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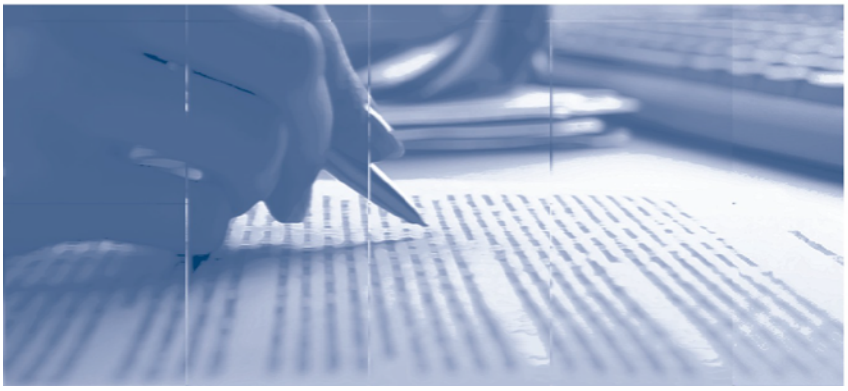

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International Capital Flows and Yields of Public Debt Bonds*

Márcia Saraiva Leon**

Abstract

The paper analyzes nominal yields of five-year fixed-rate Brazilian Domestic Federal Public Debt (DFPD) bonds in response to fluctuations in international net capital flows to Brazil for the period January 2007 to July 2012. The results show that estimation in differences with error correction obtains a long-run relationship between the yield, the foreign participation in the DFPD and the target Selic rate that reproduces previous results. When the ratio of net foreign long-term fixed-income investments relative to GDP is a substitute for foreign participation in the DFPD, the new explanatory variable is also significant in the long run, when the cointegrating equation includes the yield of five-year United States Treasury bonds. In turn, fiscal balance, investors' risk aversion, output gap, the tax rate on financial transactions made by nonresident investors and the effective rate of reserve requirements influence the yields in the short run.

Keywords: Bond, International Capital Movement
JEL Classification: F210, G120

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1. Introduction

Recent evidence on the link between international capital flows and asset prices shows that countries presenting the largest movement in house prices were also the ones that exhibit the biggest and rising net foreign capital inflows, as argued by Favilukis *et al.* (2012). Moreover, as pointed out by Peiris (2010), foreign investment into capital markets is a source of demand that can lower yields of domestic bonds and also increase the liquidity of these markets. The role played by these flows on house prices and on the prices of other assets has interested policymakers, because of the instability in the local financial sector that might be brought by their sudden and sharp movements.

Since the 1980's total net capital flows to emerging market economies (EMEs) have fluctuated significantly[1]. According to the IMF (2011), net capital flows to EMEs are negatively correlated with global interest rates and risk aversion: rising in times of low global interest rates and investors' greater appetite for risk and falling, otherwise. Furthermore, the widening of the interest rate differentials between Latin America and the developed regions, aided by the recent quantitative monetary easing policies in the advanced economies, has contributed positively to increasing the participation of foreign investors in local-currency debt markets, in particular, in the more liquid ones for local-currency securities, as Mexico and Brazil (see IIF (2012)).

During the 1990's, Brazil initiated a gradual liberalization of its financial account, which has produced since then a rise in foreign direct investment and significant inflows of portfolio investments. Between 2006 and 2011, the share of Brazilian public debt bonds in foreign investors' total assets has increased almost three times (CEMEC, 2012). The public debt bonds that have had a major part in their portfolio have been the long-term fixed-rate bonds (see Ajax and Moreira (2010, p. 331))[2].

[1] See Figure 4.1 from IMF (2011). Net flows are the sum of gross inflows and outflows. Outflows are registered with a negative sign.

[2] Fixed-rate bonds are the NTN-F (Notas do Tesouro Nacional – série F) and the LTN (Letras do Tesouro Nacional). The first NTN-F was issued as of December 2003, with maturities in January 2008 – 4 years period. These bonds have bi-annual interest coupons yielding 10% per year and allow for the stripping of the coupons. This characteristic allows investors to decompose these bonds into several fixed-rate "zero-coupon" bonds with different maturities, similar to the existing LTN. (From Secretaria do Tesouro Nacional (2005))

This paper aims at studying the price of assets, which perform as collateral in credit transactions in Brazil, to analyse their response to fluctuations of international net capital flows to the country. House prices are the leading price of assets being considered recently in studies that discuss the effect of international capital flows on the prices of assets[3]. However, local credit lines that use houses as collateral (known as home equity) have so far limited room in the biggest Brazilian banks, estimated to represent at most one percent of total credit operations to the housing sector. In turn, the Brazilian Domestic Federal Public Debt (DFPD) bonds have a special role of being used as collateral in repurchase operations and have, as well, attracted the interest of foreign investors[4]. Therefore, it seems more appropriate to focus on the price of fixed-rate DFPD bonds.

The model developed for Brazil is based on Warnock and Warnock (2005) and Pradhan *et. al* (2011). It started with a selection of economic variables that are considered appropriate in the theoretical and empirical literature for analyzing the impact of movements in foreign capital flows on the price of fixed-rate domestic public bonds issued by EMEs. Our sample covered monthly data from January 2007 to July 2012, since monthly information on nonresident participation in the Brazilian DFPD started only in January 2007.

