

“Long-run equilibrium exchange rate in Latin America and  
Asia: a comparison using cointegrated vector”

Simone Maciel Cuiabano

## Long-run equilibrium exchange rate in Latin America and Asia: a comparison using cointegrated vector

Simone Maciel Cuiabano<sup>1</sup>

**Abstract:** *The goal of this paper is to analyze the long-run equilibrium exchange rate in Latin America and Asia countries using the monetary model described in Obstfeld and Rogoff (1996) to evaluate the exchange rate gap between the regions. I use panel cointegration tests to verify the existence of panel cointegration for the countries. I estimate the coefficients of the long-run exchange rate function using the dynamic OLS (DOLS) from a balanced panel of 14 countries and quarterly observations that span from 1999 to 2015. The estimation shows the impact of monetary aggregates on the exchange rate. In addition, it points the exchange rate gap between Latin America and Asia. For example, long run equilibrium exchange rate between Latin America and Asia means 4% depreciation in this last region's currency.*

**Keywords:** exchange rate determination; monetary model; cointegration, panel.

**JEL:** F21; F31; C22; C23.

**Resumo:** O objetivo deste artigo é encontrar a taxa de câmbio de equilíbrio de longo prazo entre países da América Latina e da Ásia usando o modelo monetário descrito em Obstfeld e Rogoff (1996), com o objetivo de avaliar a diferença cambial entre as regiões. Testes de cointegração em painel são usados para verificar a relação entre os países. Em seguida, os coeficientes da função de taxa de câmbio de longo prazo são estimados em um painel balanceado com 14 países e observações trimestrais entre 1999-2015. Os resultados mostram o impacto dos agregados monetários sobre a taxa de câmbio, além de apontar a existência de uma diferença entre taxas de câmbio. Por exemplo, uma taxa de câmbio de longo prazo entre a América Latina e a Ásia significa 4% de depreciação nas moedas desta região.

**Palavras-chave:** determinação da taxa de câmbio; modelo monetário; cointegração; painel.

**JEL:** F21; F31; C22; C23.

---

<sup>1</sup> Postdoctoral Research Fellow at Toulouse School of Economics and Auditor of Finance of the Brazilian Treasury. E-mail address: scuiabana@gmail.com. The author thanks the 71st International Atlantic Economic Conference and the XX Regional South Economist Meeting participants at for their contribution.

## 1. Introduction

In the wake of the financial crisis in 2008 and during the debt crisis in Europe currency war was a hot trend topic. The G-20 agreement in Seoul declared countries "to move towards more market-determined exchange rates"<sup>2</sup>. For exchange rate assessment, the equilibrium among currencies is an important issue to evaluate to what extent there is a gap among nominal exchange rates in terms of over or under currency valuation.

The goal of this paper is to assess the long-run nominal exchange rate equilibrium in Latin American and Asian countries using the flexible price monetary model described in Obstfeld and Rogoff (1996). In this model, nominal prices are perfectly flexible and they adjust immediately to clear product, factor and asset markets. Despite the fact that some of the sample countries have regulated prices, the analysis is carried on in a long-run basis in which even regulated prices are adjusted within some frequency. This model also provides a starting point for thinking about nominal exchange rates as relatives prices of different currencies.

The development of new econometric methods and more data availability have stimulated a great number of empirical works on exchange rates (Sarno and Taylor, 2002). Therefore, this paper uses a panel cointegration analysis to check the existence of a cointegrated vector between Asia and Latin America. It also aims to estimate the long-run exchange rate vector capturing the difference between the two regions. The estimated cointegrated vector points to a nominal exchange rate in Asia depreciated by 4% (or appreciated in 4% for Latin American economies).

This paper contributes to the recent literature in many ways. First, it uses the most recent methodology for panel cointegrating analysis and it uses a dynamic ordinary least square model to estimate the long-run exchange rate among the analyzed countries. Second, it explores the most recent and available database with monetary information, surpassing some of the problems found in the literature regarding pegged exchange rate regimes and low quality information. Third, it reassures the relevance of monetary variables to the comprehension of exchange rate movements in Latin American and Asian countries. Last, it contributes to the analysis of recent trends in exchange rates, an important point to decision makers who need to consider these factors to long-run planning.

Particularly in Brazil, the literature on exchange rate determination and what is considered an equilibrium exchange rate is not large. Apart from the papers issued by the Central Bank of Brazil, the works of Moura et al (2008), Cuiabano and Divino (2010),

---

<sup>2</sup> [http://www.consilium.europa.eu/uedocs/cms\\_data/docs/pressdata/en/er/117705.pdf](http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/er/117705.pdf)

Galimbert and Moura (2013) and Felicio and Rossi Junior (2014) discuss the relationship among fundamentals, including not only monetary explanatory variables, to the exchange rate. The comparative discussion among the Brazilian Real, other Latin American neighbors and Asian currencies does not appear in the literature. This paper tries to fill this gap by starting the discussion about the existence of a long run equilibrium exchange rate between these two regions.

