an indicator of price competitiveness of the economy, while increased RER indicates that a country produces goods traded in a relatively more efficient way than the rest of the world.

Moreover, the international empirical evidence suggests that the income elasticity of non-tradable goods and services demand is generally greater than one, so that as an economy reaches higher levels of income, private spending shifts from tradable to non-tradable goods and services, hence the economies whose paths tend to increase the income level experience real appreciation phenomena.

7. The paper estimates that, in the medium term, the country's RER is a homogeneous linear combination of Argentina and Brazil RER, that respond to the following equation: $LRER\_uru$=0.41$LRER_arg$ + 0.59$LRER_bra$

IV.1 The purchasing power parity (PPP)

The absolute version of PPP is based on the law of one price, which states that:

$$P_i = NER \,.\, P_i^* \qquad (2)$$

Where NER is the nominal exchange rate defined as the number of units of local currency to be paid to acquire a unit of foreign currency; P_i is the price of the i good nominated in local currency and P_i^* is the international price of the same good. In this version, the RER must be constant and equal to 1.

There is also a relative version of the PPP which states that the price relationship between two economies may vary in proportion to maintain constant purchasing power of the domestic relative to foreign currency.

$$RER = \frac{NER.P^*}{P} \qquad (3)$$

Applying a logarithmic transformation we get:

$$RER = NER + P^* - P \qquad (4)$$

According to this definition, an increase of RER represents a depreciation of the domestic currency, while raising the relative price of the basket of goods and external services, while a reduction in the indicator reflects a real appreciation of the domestic economy which makes more expensive the domestic basket of goods and services.

The PPP is a traditional theoretical basis for establishing the long-term equilibrium RER, which in its relative version postulates that RER changes are due to the relative differences in the rates of change in prices. The effective RER is, therefore, a measure of the deviation from the PPP.

Froot and Rogoff (1995), note that relative prices and exchange rates are not stationary. Therefore, an equilibrium RER based on the PPP is not constant. Furthermore, the results of PPP estimations in a given period do not offer a powerful perspective on whether the PPP may be valid as a long-term proposition. In turn, Edwards and Savastano (1999) conducted an extensive and thorough compilation of various empirical work on the PPP, both for groups and individual countries, concluding that although PPP provides a very useful benchmark for assessing the RER evolution in the long term for

developed economies, the hypothesis that this relative price between economies is stationary is not verified, especially in developing economies.

Taylor and Taylor (2004) support the "consensus view" that in the short term the PPP does not take place while in the long run it may make sense to argue that there is a reversion to the mean of the RER, although they may exist some factors, including transaction costs, which deviate RER from this value for long periods.

V. REAL EXCHANGE RATE FUNDAMENTALS

V.1 Absorption and Real Exchange Rates

The equilibrium RER is such that ensures simultaneous internal and external balance of the economy. According to Gianelli and Mednik (2006), there is an inverse relationship between the absorption and the RER on the domestic sector. Starting from an equilibrium point, an increase of aggregate demand represents an excess in the non-tradable market, which requires a real appreciation of the domestic currency to return to balance, while regarding the external sector, the relationship between the absorption and RER is direct, since an increase in spending causes a current account deficit that requires depreciation to clear the market. The authors also note that the return to equilibrium after deviations caused by the external canal of the economy, is usually slower than when imbalances are originated in the domestic sector, which is why in various RER equilibrium modelling the external equilibrium condition is considered a long term condition, while the internal equilibrium condition is measured as a short term one.

The approach taken here considers the RER as an endogenous variable determined by the macroeconomic system in which the fundamentals are the main variables. Thus, changes in the RER may depend on a number of factors such as productivity differentials, terms of trade, capital flows, fiscal balance, the differential in real interest rates and the degree of external openness of the economy. The impacts of these factors on the RER also affect the composition and size of the various sectors of the economy.

On the supply side of the economy, the factor endowment is also part of the fundamentals of RER and affects its movement. The increase in the factor endowment contributes to cause an increase in the supply of all goods, which entails a reduction in the factors prices and in non-tradable prices (as

prices of tradable are determined internationally). The reduction of factor prices increases production and consumption of all goods. Therefore, the increase in the factors supply leads to increased RER.

V.2 Fundamentals of Long Term Real Exchange Rate

The productivity differential between tradable and non-tradable sectors of the economy, implies that an increase in productivity in the tradable sector of the economy in relation to the non-tradable sector causes a shift of resources from non-tradable to tradable, which is equivalent to a negative supply shock in the sector exposed to competition. With international prices given, the non-tradable sector must raise prices to restore the balance, which will appreciate the domestic currency.

The terms of trade (TT), defined as the ratio between export and import prices ($TT=P_X/P_M$) are one of the factors from the demand side, that determine the RER. A raise in the TT represents an increase in the price of exportable in terms of importable goods, which results in a shift of resources from the non-tradable to the tradable sector of the economy, which production has become more profitable. This phenomenon can be assimilated to a negative supply shock in the non-tradable sector, which added to the positive wealth effect that comes from the improvement in export prices, leads to an increase in demand in the non-tradable sector which causes an increase in its prices, thereby causing a fall of RER. However, while there is a fall in the relative prices of importable goods it causes a substitution effect that could lead to a contraction in demand for non-tradable goods, contributing to the real depreciation. However, the wealth effect is considered more intense and therefore the appreciation of the local currency dominates. Furthermore, the prices growth of exportable goods stimulates a positive trade balance which magnitude more than offsets the increase in imports due to the wealth effect and substitution above. Hence, the impact on the external sector strengthens domestic appreciation.

The impact of TT on the RER is particularly strong in countries which exports are concentrated in commodities. When the improvement of TT is due to specific export sectors, then the phenomenon known as Dutch Disease occurs. According to Corden and Nearly (1982), the price increase in the exportable sector that experienced the boom, causes the RER to decrease in the rest of exportable sectors, which affects its price competitiveness.

As will be seen later, Uruguay has the particularity of being an exporter of goods with agricultural origin and an importer of oil, making it possible to suspect that the effects of increases in commodity prices are offset by a zero incidence in changes in *TT*, as it affects both the export as well as in the import basket.

Capital flows can be assumed as changes in the budget constraint of the local economy, as capital inflows can increase absorption in the short term. Internally, it promotes increases in the demand that will raise non-tradable good prices, with the consequent fall of RER. Nevertheless, it is particularly important to distinguish between short-term capital inflows from the long term one. While short-term capital inflows temporary appreciate the local currency, the opposite occurs when short-term capital leaves, whereas if capital inflows are assumed to be permanent, its impact is reflected in a change in the fundamentals that depresses the long run RER equilibrium. This distinction has led various economies to create obstacles to short-term capital inflows to avoid damage to price competitiveness.

