An empirical study of the substitution of foreign for domestic savings in Brazil

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Abstract

This study aims to investigate the relations between the level of the real exchange rate, foreign savings and domestic savings in Brazil. The appreciation of the domestic currency caused by financing the current account deficit reduces the expected profit rate in the tradable goods industry, leading to a drop in domestic savings and the substitution of foreign for domestic savings. An econometric analysis of the Brazilian economy indicates a stable long-term relation between the exchange rate and domestic savings, and that relative devaluations of the real exchange rate positively and significantly affect domestic savings in 1994–2013. The estimations' results persist even after the period is divided into two samples, after tests showing the presence of a structural break in the model in 2002. In addition, the results of the estimations performed on the two samples confirm the presence of substitution of foreign for domestic savings.
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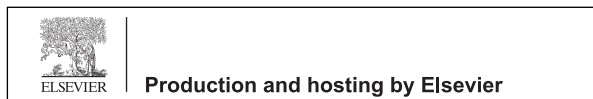
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Resumo

Este trabalho tem como objetivo investigar as relações entre nível da taxa de câmbio real, poupança externa e poupança interna no Brasil. A apreciação da taxa de câmbio causada pelo financiamento do déficit em conta corrente leva à redução da taxa de lucro esperada no setor de bens comercializáveis, resultando numa queda na poupança interna, bem como na substituição da poupança interna pela externa. A análise econométrica realizada para a economia brasileira indica que há uma relação estável de longo prazo entre taxa de câmbio e poupança interna, e que desvalorizações relativas da taxa de câmbio real têm impactos positivos e significantes sobre a poupança interna no período 1994–2013. O resultado das estimativas se mantém mesmo quando o período é dividido em

duas amostras, seguindo testes que apontaram a existência de quebra estrutural no modelo no ano de 2002. Além disso, os resultados das estimativas para as duas amostras confirmam a existência de substituição de poupança interna por poupança externa.

1. Introduction

The fact that a competitive exchange rate is a decisive condition for economic development is becoming increasingly clear (see Razin and Collins, 1997; Bresser-Pereira and Nakano, 2003; Gala, 2006; Frenkel and Taylor, 2006; Eichengreen, 2008; Rodrik, 2008; Williamson, 2008). On the other hand, a macro-economics of development is being developed around the exchange rate, with the tendency for cyclic and chronic overappreciation of the domestic currency as a general thesis (Bresser-Pereira, 2010). The clearest historical evidence of this relationship is seen in dynamic Asian countries that, in general, show current account surpluses, a correspondingly competitive exchange rate, and high rates of investment and savings. Therefore, they grow based on "foreign dissavings", despite the common wisdom having it that capital-poor countries should receive savings from capital-rich ones. China, Malaysia and Taiwan illustrate the case, as do Indonesia, South Korea, Malaysia and Thailand, which endured the 1997 balance-of-payments crisis when they abandoned this policy and resorted to foreign savings. A clear relation therefore exists between the exchange rate and growth, as well as between trade surpluses and accelerated growth. A wealth of empirical studies demonstrate the negative effects of the use of foreign savings on domestic savings, which has become known as "savings displacement" in the literature (Edwards, 1995; Reinhart and Talvi, 1998), but these papers lack a theory relating low growth and high use of foreign savings and, therefore, foreign debt.

In a recent paper, Montiel and Sérven (2008) point out the increasing number of advocates of the notion that the level of the real exchange rate has important effects on growth because it affects capital accumulation. For Bresser-Pereira and Gala (2007) there usually exists a high rate of substitution of foreign for domestic savings as a result of the currency appreciation associated with current account deficits and capital inflows. The ordinary wisdom view that it is "mismatches" (or temporary exchange rate deviations from its equilibrium level) that affect growth because the distort a crucial relative price in the economy does not, therefore, appear to be a good explanation for the low growth associated with the foreign savings and indebtedness policy many countries embrace. It makes more sense to explain it by means of the appreciation of the exchange rate that this policy causes, which, on the one hand (income) causes an increase in real wages and, given a high marginal propensity to consume, causes increased consumption, thereby reducing domestic savings as foreign savings increase; and, on the other hand (demand) causes business firms to lose competitiveness, reduce their expected profits and, as investment falls, so do domestic savings, which are displaced by foreign savings.

In Brazil, some authors like Pastore (2009, 2010) argue that the Brazilian total savings rate can be and is being increased by resorting to foreign savings. According to this thesis, the absorption of foreign savings complements domestic ones, increasing the economy's total savings, and it is improper to perceive a substitution of foreign for domestic savings. According to Pastore, by reducing real wages, local currency depreciation, would reduce aggregate consumption and demand. This argument, however, only considers the very short term. Efficient business firms using world-class state-of-the-art technology are quick to realize that they have become competitive, that they can now sell on both the domestic and foreign markets, and resume investment. The exchange rate therefore works like a switch that connects (or disconnects) the country's competent business firms to or from their markets.

This paper aims to contribute to the debate. Along the same lines as Bresser-Pereira and Gala (2007), we develop a model and provide empirical evidence to explore the macro-economic channel of the effects of the exchange rate and foreign savings on domestic savings. Starting from a theoretical and empirical perspective different from Montiel and Sérven's, we find empirical results other than those these authors present. Besides this brief introduction the paper has four more sections and a conclusion. Section 2 provides theoretical views of the effects of currency depreciation on the levels of income, consumption, aggregate investment and domestic and foreign savings. Section 4 theoretically evaluates the influence of foreign savings on domestic savings, and the following section presents our empirical analysis

of the relation between domestic savings and real exchange rate. Finally, the paper's conclusions are presented in Section 5.

2. Model

Let us assume a Stateless economy whose product is the sum of investment, consumption and exports minus imports; the gross income is the sum of worker wages, professional middle-class salaries and profits, and the national income is the gross income minus returns on capital transferred abroad. Investment equals domestic plus foreign savings. Macro-economically, investment determines savings *ex-ante*; savings finance investment *ex-post*. The income level is determined by consumption and investment spending. Foreign savings, that is, the savings a country receives from abroad, equals the current account deficit, which, in turn, corresponds to the balance of trade plus net revenue sent abroad.