Following this introduction, Section 2 makes a brief review of the recent literature on monetary models of exchange rates; Section 3 explains the theoretical model; Section 4 describes the empirical analysis, explaining the used data, the results of the panel unit root and cointegration tests. This section also shows the estimated exchange rate using Dynamic Ordinary Least Squares (DOLS) which accounts for the possibility of serial correlation and endogeneity. Section 5 concludes and evaluates the policies that can be used to maintain the equilibrium exchange rate among the countries.

## **2. Literature review**

The monetary approach to the exchange rate emerged as dominant model in early 1970s, in the recent float period (Taylor, 1995). It defines exchange rates as the relative price of two currencies modeled in terms of relative supply of and demand for which currency. The gathering of data on independently floating systems allowed the proliferation of several empirical studies, like Bilson (1978), Hodrick (1978) and Putnam and Woodburry (1979), who found favorable evidence to the flexible price monetary system.

Monetary models of nominal exchange rate determination continue to form an important part of current international macro models. These models appeared to fit in-sample empirical estimations fairly well. Nonetheless, these models were dealt a severe blow by the seminal work of Meese and Rogoff (1983). Using a set of post Bretton Woods exchange rates for several major industrial countries, the authors showed that a simple random walk had more out-of-sample predictive power than the monetary models, even when the future realizations of the explanatory variables in the monetary models were used to generate the out-of-sample forecast. Subsequent authors tried to overturn these results, but any promising findings turned out to be fragile and the literature has remained pessimist about the link between exchange rates and monetary fundamentals (Frankel and Rose, 1995; Rogoff, 1999, Sarno and Taylor, 2002).

A recent resurgence of empirical work tries to evaluate exchange rate models using new methods for in-sample and out-of-sample evaluation. For instance, Rogoff (2007) acknowledges that greater data availability and the development of the financial system might

have contributed to the better development of structural models. He states that, in developing countries, a random walk model may not be the most efficient model to explain exchange rate movements.

With advances in the econometrics of nonstationary data, in-sample analysis has turned to cointegration to look for long-run relationships between exchange rates and fundamentals. Evidence for cointegration has been mixed, with results depending on the country and sample used. For example, MacDonald and Taylor (1993) provide early favorable evidence for cointegration between nominal exchange rates and monetary fundamentals for the U.S. dollar-Deutsche Mark exchange rate. Rapach and Wohar (2002) use data for 14 industrial countries that span as long as 115 years (1880-1995), and find some evidence of cointegration for 8 of the 14 countries.

Very recent work focuses on using panel cointegration tests to take advantage of the power of using multiple country exchange rates and fundamentals. Husted and MacDonald (1998) find evidence of cointegrating relationships in panel data sets for the US dollar, German mark and Japanese yen exchange rates using annual data for the recent floating experience.

Motivated by the idea of cointegration between variables, the recent out-of-sample analysis examines whether the current deviation of the exchange rate from its long-run equilibrium is useful for predicting the future exchange rate returns (Mark 1995, Mark and Sul, 2001).

Cerra and Saxena (2010) revisited the dramatic failure of monetary models in explaining exchange rate movements. Using information for 98 countries, they found strong evidence for cointegration between nominal exchange rates and monetary fundamentals. They also found fundamentals based models very successful in beating a random walk in out-of-sample prediction. These authors highlight that previous literature has largely ignored information provided by a large set of countries because there has been a concern regarding fixed exchange rate regimes in many non-industrial countries. However, they argue that mixed exchange rate regimes are no longer an issue because of the high frequency pace at which countries adjust their pegs. In addition, they consider that there may be more independent flexibility for the broad sample of countries than for the sample of industrial countries.

The use of panel cointegrating methods has received great attention in the international literature. One reason is the augmentation of time series and cross-section data. Despite of that, many studies have failed in reject the non-cointegration hypothesis even if

suggested by theory. According to Westerlund (2007) one possible explanation is that previous works were based on residuals tests which requires the long-run variables to be equal the short-run ones. He suggests a structural based test to check panel cointegration so this last will be used in this work.

In order to estimate a cointegrating relationship, new studies have found that ordinary least squares (OLS) is a super consistent estimator of the coefficients of cointegrated variables. Methods have been developed to address these problems, such as the dynamic ordinary least squares (DOLS). An alternative estimation approach would be a vector error correction model (VECM), but general VECMs are not feasible for panels with many countries due to the large number of parameters. The group mean dynamic OLS uses the group mean of the Stock and Watson (1993) DOLS estimator, in which leads and lags of the right hand side variables in first difference are used to correct for endogeneity and serial correlation.

