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# A structuralist-Keynesian model for determining the optimum real exchange rate for Brazil's economic development process: 1999-2015

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## Abstract

The “optimum” long-run real exchange rate is the rate that will efficiently channel production resources into industries that generate and diffuse productivity gains in the economy as a whole and that will thus tend to speed up and sustain the economic development process. Rather than employing conventional models, a structuralist-Keynesian model is used to demonstrate, both theoretically and empirically, that the factors influencing the path of the long-run real exchange rate and the divergence of the observed real exchange rate from the “optimum” real exchange rate in terms of economic development are accounted for by both structural and short-term macroeconomic policy variables. Econometric estimates for 1999-2015 indicate that, following a prolonged period, beginning in late 2005, during which the Brazilian currency appreciated quite steeply, the real exchange rate in Brazil reached its “optimum” level in mid-January 2016.

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## Keywords

Economic development, structural adjustment, economic convergence, macroeconomics, foreign exchange rates, monetary policy, development models, econometric models, Brazil

## JEL classification

F30, F32, F39

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## I. Introduction

In his work in the field of structuralist development macroeconomics, Professor Luiz Carlos Bresser-Pereira has placed a great deal of emphasis on the preponderant role of the real exchange rate<sup>1</sup> in the development and economic convergence or catching-up process<sup>2</sup> of developing countries (see Bresser-Pereira, 2010).<sup>3</sup> He is by no means attempting to reduce the highly complex phenomenon of economic development —in which not only economic forces but historical, social, cultural and many other factors are at work— to a single variable (the real exchange rate). On the contrary, assuming that the various factors influencing the development process are helping to move it forward, in a recent book published along with his co-authors (Bresser-Pereira, Oreiro and Marconi, 2014), Professor Bresser-Pereira argues that a development process will be sustainable provided that the country in question has a stable rate of inflation, an average real interest rate below the average real rate of return on capital, average wage levels that rise in tandem with the economy's productivity and an exchange rate that can be regarded as competitive.<sup>4</sup> Nonetheless, these authors do take the position that the real exchange rate is the most important macroeconomic price of all these variables because it influences all the others (including the inflation rate). In their words:

Key macroeconomic variables are composed of the current account deficit and the exchange rate [...] Imports, exports, the investment rate, the savings rate, and inflation depend on the [real] exchange rate. Investments depend on it: We may think of the [real] exchange rate as the light switch that connects or disconnects the efficient business enterprises existing in a country from foreign markets and their own domestic markets (Bresser-Pereira, Oreiro and Marconi, 2014, p. 3).

It is no coincidence that the national currencies of Asian economies that are successfully catching up to developed-countries in terms of per capita income and well-being levels (especially the Republic of Korea, the Chinese province of Taiwan and Singapore) and those that continue to pursue this strategy (such as China and India), are rarely overvalued for a long period of time, as has been the case of Brazil over the past few decades.<sup>5</sup>

Oddly enough, the theoretical literature on economic development does not attribute due importance to the real exchange rate as a crucial strategic variable.<sup>6</sup> Nevertheless, there is a vast body of empirical literature that seeks to evaluate the relationship between the trend of the real exchange rate and long-term economic growth. An impressive number of econometric studies have reached the

<sup>1</sup> In this paper, the exchange rate is defined as the domestic price of a unit of foreign currency (e.g. the price of US\$ 1.00 in reais). Accordingly, an increase in the exchange rate signals a depreciation of the national currency, while a decrease signals an appreciation.

<sup>2</sup> The process of catching-up is understood as the convergence of poor countries towards per capita income levels and levels of well-being similar to those found in developed countries. This concept is a central element in both the classical and neoclassical economic development literature, even though these two schools of thought are radically different from one another. In the classical development literature, see Rosenstein-Rodan (1943), Prebisch (1950), Lewis (1954), Myrdal (1957), Hirschman (1958) and Kaldor (1966), among others, while, in the neoclassical literature, see Solow (1956), Swan (1956), Romer (1986) and Lucas (1988), among others.

<sup>3</sup> Although some authors have acknowledged its importance (especially Kaldor (1966 and 1978)), the relationship between the real exchange rate and economic development has been analysed more thoroughly in empirical studies than in theoretical ones. As will be discussed later on, several recent empirical studies have concluded that, *ceteris paribus*, countries in the process of catching up whose currencies are marginally undervalued in real terms tend to show faster long-term growth. See Rodrik (2008), Williamson (2008) and Berg and Miao (2010). For the case of developing countries, see Gala (2008) and Araújo (2009).

<sup>4</sup> An exchange rate is deemed to be competitive if the national currency is slightly undervalued in relation to the United States dollar (or a basket of currencies) in real terms. As will be discussed later on in this article, the empirical evidence suggest that a "competitive" exchange rate will, *ceteris paribus*, tend to speed up the economic development process.

<sup>5</sup> See Amsden (1989 and 2001), Nassif, Feijó and Araújo (2011) for a discussion of the situation in Brazil, and Nassif, Feijó and Araújo (2015a) for an analysis of the cases of China and India.

<sup>6</sup> As noted by Gala (2008, p. 273), "while the econometric literature on this issue is relatively rich, theoretical analysis of channels through which real exchange rate levels could affect economic development are very scarce".

conclusion that, unless it is a “natural” result of the increased productivity of tradable goods compared with non-tradables — especially services — (a phenomenon that is captured by the Harrod-Balassa-Samuelson effect), an overvaluation of developing countries’ exchange rates for lengthy periods of time will tend to depress their long-term economic growth rates (Razin and Collins, 1999; Dollar and Kraay, 2003; Prasad, Rajan and Subramanian, 2006; Gala, 2008).

Recently, a number of more thorough empirical studies have shown not only that an overvalued exchange rate hampers economic development, but also that a real exchange rate that is slightly higher than the long-run equilibrium exchange rate (equivalent to a slight depreciation in real terms) tends to boost the pace of development. While this empirical finding was first presented by Rodrik (2008) and later confirmed by Berg and Miao (2010), Williamson (2008, p. 14), a renowned specialist in real exchange rates, also concluded that: “Indeed, the very best policy (in terms of maximizing growth) appears to be a small undervaluation”. Williamson’s emphasis on the word “small” is important, since, clearly, a large undervaluation of the real exchange rate (as measured against the “neutral” equilibrium real exchange rate) that is compatible with purchasing power parity in real terms will tend to fuel more lasting inflationary processes.<sup>7</sup>

In a previous paper (see Nassif, Feijó and Araújo, 2011) we proposed a theoretical and econometric methodology for estimating the long-run path of the real exchange rate in developing economies. This study introduced the concept of an “optimum” (or “competitive”) long-run real exchange rate — defined as the rate that will efficiently channel resources into industries that generate and diffuse productivity gains in the economy as a whole and thus, *ceteris paribus*, sustain and accelerate economic development — and found an econometric estimate of that variable (for the first time ever in Brazil, as far as we are aware). Empirical evidence suggests that such industries are located in the manufacturing sector, which is regarded as the main driver of productivity growth both in that sector and in the economy as a whole, as was noted by Kaldor (1966) in his pioneering study based on the empirical regularity originally identified by the Dutch economist Verdoorn (1949).<sup>8</sup>

This concept of the “optimum” real exchange rate is similar to that of the “industrial equilibrium real exchange rate” proposed by Bresser-Pereira (2010). According to that author, the industrial equilibrium exchange rate is the rate that would keep firms at the state of the art of technology in their respective industry. Despite similarities, the industrial equilibrium exchange rate is not exactly the same as the long-run “optimum” real exchange rate, because the latter — being marginally depreciated in relation to its long-term trajectory — is not necessarily an equilibrium exchange rate, but is instead comparable with the “industrial equilibrium” or the “neutral” purchasing power parity equilibrium.<sup>9</sup> Since the term “optimum”, as used here, has nothing to do with maximization methods or equilibrium rates, it will appear in quotation marks throughout this study.