As a strategic macro-economic price, the exchange rate (θ), in addition to determining exports and imports and, therefore, the current account deficit or surplus, or foreign savings (foreign savings or dissavings), also determines investments and domestic savings. Many factors may determine the appreciation (or depreciation) of the exchange rate: reduced current account balances (usually associate with the policy of growth with foreign savings), capital inflows to finance the resulting deficit, capital inflows that exceed outflows and increase the country's reserves. Given an appreciation of the exchange rate due to any of these reasons, how will it affect savings and investment?

To answer this question, we must consider it from the angles of income and demand. Beginning with income, let us assume that the exchange rate appreciates. We could build the reasoning based on a depreciation of the currency or the exchange rate, but prefer depreciation because it is more frequent in developing countries due to the trend toward exchange rate overappreciation (Bresser-Pereira, 2008). Advancing to the conclusion, the more appreciated a currency, the lower the domestic savings. This is due to the fact that, the more appreciated the foreign exchange rate, the higher the real wages, insofar as the prices of internationally tradable consumer goods drops as the local currency appreciates. Consumption, in its turn, depends on real wages and salaries. Therefore, consumption varies in the same direction as wages and salaries. On the other hand, the profits of the capitalists will drop because, on the income side, wages rise and, on the demand side, domestic capitalists export and invest less. Each economy will see a variation in real wages relative to the exchange rate that will be greater for each household the greater the consumption of tradable goods and the greater the sensitivity of exports and imports to the exchange rate. Profits, wages and salaries, therefore, in addition to being substantially dependent on the economy's productivity level and income distribution pattern, also depend on the exchange rate.

In other words, assuming that workers receive a nominal wage and acquire tradable and non-tradable goods, we find that the cost of living of workers will depend on the nominal exchange rate and the share of tradable goods in their consumption basket. Assuming also that prices are formed in the economy according to the well-known Kaleckian rule, which relates price levels with nominal wages and relates productivity levels with mark-up, then an appreciation of the exchange rate or a reduction of the price of tradables relative to nominal wages will equal an increase in real wages, as the worker's consumption basket will become more inexpensive.

As for the relation between exchange rate and the rate of profit, we know, firstly, that the rate of profit is the inverse of the wages rate; secondly, that profits depend on investments, which, in their turn, in addition to depending on the expected rate of profit, also depend on exports. Therefore, the expected rate of profit, investments and profits drop when the exchange rate appreciates and exports drop – and the reduction in capitalist profit is complementary to the increase in the wages and salaries of workers and the professional middle-class.

In conclusion, when the exchange rate appreciates, wages and salaries rise as profits drop. Assuming a high propensity to consume for worker and the middle class, consumption will rise and domestic savings will drop accordingly. Domestic savings are a function, in this formulation, of the exchange rate, and the greater the marginal propensity to consume, the greater the effect of the variation of the real exchange rate on domestic savings.

One might argue that rising worker wages in middle-development economies, where high-income concentration prevails, is not a negative development and that it will not necessarily reduce profit rates if insufficient demand exists. Firstly, however, we must clarify that wage gains from increase productivity or lower interest, rents and speculative profits are always welcome; we do not, however, believe that an artificial increase in wages from an overappreciated exchange rate should lie among desirable or legitimate causes of wage increase.

We have so far viewed the issue from the angle of income; let us now consider an exchange variation from the angle of demand, that is, in terms of investment as a determinant of savings. From this viewpoint, currency appreciation will bring about a reduction in savings by means of reduced opportunities for export-oriented profitable investments. With reduced expected profit, investment will drop and, as per Kalecki, so will profits, and, as per Keynes, so will domestic savings.

The two movements validate one another and the exchange rate appreciation results in reduced investment and domestic savings. When the overappreciation is chronic, as is often the case in developing countries due to the presence of some degree of Dutch disease that is not properly neutralized, due to the use of the exchange rate as an anchor for inflation control, and due to the insistent attempts to grow with foreign savings, then domestic saving will be permanently depressed. And therefore, due to exchange rate appreciation, foreign savings will not add themselves to domestic savings, except in part, and a high rate of substitution of foreign for domestic savings, z, will tend to occur.

3. Rate of substitution of foreign for domestic savings

We are now equipped to define the rate of substitution of foreign for domestic savings as a function of changes in foreign savings. Let us imagine two periods: t, where foreign savings is zero and the rate of exchange is the reference, or "equilibrium" rate of exchange, and a period $t+1$, where a current account deficit emerges and the exchange rate correspondingly appreciates. The main unknown is whether or not the investment rate will rise. On the supply side, the key variable is propensity to consume, responding to wages and salaries variation in one direction and to profits variation in the other, a greater or lesser variation in consumption depends on the difference between the expected rate of profit and the interest rate. On the demand side, the key variable is the elasticity of exports relative to changes in the exchange rate, followed by the elasticity of the investment rate relative to exports, or, more directly, the variation of investment relative to the exchange rate.

How far will domestic savings vary as a function of the appreciation of the currency of a country that is a recipient of foreign savings? Or, in other words, what will the rate of substitution of foreign for domestic savings depend on? Here we find a trade-off: an increase in the former tends to imply a reduction of the latter. An appreciation of the local currency may reduce domestic savings in the same amount or even less than the increase in foreign savings, thereby characterizing a displacement of domestic savings. We find that if the drop in S_i is greater than the rise in S_x, total savings drop, total investment drops, total consumption rises and income remains stable.

Given the marginal propensity to consume and the elasticity of investments relative to exports, we may define the rate of substitution of foreign for domestic savings, z, as equal to 1 minus the change in investment rate or total savings divided by the change in foreign savings rate for the period at hand.

$$z = 1 - (I/Y_t - I/Y_{t-1})/(S/Y_{x1} - S/Y_{xt-1}) \qquad (1)$$

If, for example, the investment rate in a certain period changes from 20% to 21% of GDP, while, in the same period, the current account deficit or foreign savings rises by four percentage points of GDP, the rate of substitution of foreign for domestic savings will have been 75%. Only 25% of the money received from abroad effectively becomes investment; the remaining 75% were diverted into consumption.