### 3. Theoretical model

Obstfeld and Rogoff (1996) describe a discrete money demand model and apply to it the Keynesian money supply equation, with PPP and UIP. Considering the equation:

$$m_t - p_t = -\eta i_{t+1} + \phi y_t \quad (1)$$

where  $m_t$  is the log of nominal money at time  $t$ ,  $p_t$  is the log of price index at  $t$ ,  $\eta$  is the semielastic demand for real balances in terms of expected inflation,  $i_{t+1}$  is the nominal interest rate at  $t+1$  and  $y_t$  the log of real GDP. From UIP hypothesis we find the interest rate differential between countries occurs according to the currency movement:

$$i_{t+1} = i_{t+1}^* + E_t e_{t+1} - e_t \quad (2)$$

$i_{t+1}^*$  is the interest rate on foreign-currency bonds (which we call “international interest rate”) and the differential  $E_t e_{t+1} - e_t$  represents the difference between the expected value of the exchange rate at  $t+1$  and  $t$ .

The hypothesis of uncovered parity with the agent’s perfect prediction is due to the supposition of arbitrage non existence. In the long run, the purchase power parity is assumed,

so, substituting  $i_{t+1}$  in and using  $e = \frac{p}{p^*}$  in (1):

$$(m_t - \phi y_t + \eta i_{t+1}^* - p_t^*) - e_t = -\eta (E_t e_{t+1} - e_t) \quad (3)$$

Exchange rate solution with PPP and UIP at  $t$  is:

$$e_t = \frac{1}{1 + \eta} (m_t - \phi y_t + \eta i_{t+1}^* - p_t^*) + \frac{\eta}{\eta + 1} e_{t+1} \quad (4)$$

And in the next period (t+1):

$$e_{t+1} = \frac{1}{1 + \eta} (m_{t+1} - \phi y_{t+1} + \eta i_{t+2}^* - p_{t+1}^*) + \frac{\eta}{\eta + 1} e_{t+2} \quad (5)$$

Substituting (4) in (3) we get a 2 period result:

$$e_t = \frac{1}{1 + \eta} (m_t - \phi y_t + \eta i_{t+1}^* - p_t^*) + \frac{\eta}{\eta + 1} \left( \frac{1}{1 + \eta} (m_{t+1} - \phi y_{t+1} + \eta i_{t+2}^* - p_{t+1}^*) + \frac{\eta}{\eta + 1} e_{t+2} \right) \quad (6)$$

By  $s$  interaction, we find the exchange rate equation in a stochastic process:

$$e_t = \frac{1}{1 + \eta} \sum_{s=t}^{\infty} \left( \frac{\eta}{1 + \eta} \right)^{s-t} E_t (m_s - \phi y_s + \eta i_{s+1}^* - p_s^*) \quad (7)$$

Equation (7) shows a positive relation between money supply and exchange rate, implying depreciation, and a negative relation between the GDP and the exchange rate. This is justified by the idea that a product rise increases money demand and, being the latter static because of monetary policy, domestic prices go down to reach real balances causing a domestic currency appreciation.

This work will verify equation (7) to 14 countries in Latin America and Asia using quarterly data from the first quarter of 1999 until the first quarter of 2010. I suppose linearity in the parameters and exogeneity of international interest rate and international prices in order to approximate the exchange rate as a function of  $e_t(m, y, i^*, p)$ :

$$e_t = \alpha m_t - \phi y_t + \eta i_t^* - \beta p_t^* + \varepsilon \quad (8)$$

With  $\varepsilon$  being the random error term.

## 4. Empirical analysis

### 4.1. Data

Data set contains quarterly data from the first quarter of 1999 until the latest quarter of 2015 for 14 countries: Argentina, Bolivia, Brazil, Chile, Colombia, Mexico and Peru, from Latin America; China, Indonesia, Hong Kong, Republic of Korea, Japan, Malaysia and Thailand, from Asia, mainly Southeast Asia. Countries were chosen accordingly to frequency, period availability and their importance to the region's economy: for Latin America, they represent more than 2/3 of the region's GDP and 80% of the trade flow in the

region. Sampled Asian countries correspond to nearly 80% of total trade with Latin America<sup>3</sup>.

Time and cross country span allow evaluating exchange rates in the most recent periods with sufficient time series for estimation purposes. Data on nominal exchange rates, money supplies (i.e. base money/broad money)<sup>4</sup> and output (GDP) were taken from the International Financial Statistics of the International Monetary Fund (IMF) as well countries deflators. Exchange rates are measured as average period values using the U.S. dollar as numeraire (ie, local currency per dollar). USA Consumer Price Index (CPI) and its Central Bank Policy Rate were used as proxies for international prices and international interest rates. The dataset is a balanced panel of 14 countries using quarterly observations completing 952 observations. Data on money supply and output were desasonalised using Holt-Winters seasonal smoothing. Tables 1 and 2 summarize the main variables and panel statistics.

**Table 1. Countries General Statistics**

	<b>Obs</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>Min</b>	<b>Max</b>
Exchange Rates (ER)	952	38.7	15.0	0.9	13850.8
Money	952	755,209 <sup>6</sup>	93.6	229.9 <sup>6</sup>	224,377 <sup>7</sup>
GDP	952	3.5 <sup>12</sup>	7,391.8	94.9	1.7 <sup>21</sup>
I*	952	0.8	5.0	0.1	6.5
CPI	952	93.3	1.1	75.4	109.2

Source: International Monetary Fund (IMF).