Our first study (see Nassif, Feijó and Araújo, 2011) concluded that the real exchange rate reached its “optimum” level (the estimated long-run real exchange rate rather than the observed rate) in 2004 (average for the period). In April 2011, when the “optimum” real exchange rate should have been 2.90 reais per dollar, whereas the observed rate was just 1.59 reais per dollar, there was a (mega) overvaluation of 82% in relation to the competitive rate needed to sustain Brazil’s economic development process.

<sup>7</sup> As shown by Krugman and Taylor (1978), when a country introduces a sharp, one-off correction for a large overvaluation (e.g. in Brazil in 2015), the inflationary and recessionary effects (since real wages decline) in the short run are clearly observed. However, as soon as economic agents incorporate this new equilibrium level of relative prices, *ceteris paribus*, the real average rate of return on capital in production activities will tend to rise and, in consequence, economic growth and productivity will increase and be sustained over the long term.

<sup>8</sup> For recent evidence of this empirical regularity (known as the Kaldor-Verdoorn law) in Latin America, see Ros (2014).

<sup>9</sup> In addition, although the estimation of the real industrial equilibrium exchange rate is not performed using maximization methods either, the resulting real rate of depreciation in relation to the neutral long-term equilibrium exchange rate may or may not be very high. For the proposed concept of a real “optimum” exchange rate, the level of real depreciation is only slightly above the “neutral” real exchange-rate equilibrium.

Considering that the Brazilian real depreciated sharply in nominal terms throughout 2015, this paper has two main goals: (i) to refine the theoretical discussion of the proposed structuralist-Keynesian model in order to distinguish it from conventional models, both in terms of the theoretical and empirical considerations relating to the path of the long-term real exchange rate and in terms of the misalignment of the actual real exchange rate from the optimal level; and (ii) to estimate once again the optimal real exchange rate in order to identify whether the observed level prevailing at in early 2016 was above (undervalued), below (overvalued) or close (or even equal) to the optimal level. The article is divided as follows. Section II offers a critical analysis of the conventional models for determining the real long-run exchange rate and its misalignment with respect to its long-term equilibrium level. Section III presents the proposed structuralist-Keynesian model, noting its theoretical and empirical methodological differences from the conventional models. Section IV sets forth the econometric estimation of both the long-term path of the real exchange rate in Brazil in the 1999-2015 period and the level considered “optimum” for purposes of economic development. Section V presents the study’s conclusions.

## II. The conventional model for the determination of the long-run real exchange rate and the degree of misalignment: a critical analysis

The mainstream theory about the behaviour of the long-run real exchange rate (*RER*) is based on the purchasing power parity hypothesis.<sup>10</sup> According to this hypothesis, in order for the purchasing power of two currencies (expressed in the same monetary unit) to remain constant over time, the nominal exchange rate in the market (expressed as the domestic price of a unit of foreign currency —for example, the price of one dollar in reais) should be adjusted by the difference between the domestic and international inflation rates.<sup>11</sup> The change in the real exchange rate over time can be expressed as:

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

where *RER* is the real exchange rate; *e* is the nominal exchange rate; *P* is the domestic price level; and *P\** is the external price level (e.g. of the United States). As the dots appearing above the different variables denote instantaneous changes over time, equation (1) shows that the increase in the real exchange rate over time (i.e. a real depreciation of the domestic currency against the foreign currency) should be equal to the increase in the nominal exchange rate (in other words, to the nominal depreciation of the domestic currency) minus the differential between the domestic and external inflation rates.

That definition assumes that an increase in *RER* or *e* will result in a depreciation in the domestic currency against the foreign currency (real and nominal, respectively), while a reduction in *RER* or *e* will produce an appreciation of the domestic currency against the foreign currency (real and nominal, respectively). The main theoretical issue has to do with the key forces leading the real exchange rate to its equilibrium level in the long-term, so that it will be equal, in this case, to what is regarded as being the “neutral” —from the standpoint of competitiveness— nominal exchange rate (a “neutral” exchange rate means that exporters, importers and domestic producers who compete with foreign producers

<sup>10</sup> The real purchasing power parity hypothesis was developed by Cassel in 1918 and, since then, has become the principal theoretical point of reference for evaluating the behaviour of the long-run real exchange rate (see Sarno and Taylor, 2002). The empirical evidence does not bear this hypothesis out in its absolute form, however (see Sarno and Taylor, 2002). Even though the empirical evidence for the validity of the relative version of the real purchasing power hypothesis is not very robust either, Rogoff (1996, p. 647) contends that most economists instinctively believe in some variant of purchasing power parity as an anchor for long-term real exchange rates.

<sup>11</sup> For an excellent mathematical demonstration based on the absolute version of the purchasing power parity hypothesis, see Simonsen and Cysne (1995, pp. 99 and 100).



are equally benefited). According to the conventional theory, in the absence of nominal or real shocks, there are “fundamental” forces inherent in the capitalist economic system that will cause the nominal exchange rate to converge towards its real equilibrium level over the long term (Taylor and Taylor, 2004).<sup>12</sup> Any divergence of the real exchange rate from its fundamental equilibrium level would be seen as a transitory deviation caused by random shocks (Razin and Collins, 1999).

Not by chance, in conventional empirical estimates of the real exchange-rate trajectory as well as of the deviation of the real exchange rate from its long-term equilibrium, the two fundamental forces that explain such trends are: (i) the relation between change in the productivity of tradable goods compared with the change in the productivity of non-tradable goods; and (ii) the terms-of-trade (*ToT*) behaviour.

In the case of the first structural economic force, as productivity tends to increase faster in tradable goods than in non-tradable goods in the process of economic development, the drop in relative prices of the former implies that the domestic currency will tend to “naturally” appreciate in real terms. This is the well-known Harrod-Balassa-Samuelson effect, in which, as noted by Obstfeld and Rogoff (1996, chap. 4), price levels tend to rise (or, in other words, the real exchange rate tends to appreciate) as per capita income increases.<sup>13</sup>

Yet, as to the second “fundamental” force, the expected impact of *ToT* on the real exchange-rate trajectory is ambiguous. Baffes, Elbadawi and O’Connell (1999, p. 413) state (as do most authors) that: “An improvement in the terms of trade increases national income measured in imported goods; this exerts a pure spending effect that raises the demand for all goods and appreciates the real exchange rate”. However, Edwards (1989) provides a theoretical demonstration that it can also have the opposite effect: if the increase in income generated by an improvement in the terms of trade triggers the large-scale substitution of tradables for non-tradables (notably services), then the increase in the relative prices of the former will translate into a depreciation in the currency in real terms. In other words, according to Edwards (1989), the impact of an improvement in the terms of trade on the real exchange rate can go either way: if the income effect is greater, there will be a real appreciation of the currency, but if the substitution effect is greater, there will be a real depreciation.<sup>14</sup>

Having identified the two main forces that influence the fundamental equilibrium path of the real exchange rate, the next step of conventional models is to use econometric methods to estimate the misalignment of the exchange rates (i.e. to estimate the percentage of overvaluation or undervaluation of the nominal exchange rate relative to its fundamental equilibrium level). Conventionally, this misalignment tends to be associated with transitory random shocks.<sup>15</sup> Viewed from this perspective, a real exchange rate is misaligned when “it deviates from the underlying *REER* that would have prevailed in the absence of price rigidities, frictions and other short-run factors”, as noted by Razin and Collins (1999, pp. 59-60). While the models are of differing degrees of sophistication, the econometric equations that are intended to measure the extent of exchange rate misalignment are, essentially, estimating the deviation of the observed real exchange rate — which is estimated, for example, by the Central Bank of Brazil based on the real exchange rate indices relating to equation (1)— from a linear combination of proxy variables for

<sup>12</sup> According to Taylor and Taylor (2004), the empirical evidence shows that, because of the rigidity of nominal prices, nominal exchange rate variations are transmitted on a 1-to-1 basis to the real exchange rate within a very short period of time. In other words, a nominal depreciation will immediately trigger a more or less proportional real depreciation.