What does z depend on? The rate depends (1) on the variation of wages and salaries relative to the appreciation of the exchange rate, (2) on the variation of profits relative to the exchange rate (two relations that can be considered reasonably stable), (3) on the marginal propensity to consume, and (4) on the interest-profit spread, that is, on investment opportunities. Where great profit opportunities exist, in addition to the capitalist class using a larger portion of its expected and effective income to invest, increasing their marginal propensity to invest, the rising worker wages and, in particular, professional salaries, will also increase their marginal propensity to invest, potentially nullifying the stimuli for increased consumption arising from real wage gains. On the demand side, z, or the rate of substitution of foreign for domestic savings, will be greater the greater the elasticity of exports relative to variations in the exchange rate and the elasticity of investments relative to exports, and, therefore, the coefficient that relates investment and exchange rate variation. The drop in domestic savings caused by the reduction in exports and investment brought about by exchange rate appreciation is supported by the direct reduction in domestic savings caused by rising real wages and rising consumption that the same exchange rate appreciation causes.

The rate of substitution of foreign for domestic savings will be greater the greater the marginal propensity to consume because, in this case, the spread between the expected profit rate and the interest rate will be small, that is, investment

opportunities will be small and, as a consequence, there will be no stimulus for investment on the part of wage-earners. The opposite case – low substitution – will only occur when the economy is already experiencing rapid growth because, in this case, workers and the middle class will consume relatively less in order to be able to enjoy attractive investment opportunities. If, therefore, the profit-interest spread is small (as is usually the case), investment opportunities will be "normal" and will not encourage workers and the middle class to divert some of their wage gains to investment. As a consequence, foreign savings inflows will be strongly offset by domestic savings reduction arising from the rise in consumption. Furthermore, profits and reinvestment themselves will be modest. The result of these two facts will be that new investments will not occur, despite the foreign savings inflows. At the opposite end of the spectrum, if the profit-interest spread is wide and propensity to consume is low, as tends to occur in the few moments when the economy is experiencing quick-paced growth, a large portion of the increase in wages and salaries will flow not to consumption, but to investment. Only in this case will a low rate of replacement result.

Our assumption for this paper is that, under normal circumstances, the rate of substitution of foreign for domestic savings tends to be high, in excess of 50%, and approaching 100% when current account deficits occur while the economy is not growing quickly and without reduction in marginal propensity to consume. This is what happened in Latin America in the 1990s, for example. We know, however, historically or empirically, that countries did develop with foreign savings under certain circumstances. What is the condition for this to occur, that is, for the substitution of foreign for domestic savings to be close to 0? For z to be closer to 0 than to 100%, a favorable confluence of externalities and increased demand will be required to create a scenario of great investment opportunities expressed as high expected profit rates, combined, in any case, with high GDP growth rates. This was, for example, the case during the Brazilian "miracle" of 1968–1973.

It is important to point out that, in much the same way as the substitution of foreign for domestic savings takes place when the current account deficit increases, the inverse may occur, with substitution of domestic for foreign savings when there is a decrease in the current account deficit or foreign savings. In this case, on the supply side, wages and salaries will drop, and exports and investments will rise on the side of demand, causing a reverse substitution.

4. An empirical analysis for Brazil

In the previous sections, we saw that an overappreciated exchange rate causes, on the side of demand, a reduction of investment opportunities of expected capitalist profits, which brings about lower interest rates and domestic savings. At the same time, on the income side, the wage-mass increase caused by the appreciated currency leads to a drop in investment financed with local savings by increasing consumption and reduce the profit mass. We further emphasized that, due to foreign exchange appreciation, foreign savings can displace domestic savings.

To explore these theoretical propositions, we begin by analyzing the empirical relation between the level of the exchange rate and domestic savings to check whether it is in fact possible to find a positive relation between the real exchange rate and domestic savings.

Graphic 1 shows annual series for the real exchange rate (RER) and the domestic private-sector savings rate (TS) to enable a better understanding of their paths and relations.

We find that the domestic private-sector savings and exchange rate series appear to follow a joint path over the course of the 1950–2007 period. We further find that a positive and somewhat lagged relation exists between the two variables. Therefore, a shift that positively (negatively) skews the exchange rate is followed by a rise (drop) in the savings rate.

In addition to the relation between real exchange rate and domestic savings, it would be interesting to investigate how the latter interacts with foreign savings. More specifically, to find whether a substitution of foreign for domestic savings does occur. Graphic 2 shows the paths of the domestic savings (TS) and foreign savings (SX) series, both as percentage of GDP. The former series is the same as in Graphic 1, while the latter is the inverted-sign current transactions balance as percentage of GDP, representing the fact that a current account deficit implies the use of foreign savings.

Observation of Graphic 1 shows that foreign savings and domestic private-sector savings are negatively correlated, so that times of rising (dropping) foreign savings rate also show a drop (rise) in domestic savings.