Total consumption expenditure is another RER determinant. The increase in spending, both public and private, causes excess demand for tradable and non-tradable goods. In growing economies like Uruguay, this increase in spending is more intensive in non-tradable, so it pushes prices of these goods up, which determines a real appreciation. In particular, and as noted by Romaniello (2008), in Uruguay, public spending is skewed toward services and non-tradable goods, so government spending reinforces the effect of overall spending.

A decline in international interest rate makes it possible to finance a larger current account deficit, which is associated with a more appreciated currency. This also is treated as a positive demand shock on investment goods as it decreases its opportunity cost, which would boost an increase in non-tradable prices. In addition, there is a wealth effect due to the decrease of external debt service and greater capital endowment. Hence, a reduction in international interest rate implies a fall in the RER.

Moreover, an increase in interest rate differential between the domestic economy and the rest of the world, will induce a nominal depreciation to a restrictive monetary policy, so as to restore the uncovered parity $i = r^* + \widehat{NER^e}$ where i is the nominal interest rate, r^* international interest rate, ($\widehat{NER^e}$) the expected nominal exchange rate variation.

An increase in the economy openness will lead to more exports, generating conditions for increased import demand, so that both phenomena have an opposite effect on the trading account. Cheaper imports can be seen as a positive supply shock and a negative shock on the local economy demand. The first would generate cheaper imported inputs needed for production, while the second would cause a substitution effect of non-tradable for tradable goods. Both effects generate a fall in non-tradable goods prices, so imports increase, due to increased external openness of the economy that leads to real exchange rate depreciation. Moreover, the increased export flow, increasing foreign exchange earnings and aggregate demand, would pressure on non-tradable good prices and cause an appreciation of the domestic currency.

This paper emphasizes the consequences of increased export flow, so economy openness will be treated as referring only to that phenomenon. Given this, to model economy openness we construct a variable that approximates the increased flow of the Uruguayan economy exports to markets outside the region. It is expected that exports' increase outside the region causes a real appreciation of the domestic currency.

VI. Empirical Analysis

VI.1 Variables

The real exchange rate, tcr, is calculated as a ratio of tradable and non-tradable goods price indices of the Uruguayan economy, using the decomposition of the Consumer Price Index (CPI) of the National Statistics Institute of Uruguay (INE).

The terms of trade of goods and services ti is calculated as the ratio of the deflator of exports and imports, using National Account data from the Central Bank of Uruguay (BCU).

The productivity gap, $preleeuu$, is calculated as the ratio between the average productivity of the Uruguayan economy, estimated as the ratio of GDP index and the worked hour's index, using data from BCU and INE and the GDP per hour worked in the U.S. non-agricultural sector, using data from the Bureau of Labor Statistics from the U.S.

Total consumption expenditure of the economy, $gtot$, is calculated as the sum of real public and private spending, using data from BCU.

A measure of the openness of the economy, xx, is calculated as the share of extra-regional good exports over total good exports, using data from BCU and Uruguay XXI, which also aims to reflect a change in the Uruguayan international insertion pattern verified in the last decade, when there was a fall in the share of the regional trade of goods over total trade.

The interest rate differential, $tasas$, is the difference between the domestic interest rate in U.S. dollars and the 6 months Libor in dollars.

It should be noted that the available time series severely limit analysis, because there are no reliable series of Total Productivity for the entire period, which would have allowed capturing in a better way the evolution of aggregate productivity of the economy for the two relevant factors: capital and labor, not just the latter. Furthermore, the coefficient of productivity differential between tradable and non-tradable sector, calculated as the ratio of labor productivity in the manufacturing industry and the average labor productivity of the economy, does not have the expected signs in the estimated model. Due to the availability, data is quarterly considered, from first quarter of 1988 up the fourth quarter of 2010.