**Table 2. Panel Statistics**

Variable		Mean	Std. Dev.	Min	Max	Observations
er	overall	38.7	15.0	0.9	13,850.8	N = 952
	between		16.5	2.2	9,581.2	n = 14
	within		1.2	12.4	126.7	T = 68
money_n(E+9)	overall	755,209	93.6	229.9	2.2	
	between		104.6	508.8	1.2	
	within		2.0	115224.7	5.9	
gdpdel_n	overall	3.6+12	7391.8	94.9	1.7E+21	
	between		10263.9	104.6	1.1E+21	
	within		1.2	6.7E+11	7.5E+12	

Source: International Monetary Fund.

<sup>3</sup> IMF Data and Asian Development Bank (2012).

<sup>4</sup> Monetary data were combined using even the Standardized and Non Standardized Report Forms in the IFS. As the estimation requires analyzing money basis and exchange rate relationships, the use of non standardized information does not affect estimations results. Due to lack of information, reserves were proxied as broad money for Honk Kong from 1999-2000.

## 4.2. Estimation

### 4.2.1. Panel unit root tests

Cointegration reflects a long term relationship between nonstationary data. Thus, we must first establish whether the nominal exchange rate and monetary fundamentals are nonstationary, that is, integrated at least of order one. We test each variable for a unit root.

Levin and Chu (2002) and Im, Pesaran, and Shin (2003) have developed panel unit root tests that allow for heterogeneous dynamics. The basic form of the test is the following:

$$\Delta y_{it} = \rho y_{it-1} + \alpha_i + \mu_{it} + \eta_{it}$$

where  $\mu_{it}$  represents the short-run dynamics:

$$\mu_{it} = \sum_k^K \phi_k \Delta y_{i,t-k} \quad (9)$$

The null hypothesis is that every country's data contains a unit root. That is  $H_0 : \rho = 0$ . Under the alternative hypothesis of stationarity, the common slope is negative for all countries,  $\rho_i = \rho < 0, \forall i$ . Levin, Lin, and Chu (LLC) employ this assumption. Alternatively, Im, Pesaran, and Shin (IPS), Fisher-ADF and Fisher-PP develop a group mean test that allows for heterogeneity even in the autoregressive coefficient, relaxing the alternative hypothesis strong assumption of the LLC test.

All variants of panel unit root tests on exchange rates and their monetary fundamentals are shown in Table 3. The null hypothesis of a unit root would be rejected by large negative and positive values (p-values in parenthesis). All of the test values are unable to reject the unit root, with few exceptions. The null hypothesis of a unit root in the international price can be rejected for 2 test statistics: the LLC and IPSHIN, as well the LLC test for GDP. Thus, the overall preponderance of evidence suggests that the variables are integrated.

**Table 3. Panel Unit Root Tests**

	<b>ER</b>	<b>Money</b>	<b>GDP</b>	<b>I*</b>	<b>P*</b>
<b>Levin, Lin &amp; Chu</b>	-1.2126 (-0.1126)	1.2382 (-0.8922)	-1.5356 (-0.0623)	-0.6873 (-0.2459)	-6.5434 (0)
<b>IPShin</b>	1.5124 (-0.9348)	6.5635 (-1.00)	0.8877 (-0.8126)	1.1564 (-0.8762)	-1.6998 (-0.0446)
<b>ADF Fisher</b>	25.9784 (0.5742)	2.6626 (1.00)	21.247 (0.8149)	11.7898 (0.9969)	30.607 (0.3348)
<b>PP Fischer</b>	-0.2702 (0.6065)	-3.3859 (0.9996)	-0.9024 (0.8166)	-2.1662 (0.9849)	0.3484 (0.3638)

Time trends not included, no lags.

Source: own calculations.

#### 4.2.2. Panel cointegration tests

I found strong evidence of exchange rates and fundamentals nonstationarity. Following the methodology, I performed cointegration tests to look for stable long run relationships among them. If a set of variables is cointegrated, the residuals from the cointegrating equation should be stationary. Thus, panel tests of the null hypothesis of no cointegration are essentially panel unit root tests applied to the estimated residuals of cointegrating regressions.

The first step in the cointegration test is to estimate the cointegrating equation. Because least squares is a superconsistent estimator of the point values of the coefficients, it is sufficient to estimate each equation by OLS in this first stage. Of course, standard errors on coefficients may be invalid under some circumstances, but these are not required for the cointegration test. It is necessary only to estimate the equation and obtain the residuals. The second step of the cointegration test is to do a panel version of augmented Dickey Fuller tests on these residuals. I estimate the equation below:

$$\Delta \hat{\mu}_{it} = \rho \hat{\mu}_{i,t-1} + \sum_j^p \phi_{ij} \Delta \hat{\mu}_{i,t-j} + \varepsilon_{it} \quad (10)$$

where  $i$  is the country and  $t$  is the year, and conduct a one-sided test of the null hypothesis that the parameter of adjustment to long-runequilibrium  $\rho = 0$ , against the alternative that  $\rho < 0$ . I performed the cointegration test suggested by Pedroni (1999, 2004) which allows for heterogeneity of the adjustment parameter. Pooled tests assume only a common autoregressive coefficient in the residuals whereas group mean tests relax this restriction. For pooled and group mean tests, semi-parametric rho and t-statistic tests (as in Phillips-Perron,

1988) and parametric t-tests (analogous to ADF regressions) are available. A nonparametric pooled variance ratio statistic (analogous to Phillips-Ouliaris variance statistic) is also available.