However, instead of investigating the relation between savings and exchange in the long-run, we chose to focus on a more recent period to enable investigating how the economy's total savings (public- and private-sector, and foreign) relate with the real exchange rate. The period of analysis begins in the third quarter of 1994 and ends in the third
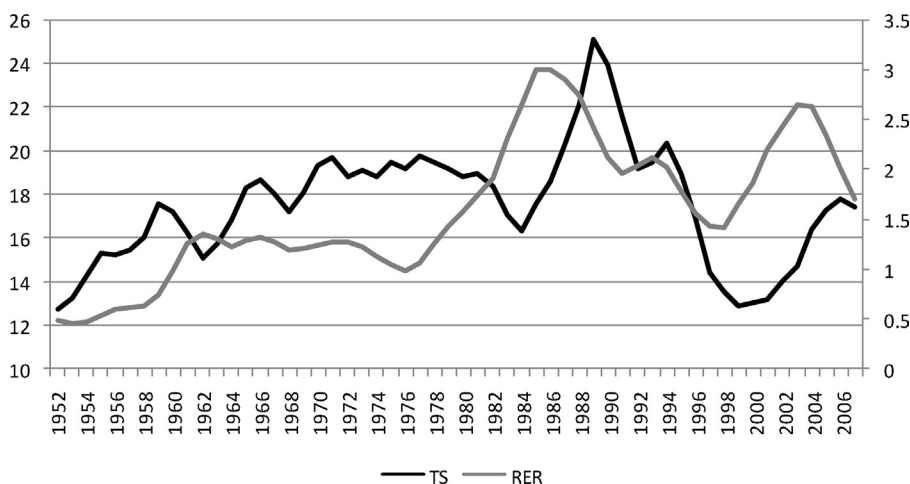
Graphic 1. Real exchange rate and domestic private-sector savings as % of GDP (1950–2007).
Source: PENN TABLE and Banco Central Do Brasil (2009).
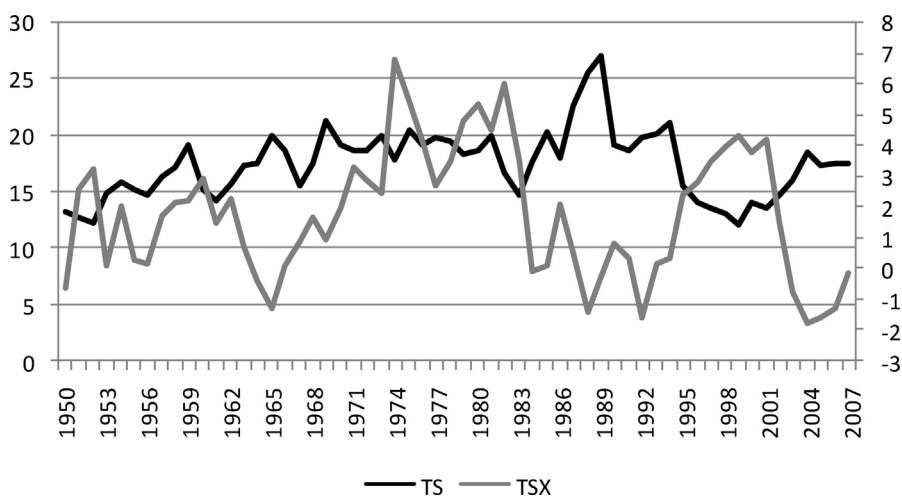
Graphic 2. Domestic savings and foreign savings as % of GDP.
Source: Banco Central Do Brasil (2009).

quarter of 2013, because in the years that preceded the Real Plan – from the first quarter of 1991 to the second quarter of 1994, a period for which quarterly data are available from the IBGE National Accounts System – some economic series, such as private-sector savings, for example, show abrupt changes that may compromise the analysis. The data sources are the Brazilian Geography and Statistics Institute (IBGE) and the Central Bank of Brazil.

The first step in estimating a relation between savings and the exchange rate is to correct the exchange rate using the Balassa-Samuelson effect, according to which the exchange rate must reflect the productivity gap between each country's tradable and non-tradable goods sectors.[1]

This is due to the fact that changes in the demand for non-tradable goods and services imply an increase in the price of such goods, leading to an appreciation of the real exchange rate. These changes in the demand for non-tradable services usually track nations' development and rising living standards, so that the exchange rate tends to be lower in nations with higher per capita GDP. The fact that tradable goods industries are usually more productive than those that

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[1] See Balassa (1964) and Samuelson (1964).

Table 1
Augmented Dickey-Fuller (ADF) test: level and difference.

Variable	Lags	T-statistic	Critical value: 1%	5%	10%
*RER^*	0	−2.095	−4.068	−3.462	−3.157
RER	0	−2.090	−4.068	−3.462	−3.157
pibpc	4	−2.007	−4.068	−3.462	−3.157
TS	3	−3.128	−4.068	−3.462	−3.157
SX	1	−1.784	−4.068	−3.462	−3.157
SPUB	1	−2.979	−4.068	−3.462	−3.157
*DRER^*	0	−8.547	−4.068	−3.462	−3.157
DRER	0	−8.577	−4.068	−3.462	−3.157
Dpibpc	3	−3.811	−4.068	−3.462	−3.157
DTS	2	−11.15	−4.068	−3.462	−3.157
DSX	0	−6.167	−4.068	−3.462	−3.157
DSPUB	0	−6.001	−4.068	−3.462	−3.157

Source: developed by the authors based on research data.
Note: All tests run with constant and intercept.

make non-tradables also contributes to the Balassa-Samuelson effect. This lower productivity leads to higher prices for non-tradable goods. Therefore, the greater the international competitiveness, the lower the real exchange rate.

To adjust a country's exchange rate by means of its factors endowment, the following regression can be estimated[2]:

$$RER_t = a + bPIBPC_t + u_t \qquad (2)$$

where RER is the country's real exchange rate in period *t*; *a* is a constant and *b* is a parameter; and PIBPC is per capita GDP.

The estimated Balassa–Samuelson effect for the Brazilian economy for the relevant period of time is robust and equal to −0.448, which implies that a 10% rise in per capita GDP causes a 4.5% appreciation of the exchange rate.

Having corrected the exchange rate, the next step is to estimate the model that relates domestic private-sector savings (TS) with the variables corrected exchange rate (RER̂), foreign savings (SX) and domestic public-sector savings (SPUB), with all series as normal logs to enable interpretation in terms of elasticities.

Edwards (1995) suggests additional important variables to explain the behavior of domestic savings and that could, therefore, serve as control variables for a model explaining the behavior of the domestic private-sector saving rate. These variables include: interest rate, the currency-to-GDP ratio, per capita GDP, population age, private-sector credit, inflation, etc. To include them would improve the model's fit, but lead to a loss in terms of degrees of freedom. As a result, we chose to restrict the model to the variables mentioned earlier, making it as parsimonious as possible.

