A Structuralist-Keynesian Model for Determining the "Optimal" Real Exchange Rate for the Brazilian Economic Development: 1999-2015

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1st New Developmentalism Workshop: Theory and Policy for Developing Countries, FGV-EESP

July 2016

Motivation:

- Real exchange rate is one of the key-macroeconomic prices supporting economic development;

- Its central role is theoretically underemphasized in development economics;

- Notwithstanding, a large body of empirical studies have shown that domestic currency overvaluation reduces long-term growth (Razin and Collins, 1999; Dollar and Kray, 2003; Prasad, Rajan and Subramaniam, 2006; Gala, 2008);

- Recently, empirical evidence has gone further and concluded that a small domestic currency undervaluation accelerates, *ceteris paribus*, economic development (Rodrik, 2008; Williamson, 2008; Berg and Miao, 2010).

According to Williamson, 2008:14

"the very best policy (in terms of maximizing growth) appears to be a *small* undervaluation" (p. 14, italics from the original).

In Nassif, Feijó and Araújo (2011), we defined the "optimal" real exchange rate as:

The one able to reallocate efficiently productive resources towards industries of high productivity levels and high capacity to spill over their gains from productivity to the economy as a whole, in such a way that economic development is, *ceteris paribus*, accelerated.

In this paper, we proposed a methodology aiming at:

- Refining the theoretical model;

- And reestimating the "optimal" real exchange rate for promoting economic development in Brazil.

The conventional model for determining the long-term real exchange rate

- Traditional approach: based on the hypothesis of purchasing power parity (PPP in the relative version):

$$\dot{RER} = \dot{e} - (\dot{P} - \dot{P}^*) \qquad (1)$$

RER: real exchange rate;

e: nominal exchange rate (defined as the domestic price of a foreign currency; so, an increase means a depreciation of domestic currency; a decrease means an appreciation of domestic currency);

P: domestic price level

*P**: external price level (dots mean change over time)

Traditional approach:

- The economic system has internal forces that make the nominal exchange rate converge with its long-term real equilibrium level (Taylor and Taylor, 2004);

- Any deviation of the actual real exchange rate from its long-term **fundamental** real equilibrium level is explained by stochastic shocks (this deviation would be transitory).

In theoretical terms:

$$RER_t = g_t(y_t^s, d_t, i^*) + f_t(\lambda_{mt}, \lambda_{yt}) \qquad (2)$$

Long-term "fundamental" variables (all real variables)

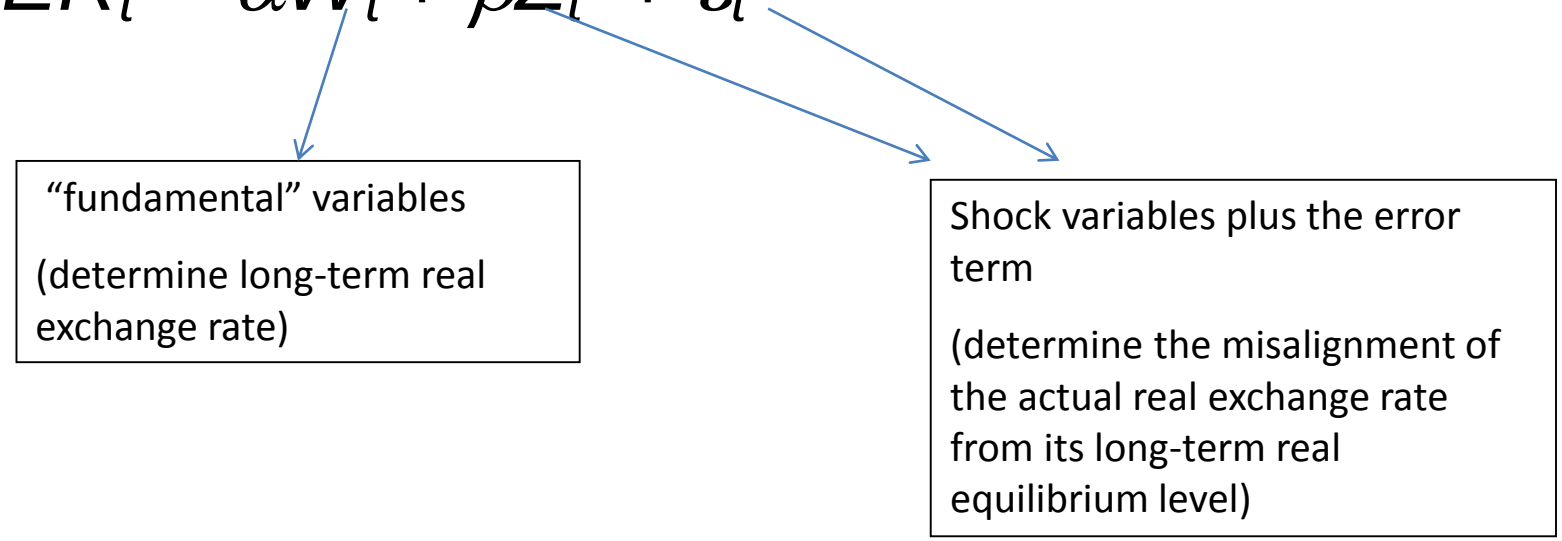
Shock variables (monetary or real variables)