Westerlund (2007) proposes four new panel tests of the null hypothesis of no cointegration that are based on structural rather than residual dynamics and therefore do not impose any common factor restriction. The proposed tests are panel extensions of those proposed in the time-series context by Banerjee, Dolado and Mestre (1998). As such, they are designed to test the null by inferring whether the error correction term in a conditional error correction model is equal to zero. If the null hypothesis of no error correction is rejected, then the null hypothesis of no cointegration is also rejected. Each test is able to accommodate individual-specific short-run dynamics, including serially correlated error terms, non-strictly exogenous regressors, individual specific intercept and trend terms. Two tests are designed to test the alternative hypothesis that the panel is cointegrated as a whole, while the other two test the alternative that there is at least one individual that is cointegrated.

Table 4 presents results for Pedroni and Westerlund panel cointegration tests. The null hypothesis for all of tests is that residuals of the cointegrating vectors contain unit roots, implying no cointegration. The null hypothesis of no cointegration is rejected for all cointegration tests, either the group mean or the panel mean. Overall we strongly reject unit roots in the residuals of the cointegrating vectors which is the same as finding strong evidence for cointegration among exchange rates, money supplies, GDP, international interest rates and international prices.

**Table 4. Panel Cointegration Tests**

<i>Pedroni Residual Cointegration Test*</i>			
<i>Panel v-Statistic</i>	<i>Panel PP-Statistic</i>	<i>Panel rho-Statistic</i>	<i>Panel ADF-Statistic</i>
0.93	-0.795	-0.3261	1.767
<i>Group rho-Statistic</i>	<i>Group PP-Statistic</i>	<i>Group ADF-Statistic</i>	
0.663	0.3777	2.241	
<b>Westerlund Cointegration Test**</b>			
<i>Group t</i>	<i>Group a</i>	<i>Panel t</i>	<i>Panel a</i>
-1.602	-5.782	-8.96	-8.308
(-0.915)	(0.984)	(0.011)	(0.131)

\*All test statistics are distributed  $N(0,1)$ , under a null of no cointegration.

\*\*Test procedure with no constant, no trends, one lead and one lag.

Source: own calculations

### **4.2.3. Long-run estimation**

In the previous section I showed exchange rates and monetary fundamentals are cointegrated. However, I am interested in the coefficient estimates of the cointegrating vectors especially to verify exchange rates regional trends and dynamics.

OLS is a superconsistent estimator of the coefficients of cointegrated variables. The standard errors of OLS are biased and thus invalid for hypothesis testing under conditions of serial correlation and endogeneity. Methods have been developed to address these problems. We employ dynamic OLS (DOLS) method proposed by Christiansen et al (2009). Under the assumption of  $I(1)$  cointegrated variables, dynamic ordinary least squares (DOLS) with fixed effect provide – from the coefficients of the variables in levels – an estimate of a long-run cointegrating relationship between the nominal exchange rate and the monetary fundamentals. As part of the DOLS specification, in addition to the variables in levels, we enter changes in right hand side variables and – given the short length of the sample – one lead and one lag of these changes to correct for endogeneity and serial correlation.

Table 5 provides results from the DOLS estimators for the cointegrating vector. Four models are estimated: the first containing all countries; the second containing only Latin America countries; the third, only countries in Asia; and the last one containing all countries and a regional dummy to catch the impact of the region on the long-run nominal equilibrium exchange rate between regions.

**Table 5. Panel Dynamic OLS 1999-2015**

<b>ER</b>	<b>Pedroni's DOLS</b>	<b>DOLS Kao &amp; Chiang</b>	<b>Latin America</b>	<b>Asia</b>	<b>Regional Dummy</b>
GDP	0.1681 [-0.8258]	0.1913 [0.0781]	0.5596 [0.1638]	0.2889 [0.032]	0.3803 [0.078]
Money	-0.1538 [-7.006]	-0.0194 [0.0526]	-0.7693 [0.0513]	-0.3232 [0.034]	-0.4529 [0.052]
I*	-0.008451 [-2.786]	0.0221 [0.0083]	-0.3231 [0.009]	0.0066 [0.004]	-0.0021 [0.008]
P*	0.7712 [3.095]	-0.0124 [0.358]	-1.1002 [0.457]	0.3354 [0.182]	1.7207 [0.358]
Dummy_Asia		-	-	-	4.075

[Z-statistics]

Source: own calculations

Theoretical model of equation (8)<sup>5</sup> admits that an increase in money supply and international interest rates are associated with exchange rate depreciation, while an increase in GDP and international prices are associated with an exchange rate appreciation. These last two are explained by the fact that an increase in GDP is associated with foreign exchange attraction and a larger demand for local currency. An increase in international prices shift demand to local products, causing an appreciation in the local currency.