4.1. Unit-root tests

Unit-root tests will be applied to the model's series to determine whether or not they follow a stationary stochastic process. Table 1 shows the results of the Augmented Dickey-Fuller Test as proposed in Said and Dickey (1984), with the null hypothesis (H_0) that the tested variable has a unit-root (is non-stationary).

For the level series, the calculated *t*-statistic is not greater than the critical value, so that we cannot reject the null hypothesis of the series being non-stationary at a 1% significance level. Therefore, the series can be differentiated as many times as needed, and the unit-root test can be used to tell when it becomes stationary, thereby finding its order of integration. Table 1 also shows the results of the ADF test for the series' first difference. The *t*-statistics found enable rejecting the null hypothesis, indicating that the series are stationary at first-difference and, therefore, first-order integrals, *I*(1).

These results are also confirmed by the Phillips and Perron (1987) test in Table 2, whose null hypothesis is also that the variable has a unit root.

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[2] Dollar (1992), Aguirre and Calderón (2005) and Rodrik (2007) are illustrative of papers that use this method to correct the exchange rate for variations in productivity.

Table 2
Phillips-Perron (PP) test: level and difference.

Variable	Lags	T-statistic	Critical value: 1%	5%	10%
*RER^*	3	−2.152	−4.068	−3.462	−3.157
RER	3	−2.151	−4.068	−3.462	−3.157
pibpc	14	3.054	−4.068	−3.462	−3.157
TS	4	−3.117	−4.068	−3.462	−3.157
SX	3	−1.599	−4.068	−3.462	−3.157
SPUB	4	−2.492	−4.068	−3.462	−3.157
*RER^*	8	−8.351	−4.068	−3.462	−3.157
RER	8	−8.532	−4.068	−3.462	−3.157
pibpc	78	−21.68	−4.068	−3.462	−3.157
TS	19	−7.518	−4.068	−3.462	−3.157
SX	1	−6.110	−4.068	−3.462	−3.157
SPUB	2	−5.980	−4.068	−3.462	−3.157

Source: developed by the authors based on research data.

Note: All tests run with constant and intercept.

The PP test therefore confirms the non-rejection of the null hypothesis that the tested series have a level unit-root and are first-difference stationary.

4.2. Structural break test

To find whether significant changes exist in the relation between the series over the period at hand, structural break tests were applied to the exchange rate, public savings, private-sector savings and foreign savings series to enable investigating whether two or more periods show significant differences between the parameters that establish the relations among series. The structural break test will indicate such a difference in parameter and determine the date of occurrence of the structural break (Fig. 1).
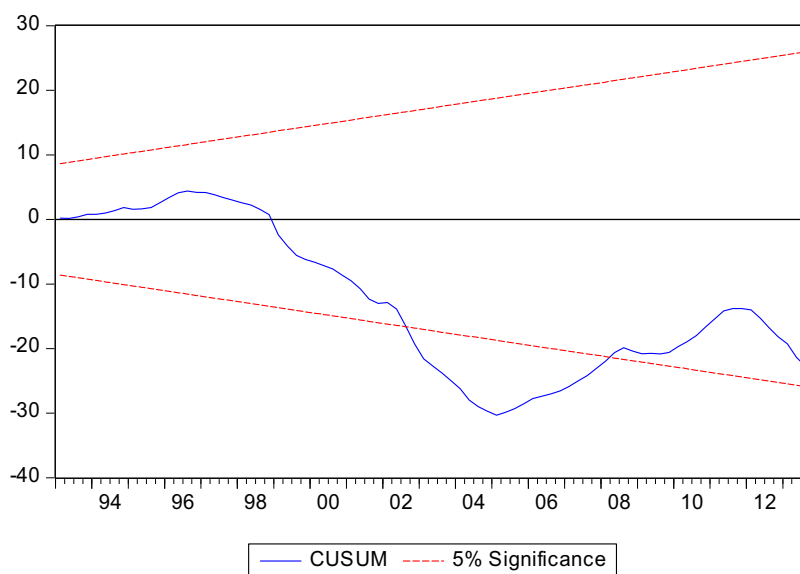

Fig. 1. Structural break test: CUSUM.

Fig. 2. Structural break test: recursive residuals.

Table 3
Structural break test.

Chow structural break test: May 2004	
Statistics	Probability
F-Value (4.567001)	0.0023
Maximum likelihood ratio (18.09793)	0.0012

Source: developed by the authors based on research data.

We first applied the CUSUM[3] test, based on the accumulated sum of recursive residuals and detecting the variable's instability when the data exceed an area delimitated by two critical lines of 5% significance. The test results show in Fig. 2 indicate instability of the model estimated in the second half of 2002.

Likewise, in the Recursive Residuals Test, the residuals are plotted on a zero mean line with critical boundaries of (plus and minus) two standard errors. The test suggests that the equation's parameters are unstable where those critical limits are exceeded. Fig. 2 summarizes our results, indicating a structural break in 2002.

We find that the CUSUM and recursive residuals tests both exceed the 5% significance critical line in the third quarter of 2002, suggesting the presence of a structural break in this period.

Next, based on the results of the CUSUM and Recursive Residuals tests, we run the Chow Test to check, using the *F*-value, whether the date of the observed break is significant.

Based on the results shown in Table 3, show a rejection of the Chow test's null hypothesis of absence of structural break, pointing out a structural break in the period indicated by previous tests.

Statistical tests are therefore consistent with events had in the Brazilian economy associated with uncertainty surrounding the 2002 presidential vote, the balance-of-payments crisis that then ensues and, as a result, the structural break that takes place at this point. Although then-candidate Luiz Inácio Lula da Silva, made a pre-vote promise to respect private property and contracts, as reflected in the document titled "Letter to Brazilians" ("Carta aos brasileiros"), the uncertainties around and fear of the Lula administration were exacerbated, as Fábio Erber (2011) pointed out. As a result, Brazil, which was highly indebted in foreign currency, lost creditor confidence and a foreign exchange crisis followed, leading to an exchange depreciation, an inflation spike, and reduced product growth. In addition, facts like the power utilities crisis, 9/11 and the Argentine collapse still affected the formation of players' expectations.