Essential in this approach: in the absence of any nominal rigidity and imperfect competition, the actual real exchange rate converges with the long-term "fundamental" equilibrium level;

Exchange rate "misalignments" are essentially explained by monetary and real shocks, see Razin and Collins, 1999: 64-65).

In econometric equation:

$$RER_t = \alpha W_t + \beta Z_t + \varepsilon_t \qquad (3)$$



That is, in econometric estimates, exchange rates misalignments are calculated by the sum of the estimated βs plus the error term of regressions.

Our proposed Structuralist-Keynesian model:

- Both the long-term “optimal” real exchange rate and the deviations of the actual real exchange rate from that “optimal” level are **jointly** explained by long-term structural forces (structural variables) and short-term economic policies

- The model is Structuralist, because a **part** of the real exchange rate path and a part of the deviation of the actual real exchange rate from its “optimal” level are explained by variables associated with the structure of the economy.

- And it is Keynesian, because the other part (in some cases, the majority) is explained by variables directly or indirectly associate with short-term macroeconomic policy (especially monetary policy).

Our basic theoretical equation:

$$RER_t = g_t(struct_{lp_t}) + m_t(cp_t) \qquad (4)$$

All variables of the right side (structural and short-term policy ones) determine both the real exchange rate path and the misalignment of the actual real exchange rate from its "optimal" level".

Two aspects of our model in comparison to the conventional model:

i) Despite some variables which represent *g* being similar to those used by conventional models, we rejected the hypothesis that only fundamental (or even structural) variables would be able to converge the real exchange rates with its long-term equilibrium level.

ii) **All** variables of the right side **simultaneously** explain both the long-term real exchange rate trajectory and the deviation of the actual real exchange rate from its "optimal" level.

An econometric model for Brazil:

$$\ln RER_t = c_0 + \alpha_1 \ln Y_t + \alpha_2 \ln ToT_t + \alpha_3 \ln CC_t +$$

Strutural component

$$+ \beta_1 (\ln IDIFER)_t + \beta_2 (\ln IDIFER)_{t-2} + \beta_3 \ln RI_t + \beta_4 \ln CR_t + \varepsilon_t$$

Policy component

RER is the actual real exchange rate;

Y is Brazil´s per capita income (in US dollar);

ToT is the term of trade;

CC is current account balance (as a proportion of GDP);

IDIFER is the interest rate differential; that is, the differential between short-term nominal domestic (*Swap DI* for 360 days) and external interest rates (*FDTR- US Federal Fund Target Rate*, *proxy* for short-term external interest rates);

$IDIFER_{t-2}$ is the previous variable with a time lag;

RI is the stock of international reserves (as a proportion of GDP);

CR is Brazil's risk premium (represented by the *EMBI Brazil Sovereign Foreign Currency*, of JP Morgan;

ε is the error term*;*

and subscripts *t are reference for time t* (in our econometric model, a month).

Expected signs of estimated coefficients for explaining variables:

Explaining variables	Expected signs of the estimated coefficient
Per capita income (*Y*)	-
Terms of trade (*ToT*)	twofold (+ or -)
Current-account balance (*CC*)	+
Interest rate differential (*IDIFER)*	twofold (+ or -, respectively, in the very short term, and in the short/medium term)
Stock of international reserves (*RI*)	twofold (+ or -)
Brazil's risk premium (*CR*)	+

Statistical tests of time series:

Unit root tests - *Augmented Dickey-Fuller* (ADF) e *Phillips-Perron* (PP) test: all series integrated of 1 level, that is, non-stationary in level, but stationary in first-difference.

Endogeneity issues: eventual endogeneity between explaining and explained variables could show biased estimators, due to correlation between the explaining variables and the error term.

However, as Baffes et.al. (1999) argue, even appropriate endogeneity tests cannot be able to solve endogeneity bias if the marginal distribution of explaining variables is changed.