Exchange rate estimations for the recent period indicate though a different relation: 1% GDP change is associated with 0.16-0.19% exchange rate depreciation, having stronger depreciation impact in Latin American countries (0.56% against 0.29% for Asia). The impact of money expansion, on the contrary, was related to an appreciation of exchange rates, yet its coefficient was rejected for all models. These two results require further analysis and the use of counterfactuals to evaluate these distorted results, as well as a stronger instruments investigation for analyzing endogenous relations between these two variables.

I found a not so clear foreign interest rates effect, meaning a small appreciation of 0.008%; but other models show that they are not significant. This last can be explained by the

<sup>5</sup>  $e_t = \alpha m_t - \phi y_t + \eta_t^* - \beta p_t^* + \varepsilon$

interest rate differentials effect because analyzed countries kept much higher interest rates during the period than the United States, which also went to historical lower level. Even a raise of the Fed Funds interest rate did not prevented exchange rates appreciation.

The raise of foreign prices, on the contrary, pointed to a depreciation effect in both Pedroni's DOLS methodology as well for Asian countries and using a model controlling for the region effect. International prices were highly significant for Latin America, causing a 1% appreciation effect, while it was related to 0.33% depreciation in Asian countries. In equilibrium, the raise of foreign prices was associated with strong depreciation (1.7%). Asian more integrated markets, where imports are a big part of their economies, may be the cause of this opposite effect, since a raise in foreign prices also means a raise of domestic inflation. This reserves a better investigation, though.

Dummy coefficient for Asia was used to compare the exchange rate trends in comparison with Latin America (LA) countries. What one can observe is that the region by itself is associated with a depreciation of 4% of its local currency comparing to Latin America countries. For instance, looking for the long-run nominal exchange rate forecast, in order to keep the long term equilibrium, Latin America currencies have a tendency to be 4% more appreciated than Asian ones. To illustrate that, suppose one of Latin America currencies value 2,00 LC/US\$ and Asian currencies value 1,00 LC/US\$, a long run equilibrium would mean 1,04 LC/US\$ for Asian currencies and 1,92 LC/US\$ to LA currencies.

One must observe that it has not been said that each country should promote its own currency appreciation/depreciation. Actually, variables in the monetary model have been associated with depreciation in both regions. That means, if one observes both regions have been receiving a great amount of capital flow and international investment during the analyzed period, exchange rate depreciation has been a fact, not necessarily meaning monetary policies have been in place to fiercely cause this effect. Exchange rates controls variables such as federal fund rating, foreign investment and fiscal debt need to be incorporated both in empirical and theoretical models for further research.

## **5. Concluding remarks**

The debate about what is a fundamental or equilibrium exchange rate started when, in 2010, Brazil's finance minister, Guido Mantega, declared that a "currency war" had broken out in the global economy<sup>6</sup>. This argument was based on 1930's trade war after the financial crisis. However, many economists disagreed on the above, despite competitive devaluations

---

<sup>6</sup> For example, see "Brazil Warns of World Currency War," Reuters, September 28, 2010.

in the period following the global financial crisis of 2008-2009. Since currency devaluations can often involve printing domestic currency or implementing expansionary monetary policies, they can stimulate short-term economic growth: however, it is not clear whether these policies were necessarily good for the global economy<sup>7</sup>. The debate brought back a question on the exchange rate fundamentals, since a currency misalignment can occur when the exchange rate set by the government, or the official rate, differs from what would be set by the market if the currency were allowed to float.

The development of new econometric methods and data availability stimulated a great number of empirical works on exchange rates and this paper is not an exception. I enjoy these new tools to bring some reflections to the described debate. I analyze the existence of a long-run equilibrium of the nominal exchange rate among some Latin American and Asian countries using the flexible price monetary model. In this model, nominal prices are perfectly flexible and they adjust immediately to clear product, factor and asset markets.

I found that monetary fundamentals are cointegrated with the nominal exchange rate using panel cointegration tests. The analysis was carried on in a long-run estimation using DOLS and one can observe that the variables in the monetary model have been associated with an appreciation of the exchange rate in all countries in the sample. Coefficients signs were not as expected by the theoretical model, being associated with depreciation in both analyzed regions. That means, if one observes that both regions received a great amount of capital flow and international investment during the period, exchange rate depreciation has been a fact, not necessarily meaning monetary policies have been in place to cause this effect.

A dummy for Asia was created to compare the effect of the monetary policies of the region to Latin America countries. It can be observed that the region by itself is associated with a depreciation of 4% of its local currency comparing to Latin America countries. As a future teller exercise, supposing one of Latin America currencies value 2,00 LC/US\$ and Asian currencies value 1,00 LC/US\$, a long run equilibrium would mean 1,04 LC/US\$ for Asian currencies and 1,92 LC/US\$ to LA currencies. Further research requires the conciliation of exchange rates controls such as federal fund rating, foreign investment and fiscal debt results.