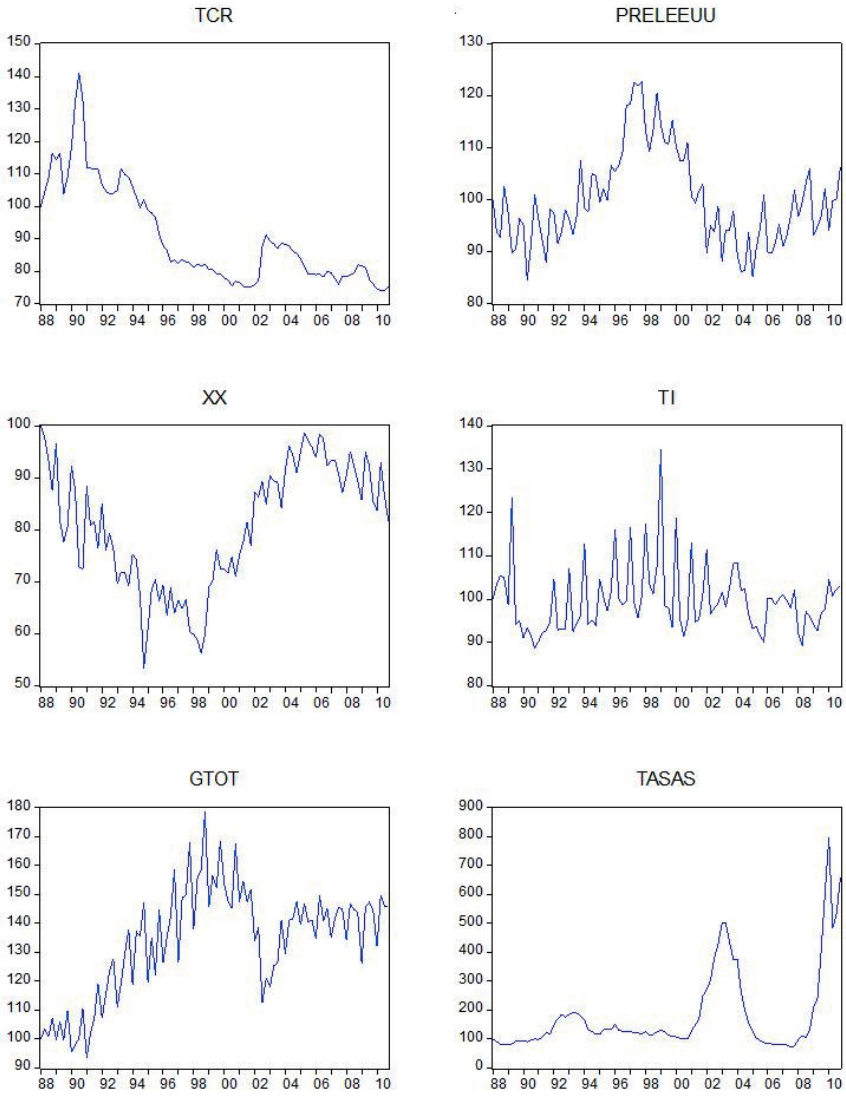
VI.2 Johansen method

Considering that the set of variables involved in this modelling, which are all first order integrated, may result in one or more long-term relationships, we will use Johansen's Full Information Maximum Likelihood method (FIML) for the analysis of long-term relationship between the equilibrium RER and its fundamentals. A VECM is a restricted VAR designed to be use with non-stationary cointegrated variables and to analyze the dynamics of adjustment of the variables to short-term shocks that temporarily moves away from the long term equilibrium relationship.

Table 1: Variables included in the model

$logtcr$	Logarithm of Real exchange rate estimated as the ratio between TP and NTP
$logpreleeuu$	Logarithm of the ratio of Uruguayan average labor productivity to U.S. average labor productivity
$logxx$	Logarithm of the ratio of extra-regional exports to total exports of goods
$logti$	Logarithm of the Terms of Trade of goods and services
$loggtot$	Logarithm of Total Consumption Expenditure
$logtasas$	Logarithm of the ratio between the Libor and domestic rate, both in dollars for 6 months

Figure 1: Original series (Index, 1988.I = 100)



VI.3 Unit roots

The series figures suggest that they may be not stationary, thus it corresponds to make the Augmented Dickey - Fuller (ADF) test. After performing it, we could not reject the null hypothesis of not stationarity for all the series considered (see Annex 1).

But as sometimes the ADF test is not enough to prove the not stationary condition; we performed also the Zivot-Andrews test, which considers the possibility of a structural break, as Uruguay had a very hard crisis in 2002, and an important devaluation of its currency afterwards. This test also did not allow us to reject the not stationarity hypothesis in all the series considered.

VI.4 VECM specification

According to the Granger representation theorem, a cointegrated VAR model can be expressed as an error correction model (VECM). Therefore, taking into account the Akaike information criterion, we specified a VECM with one lag. The presence of seasonality in the variables and of multiple outliers was corrected introducing several dummy variables in the specification (see Table 1 in Annex).

The theoretical framework states that the real exchange rate adjusts in the long run to changes in exogenous variables: productivity differential, openness, consumption, interest rates differential and terms of trade. To demonstrate these assumptions empirically, it must be verified that the variables that are part of the cointegration relationship (or others deemed to explain the deviations from equilibrium RER) are not weakly exogenous, that is, they do not fit short term imbalances. The weak exogeneity occurs when the coefficient associated with a variable in the short-term adjustment is not significantly different from zero.

Once the model is estimated, the different variables were checked through the corresponding exclusion tests. As $\log ti$ and $\log tasas$ variables were not significant, the model was re-estimated eliminating these variables from the relationship (Table 2).

From this new estimation, the following cointegrating vector arises:

$$\log tcr_t = 17.861 - 1.259 \log preleeuu_t - 0.880 \log xx_t - 0.762 \log gtot_t \quad (5)$$

(1.427)	(0.252)	(0.124)	(0.102)
[12.514]	[-4.991]	[-7.090]	[-7.479]

The theoretical framework adopted argues that the RER is set in the long term evolution of the exogenous variables which are established as fundamentals. If cointegration exists then we have a set of coefficients describing the conditional model of RER according to their long-term fundamentals and a matrix of coefficients of the marginal model representing the speed of adjustment of the error correction term.

Table 2: Cointegration results

H0: No cointegration	Eigenvalue	Trace Statistic	0.05 Critical Value	Probability(**)
None (*)	0.351960	5.901.183	5.407.904	0.0170
At most 1	0.126490	1.996.958	3.519.275	0.7286
(*) Denotes rejection of the hypothesis at the 0.05 level				
(**) MacKinnon-Haug-Michelis (1999) p-values				

According to Johansen (1992) weak exogeneity is verified if the following two conditions are met: a) the parameters of interest are a function only of the parameters of the conditional model, and b) The parameters in the conditional model and the parameters in the model marginal variation are free; that is, they have no restriction joint therefore conditional model residuals are not correlated with the residuals of the short term model.

Hence are tested the weak exogeneity conditions which imply that the coefficients associated with the variables in the short-term adjustment are not significantly different from zero. The adjustment coefficients to variable imbalances are as follows:

Table 3: Adjust Coefficients to Variables Imbalances

	$\Delta \log tcr$	$\Delta preleeuu$	$\Delta \log xx$
Error correction term	-0.060985	-0.173575	-0.304830
t Statistic	[-2.19575]	[-3.59522]	[-3.72351]

VI.5 Interpreting the Long-Term Relationship

An increase in domestic economy productivity over trading partners,[8] contributes to the fall of the RER, as predicted by the so called Balassa-Samuelson effect, which is consistent with the hypothesis set out at the beginning of this work.

8. The variable used refers to the differential of labor productivity average of Uruguayan and U.S. economies, the latter taken as a proxy of developed economies productivity.

It is important also that the sign of the relationship is consistent with results obtained by existing studies for the Uruguayan economy. In Aboal (2002), with quarterly data, for the 1986.I-2000.IV period, the variable is estimated through the ratio between total average productivity and industry productivity (as an expression of the tradable sector),[9] and Gianelli and Mednik (2006) found a relationship of the same sign with data for the period 1983.I-2005.IV, using the labor average productivity of the domestic economy.

The export growth through the increase of extra-regional trade also results in domestic currency appreciation. Foreign sales growth implies an increase of disposable income which, with international prices given, causes a demand shock in the non-tradable sector that raises their prices, so the RER falls. In particular, the approach to openness through exports outside the region seeks to explain the trend shown by the Uruguayan economy in terms of losing weight of regional countries as trading partners.