<sup>13</sup> As will be seen later on, when expressed econometrically, the sign of the estimated coefficient for per capita income (the variable used to capture the Harrod-Balassa-Samuelson effect) is negative because the increase in per capita income tends to lower (appreciate) the real exchange rate.

<sup>14</sup> The expected sign of the estimated coefficient for the terms of trade in the econometric equation shown in section III may be negative, if the income effect predominates, or positive, if the substitution effect prevails.

<sup>15</sup> The main policy implication of this approach, according to which shocks that cause the real exchange rate to diverge from its long-run equilibrium path are short-lived, is that the most suitable exchange regime would be a clean (or nearly clean) float.

the path of the long-run real equilibrium exchange rate (associated with flex-prices). In the econometric calculations, these deviations are associated, in the final analysis, with variables representing short-term shocks plus the term that represents the residual of the regression (Razin and Collins, 1999, pp. 65-67). In formal terms, the real exchange rate is expressed as follows in the conventional theoretical models (all the variables except the interest rate are expressed in logarithms):

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

where the *RER* (all the *t* subscripts represent time *t*) is simultaneously determined by two sets of factors: (i) the first, represented by the function *g* (...), basically incorporates fundamental variables that presumably would push the real exchange rate towards its long-term equilibrium level. Therefore, all the variables represented by *g* are real variables: *y*<sup>s</sup> is the real output; *d* is real aggregate demand and *i*<sup>\*</sup> is the real world interest rate (which is compatible with the long-term “natural” interest rate). In a world where there is perfect competition and no rigidity in nominal prices and no unforeseen random shocks, the *RER* would naturally converge towards *g* (...) over the long term and would thus be aligned with the equilibrium level determined by economic fundamentals.

Nevertheless, given the imperfections present in the real world, the conventional theory attributes the causes of real exchange rate misalignments relative to the fundamental long-term equilibrium path to the variables represented by *f*(...) – whether they be monetary shocks (represented by  $\lambda_m$ ) or real shocks (represented by  $\lambda_{yt}$ ).

Thus, to estimate the path of the long-run real exchange rate and its misalignment relative to its equilibrium path, equation (2) can be translated into the following econometric equation (see Razin and Collins, 1999, pp. 64-65).<sup>16</sup>

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

The diagram shows equation (3) with two arrows pointing downwards from the terms  $\alpha W_t$  and  $\beta Z_t + \varepsilon_t$ . The arrow from  $\alpha W_t$  points to a box containing the text: "Fundamental" variables (determine the long-run real exchange rate). The arrow from  $\beta Z_t + \varepsilon_t$  points to a box containing the text: Short-run shock variables plus the term that represents the residual of the regression (which determines the exchange-rate misalignment).

Where *RER* is the observed real exchange rate (expressed in logarithms), *W* is a set of variables that capture fundamental long-term equilibrium factors and *Z* is a set of variables representing short-term shocks that, together with the term that represents the residual  $\varepsilon$ , explains the exchange rates' misalignment.<sup>17</sup>

<sup>16</sup> It is useful to characterize both the theoretical and the econometric approaches to determining the long-run real exchange rate and the method used for estimating exchange-rate misalignments in conventional models, because they help to mark the radical differences of these models from the structuralist-Keynesian theoretical and empirical models proposed later and from the methodology used in this study for estimating exchange-rate misalignments.

<sup>17</sup> It is not by chance that the estimation of exchange rate misalignments using conventional models is expressed as the difference between the left-hand side and the first component on the right-hand side of the equation (3).

### III. The determination of the long-term real exchange rate and its deviation from the “optimum” rate for development: a structuralist-Keynesian model

This section will focus on a structuralist-Keynesian model in which the path of the long-term real exchange rate and its divergence from the observed real exchange rate relative to its neutral equilibrium level and its “optimum” level (as defined earlier) are accounted for, at one and the same time, by long-term variables associated with the structure of the economy and by variables that are directly or indirectly linked to short-term macroeconomic policy (or, in other words, variables falling within the scope of action of policymakers who are either trying to deal with the ups and downs associated with short-term business cycles or to keep inflation under control). In fact, our structuralist-Keynesian model assumes that short-term macroeconomic policies (especially monetary and exchange-rate policies) have a strong and long-lasting influence on the misalignment of the observed real exchange rate relative to the “optimum” real exchange rate.

In our theoretical model, both the path of the long-run real exchange rate and the divergence of the observed real exchange rate from its “optimum” level can be represented by the following equation:

$$RER_t = g_t(struct_{pt}) + m_t(cp_t) \quad (4)$$



All the (structural and short-term) variables on the right side of the equation determine the path of the long-run real exchange rate as well as the degree of the misalignment of the observed real exchange rate with the “optimum” rate.

Where  $g$  is formed by a set of structural variables ( $struct_{pt}$ ) that influence the long-term real exchange rate (especially per capita income ( $Y$ ) — which, as noted earlier, captures the Harrod-Balassa-Samuelson effect —, the terms of trade ( $ToT$ ) and current account balance ( $CC$ )), while  $m$  refers to a set of variables that are directly or indirectly influenced by short-term macroeconomic policy ( $cp_t$ ).<sup>18</sup> In the proposed econometric model, which will be set out in detail in the following section, the most important short-term variables are the spread between the domestic  $i$  and external  $i^*$  short-term nominal interest rates ( $IDIFFER$ ), the stock of international reserves ( $RI$ ) and the country risk premium ( $CR$ ).

Two distinctive aspects set the proposed model apart from conventional models for determining the long-term real exchange rate. The first is that, although the variables represented by  $g$  are similar to those that influence the so-called “fundamental” variables of conventional models, the proposed model rejects the hypothesis that these variables always cause the real exchange rate to converge towards its long-term equilibrium level. This means that market forces may or may not steer the real exchange rate towards its “optimum” long-term level, but, if this does occur, it will be a random effect or be attributable to sudden, sharp adjustments in the exchange rate during crisis periods (as happened, for example, in Brazil after the speculative attack of 1999 and, more recently, as appears to have happened in 2015, as indicated by the empirical results discussed in section IV). If market forces are not always efficient in promoting exchange-rate adjustments or averting substantial misalignments (especially in

<sup>18</sup> In the econometric approach described in section IV, the term that represents the residual of the regression is added to the right side of the econometric equation that represents the theoretical equation (4) of the proposed model. This means that this term, together with the variables representing the structural and short-term policy component, will also influence the path of the long-run real exchange rate and the deviation of the observed real exchange rate from its “optimum” level.



the case of overvaluations), then the main policy implication would be that policymakers should work not only to avoid volatility but also to prevent the real exchange rate from deviating from its “optimum” level or appreciating in real terms. In other words, instead of a clean or dirty float, the most suitable exchange-rate regime would be a managed float, which —as shown by Aizenman, Chinn and Ito (2010)— is what is used in most of the developing countries of Asia.

The second aspect that distinguishes the two types of models from one another is that, whereas, in conventional models, the variables associated with short-term shocks are the only ones that are responsible for real exchange rate misalignments relative to the rate’s long-term equilibrium level, in the proposed structuralist-Keynesian model, all the variables on the right side of the equation (4) may together account for an exchange rate misalignment, whether relative to the rate’s equilibrium level or the “optimum” long-term real exchange rate, as is noted in the text table appearing below that equation.