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[3] Brown et al. (1975).

The structural break tests attempted to address the possibility of a regime change in the relation among the model's variables, indicating the presence of a structural break in 2002. To address this issue, the sample was divided into two periods, one from the third quarter of 1994 to the second quarter of 2002, and another from the third quarter of 2002 until the third quarter of 2013.

4.3. Cointegration test

Because the model's variables are non-stationary and have the same order of integration, the cointegration test can be used to investigate a stable long-term relation among them.[4]

The simplest example of cointegration occurs when two variables are non-stationary, that is, $I(1)$, but a linear combination of the two exists that is stationary, that is, $I(0)$. Please note that having two non-stationary variables means that they can follow any path and that so can a linear combination of the two. More specifically, we expect a combination of the two $I(1)$ variables to be $I(1)$ as well in the vast majority of cases, making cointegration a rare event. Therefore, when two $I(1)$ variables cointegrate, this means that they can follow any path, but that – in the long run – they follow this path together, or that, otherwise, a long-term "equilibrium" relation exists between them.

One way to test for cointegration between two series is to use the method proposed in Engle and Granger (1982). The procedure's basic intuition is that, if two $I(1)$ variables cointegrate, the residuals of the regression of one against the other must be stationary. In practical terms, we estimate a regression with the variables at a level and apply the unit-root test to the regression's residuals; stationary residuals mean that the series are cointegrated.

Unlike the Engle–Granger test, the Johansen (1988) test does not determine the dependent variable in advance. The test assumes, based on a vector autoregressions (VAR) framework, that all variables are endogenously determined. Cointegration vectors can be determined using two likelihood ratio tests: Trace and Maximum Autovalue.

The former test's null hypothesis is that the number of cointegration vectors is $r \leq p$ (where $p = 1, 2, 3, \ldots, n - 1$), and the alternative hypothesis is that $r = n$, a more generic hypothesis. The latter test's basic reasoning is to check for the significance of the highest autovalue, confronting the null hypothesis that r cointegration vectors are significant against the alternative that the number of significant vectors is $r + 1$, that is, $r = 0$ against $r = 1$, $r = 1$ against $r = 2$, and so on. The tests are respectively given by:

$$\lambda_{\text{trace}} = -T \sum_{i=r+1}^{p} \ln(1 - \hat{\lambda}_i), \quad P = 1, 2, 3, \ldots, n - 1 \tag{3}$$

$$\lambda_{\text{max}} = -T \ln(1 - \hat{\lambda}_{r+1}), \quad P = 1, 2, 3, \ldots, n - 1 \tag{4}$$

According to Johansen (1988), if the values calculated by the λ_{traco} and λ_{maximo} statistics exceed the respective critical values, we reject the null hypothesis of non-cointegration in favor of the alternative hypothesis of one or more cointegrated vectors being present. The tests' values can be seen in Table 4.

Considering the 5% significance level, Table 4 shows that the null hypothesis of non-cointegration can be rejected, and that the alternative hypothesis of at least one cointegration vector can be accepted for both samples. The trace and maximum autovalue statistics indicate the presence of one cointegrated vector, suggesting that the model's non-stationary variables show common, or block, paths, so that there is at least one stable relation between them in the long run. This allows concluding that the four variables included in the model display a long-term equilibrium relation.

4.4. Error correction vector

The vector estimated according to the Johansen procedure, which corresponds to the long-term relation between the variables, can be seen in Table 5.

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[4] Please note that, before running cointegration tests on the two samples, we tested the model's series order of integration again, finding that the series-split did not imply changes to their orders of integration.

Table 4
Cointegration test.

	Trace Statistic			Maximum Autovalue Statistic		
	Observed	Critical value 5%	*P*-value	Observed	Critical value 5%	*P*-value
First sample: 1994:3–2002:2						
$R = 0$	65.83614	54.07904	0.0032	35.60482	28.58808	0.0054
$R \leq 1$	**30.23132**	35.19275	0.1555	**19.10356**	22.29962	0.1318
$R \leq 2$	11.12776	20.26184	0.5299	8.928340	15.89210	0.4416
Second sample: 2002:3–2013:3						
$R = 0$	100.0658	63.87610	0.0000	59.53130	32.11832	0.0000
$R \leq 1$	**40.53450**	42.91525	0.0849	**23.34308**	25.82321	0.1028
$R \leq 2$	17.19142	25.87211	0.4008	11.73378	19.38704	0.4403

Source: developed by the authors based on research data.
Note: The first sample's model was estimated with intercept and without trend, using three lags as indicated by the lag-selection criterion test; the second sample's model has a constant and trend, and uses four lags.

Table 5
Long-term equation (normalized).

TS (-1)	LOGRER$\hat{}(-1)$	LOGSX (-1)	LOGSPUB (-1)	12.82995
First sample: 1994:3–2002:2				
1.000000	-2.723460	0.169707	-0.333701	
	(0.38879)	[4.47145]	[-6.51371]	
	[-7.00498]	(0.03795)	(0.05123)	

TS (-1)	LOGRER$\hat{}(-1)$	LOGSX (-1)	LOGSPUB (-1)	8.3224166
Second sample: 2002:3–2013:3				
1.000000	-1.875212	0.519251	-1.277005	
	[-4.54564]	[5.05772]	[-5.56552]	
	(0.41253)	(0.10267)	(0.22945)	

Source: developed by the authors based on research data.
Note: The first sample's model was estimated using three lags, as indicated by the lag selection criterion; the second sample's model uses four lags.