From another point of view, the results could be reinforcing the intuition that in contexts of falling relative prices, external integration intensifies in those goods with comparative advantage, namely primary products of agricultural origin. To examine this intuition, we test Granger causality for the real exchange rate and extra-regional exports. With a 95% confidence level, we can reject the hypothesis that exports do not Granger cause RER, but we cannot reject that RER do not Granger causes exports. Therefore, causation is given from exports to the RER, so that it can be argued that the opening precedes the currency appreciation, however this assertion is quite debatable according to the definition of this causality test.[10]

As productivity gap also entered the short run adjustment, we also applied Granger causality test, but the results are not conclusive in either direction.

The output of the model is also consistent with the stylized facts which show that in the context of rapid growth, as is the case of our economy, con-

9. In Aboal (2002) the variable associated with productivity is positive, since it is defined as the ratio between the average productivity and industrial productivity of labor, so that productivity gains in the tradable sector drops the relationship between average productivity and industrial productivity, thereby bringing down the RER.

10. The construction of the model incorporates a set of implicit assumptions from economic theory about the relationship between the variables, hence the need to define the causality of relationships described by the model. Z is said to "cause in the sense of Granger" Y, if taking into account the past values of Z is possible to make better predictions to Y, ceteris paribus. However, this definition cannot be taken strictly as determining cause and effect, but the ability to make predictions.

Table 4: Granger causality test between RER, productivity gap and extra-regional exports

Pairwise Granger Causality Tests			
Sample: 1988Q1 2010Q4			
Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Prob.
$\log tcr$ does not Granger Cause $\log preleeuu$	90	0.58519	0.5592
$\log preleeuu$ does not Granger Cause $\log tcr$		0.90314	0.4091
$\log tcr$ does not Granger Cause $\log xx$	90	0.73650	0.4818
$\log xx$ does not Granger Cause $\log tcr$		3.14882	0.0479

comitantly to the appreciation of the domestic currency, an increase in consumer spending –both public and private– is verified and it is biased towards non-tradable goods and services. The theoretical framework establishes a relationship between spending and RER by which the spending increases causes currency appreciation. As a result, domestic demand increases and the share of non-tradable is grater as available income increases. That sort of wealth effect will cause an increase in the price of the sector not exposed to competition and thus a fall of RER, the so called Salter-Swan effect.

At the same time, if productivity (which is supposed to be more intensive in the tradable sector) and consumption effects on the RER are considered jointly , it is estimated that productivity growth favors the accumulation of capital in the sector exposed to competition through exports increase, helping to bring down the external debt, while increasing consumption stimulates the debt increase as imported goods and services demand also increases, while pressing diminishing capital as it stimulate non-tradable sector output. In that sense, the effects are opposite, so a priori the net effect has not a definite sign. However, Aboal (2002) affirms that in Uruguay the sum of both effects has led to increased relatively non-tradable prices, which represent a decrease of RER. Thus, the sign of the coefficient associated with consumption, both public and private, is consistent with this result.

In the estimation reported here, the coefficients of productivity differential, extra-regional exports and, to a lesser extent, the consumption of the overall economy in the long-term relationship are close to 1. So, it can be assumed that the productivity gains, extra-regional export increase and consumption growth are completely transferred to equilibrium RER, appreciating the domestic currency.

The test results confirm the intuition of unitary elasticity of the equilibrium RER to productivity and exports outside the region considered separately. However, this cannot be affirmed with respect to total consumption, considered separately or together with other variables. Below are the results:

Table 5: Restriction tests on parameters

H_0: $\beta_i = 1$

	$\log preleeuu$	$\log xx$	$\log tot$	$\log preleeuu$ $\log xx$	$\log preleeuu$ $\log xx$ $\log tot$
Statistic-value	2.303.519	1.989.485	7.743.300	9.469.353	12.035.500
p-value	0.316080	0.369819	0.020824	0.023660	0.017089

The critical value of 95% (99%) of significance of χ^2 (4) is 9.49 (13.28).

A value of 1 for the elasticity of RER to productivity and exports has important implications for the future, as it is expected that the Uruguayan economy continue growing stimulated by increasing productivity as well as increasing extra-regional demand.

Meanwhile, although from the beginning of 2002 crisis there has not been a very important increase in total consumption spending, a phenomenon verified by various economies that have experienced real appreciation in the period, it is possible that, even at moderate levels, consumption accompany economic growth increase. The impact of the three events on RER is consensually accepted, and sometimes they turn-on alerts regarding policy measures for slowing aggregate consumption.

Regarding this work results, the greatest effect on the equilibrium RER fall is caused by the relative productivity increase. In turn, if one takes into account that in the period analyzed the distribution between public and private spending was 14% and 86% respectively, but that the latter has not grown significantly, it is highlighted the importance of targeting measures to prevent domestic currency appreciation by moderating public spending.

Finally, regarding the estimation of the terms of trade coefficient, in this work as in that of Aboal (2002), it was not significant, so it is not part of the long term relationship. Additionally, the terms of trade in this analysis refer to goods and services and as noted in specific studies (which analysis is beyond the scope of this paper), the Uruguayan economy verifies an ad-

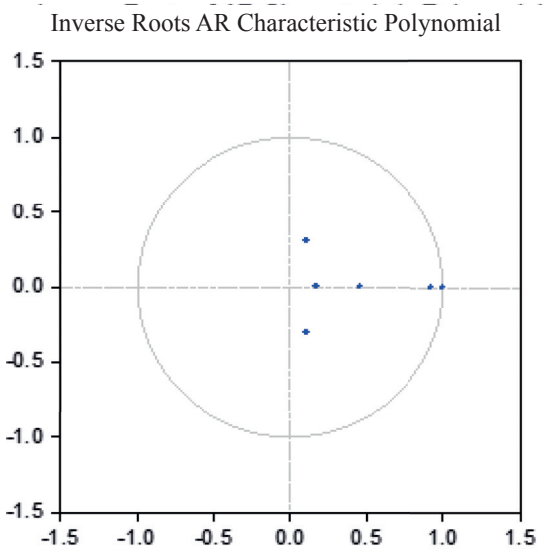
verse terms of trade relationship in goods, which is roughly compensated by a favorable one in services. It is likely that by measuring the terms of trade relationship in this way one cannot observe more closely the influence of the increase in commodity prices on the RER, taking into account their relative importance, both in the export and imports basket of goods.

VI.6 The short-term adjustment and parameters stability

According to short-term adjustment coefficients that take place over a quarter, RER adjusts 6.09% imbalance, productivity 17.3% and extra-regional exports 30.48%. Thus, the RER returns to its equilibrium value after 18 quarters, confirming that the RER, or components of the tradable and non-tradable prices, correct misalignment significantly slower than productivity and much more slowly than extra-regional exports.