Johansen's (1988) cointegration test: high robust to solve endogeneity bias in models with more than one endogenous variable (for this test not only considers all variables in the econometric estimate as endogenous, but also it simultaneously determine the equilibrium relationship between them).

Johansen's (1988) cointegration test : Since there was a vector of cointegration among the series, we can assure the existence of long-term stable relationship among the variables.

Econometric estimation models: since the series are non-stationary and cointegrated, OLS (ordinary least squares) and ECM (error correction model) are consistent estimators.

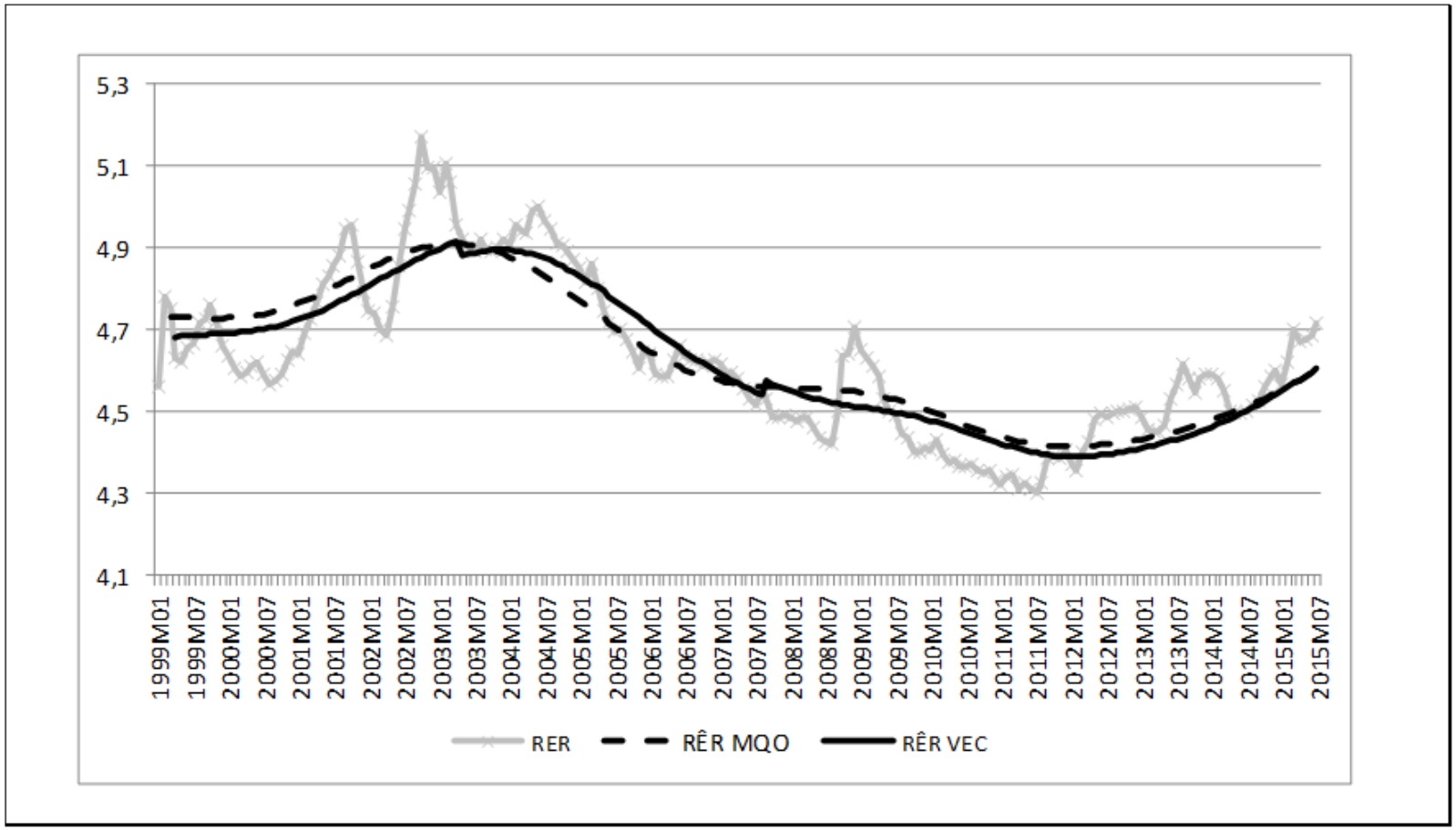
Results:

Variável	Variável	Coeficiente MQO (Estatística *t* entre colchetes)	Variável	Coeficiente VEC (Estatística *t* entre colchetes)
C	constante	6.650088*** [10.41783]	***C***	5.9805***
lnY-2	Log do PIB per capita	-0.33637*** [-7.61376]	***lnY-3***	-0.763422*** [-7.93942]
lnTOT	Log dos termos de troca	-0.26492** [-1.91535]	***lnTOT-1***	-0.454013* [-1.69178]
lnCC-1	Log do saldo em conta corrente/PIB	0.068764*** [4.538101]	***lnCC-1***	0.085584*** [2.34562]
Ln(IDIFER)	Log do diferencial de juros de curto prazo	0.296203** [2.320963]	***Ln(IDIFER)***	- -
Ln(IDIFER)-2	Log do diferencial de juros de curto prazo defasado	-0.24448** [-2.0114]	***Ln(IDIFER)-2***	-0.26921** [-4.41106]
lnRI-1	Log do estoque de reservas internacionais/PIB	0.223979*** [6.6185]	***lnRI-1***	0.167482** [2.37291]
lnCR	Log do prêmio de risco-Brasil	0.039893* [1.70786]	***lnCR-1***	0.372263*** [5.96244]

Nota ao modelo MQO: R-quadrado: 0.839; R- quadrado ajustado: 0.833; Durbin-Watson: 1.833; Estatística F: 141.169; Prob (teste F): 0.000; número de observações: 197 depois dos ajustamentos. A variável *IDIFER* foi incluída em nível e com duas defasagens; as variáveis CC e *RI* foram incluídas com uma defasagem e a variável *Y* com duas defasagens.
Nota ao modelo VEC: 3 lags; número de observações: 193 depois dos ajustamentos. As variáveis *ToT*, *CC*, *RI* e *CR* foram incluídas com uma defasagem; *IDIFER* com duas defasagens e *Y* com três defasagens.
Note: *** Significante a 1%; ** Significante a 5%; * Significante a 10%

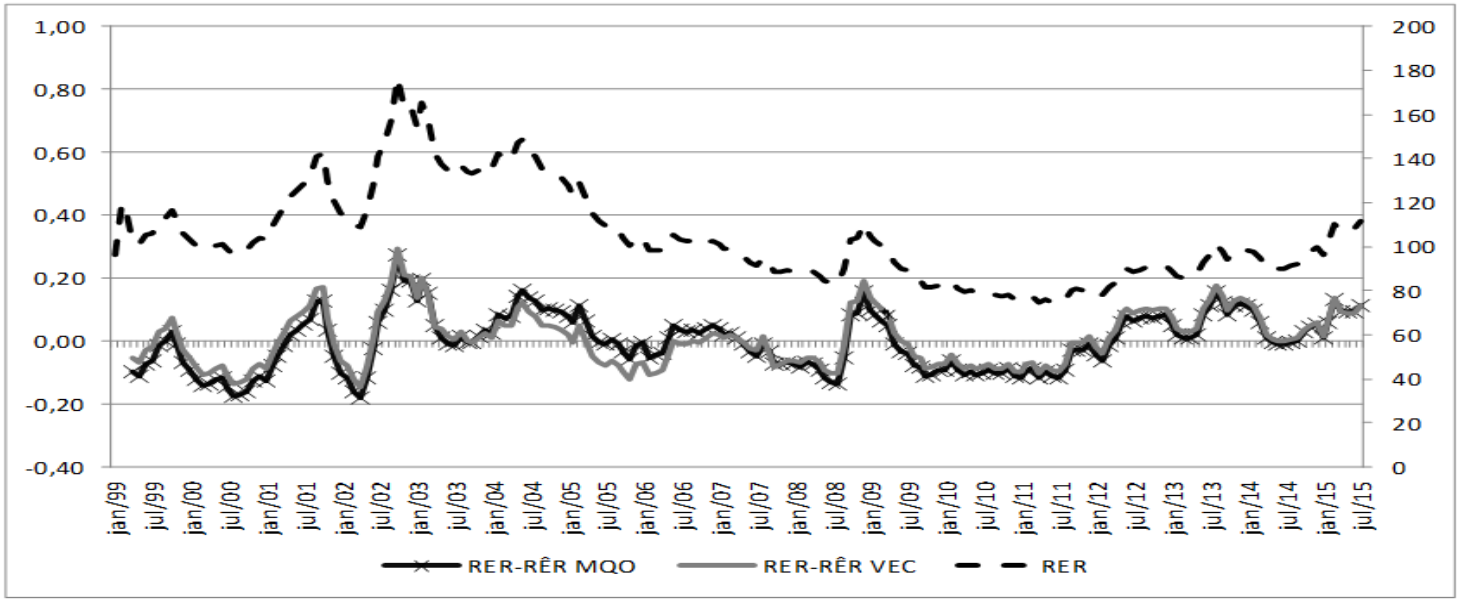
Per capita income, terms of trade and interest rates differential: Variables with highest estimated coefficients

Estimated long-term real exchange rate path in Brazil:



Using Hodrick-Prescott (HP) technique, we estimated the series long-term trend.