To sum up, the estimated model predicts the presence of a long-term relation among the variables for each sample, as follows:

$$TS_t = -12.829 + 2.723\hat{RER} - 0.169SX + 0.333SPUB \tag{5}$$

$$TS_t = -8.322 + 1.875\hat{RER} - 0.519SX + 1.277SPUB \tag{6}$$

In both samples, domestic savings are treated as endogenous variables that depend positively on the exchange rate and on the public savings rate and negatively on foreign savings. The results are in line with what Edwards (1995) predicts, except for the positive coefficient of the public savings variable; according to that author's results, the public savings variable's coefficient was negative, which, for him, captures the fact that governmental savings tend to displace private sector savings (*crowding out* effect). He further emphasizes that a coefficient lower than 1 indicates that increases in public savings are not entirely offset by reductions in private-sector savings. In our model, the coefficient was positive for both samples, showing that public savings do not displace private-sector savings, but contribute to increase them instead. As for the foreign savings variable, its coefficient shows the degree of substitutability between domestic savings and foreign savings (or current account deficit). According to our estimated equation, substitution of foreign for domestic savings is not complete, as a 10% increase in foreign savings implies a 1.6% decrease in domestic savings in the first period and a 5.19% decrease in the second period. Finally, the exchange rate is positively related
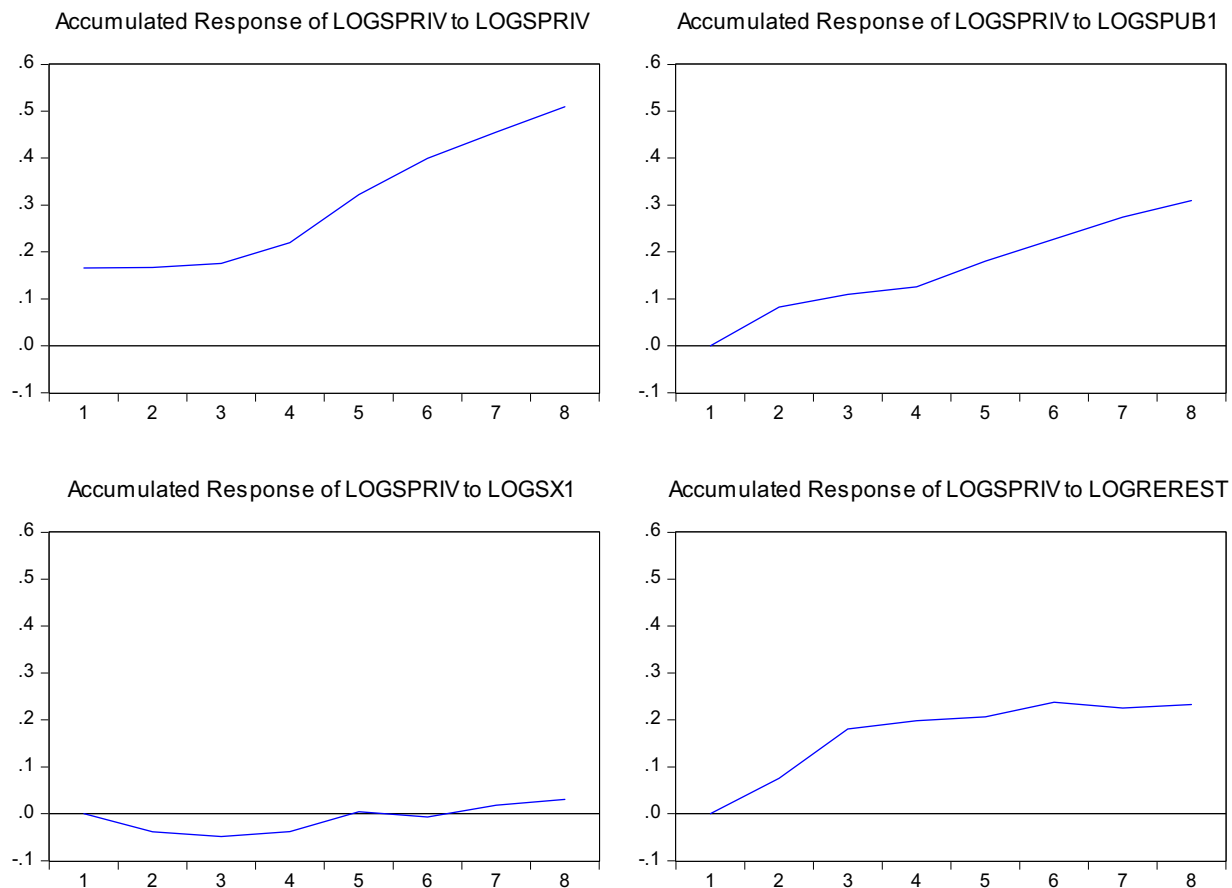
Accumulated Response of LOGSPRIV to LOGSPRIV　　　Accumulated Response of LOGSPRIV to LOGSPUB1

Accumulated Response of LOGSPRIV to LOGSX1　　　Accumulated Response of LOGSPRIV to LOGREREST

Fig. 3. Accumulated impulse-response function – 1994:3–2002:2.

Source: developed by the authors based on research data.

with domestic private-sector savings, so that exchange rate devaluations bring about increases in the private-sector savings rate (Fig. 3).

The graphs next represent the 1–8 quarter response of private savings to cumulative shocks in the private-sector domestic savings, public savings, foreign savings and corrected exchange rate variables, with shocks of one standard error and according to the Cholesky decomposition.

As for public savings, its shock has a positive effect on private-sector savings and makes itself felt in the third quarter following the shock, peaking in the seventh period and stabilizing from that point on. The effect of a foreign-savings shock on private-sector savings is negative and visible after the third quarter since the shock. The minimum level occurs in the third quarter, after which the foreign savings variable stabilizes and returns to the initial level. Finally, as for the effect of exchange rate shocks, private-sector savings respond positively starting in the first period, peaks in the sixth period and stabilizes from that point on.

Fig. 4 shows the impulse-response functions for the second sample.

Based on the data presented, we find that the effects are similar to those analyzed with the first sample, where private-sector savings responded positively to foreign exchange and public savings shocks, and negatively to foreign savings shocks.