This means that the proposed econometric procedure for estimating the deviation of the “optimum” real exchange rate from the observed real exchange rate will be different from the methodology used in conventional models. While the latter estimates the deviation by measuring the differential between the estimated observed real exchange rates and long-term exchange rates that are compatible with the “fundamental” equilibrium (and, therefore, the deviation would be influenced by the coefficients for the variables associated with short-term shocks plus the error term of the regression), the proposed procedure for calculating the deviation involves, first of all, using the Hodrick-Prescott filter technique to estimate the long-term trend of the series. The next step is to take the trend series and choose a reference period (an analysis of the selection criteria is presented in section IV) for the calculation of the observed real exchange rate’s deviation from the estimated “optimum” real rate.

In short, the proposed model is structuralist because it accepts the hypothesis that the path of the long-term real exchange rate is influenced by structural variables, especially by the productivity growth of tradables relative to non-tradables (the Harrod-Balassa-Samuelson effect) and by the terms of trade. It is also a Keynesian model because, based on Keynes’ argument (1936, especially chap. 12) that long-term trends are nothing more than the sum of events occurring in a succession of short periods, it rejects the conventional hypothesis that distinguishes short- and long-term real equilibrium exchange rates.<sup>19</sup> From an impressionistic perspective, then, we could say that both the level and the path of the short- and long-term real exchange rates are simply two sides of the same coin.<sup>20</sup>

Keynesian theory emphasizes that real exchange rates are heavily influenced by net short-term capital flows (Kaltenbrunner, 2008 and 2010), especially in developing economies that are very open to global financial activity. It is no coincidence that, even though he was not living in an era of financial globalization, Keynes (1923) witnessed the intensive movement of short-term capital flows that occurred in the wake of the First World War and the demise of the gold standard —triggered by defensive moves to raise short-term interest rates in the countries of the “centre”, especially England— and realized that these financial flows in the international arena were the primary mechanism for the transmission of inter-country short-term interest rate differentials to the real exchange rate.

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<sup>19</sup> See also Hahn (1984).

<sup>20</sup> Therefore, although structural variables such as trends in productivity and the terms of trade continue to be regarded as long-term variables, they are also heavily influenced by short-term economic policies. Thus, here again, we can see that long-term variables are nothing more than the sum of a succession of events occurring within a short-term time frame (which are, in their turn, influenced by short-term economic policies).

## IV. An econometric estimate of the path and “optimum” level of the long-run real exchange rate

The econometric specification of the model for determining the path of the long-run real exchange rate can be expressed as follows:

$$\ln RER_t = c_0 + \alpha_1 \ln Y_t + \alpha_2 \ln ToT_t + \alpha_3 \ln CC_t + \beta_1 (\ln IDIFFER)_t + \beta_2 (\ln IDIFFER)_{t-2} + \beta_3 \ln RI_t + \beta_4 \ln CR_t + \varepsilon_t \quad (5)$$

Where (all the variables of the model are expressed in logarithms): *RER* is the observed real exchange rate, *Y* is real per capita GDP in dollars, *ToT* is the terms of trade, *CC* is the current account balance expressed as a percentage of GDP,<sup>21</sup> *IDIFFER* is the spread between the domestic short-term interest rate (360-day swap rates) and the international short-term interest rate (the United States' target federal fund rate, which is taken as a proxy for the external short-term interest rate), *IDIFFER*<sub>*t-2*</sub> is the preceding variable converted into a two-period lagged variable,<sup>22</sup> *RI* is Brazil's stock of international reserves expressed as a percentage of GDP, *CR* is Brazil's country risk, as measured by its rating on the J.P. Morgan Emerging Market Bond Index (EMBI),<sup>23</sup>  $\varepsilon$  is the error term of the regression and the *t* subscripts are the time reference (in the proposed econometric model, the unit used is one month). While the first three variables on the right side of equation (5) are structural variables (i.e. per capita income (*Y*), the terms of trade (*ToT*) and the balance on current account (*CC*)), the rest of the variables are associated with short-term economic policy. The sources for the database, which covers the period from January 1999 to July 2015, are given in annex A1.

The selection of variables for inclusion in the model is not arbitrary but is instead the one used in a large number of models for determining the real exchange rate (see, for example, Helmers, 1988; Edwards, 1988; Calvo, Leiderman and Reinhart, 1993; Rodrik, 2008; Berg and Miao, 2010). Even so, the fact remains that both the structural and the short-term economic policy variables are suited to the proposed theoretical model. From a long-term perspective, trends in per capita income, the terms of trade and the balance on current account are the most important structural variables for a country such as Brazil, whose production and export structures rely heavily on natural-resource-intensive goods and whose development strategy over the past few decades has been based on attracting “external savings” (deficits on current account).<sup>24</sup> From a short-term perspective, the Keynesian literature (see Harvey, 2006, and Kaltenbrunner, 2008) suggests that the policy variables that we have chosen (the

<sup>21</sup> According to Bogdanski, Tombini and Werlang (2000), when the balance on current account (*CC*) has a negative sign, a positive number should be added in order to apply the logarithmic form. In those cases, the following procedure was adopted:  $CC = I + CC$ .

<sup>22</sup> The incorporation of the one-period lagged interest rate differential in the proposed econometric equation is justified because, given the external interest rate and assuming that everything else remains equal, an increase in the domestic short-term interest rate will tend to spur the net inflow of short-term capital, which would then (albeit with some time lag) cause the domestic currency to appreciate in both nominal and real terms.

<sup>23</sup> The choice of the EMBI as the most suitable measurement for evaluating Brazil's country risk is backed up by the Central Bank of Brazil (2015), which states that the most commonly used daily indicators in the market for that purpose (measuring foreign investors' credit risk in Brazil) are the EMBI+Br and the Credit Default Swap (CDS) of Brazil.

<sup>24</sup> Although disaggregated data for the most recent period are not yet available, Nassif (2008, table 1, p. 87) has calculated the share of Brazil's total manufacturing output that was accounted for by the value added by natural-resource-intensive manufacturers as of 2004 at 40.1%, as compared to a share of 32.7% in 1996. Bresser-Pereira, Nassif and Feijó (2016, table 2, p. 26) have calculated that exports of primary products and natural-resource-intensive manufactures (commodities) had risen to 62.1% by 2014 from 40.3% in 2000. Regarding Brazil's emphasis on financing its development with net inflows of external savings, see Bresser-Pereira and Nakano (2003) and Bresser-Pereira, Nassif and Feijó (2016).

interest rate spread, the stock of international reserves and country risk) are the best ones for capturing the direct and indirect effects on the real exchange rate in an economy that is extremely open to external capital movements, as is the case of Brazil during the period under study.

The model being proposed here differs from conventional models in its theoretical and empirical approach to the determination of the long-run real exchange rate and its degree of misalignment (in this case, its misalignment relative to the “optimum” level for purposes of economic development), as noted in earlier sections. Before moving on to the statistical tests and the application of the econometric model, it is worth analysing the expected signs of the estimated coefficients for the model’s variables, which are outlined in table 1.