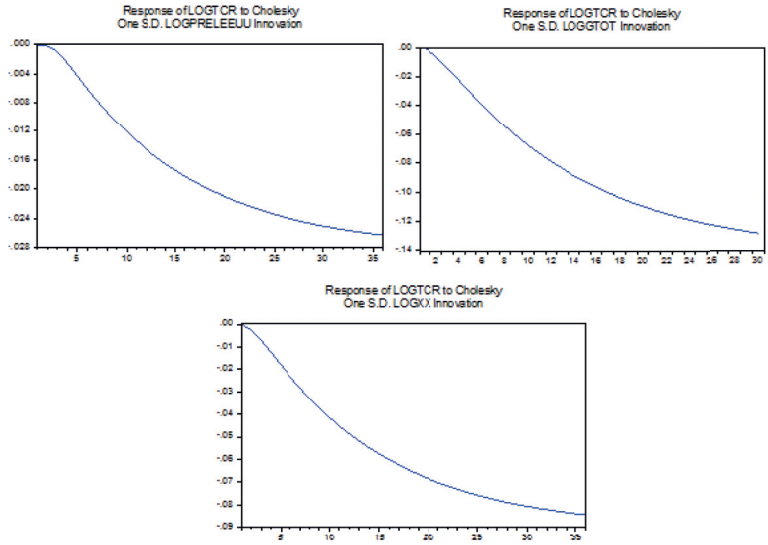
To analyze the parameters stability, as suggested in Hendry and Juselius (2000), the roots of the characteristic polynomial contain all necessary information about the stability of the process. If the roots are less than one (as shown in the graph above), the process is stable.

Figure 2: Inverse Roots



VI.7 Impulse responses

Figure 3: RER response to an impulse in Productivity gap, total consumption and extra-regional exports



The preceding graph shows the equilibrium RER response to a shock of one standard deviation in the economy's relative productivity. It is emphasized that the shock causes a permanent drop of around 3.6% in the RER that is consolidated after the thirty quarter, after the bulk of the adjustment process occurs in the first 24 quarters when the RER falls continuously. It should be emphasized the irreversibility of the change in the equilibrium real exchange rate level, reinforcing the notion that productivity increases appreciate permanently the domestic currency.

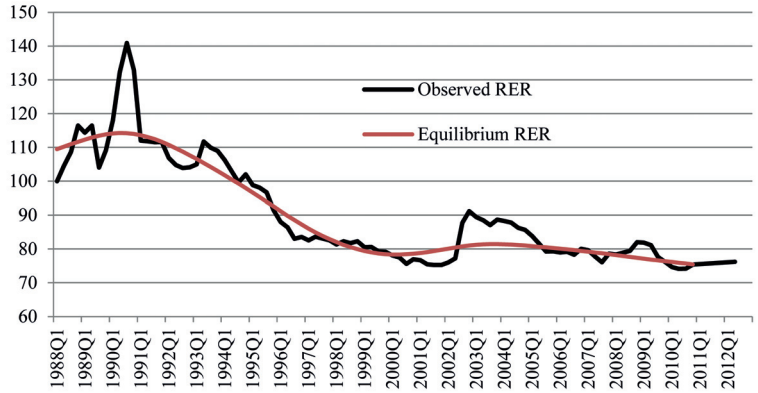
Meanwhile, in the graph above it can be seen that a stimulus of a standard deviation in extra-regional exports culminates appreciating domestic currency in about 4% after 24 quarters. The decline of the RER process continues until quarter 24 when RER returns to equilibrium at a lower level.

Regarding the influence on the RER of a shock of one standard deviation in total consumption, it is stressed that the process involves an appreciation of around 9%, with an adjustment of about 20 quarters and a path of convergence of other 4 quarters until it is consolidated from quarter 24 an on. Thus, we see that the variable has a greater effect on the RER.

VI.8 RER behavior in the period

Using the coefficients of the long-term equilibrium relationship obtained on $\log tcr$, $\log preleeuu$, $\log xx$ and $\log tot$, purged of seasonal components using the Tramo-Seat filter, we construct the equilibrium RER and contrasted its series with the observed RER according to what is shown in the graph below:

Figure 4: Evolution of the trend and observed RER (Index, 1988.I = 100)



The graph shows that there is a markedly turbulent period during the 90's, a strong overreaction by the RER misalignment as a result of the 2002 crisis, and misalignments of lesser magnitude after 2005, except for 2009 after the 2008-2009 crises.

Consequently, we can say that the imbalances surge not necessarily due to the RER misalignment from its equilibrium level, but rather from the effect of shocks on the fundamentals, judging by the almost parallel evolution of observed and equilibrium RER. In particular, the regional shock that precipitated the 2002 crisis had an effect of similar magnitude in both the observed RER as in its fundamentals. After the 2002 crisis, there is a slightly higher evolution of observed RER relative to equilibrium RER, and the international crisis of 2008-2009 shows a further period of real depreciation relative to fundamentals. In 2010, this phenomenon was reversed with a slight appreciation in the long-term equilibrium level.

Moreover, the graph confirms Aboal (2002) affirmation that *"major misalignments have been more frequent in the pre stabilization period 1987-*

1991 and in 1995-2000, when the economy received important external shocks", while the 2002 crisis caused a domestic currency depreciation in both observed and equilibrium level.

Finally, it may also be noted that after the 2002 crisis, the combination of a less interventionist exchange rate policy[11] and greater openness of the economy have contributed to a significant reduction of the misalignment between the RER and its fundamentals.

VI.9 Misalignments and cycle

Following Aboal (2002), it is interesting to analyze the potential consequences of RER misalignments linked to factors associated with the business cycle. Misalignment refers to the difference between the current and the long term RER. In a small open economy like Uruguay, it is important to examine the consequences of RER misalignments on some relevant variables, namely nominal exchange rate, inflation and output gap.

If the RER misalignment is caused by an increase in international prices of products exported by the country, as happened since the early years of the last decade, the shock stimulates the production of goods for export, while discourages imports demand, generating a current account surplus, an increase in the level of employment and output growth. Assuming that the adjustment of the nominal exchange rate does not occur instantaneously, we can observe an increase in non-tradable prices, a fall in nominal exchange rate and a GDP growth above its potential level.

If a shock that causes an increase in the nominal exchange rate occurs, such as the one caused by a phenomenon like "flight to quality" because of the turmoil in the international financial markets, we will attend a misalignment of the RER that will incentive tradable goods production, with the same effect as in the previous case. Thus, RER and GDP misalignments cause upward pressure on non-tradable prices.