Estimated undervaluation and overvaluation levels of the actual real exchange rates compared with estimated real exchange rate:



Nota: Os percentuais de subvalorização e sobrevalorização foram calculados como a diferença entre a taxa de câmbio real observada (RER) e as tendências de longo prazo das taxas de câmbio reais estimadas pelos dois modelos (RÊR). Se este resultado for superior a zero, existe uma subvalorização do real brasileiro, ao passo que se for inferior a zero, existe uma sobrevalorização. Esses resultados, expressos em percentuais, estão indicados na escala vertical à esquerda do Gráfico 2. Já os desalinhamentos da taxa de câmbio real observada em relação à média de 2000 (=100) estão indicados como números-índices na escala vertical à direita do Gráfico 2: acima de 100 indica subvalorização do real em relação ao ano-base, enquanto abaixo de 100 indica sobrevalorização em relação ao mesmo ano-base (média de 2000).

Fontes: estimativas dos autores de acordo com a metodologia descrita, para as taxas de câmbio reais estimadas; e Banco Central do Brasil, para as taxas de câmbio reais observadas (ver Apêndice 1).

Methodology for determining the "optimal" real exchange rate:

3 simultaneous criteria:

i) Following the empirical literature that shows that a small undervaluation of domestic currency accelerates long-term growth, the chosen period must be the one when the **estimated r**eal exchange rate (not the actual one) is marginally (but not too much) undervalued (a little above 0.00 in Figure 2);

ii) The chosen period must be the one when macroeconomic indicators are good (especially real output growth and current account balance, which should be either in equilibrium or present some surplus);

iii) The chosen period must be the one when the actual real exchange rate is not overvalued (not below 100 in Figure 2).

The chosen period:

The “optimal” real exchange rate was reached between June 2003 and April 2005, the only one which fulfills the previous 3 required conditions:

i) For instance, in 2004, Brazil had a 5.8% in real GDP growth and 1.8% of GDP in current account surplus (according Brazil’s Central Bank database);

ii) A small **estimated** undervaluation of the Brazilian real (around 5% on average according to our two estimates OLS and ECM);

iii) And the actual real exchange rate did not indicate overvaluation.

The “optimal” real exchange rate:

The average index of the estimated long-term real exchange rate was 127.82 (OLS: 125.87 and ECM: 129.87) for the subperiod June 2003 to April 2005;

Actual real exchange rate in July 2015 (the last month of our time series): 111.81

That is: the actual RER < estimated RER: still a 14.4% overvaluation compared with the “optimal” real exchange rate between June 2003 and April 2005.

In July 2015, the nominal exchange rate should have reached

R$3.88 per US dollar (against the observed R$3.39 per US dollar) for equalizing the estimated “optimal” real exchange rate.

With PPP approach (differential between Brazil’s and the US inflation), we adjusted the “optimal” real exchange rate until December 2015:

Between July and December 2015: Brazil IPCA: 3.6%; and US CPI: -0.1%

So, the “optimal” real exchange rate in December 2015 should have been R$4.02 per US dollar (practically the same level observed in the first half of January 2016, on average). In conclusion, after a long cycle of overvaluation since 2004, Brazil reached its “optimal” real exchange rate in January 2016.

Conclusion:

A Structuralist-Keynesian model for determining both the trajectory and the “optimal” level of the real exchange rate was proposed. In our model, both variables associated with the structure of the economy and those variables linked to the short-term macroeconomic policy jointly determine both long-term real exchange rate trajectory and the deviation of the actual real exchange rate from its “optimal” level.

Both estimated models confirm a trend of overvaluation of the real exchange rate in Brazil in the 2000s.

Structural forces (more) and impacts of monetary policy have been responsible for the overvaluation trend.

Policy implications: Since the real exchange rate is the key-price for determining the behavior of the aggregate productivity, we recommend a managed floating exchange rate regime (and not just dirty flotation) as adopted by several countries in Asia (a policy *mix* combining interventions in spot and forward markets, macroprudential policies and ad hoc capital control).

(ver Ostry et.al. (2011)

THANKS A LOT!