Finally, it is worth noting that the results discussed in this paper persisted even under various robustness tests that ensured the reliability of the results, such as different series, at level and at difference, different orderings, and more. Empirical analysis also indicates that the model's results persist in the two analyzed periods, ensuring the reliability of our results.
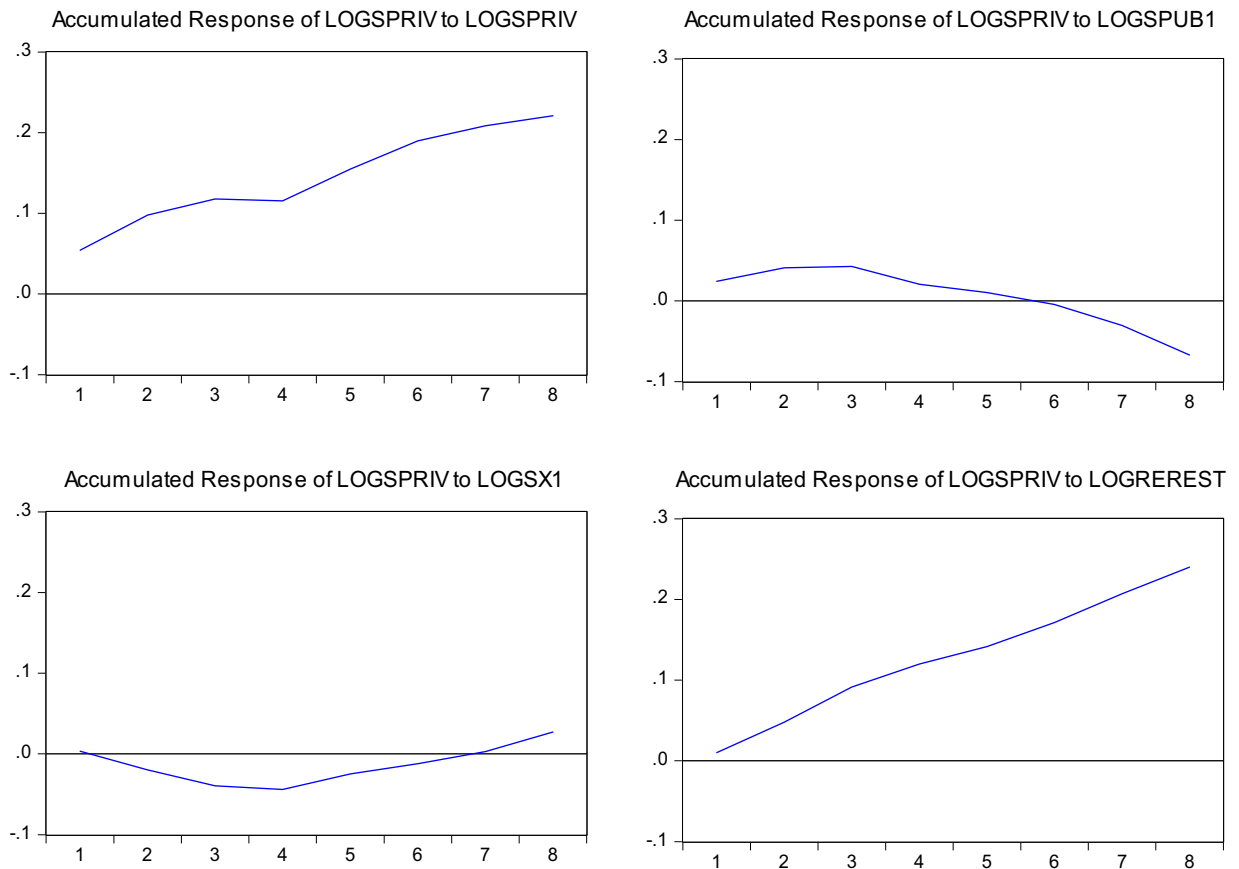
Accumulated Response of LOGSPRIV to LOGSPRIV

Accumulated Response of LOGSPRIV to LOGSPUB1

Accumulated Response of LOGSPRIV to LOGSX1

Accumulated Response of LOGSPRIV to LOGREREST

Fig. 4. Accumulated impulse-response function – 2002:3–2013:3.

Source: developed by the authors based on research data.

5. Conclusion

This study presented theoretical and empirical views exploring the macro-economic channel of the effects of the exchange rate on domestic savings. According to the theoretical model at hand, cases of excessively overappreciated real exchange rates lead to a reduction of the expected profit rate for tradable goods industries, resulting in an important drop in investment and aggregate domestic savings levels and, therefore, implying a high rate of substitution of foreign for domestic savings. The empirical analysis done for the Brazilian economy showed a stable long-term relation was found between the exchange rate and domestic savings, and that relative overappreciations of the real exchange rate have positive and significant impacts on domestic savings in the 1994–2013 period. The results of our estimations persist even when the period is divided into two samples as suggested by tests that indicated the presence of a structural break in the model in 2002. In addition, the estimated results for both samples confirm the presence of the substitution of foreign for domestic savings.

This analysis differs from authors who argue that the Asian model cannot be implemented in Brazil or Latin America due to low private-sector savings levels. Treating the countries' current account as a residual, they posit that the low individual propensity to consume among Asians is responsible for the high levels of domestic savings and current account surpluses. Not to go into "culturalist" explanations, the model presented above inverts this orthodox relation: it is not the propensity to save that explains high savings and current account surpluses, but a competitive – as opposed to overappreciated – exchange rate that reduces aggregate consumption on the one hand and, on the other, creates lucrative investment opportunities, consequently increasing investment and, via this Keynesian path, savings as well. Therefore, then secret to the high savings levels in Asian nations, according to our model lies in the policy of maintaining a

competitive exchange rate or preventing it from overappreciating, implying relatively low real wages in the short run, given a certain productivity level, so that wages can rise further in the medium run as a result of brisker growth.

It is worth pointing out that this entire discussion assumes certain productivity levels. Raising real wages without corresponding productivity increases is problematic because it puts the economy on an unsustainable path that usually ends up in a balance of payments crisis. On the other hand, under a competitive exchange rate regime, the profitability of investments and exports increases, which tends to raise the economy's productivity level in the long run, enabling a more balance increase in real wages.

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