**Table 1**

Structuralist-Keynesian model for the determination of the long-run real exchange rate: expected signs of the estimated coefficients for the variables included in the model

Variables	Expected sign of the estimated coefficient
Per capita income ( $Y$ )	-
Terms of trade ( $ToT$ )	Either (+ or -)
Balance on current account ( $CC$ )	+
Domestic/external interest rate spread ( $IDIFER$ )	Either (+ or -, respectively, at very short, short and medium terms)
Stock of international reserves( $R$ )	Either (+ or -)
Country risk premium ( $CR$ )	+

**Source:** Prepared by the authors.

The expected signs of the estimated coefficients for per capita income ( $Y$ ) and the terms of trade ( $ToT$ ) were discussed in section II. The expected sign of the coefficients for the balance on current account ( $CC$ ) is positive because a long-term current account surplus is associated with a depreciated currency in real terms, as discussed by the theoretical literature (Obstfeld and Rogoff, 1996). The expected sign of the coefficients for the interest rate differential could go either way: while, in the very short term, given the level of the external interest rate, an increase in the short-term domestic interest rate could lead to a depreciation of the currency (positive sign) via expectations (“fear of a float” or, in this case, “fear of a depreciation”, as argued by Calvo and Reinhart, 2002), on the other hand, in the short and medium terms, an increase in the domestic interest rate (given the level of the external interest rate) would tend, *ceteris paribus*, to spur net capital inflows and, consequently, an appreciation of the currency in real terms (negative sign). The sign of the expected coefficient for the variable associated with the stock of international reserves could also go either way: an increase in external reserves over time means that the government is buying up international currency on the spot market in order to slow down a possible appreciation or even to trigger a sharper depreciation (positive sign). However, a large stock of international reserves may, *ceteris paribus*, lower the country risk premium, thereby stimulating net capital inflows and, consequently, lead to an appreciation of the domestic currency in real terms (negative sign). Clearly, the expected sign of the country risk premium is positive, since an increase in that premium may spark capital flight, leading to a depreciation of the domestic currency in real terms (positive sign).

The first step in the empirical analysis was to run the augmented Dickey-Fuller test and the Phillips-Perron test. The results indicate that all the series are integrated of order 1, or, in other words, non-stationary in level but stationary in first difference.

In addition to their stationarity, it is also important to consider the possible endogeneity of the model’s variables because, since the model violates the assumption of the model of ordinary least squares (OLS) that the residual should not correlate with the explanatory variables of the regression, it may produce skewed, inconsistent and inefficient OLS estimators and thus compromise the inferential analysis.

However, as shown by Baffes, Elbadawi and O'Connell (1999, chap. 10), even the most persuasive exogeneity tests, such as the one proposed by Engle, Hendry and Richard (1983), cannot always resolve endogeneity problems when there are changes in the marginal distribution of explanatory variables. Even so, Johansen's cointegration test (1988) provides a very powerful means of dealing with the problem of endogeneity in models with more than one endogenous variable, not only because it considers all the variables in an estimation process to be endogenous, but also because it simultaneously determines the equilibrium relationship among them.

Since the variables are not stationary and have the same order of integration, the cointegration test proposed by Johansen (1988) can be used to see if a stable long-term relationship exists among them. As the test showed that there was a cointegration vector, the existence of a stable long-term relationship among the model's variables can be accepted.<sup>25</sup>

Once it is known that the series are non-stationary and cointegrated, equation (5) can be estimated using ordinary least squares (OLS) and the error correction model (ECM).<sup>26</sup> Table 2 gives the results of the econometric model. All the estimated coefficients were statistically significant and displayed the expected signs shown in table 1. It is important to note that, while the interest rate differential was included in the econometric equation (5) for economic reasons (see footnote 23), some of the model's variables were lagged one or two periods (months) simply for econometric reasons. Since the selected variables are monthly, it can be assumed that the explanatory structural and economic policy variables will not alter the real exchange rate in such a short span of time (scarcely a month), so it is reasonable to expect the model to fit the data better when the data are incorporated with some time lag.

**Table 2**  
Brazil: estimated long-term real exchange rate models, 1999-2015  
(Dependent variable: real exchange rate (RER))

Variable	Variable	OLS coefficient		ECM coefficient	
		( <i>t</i> statistics in brackets)	Variable	( <i>t</i> statistics in brackets)	
<i>C</i>	Constant	6.650088*** [10.41783]	<i>C</i>	5.9805***	
<i>lnY-2</i>	Log of per capita GDP	-0.33637*** [-7.61376]	<i>lnY-3</i>	-0.763422*** [-7.93942]	
<i>lnTOT</i>	Log of the terms of trade	-0.26492** [-1.91535]	<i>lnTOT-1</i>	-0.454013* [-1.69178]	
<i>lnCC-1</i>	Log of the balance on current account/GDP	0.068764*** [4.538101]	<i>lnCC-1</i>	0.085584*** [2.34562]	
<i>Ln(IDIFFER)</i>	Log of short-term interest rate differential	0.296203** [2.320963]	<i>Ln(IDIFER)</i>	-	
<i>Ln(IDIFFER)-2</i>	Log of the lagged short-term interest rate differential	-0.24448** [-2.0114]	<i>Ln(IDIFER)-2</i>	-0.26921** [-4.41106]	
<i>lnRI-1</i>	Log of the stock of international reserves/GDP	0.223979*** [6.6185]	<i>lnRI-1</i>	0.167482** [2.37291]	
<i>lnCR</i>	Log of Brazil's risk premium	0.039893* [1.70786]	<i>lnCR-1</i>	0.372263*** [5.96244]	

**Source:** Prepared by the authors.

**Notes:** OLS model: R2: 0.839; adjusted R2: 0.833; Durbin-Watson statistic: 1.833; *F* statistic: 141.169; Prob (*F* test): 0.000; number of observations: 197 after adjustments. The *IDIFFER* variable was included with two lags; the *CC* and *RI* variables were included with a lag and the *Y* variable with two lags. The ECM: three lags; number of observations: 193 after adjustments. The *TOT*, *CC*, *RI* and *CR* variables were included with a lag, *IDIFFER* with two lags and *Y* with three. \*\*\*significant at 1%; \*\*significant at 5%; \*significant at 10%.

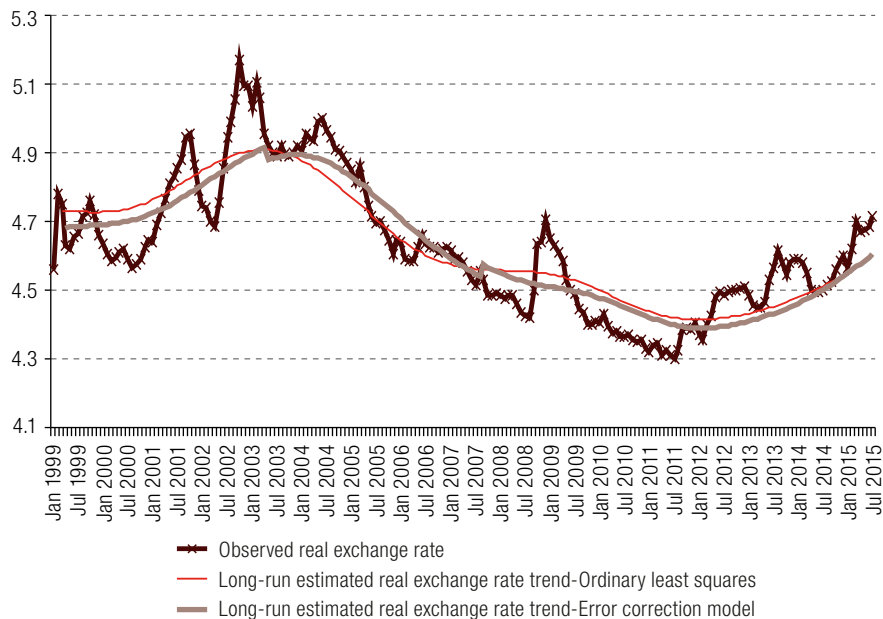
<sup>25</sup> The results of all the tests described in this section can be requested from the authors via email.

<sup>26</sup> As noted by Hamilton (1994), if the series exhibit these characteristics, then the OLS method will continue to be a highly consistent estimator. For a formal demonstration of this, see Hamilton (1994, p. 587).