Moreover, if the shock comes from an increase in the domestic price level, there is a RER misalignment that discourages exports causing an output fall and a current account deficit.

11. In the period considered in this paper Uruguay had basically two Exchange rate regimes: up to 2002 crises a fixed exchange rate regime, and from 2002 crises on, an exchange rate dirty float.

VII. Final remarks

This study aimed to identify the evolution of the equilibrium RER fundamentals, considering the possibility that the Uruguayan economy is attending a currency appreciation phenomenon resulting from a productivity increase, a weakening of the regional commercial insertion and a stronger emphasis on the extra-regional trade, where the country has comparative advantages in agricultural goods.

Analyzing the evolution of fundamentals we found the relations expected by the theoretical framework and in particular the unitary elasticity of the equilibrium RER to productivity and growth of extra-regional export flow. Therefore confirming the intuition regarding that the recent appreciation of the domestic currency is due to the combined effect of productivity gains and increased extra-regional integration.

This work also shows that the observed misalignments between RER and its equilibrium level are minor than those that could be previously suspected, since the variations observed in the RER in the analysis period are due primarily to movements in fundamentals rather than the fluctuations of the business cycle, which rules out the possibility of overvalued exchange rate phenomena. At the same time, this confirms the low relevance of using PPP to estimate the equilibrium value of the RER.

The evolution of fundamentals during the analysis period and particularly during the last decade support the expectation that domestic appreciation will continue, judging by export performance, coupled with the perspective that stagnation of developed economies does not seem to reverse in the short-term, at least so as to generate shocks that impact in the productivity differential.

Furthermore, it is likely that the exported good prices will continue to rise, intensifying the displacement of non-tradable sector resources into the competitive sector. Additionally, while the coefficient associated with the interest rate differential is relatively small, it may be because the implementation of monetary policy with an inflation target regime where the interest rate is a privileged instrument's is very recent and therefore is not fully captured by the data during the period of analysis used in this paper.

Moreover, the exchange rate regime has acted in the expected direction, since fluctuations in RER are less intense right at the end of the analysis

period, when the monetary authority ceased to consider the exchange rate as a nominal anchor. Thus, changes in the NER reflect more clearly changes in the RER fundamentals, without the distortions introduced by exchange rate policy.

Finally, the results reaffirm the notion that RER imbalances with respect to its fundamentals are strongly linked with other relevant variables of the Uruguayan economy such as the nominal exchange rate, the output gap and inflation.

VIII. REFERENCES

Aboal, D. (2002). "Tipo de Cambio Real de Equilibrio en Uruguay". Instituto de Economía, Facultad de Ciencias Económicas. Universidad de la República, DT3/02.

Balassa, B. (1964). "The Purchasing Power Parity doctrine: a reappraisal". *Journal of Political Economy*, 72 (6), 584-596.

Bergara, M.; Dominioni, D.; Licandro, J.A.(1995). "Un modelo para comprender la Enfermedad Uruguaya". Banco Central del Uruguay, *Revista de Economía*, Vol. II, Nº2, 39-75.

Capurro, A.; Davies, G.; and Otonello, P. (2006). "El tipo de cambio real y los precios relativos en un enfoque de tres bienes: Un análisis de la influencia regional en el largo plazo". Banco Central del Uruguay, *Revista de Economía*, Vol. XIII, Nº2, 23-77.

Corden, W.M.; Nearly, J.P. (1982). "Booming Sector and De-industrialization in a Small Open Economy". *The Economic Journal* 92, pp. 825-848.

Edwards, S. and Savastano, M.A. (1999). "Exchange Rates in Emerging Economies: What Do We Know? What Do We Need to Know?" NBER Working Paper W7228.

Fernández, A., Ferreira, M., Garda, P., Lanzilotta, B., Mantero, R.(2005). "TCR 'Competitivo' y Otras Soluciones Desajustadas". CINVE, Montevideo, Uruguay.

Froot, K, and Rogoff, K. (1995). "Perspectives on PPP and Long-Run Real Exchange Rate". In Grossman, G. and Froot, K. (ed.) *Handbook of International Economics*.Amsterdam: North Holland Press.

Gianelli, D.; Mednik, M. (2006). "Un modelo de corrección de errores para el tipo de cambio real en el Uruguay: 1983:I-2005:IV". Banco Central del Uruguay, *Revista de Economía*, Vol. XIII, Nº2, 79-126.

Hausmann, R.; Rodríguez-Clare, A.; Rodrik, D. (2005). "Towards a strategy for economic growth in Uruguay". RE1-05-003 Economic and Social Study Series. Inter-American Development Bank, 2005.

Hendry, D.F. and Juselius, K. (2000). "Explaining Cointegration Analysis: Part II". Discussion Papers 00-20, University of Copenhagen.

Johansen, S. (1992). "Cointegration in Partial Systems and the Efficiency of Single-equation Analysis". *Journal of Econometrics*, 52, 3, pp. 389-402.

Masoller, A. (1998). "Shocks regionales y comportamiento de la economía uruguaya". Banco Central del Uruguay, *Revista de Economía*, Vol. V Nº1, 141-214.

Montiel, P. J. (1999). "Determinants of the Long Run Equilibrium Real Exchange Rate: An Analytical Model". In *Exchange Rate Misalignment: Concepts and Measurement for Developing Countries*, edited by L. E. Hinkle and P. J. Montiel. New York: Oxford University Press.

Nurkse, R. (1945). Conditions of International Monetary Equilibrium. *Essays in International Finance,* n. 4. NJ: Princeton University Press. Princeton.

Romaniello, G. (2008). "El efecto del tipo de cambio real en la solvencia fiscal". Tesis de Maestría en Economía Internacional, Facultad de Ciencias Sociales. Universidad de la República. Montevideo, Uruguay.

Samuelson, P. (1964). "Theoretical notes on trade problems". *Review of Economics and Statistics*, 46 (2), pp.145-154.

Taylor, A.; Taylor, M. (2004). "The purchasing power parity debate". *The Journal of Economic Perspectives*, Vol. 18, No. 4. Autumn, pp. 135-158.

Valdés, R., Délano, V. (1998). Productividad y Tipo de Cambio Real en Chile. Documento de Trabajo 38. Banco Central de Chile.