---

<sup>7</sup> For example, see Matthew O'Brien, "Currency Wars, What Are They Good For? Absolutely Ending Depressions," *The Atlantic*, February 5, 2013.

## References

- Asian Development Bank. **Trade and Commerce Between Asia and Latin America**. 2012. Disponível em: <<https://www.adb.org/features/fast-facts-asia-and-latin-america-and-caribbean>>. Acesso em: 25 maio 2017.
- BANERJEE, Anindya; DOLADO, Juan; MESTRE, Ricardo. Error-correction Mechanism Tests for Cointegration in a Single-equation Framework. **Journal Of Time Series Analysis**, [s.l.], v. 19, n. 3, p.267-283, maio 1998. Wiley-Blackwell. <http://dx.doi.org/10.1111/1467-9892.00091>.
- BILSON, John. Rational expectations and the exchange rate. In: FRENKEL, Jacob; JOHNSON, Harry. **The economics of exchange rates**. New York: (Addison Wesley, 1978. p. 75-96.
- CERRA, Valerie; SAXENA, Sweta Chaman. The monetary model strikes back: Evidence from the world. **Journal Of International Economics**, [s.l.], v. 81, n. 2, p.184-196, jul. 2010. Elsevier BV. <http://dx.doi.org/10.1016/j.jinteco.2010.03.003>.
- CHRISTIANSEN, Lone Engbo et al. External Balance in Low Income Countries. **Imf Working Papers**, [s.l.], v. 09, n. 221, p.1-52, 2009. International Monetary Fund. <http://dx.doi.org/10.5089/9781451873689.001>.
- CUIABANO, Simone M.; DIVINO, Jose Angelo. Exchange Rate Determination: An Application of a Monetary Model for Brazil. **International Advances In Economic Research**, [s.l.], v. 16, n. 4, p.345-357, 9 ago. 2010. Springer Nature. <http://dx.doi.org/10.1007/s11294-010-9276-x>.
- FELÍCIO, Wilson Rafael de Oliveira; ROSSI JÚNIOR, José Luiz. Common factors and the exchange rate: results from the Brazilian case. **Revista Brasileira de Economia**, [s.l.], v. 68, n. 1, p.49-71, mar. 2014. FapUNIFESP (SciELO). <http://dx.doi.org/10.1590/s0034-71402014000100004>.
- FRANKEL, Jeffrey; ROSE, Andrew. A Survey of Empirical Research on Nominal Exchange Rates. **Handbook Of International Economics**, [s.l.], v. 1, n. 1, p.2-76, set. 1994. National Bureau of Economic Research. <http://dx.doi.org/10.3386/w4865>.
- GALIMBERTI, Jaqueson K.; MOURA, Marcelo L.. Taylor rules and exchange rate predictability in emerging economies. **Journal Of International Money And Finance**, [s.l.], v. 32, p.1008-1031, fev. 2013. Elsevier BV. <http://dx.doi.org/10.1016/j.jimonfin.2012.08.006>.
- HODRICK, Robert J.. An Empirical Analysis of the Monetary Approach to the Determination of the Exchange Rate,. In: FRENKEL, Jacob A.; JOHNSON, Harry G.. **The Economics of Exchange Rates**. New York: Addison-wesley, 1978. p. 97-116.

IM, Kyung So; PESARAN, M.hashem; SHIN, Yongcheol. Testing for unit roots in heterogeneous panels. **Journal Of Econometrics**, [s.l.], v. 115, n. 1, p.53-74, jul. 2003. Elsevier BV. [http://dx.doi.org/10.1016/s0304-4076\(03\)00092-7](http://dx.doi.org/10.1016/s0304-4076(03)00092-7).

LEVIN, Andrew; LIN, Chien-fu; CHU, Chia-shang James. Unit root tests in panel data: asymptotic and finite-sample properties. **Journal Of Econometrics**, [s.l.], v. 108, n. 1, p.1-24, maio 2002. Elsevier BV. [http://dx.doi.org/10.1016/s0304-4076\(01\)00098-7](http://dx.doi.org/10.1016/s0304-4076(01)00098-7).

MACDONALD, Ronald; TAYLOR, Mark P.. The Monetary Approach to the Exchange Rate: Rational Expectations, Long-Run Equilibrium, and Forecasting. **Staff Papers - International Monetary Fund**, [s.l.], v. 40, n. 1, p.89-107, mar. 1993. Springer Nature. <http://dx.doi.org/10.2307/3867378>.

MARK, Nelson. Exchange Rates and Fundamentals: Evidence on Long-Horizon Predictability. **American Economic Review**, New York, v. 85, n. 1, p.201-218, 1 mar. 1995.