The results show that per capita income, the terms of trade and short-term interest rate differential were the variables whose estimated coefficients provided the best explanations for the path of the real exchange rate in Brazil between 1999 and 2015. In other words, the proposed econometric model suggests that the path of the real exchange rate in Brazil between January 1999 and July 2015 — which reflected an appreciation trend throughout most of that period, as shown in figure 1— was influenced both by structural economic variables in Brazil (such as per capita income trends, which capture the Harrod-Balassa-Samuelson effect, and the terms of trade, which were very favourable for Brazil during much of the period under analysis) and by variables that are directly linked to short-term macroeconomic policies.<sup>27</sup> In fact, the wide interest rate differential observed in Brazil in recent decades led to excessive net short-term capital inflows during economic booms and high international liquidity, which spurred an appreciation of the Brazilian currency in real terms.

The coefficients of the econometric model were used to estimate the long-run trend of the real exchange rate ( $\hat{RER}$ ). This result was then compared with the observed real exchange rate as a basis for constructing an index that could be used to determine if the latter is overvalued, undervalued or in equilibrium relative to the estimated “optimum” level. In line with the suggestions of Edwards (1989) and Alberola (2003), this study has used the Hodrick-Prescott filter technique to estimate the  $\hat{RER}$ . Figure 1 traces the observed real exchange rate (the  $RER$  that is regularly calculated by the Central Bank of Brazil, whose database is listed in annex A1) and the path of long-run real exchange rates estimated using the OLS and ECM models. Both the observed and estimated real exchange rates are expressed in logarithms in figure 1.

**Figure 1**  
Brazil: observed real exchange rates and estimated long-term real exchange rates,  
January 1999 to July 2015  
(In logarithms)



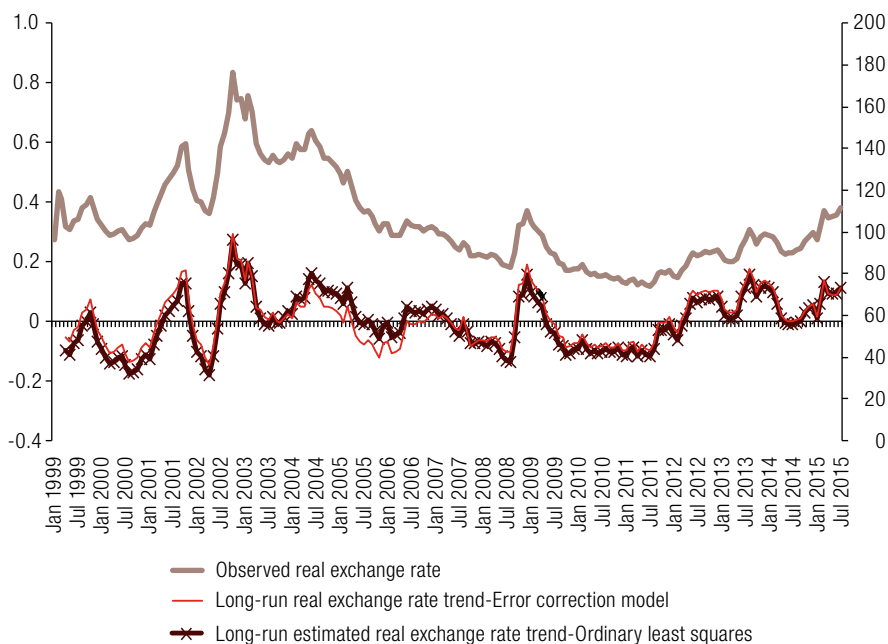
Source: Prepared by the authors.

<sup>27</sup> These two structural variables —per capita income and the terms of trade— were partially responsible for the long-term appreciation of the Brazilian currency in real terms, as predicted by economic theory.

The robust results of these estimates can be corroborated not only by the level of significance of the estimated coefficients (detailed in table 2), but also by the good fit between the paths of the estimated exchange rates with the two (OLS and ECM) estimation models. There is also a close correlation between the paths of the estimated real exchange rates obtained by both models and actual real exchange rates. Both models indicate that the real exchange rate in Brazil started to appreciate in late 2003 and early 2004, even though the observed real exchange rate in 2004 was considerably undervalued, as is depicted in figure 2.

Figure 2 compares the paths of the observed real exchange rates and estimated long-term real exchange rates generated by the OLS and ECM models.

**Figure 2**  
Brazil: observed real exchange rates and degrees of undervaluation or overvaluation relative to estimated real exchange rates, January 1999 to July 2015



**Source:** Prepared by the authors based on the methodology described in this paper for the calculation of estimated real exchange rates and based on data from the Central Bank of Brazil for the observed real exchange rates (see annex A1).

**Note:** (i) The observed real exchange rates (shown by the highest line in the graph) correspond to the indices shown on the right-hand axis (the mean for 2000=100): a value of over 100 indicates a real undervaluation relative to the base year, while a value below 100 indicates an overvaluation relative to the same base year (2000).  
(ii) The percentage degrees of under- and overvaluation (depicted by the lower lines on the graph) were calculated as the difference between the observed real exchange rate (RER) and the long-run trends of the real exchange rates estimated using the two models (OLS and ECM). If the result is greater than 0, then the Brazilian real is estimated to be undervalued, while if the result is less than 0, the Brazilian real is estimated to be overvalued. These results, expressed in percentages, are indicated on the left-hand side of the graph.

For the long-run estimated real exchange rates using the two models (represented by the two overlapping lines in the lower portion of figure 2), values below 0.00 indicate an overvaluation (expressed as a percentage) of the observed real exchange rates relative to the estimated real exchange rates, while values above 0.00 indicate an undervaluation. In the case of the observed real exchange rate (RER – represented by the dotted line in the upper portion of figure 2), indices below 100 indicate an overvaluation relative to the mean for 2000 (which, by hypothesis, is equal to 100 and is the year when the observed real exchange rate is said to have been at equilibrium, according to the Central Bank of Brazil), while indices over 100 denote an undervaluation relative to the mean for the year 2000.



Having estimated the path of the real exchange rate using the two models, the next step is to establish a methodology for identifying the period in which the real exchange rate has reached its “optimum” level for economic development. Once that period has been established, it becomes possible to determine whether the average nominal exchange rate during the first half of January 2016 (when this study was being finalized) was overvalued, undervalued or at its “optimum” level.

The criteria to be used in identifying the period during which the real exchange rate reached its “optimum” level must fulfill three simultaneous conditions: (i) in keeping with the empirical studies mentioned above, which indicate that a developing country’s currency should be slightly undervalued (i.e. it should exhibit a small real devaluation against the United States dollar or a basket of the currencies of the country’s main trading partners), the selected period should be one in which the estimated (not the observed) exchange rate exhibited a small (but not large) undervaluation (just slightly above 0.00 in figure 2);<sup>28</sup> (ii) the selected period should correspond to a time when macroeconomic indicators were fairly solid and, in particular, when the balance on current account was at equilibrium or showed a surplus; and (iii) the selected period should be a time when the observed real exchange rate was not overvalued (the index in figure 2 should not be below 100).