IX. ANNEX

Unit roots tests

1. ADF test: Unit root results[12]

Augmented Dickey – Fuller Test (ADF)

Null hypothesis (H_0): the variables have a unit root

	Level	Reject H_0	First difference	Reject H_0
$\log tcr$	-1.134.898	no	-6.354.166	yes
$\log preleeuu$	-0.226338	no	-1.979.355	yes
$\log xx$	0.359376	no	-4.649.874	yes
$\log tot$	1.006.778	no	-4.377.703	yes
$\log ti^*$	-3.294.821	no	-5.179.161	yes
$\log tasas$	-2.453.512	no	-3.071.171	yes

* Considered 99% of confidence.

2. Zivot & Andrews test

Zivot & Andrews test

Null hypothesis (H_0): the variables have has a unit root with a structural break in both the intercept and trend.

	Break point	Critical value (5%)	T statistic	Reject H_0
$\log tcr$	2002Q3	-5.08	-4.180.473	No
$\log preleeuu$	2001Q1	-5.08	-2.680.505	No
$\log xx$	1999Q1	-5.08	-2.902.238	No
$\log tot$	2001Q3	-5.08	-4.681.139	No
$\log ti$	1995Q2	-5.08	-4.228.367	No
$\log tasas$	2006Q3	-5.08	-4.687.446	No

12. All the tests and estimations were made using E-views 7.

Residual tests

Portmanteau Tests for Autocorrelations

VEC Residual Portmanteau Tests for Autocorrelations

Null Hypothesis: no residual autocorrelations up to lag h

Sample: 1988Q1 2010Q4 Included observations: 90

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	6.771719	NA*	6.847805	NA*	NA*
2	16.46908	0.9434	16.76556	0.9367	27
3	33.17518	0.8598	34.04773	0.8336	43
4	52.58530	0.7093	54.36065	0.6469	59
5	62.05577	0.8575	64.38820	0.8040	75
6	95.87161	0.3431	100.6195	0.2301	91
7	118.6070	0.2085	125.2723	0.1095	107
8	129.8587	0.3186	137.6217	0.1737	123
9	150.4406	0.2395	160.4905	0.1025	139
10	165.2253	0.2722	177.1233	0.1077	155
11	179.0686	0.3208	192.8942	0.1205	171
12	195.3903	0.3221	211.7268	0.1038	187

*The test is valid only for lags larger than the VAR lag order.

df is degrees of freedom for (approximate) chi-square distribution

*df and Prob. may not be valid for models with exogenous variables

VEC Residual Normality Tests

Orthogonalization: Cholesky (Lutkepohl)

Null Hypothesis: residuals are multivariate normal

Sample: 1988Q1 2010Q4 Included observations: 90

Component	Skewness	Chi-sq	df	Prob.
1	0.214087	0.687497	1	0.4070
2	-0.073425	0.080869	1	0.7761
3	0.138437	0.287474	1	0.5918
4	-0.349110	1.828169	1	0.1763
Joint		2.884009	4	0.5774

Component	Kurtosis	Chi-sq	df	Prob.
1	3.348432	0.455268	1	0.4998
2	3.035374	0.004692	1	0.9454
3	2.657859	0.438977	1	0.5076
4	2.854440	0.079454	1	0.7780
Joint		0.978392	4	0.9131

Component	Jarque-Bera	df	Prob.
1	1.142765	2	0.5647
2	0.085561	2	0.9581
3	0.726451	2	0.6954
4	1.907623	2	0.3853
Joint	3.862400	8	0.8693

Cointegration Test

Sample (adjusted): 1988Q3 2010Q4 Included observations: 90 after adjustments

Trend assumption: No deterministic trend (restricted constant)

Series: $\log tcr$, $\log preleeuu$, $\log xx$, $\log tot$

Exogenous series: D(S1) D(S3) D(S4) D(I891) D(I893) D(I290) D(I490) D(I191) D(I193) D(I393) D(I394) D(I494) D(I495) D(I197) D(I302) D(I103)

Warning: Critical values assume no exogenous series

Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.351960	59.01183	54.07904	0.0170
At most 1	0.126490	19.96958	35.19275	0.7286
At most 2	0.072299	7.798330	20.26184	0.8405
At most 3	0.011535	1.044172	9.164546	0.9458

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.351960	39.04224	28.58808	0.0016
At most 1	0.126490	12.17125	22.29962	0.6380
At most 2	0.072299	6.754158	15.89210	0.6994
At most 3	0.011535	1.044172	9.164546	0.9458

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

VECM Final Model

Vector Error Correction Estimates				
Sample (adjusted): 1988Q3 2010Q4		Included observations: 90 after adjustments		
Standard errors in ( ) & t-statistics in [ ]				
Cointegration Restrictions: B(1,1)=1, A(4,1)=0				
Convergence achieved after 12 iterations.				
Restrictions identify all cointegrating vectors				
LR test for binding restrictions (rank = 1):				
Chi-square(1)	1.046453			
Probability	0.306325			
Cointegrating Eq:	CointEq1			
$\log tcr(-1)$	1.000000			
$\log preleeuu(-1)$	1.259554			
	(0.25236)			
	[4.99113]			
$\log xx(-1)$	0.879798			
	(0.12408)			
	[7.09075]			
$\log tot(-1)$	0.761848			
	(0.10187)			
	[7.47880]			
C	-1.786.100			
	(1.42734)			
	[-12.5135]			
Error Correction:	D(LOGTCR)	D(LOGPRELEEUU)	D(LOGXX)	D(LOGGTOT)
CointEq1	-0.060985	-0.173575	-0.304830	0.000000
	(0.02777)	(0.04828)	(0.08187)	(0.00000)
	[-2.19575]	[-3.59522]	[-3.72351]	[NA]
$D(\log tcr(-1))$	0.956557	0.053801	-0.224719	-0.320226
	(0.07282)	(0.12413)	(0.21053)	(0.19443)
	[13.1360]	[0.43343]	[-1.06741]	[-1.64699]
$D(\log preleeuu(-1))$	0.078143	0.192021	0.075603	-0.319008
	(0.06704)	(0.11429)	(0.19383)	(0.17901)
	[1.16553]	[1.68018]	[0.39004]	[-1.78204]
$D(\log xx(-1))$	-0.006963	-0.006277	0.113695	0.020491
	(0.03815)	(0.06503)	(0.11029)	(0.10186)
	[-0.18253]	[-0.09652]	[1.03084]	[0.20117]
$D(\log tot(-1))$	-0.085324	0.214101	0.162649	0.050056
	(0.04279)	(0.07294)	(0.12371)	(0.11425)
	[-1.99398]	[2.93523]	[1.31474]	[0.43811]