MARK, Nelson C.; SUL, Donggyu. Nominal exchange rates and monetary fundamentals. **Journal Of International Economics**, [s.l.], v. 53, n. 1, p.29-52, fev. 2001. Elsevier BV. [http://dx.doi.org/10.1016/s0022-1996\(00\)00052-0](http://dx.doi.org/10.1016/s0022-1996(00)00052-0).

MEESE, Richard A.; ROGOFF, Kenneth. Empirical exchange rate models of the seventies. **Journal Of International Economics**, [s.l.], v. 14, n. 1-2, p.3-24, fev. 1983. Elsevier BV. [http://dx.doi.org/10.1016/0022-1996\(83\)90017-x](http://dx.doi.org/10.1016/0022-1996(83)90017-x).

MOURA, Marcelo L.; LIMA, Adauto R. S.; MENDONCA, Rodrigo M.. Exchange rate and fundamentals: the case of Brazil. **Econ. Apl.**, Ribeirão Preto , v. 12, n. 3, p. 395-416, Sept. 2008 . <http://dx.doi.org/10.1590/S1413-80502008000300003>.

HUSTED, Steven; MACDONALD, Ronald. Monetary-based models of the exchange rate: a panel perspective. **Journal Of International Financial Markets, Institutions And Money**, [s.l.], v. 8, n. 1, p.1-19, jan. 1998. Elsevier BV. [http://dx.doi.org/10.1016/s1042-4431\(98\)00021-3](http://dx.doi.org/10.1016/s1042-4431(98)00021-3).

OBSTFELD, Maurice; ROGOFF, Kenneth. Money and Exchange Rates under Flexible Prices. In: **Foundations of International Macroeconomics**. Cambridge: Mit Press, 1996. p. 513-604.

PEDRONI, Peter. Critical Values for Cointegration Tests in Heterogeneous Panels with Multiple Regressors. **Oxford Bulletin Of Economics And Statistics**, [s.l.], v. 61, n. 1, p.653-670, nov. 1999. Wiley-Blackwell. <http://dx.doi.org/10.1111/1468-0084.0610s1653>.

PEDRONI, Peter. PANEL COINTEGRATION: ASYMPTOTIC AND FINITE SAMPLE PROPERTIES OF POOLED TIME SERIES TESTS WITH AN APPLICATION TO THE

PPP HYPOTHESIS. **Econometric Theory**, [s.l.], v. 20, n. 03, p.597-625, jun. 2004. Cambridge University Press (CUP). <http://dx.doi.org/10.1017/s0266466604203073>

PHILLIPS, Peter C. B.; PERRON, Pierre. Testing for a Unit Root in Time Series Regression. **Biometrika**, [s.l.], v. 75, n. 2, p.335-346, jun. 1988. JSTOR. <http://dx.doi.org/10.2307/2336182>.

PUTNAM, Bluford H; WOODBURY, John R. Exchange Rate Stability and Monetary Policy. **Review Of Business And Economic Research**, New Orleans, v. 1, n. 1, p.1-10, jan. 1979.

RAPACH, David E.; WOCHAR, Mark E.. Testing the monetary model of exchange rate determination: new evidence from a century of data. **Journal Of International Economics**, [s.l.], v. 58, n. 2, p.359-385, dez. 2002. Elsevier BV. [http://dx.doi.org/10.1016/s0022-1996\(01\)00170-2](http://dx.doi.org/10.1016/s0022-1996(01)00170-2).

ROGOFF, Kenneth. Monetary Models of Dollar/Yen/Euro Nominal Exchange Rates: Dead or Undead?. **The Economic Journal**, [s.l.], v. 109, n. 459, p.655-659, nov. 1999. Wiley-Blackwell. <http://dx.doi.org/10.1111/1468-0297.00477>.

ROGOFF, Kenneth. Comment on "Exchange Rate Models Are Not As Bad As You Think. In: ACEMOGLU, Daron; ROGOFF, Kenneth; WOODFORD, Michael. **NBER Macroeconomics Annual 2007**. Chicago: University Of Chicago Press, 2008. p. 443-452.

SARNO, Lucio; TAYLOR, Mark P.; FRANKEL, Jeffery A.. Exchange rate determination: theories and evidence. **The Economics Of Exchange Rates**, [s.l.], p.97-143, jan. 2003. Cambridge University Press. <http://dx.doi.org/10.1017/cbo9780511754159.006>.STOCK, James H.; WATSON, Mark W.. A Simple Estimator of Cointegrating Vectors in Higher Order Integrated Systems. **Econometrica**, New York, v. 4, n. 61, p.783-820, 1 jul. 1993.

TAYLOR, Mark P.. The Economics of Exchange Rates. **Journal Of Economic Literature**, New York, v. 1, n. 33, p.13-47, mar. 1995. WESTERLUND, Joakim. Testing for Error Correction in Panel Data. **Oxford Bulletin Of Economics And Statistics**, [s.l.], v. 69, n. 6, p.709-748, dez. 2007. Wiley-Blackwell. <http://dx.doi.org/10.1111/j.1468-0084.2007.00477.x>.