These criteria rule out all the periods in which the estimated or observed real exchange rates were overvalued (January 2010 to January 2012, to cite just one example).<sup>29</sup> They also rule out periods in which the estimated real exchange rate was excessively undervalued, such as, for example, the period between April 2002 and April 2003 (since a large depreciation may have longer lasting inflationary effects).<sup>30</sup> The period running from April 2012 to April 2013 also has to be ruled out because, although the estimated exchange rate was slightly undervalued (by an average of 7% for the period, according to the two models) —and thereby meets the first condition— the observed real exchange rate was overvalued (an average real exchange rate index of 95.70) and the country’s macroeconomic indicators were far from solid.<sup>31</sup>

A close look at figure 2 shows that the “optimum” real exchange rate was reached at some time between June 2003 and April 2005, which is the only period in which all three conditions are met. During that period, the Brazilian economy was in the final stage of a macroeconomic adjustment that had started in mid-1999 and had higher growth rates and a surplus on its current account.<sup>32</sup> In addition, the average real exchange rate, as estimated using the two models, was slightly undervalued (by 5.05%)

<sup>28</sup> Barbosa and others (2010) state that “a structuralist theoretical model and the evidence from Brazil (1996-2009) suggest that there exists an optimal exchange rate level that maximizes growth”. In that study, the authors estimate the index for a real exchange rate that would maximize Brazil’s long-term economic growth at around 101.6 (or, in other words, a real depreciation (at the margin) of about 1.6% relative to the “neutral” real exchange rate). A real exchange rate that represented a very large real depreciation could, of course, hinder long-term growth, either because it could set off a longer lasting inflationary process or because it could generate a much greater and undesirable distortion in the allocation of the economy’s production resources.

<sup>29</sup> During this period, the estimated real exchange rates were overvalued by around 7.8% (the mean for the two models), the observed real exchange rate (*RER*) was 81.67 (which represents an overvaluation of the Brazilian real of nearly 18.3% relative to the year 2000), and the country’s macroeconomic indicators were much less sound than they were in, for example, 2007. In fact, if we look at just two indicators for the year 2011, we see that, according to the Central Bank of Brazil, real GDP growth was 3.9% (compared to 6.1% in 2007) and the deficit on current account was nearly 2.1% of GDP (compared to a surplus of 0.1% in 2007).

<sup>30</sup> The proposed model indicates that there was an estimated average undervaluation of nearly 11% (the mean for the two models) between April 2002 and April 2003, which is considered to be too large.

<sup>31</sup> In 2013, according to the database of the Central Bank of Brazil, real GDP growth amounted to 3% and there was a current account deficit equivalent to 3.6% of GDP.

<sup>32</sup> In 2004, for example, the database of the Central Bank of Brazil shows that real GDP growth was 5.8% and there was a current account surplus equivalent to 1.8% of GDP.

and, finally, the observed average real exchange rate was not overvalued.<sup>33</sup> Thus, taking the period between June 2003 and April 2005 as a point of reference for the “optimum” real exchange rate, the estimated mean index for the long-run real exchange rate was 127.82 (OLS: 125.87 and ECM: 129.87). A comparison of this last estimated index with the index for the observed real exchange rate in July 2015 — the last month for which data for all the variables of the model are available — (111.81) indicates that, in this last month, the Brazilian real exhibited a real overvaluation of about 14.36% relative to its long-term “optimum” level. In other words, in July 2015, the average nominal exchange rate should have reached approximately 3.88 Brazilian reais per dollar (compared with the observed average nominal exchange rate, of 3.39 Brazilian reais per dollar) to preserve the “optimum” level achieved between June 2003 and April 2005.

Although the available data allowed our econometric estimation to be run only until July 2015, we adjusted the results for this latter period until December 2015, based on the relative real purchasing power parity hypothesis.<sup>34</sup> Using data on the consumer price indices for Brazil and the United States (the extended consumer price index (IPCA) and the consumer price index (CPI), respectively) up to December 2015 and the cumulative inflation rate differential for Brazil and the United States between August and December 2015 (IPCA: 3.6%; CPI: -0.1%), it can be concluded that the “optimum” real exchange rate in December 2015 should have been around 4.02 reais per dollar.<sup>35</sup> This result is quite close to the average nominal exchange rate for that month (3.90 reais per dollar) and is exactly the same as the mean for the first half of January 2016 (4.02 reais per dollar), as is shown on the website of the Central Bank of Brazil. In sum, after a long period beginning in late 2005, in which the Brazilian real was appreciating considerably (and which was interrupted only for about six months immediately following the outbreak of the global financial crisis in September 2008), the real exchange rate in Brazil reached its “optimum” level in mid-January 2016.

We understand that the same adjustment procedure based on the relative purchasing power parity hypothesis could be applied in order to determine if the Brazilian real will be overvalued, undervalued or equivalent to its “optimum” level in a relatively short period of time (say, in the next two years, until the end of 2017) (i.e. using the cumulative differential between inflation in Brazil and international inflation). For longer periods, given that the long-term trajectory of the real exchange rate is strongly affected by structural variables and by short-term economic policies, the models proposed here for determining the “optimum” real exchange rate (or similar models, such as that proposed by Marconi, 2012) can be used to arrive at new estimates.

<sup>33</sup> The average index for the observed real exchange rate for this period was 135.52, which means that the Brazilian real was undervalued by 35.5% relative to the average for the year 2000. It might be argued that this period could not be considered as one in which the real exchange rate had reached its “optimum” level because the Brazilian currency was excessively undervalued. However, this argument is flawed, for two reasons: first, because the rate in question here is the observed real exchange rate, whose indices are based only on the differences between the domestic and external inflation rates (and, in the case of the real effective exchange rate, are weighted for the relative importance of each of Brazil’s trading partners); and, second (and perhaps most importantly), as may be seen from figure 2, the Brazilian currency was shedding the effects of the excessive undervaluation seen in October 2002, when there was a clear case of overshooting in the real-dollar exchange rate. As noted by Barbosa-Filho (2015, p. 405), 2003-2005 was a period of “exchange-rate correction” because that was the time during which the appreciation of the Brazilian real was undoing the sharp depreciation of the currency that had occurred in the preceding years.

<sup>34</sup> As observed earlier, according to the hypothesis of relative purchasing power parity, in order to maintain a currency’s real purchasing power, the nominal exchange rate should correct for the difference between the cumulative domestic and external inflation rates.

<sup>35</sup> The data for Brazil are taken from the Brazilian Geographical and Statistical Institute (IBGE) and the data for the United States come from that country’s Bureau of Labor Statistics. For the IBGE data, see [online] [http://www.ibge.gov.br/home/estatistica/indicadores/precos/inpc\\_ipca/defaultinpc.shtm](http://www.ibge.gov.br/home/estatistica/indicadores/precos/inpc_ipca/defaultinpc.shtm). For the data for the United States, see [online] <http://www.bls.gov/cpi/>. [Consulted on 20 January 2015].

## V. Conclusion

In the recent overvaluation cycle of the Brazilian real, which occurred between mid-2005 and the end of 2014 —and was interrupted only temporarily in the six months following the September 2008 global financial crisis— the Brazil's then Minister of Finance, Guido Mantega, attributed this trend to external factors. In particular, he attributed it to quantitative easing in the United States, which spurred a huge expansion of dollar-denominated liquidity in world markets, thereby forcing —in his opinion— emerging countries' currencies (and especially the Brazilian real) to appreciate. He also accused the Federal Reserve Bank of the United States of waging a “currency war”.

In a paper prepared for the renowned Mundell-Fleming Lecture held each year by the International Monetary Fund (IMF), Ben Bernanke (2015), the former Chairman of the United State Federal Reserve, showed that Mantega's accusation was theoretically and empirically baseless. According to Bernanke (2015, pp. 3-4), expressions like “currency wars” in have no sense in this context because “concerns about currency wars on the part of emerging-market policymakers appear to be motivated in large part by those 4 policymakers having separate goals for their own exchange rates, over and above assuring the stability of domestic output and incomes. To the extent that they have additional exchange-rate objectives, foreign policymakers are constrained primarily by the Mundell-Fleming “trilemma” —the impossibility of combining free capital flows, independent monetary policy, and exchange rate targets— not by US policy *per se*.