D(S1)	0.003328	-0.032410	-0.005363	-0.053837
	(0.00846)	(0.01443)	(0.02447)	(0.02260)
	[0.39322]	[-2.24634]	[-0.21915]	[-2.38228]
D(S3)	-0.002789	-0.006811	-0.014843	-0.016409
	(0.00475)	(0.00809)	(0.01373)	(0.01268)
	[-0.58754]	[-0.84162]	[-1.08141]	[-1.29444]
D(S4)	0.014582	0.048486	-0.064142	0.035931
	(0.00492)	(0.00839)	(0.01423)	(0.01314)
	[2.96341]	[5.78027]	[-4.50860]	[2.73475]
D(I891)	-0.055670	0.044857	0.116608	0.044774
	(0.01346)	(0.02294)	(0.03891)	(0.03594)
	[-4.13626]	[1.95521]	[2.99676]	[1.24593]
D(I893)	-0.119404	0.011459	-0.016812	-0.032914
	(0.01407)	(0.02398)	(0.04067)	(0.03756)
	[-8.48708]	[0.47782]	[-0.41333]	[-0.87619]
D(I290)	0.032900	-0.101839	0.059778	-0.019237
	(0.01386)	(0.02362)	(0.04006)	(0.03700)
	[2.37429]	[-4.31148]	[1.49216]	[-0.51994]
D(I490)	-0.114113	0.016757	0.042081	0.092715
	(0.01983)	(0.03380)	(0.05733)	(0.05295)
	[-5.75471]	[0.49575]	[0.73402]	[1.75114]
D(I191)	-0.180956	0.032051	0.165176	0.034084
	(0.01892)	(0.03226)	(0.05471)	(0.05053)
	[-9.56228]	[0.99356]	[3.01907]	[0.67457]
D(I193)	-0.009117	0.056601	-0.078198	-0.023982
	(0.01358)	(0.02316)	(0.03927)	(0.03627)
	[-0.67109]	[2.44428]	[-1.99106]	[-0.66119]
D(I393)	-0.032219	-0.004005	-0.004482	0.041768
	(0.01319)	(0.02248)	(0.03813)	(0.03521)
	[-2.44287]	[-0.17812]	[-0.11755]	[1.18611]
D(I394)	0.015495	0.065355	-0.025338	0.014974
	(0.01547)	(0.02637)	(0.04472)	(0.04130)
	[1.00178]	[2.47879]	[-0.56663]	[0.36258]
D(I494)	0.044664	0.002167	-0.127856	0.090614
	(0.01572)	(0.02679)	(0.04545)	(0.04197)
	[2.84137]	[0.08088]	[-2.81342]	[2.15901]
D(I495)	-0.051850	-0.003183	0.008951	0.076213
	(0.01364)	(0.02325)	(0.03944)	(0.03642)
	[-3.80126]	[-0.13689]	[0.22697]	[2.09259]
D(I197)	-0.002223	0.008434	0.005639	-0.110247
	(0.01332)	(0.02270)	(0.03851)	(0.03556)
	[-0.16687]	[0.37148]	[0.14645]	[-3.09996]

D(I302)	0.115626	-0.028662	-0.005192	-0.118602
	(0.01394)	(0.02376)	(0.04030)	(0.03722)
	[8.29482]	[-1.20624]	[-0.12884]	[-3.18658]
D(I103)	-0.027183	-0.050073	0.027456	0.068261
	(0.01318)	(0.02246)	(0.03809)	(0.03518)
	[-2.06315]	[-2.22948]	[0.72078]	[1.94036]
R-squared	0.828689	0.786245	0.620651	0.812115
Adj. R-squared	0.779034	0.724286	0.510695	0.757655
Sum sq. resids	0.021580	0.062706	0.180374	0.153846
S.E. equation	0.017685	0.030146	0.051128	0.047219
F-statistic	16.68882	12.68994	5.644537	14.91226
Log likelihood	247.4064	199.4056	151.8594	159.0181
Akaike AIC	-5.031.254	-3.964.568	-2.907.986	-3.067.068
Schwarz SC	-4.447.965	-3.381.279	-2.324.697	-2.483.779
Mean dependent	-0.003625	0.001407	-0.002014	0.003793
S.D. dependent	0.037622	0.057412	0.073093	0.095918
Determinant resid covariance (dof adj.)		1.48E-12		
Determinant resid covariance		5.13E-13		
Log likelihood		762.2179		
Akaike information criterion		-1.496.040		
Schwarz criterion		-1.248.836		

Dummy variables included in the VEC

s1, s3, s4: Seasonal centered dummy variables

i891 (impulse) - Negative coefficient on $\log tcr$ due to big devaluations in Argentina and Brazil and positive on $\log xx$, because regional exports fall respect to extra-regional exports.

i893 (impulse) – Negative coefficient on $\log tcr$, corresponding to the negative impact of Argentinean hyper-inflation of the period, with a very important devaluation on July, 1989.

i290 (impulse)– Positive coefficient on $\log tcr$ and $\log xx$, corresponding to the positive effect of the "Plano Collor" led in Brazil but affected negatively the coefficient on $\log preleeuu$.

i490 (impulse) - Negative coefficient on $\log tcr$, affected by the end of this Brazilian economic adjustment, which implied a big devaluation in Brazil.

i191 (impulse) - Negative coefficient on $\log tcr$, affected by continuous devaluations in Brazil, and positive on $\log xx$ due to regional exports fall respect to extra-regional exports.

i193 (impulse) - Positive coefficient on $\log preleeuu$ due to the start of stabilization plan in Uruguay.

i393 (impulse) - Negative coefficient on $\log tcr$, affected by Stability plan in Uruguay.

i394 (impulse) - Positive coefficient on $\log preleeuu$, a positive impact in Uruguay, due to the lag impact of "Efecto Tequila"

i494 (impulse) - Positive on $\log tcr$ and $\log gtot$ and Negative coefficient on LogXX, due to the "Plan real" applied in Brazil.

i495 (impulse) – Negative coefficient on $\log tcr$, due to an appreciation of RER and positive on $\log gtot$

i197 (impulse) – Negative coefficient on $\log gtot$, from movements on total expenditure

i302 (impulse) - Positive coefficient on $\log tcr$, due to big devaluation in Uruguay during the 2002 crisis and negative on $\log gtot$, adjusted by high inflation.

i103 (impulse) – Negative coefficient on $\log preleeuu$, derivate from GDP adjustment after 2002 Uruguayan crisis.