However, Bernanke (2015, p. 4) went on to argue that “...monetary and exchange-rate policies should focus on macroeconomic objectives, with the problem of spillovers [from United States monetary policy to international capital flows] being tackled by regulatory and macroprudential measures, possibly including targeted capital controls, and through careful sequencing of market reforms”. It is no coincidence, as recently pointed out by Hey (2015, p. 1) in a paper that has had a resounding impact in academic circles: “The global financial cycle transforms the ‘trilemma’ into a ‘dilemma’ or an ‘irreconcilable duo’: independent monetary policies are possible if and only if the capital account is managed”.

This criticism of Bernanke is relevant here because, as has already been shown by Aizenman, Chinn and Ito (2010), most of the Asian countries have sought to avert lengthy phases of chronic real appreciation of their currencies by implementing measures designed to overcome the constraints associated with the “trilemma”. According to those authors, since the disastrous consequences of the 1997 Asian crisis (whose origin can be found, to some extent, in the preceding period, when large net inflows of external capital caused their currencies to become enormously overvalued), policymakers in most of the countries of that region have sought to maintain monetary and exchange-rate stability and to avoid volatility and, above all, a cyclical and chronic appreciation of their currencies. To accomplish this, they make use of an array of the tools that are at their command, including interventions in the spot and futures markets, regulatory and macroprudential measures and ad hoc capital controls.<sup>36</sup> And in point of fact, the use of capital controls, which until not long ago was regarded as heresy by multilateral lending institutions, has recently been advocated by the International Monetary Fund (IMF) in official documents (see the studies of Ostry and others, 2011, and Ostry, Ghosh and Chamon, 2012). Our suggestion is that Brazilian policymakers should follow the Asian countries' example and make use —prudently and efficiently— of an array of exchange-rate policy instruments to avoid another long-lasting and chronic real appreciation of the Brazilian currency.

At the start, this paper emphasized that a slightly undervalued currency works as a powerful driver for promoting structural change, economic development and catching up in the long-term. It is important to note, however, that, even if the country manages to maintain the “optimum” real exchange

<sup>36</sup> See Aizenman, Chinn and Ito (2010) for a discussion of the Asian case and Subbarao (2014) for an examination of the case of India.

rate reached in January 2016 over the coming years, it will be no easy task to bridge the enormous technological lag accumulated by Brazilian industry in the past decade,<sup>37</sup> which is a condition *sine qua non* for reaching and maintaining higher levels of productivity, not only in this sector, but in the economy as a whole. This conclusion is backed up by robust empirical evidence that the manufacturing sector is the main driver of productivity growth in industry and in the wider economy, as first pointed out by Kaldor (1966) based on the empirical regularity originally advanced by the Dutch economist Verdoorn (1949).<sup>38</sup>

However, in view of the marked retreat of industry and the reprimarization of Brazil's export profile in recent decades,<sup>39</sup> the country's technological development — given the heavily path-dependent and locked-in nature of that process — may be hamstrung for a long time to come unless industrial and technological policies, in coordination with macroeconomic policy, can overcome the hysteresis<sup>40</sup> resulting from decades of high real interest rates (high cost of capital) and cyclical, chronic real appreciations of Brazil's currency. As Baldwin and Krugman (1989, p. 653) contended in their classic paper, “if it is wrong to ignore feedbacks from trade to exchange rate, it is probably also wrong to ignore feedback to the costs of capital”. They also argued that “a temporary overvaluation is followed by a persistent reduction in the equilibrium exchange rate but not enough to regain lost markets” (ibid, p. 637).

As shown by Krugman (1991, p. 652) in another seminal work, in the presence of static and dynamic increasing returns to scale, an economy that has fallen far behind in relation to the international technological frontier will likely face a long-term recovery with multiple equilibrium points. Accordingly, “the choice among multiple equilibria is essentially resolved by history: past events set the preconditions that drive the economy to one or another [positive or negative] steady state”.

For this reason, although it is unlikely that bringing the real exchange rate to its “optimum” level will, in and of itself, immediately revert the current regressive trend in the Brazilian economy and set it on a new path of economic convergence, the fact remains that the exchange rate is a strategic price, and its adjustment will therefore play a pivotal role in attaining that objective.<sup>41</sup> This is precisely why it is so important for Brazilian policymakers to regard the real exchange rate as a strategic price of crucial importance for economic development rather than simply as an eternal anchor for inflation.

<sup>37</sup> According to Nassif, Feijó and Araújo (2015), Brazil's technological gap, measured as the ratio between the country's labour productivity and that of the United States (a proxy for the international technological frontier), widened from 70% to 80% between 1980 and 2000, and then remained at that level until 2013.

<sup>38</sup> For recent evidence on this topic (known as the Kaldor-Verdoorn law) in Latin America, see Ros (2014).

<sup>39</sup> The loss of the share of value added by the Brazilian manufacturing sector to GDP (in real terms) has been dramatic in the last few decades, since it shrank from 21.6% in 1980 to 18.1% in 1990, 15.1% in 2000, 13.9% in 2010 and to 11.7% in the first half of 2015. The reprimarization of the country's export pattern, as noted earlier, is reflected in the expansion of the share of agricultural goods and natural-resource-intensive industrial products (commodities) in total exports, which rose from 40.3% to 62.5% between 2000 and 2014. See Bresser-Pereira, Nassif and Feijó (2016).

<sup>40</sup> The concept of hysteresis — a concept borrowed from physics and first incorporated into economic theory by Blanchard and Summers (1986) — refers to a situation in which a given material (in this case, the competitiveness of Brazilian industry) will not easily regain its original characteristics (rapid productivity growth) even after the main force that caused a disturbance (in this case, the greatly overvalued exchange rate) has been eliminated.

<sup>41</sup> For empirical evidence that the Brazilian economy is lagging farther and farther behind, see Nassif, Feijó and Araújo (2015b).

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## Annex A1

### Description of the variables and the databases used as sources

*RER* is the real effective exchange rate indicator obtained from series 11752, which is available in the Central Bank of Brazil's database [online] at:

<https://www3.bcb.gov.br/sgspub/localizarseries/localizarSeries.do?method=prepararTelaLocalizarSeries>.

*Y* is real per capita GDP in dollars. This variable was estimated by dividing monthly GDP in dollars from series 4385 by the population for the year under analysis from series 21774 (IBGE estimates), both of which are available in the Central Bank of Brazil's database (see the above entry for the Internet address). The population data for 1999 are from series 7330.

*ToT* is the terms of trade index of the Centre for Foreign Trade Studies (FUNCEX), which was obtained from IPEADATA, available [online] at: <http://www.ipeadata.gov.br/>.

*CC* is the balance on current account expressed as a percentage of GDP and was calculated by dividing the monthly balance of current transactions from series 2731 by monthly GDP from series 4385, both of which are available in the Central Bank of Brazil's database (see the above entry for the Internet address).

*IDIFER* is the spread between the monthly domestic short-term interest rate (360-day swap rate) and the monthly international short-term rate (the federal funds target rate of the United States, both of which are available [online] at:

[https://www.blumberg.com/?utm\\_source=Microsoft&utm\\_medium=cpc&utm\\_campaign=BLUM](https://www.blumberg.com/?utm_source=Microsoft&utm_medium=cpc&utm_campaign=BLUM).

*RI* is the stock of international reserves, expressed as a percentage of GDP and calculated by dividing the figure for the stock of international reserves taken from series 3546 by the figure for GDP taken from series 4385, both of which are available in the Central Bank of Brazil's database (see the above entry for the Internet address).

*CR* is the indicator of Brazil's country risk premium, which is represented by the J.P. Morgan emerging markets bond index (EMBI) rating for Brazil, which is available [online] at: [www.macrodadosonline.com.br](http://www.macrodadosonline.com.br).

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