The present paper contributes to evaluate the effect of foreign capital flows on the short and long run dynamics of the yields of five-year local-currency public debt bonds, by estimating a set of cointegrating equations and error correction models based on Johansen and Juselius (1990). We find that foreign participation in DFPD decreases the long-run yields of five-year-to-maturity local-currency Brazilian DFPD bonds, as Vale (2012) and Peiris (2010, p. 13) also did (See Table A4, in the Appendix).

The outline of the paper is as follows. Section 2 describes the recent literature related to the effect of international capital flows on the prices of public debt bonds. Section 3 presents some stylized facts about foreign participation in Brazilian domestic assets. Section 4 describes the estimation process applied to calculate the impact of

[3] See Favilukis *et al.* (2012) and Tillman (2012).
[4] According to Carta Circular number 3336, published in August 6, 2008, LTN, NTN-B and NTN-F bonds are used in repurchase operations.

international net capital flows on the yields of five-year fixed-rate Brazilian DFPD bonds. The last section concludes.

2. Relation to the Literature

Some recent papers analyse the effect of foreign capital flows on the yields of long-term public debt bonds. Warnock and Warnock (2005) investigate their impact on the yields of ten-year-to-maturity bonds from the United States Treasury. In particular, they consider that bond yields are forward-looking and, consequently, their model includes expected inflation and expected growth, besides the budget deficit, the interest rate risk premium and variables that capture the effects of monetary and fiscal policies. Pradhan *et al.* (2011) apply a similar procedure to a group of selected EMEs, including Brazil. Peiris (2010) use panel data for a group of ten EMEs with an approach based on Baldacci and Kumar (2010) to select the macro-financial control variables[5]. These papers find significant effect of foreign flows on the prices of local-currency bonds.

Myiajima *et al.* (2012) do not use explicitly international foreign capital flows or foreign participation on the public debt as control variables, but instead include their determinants. Their estimation, based on panel-data models, aims at evaluating the effects of external and domestic factors on the yields of local-currency public debt bonds. They find that domestic factors have prevailed as determinants of the EME's bond yields for a group of 11 EMEs that includes Brazil for the time period from January 2000 to December 2011[6].

For the specific case of evaluating the impact of foreign participation on the yields of Brazilian public debt bonds, Vale (2012) develops a specific model for the Brazilian case based on an identity established between the change of the DFPD in two consecutive periods and the public sector borrowing requirements. It is estimated by vector autorregression and applied for the yields of five-year fixed-rate local-currency

[5] Baldacci and Kumar (2010) are also concerned about the determinants of local-currency public bond yields, but they focus on the effects of fiscal deficits and public debt, instead of foreign participation, on the sovereign bond yields.

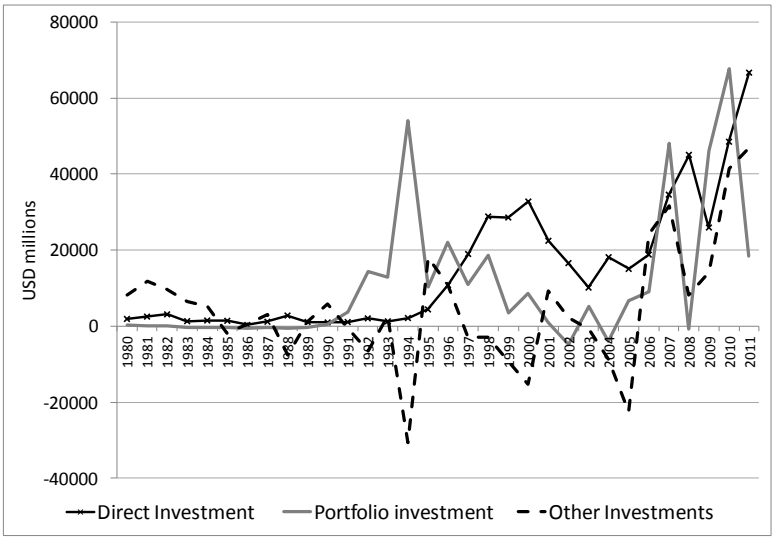
[6] As in Warnock and Warnock (2005), Miyajima *et al.* (2012) also use forecast variables in order to solve an endogeneity problem that arises, because of the effect of the state of the business cycle on interest rates (see Laubach (2003)).

federal government bonds for the period January 2005 to November 2010. The present paper focuses on identical long-term bonds, but uses an alternate model.

3. Recent evolution of foreign participation in Brazilian domestic assets

In response to the financial opening to international capital flows, Brazil experienced during the second half of the 1990's a rise in foreign direct investment and significant inflows of portfolio investments, especially in 1994, 1996 and 1998. As shown in Figure 1, net portfolio investment portrays a sharp rise after 2006, reaching 68 billion dollars in 2010[7].

Figure 1: Annual Net Foreign Capital Flows to Brazil during 1980-2011



Source: Banco Central do Brasil.

However, they fell sharply in 2008, following the collapse of the Lehman Brothers on September of this year, and also, in 2011, as a result from the Brazilian government raising the tax rate on financial transactions (the IOF tax rate) on foreign portfolio investment[8]. The analysis in Forbes *et al.* (2012), using dataset from Emerging Portfolio

[7] As pointed out by Vale (2012, p.6), Brazil obtained the status of "investment grade" in April 2008 that contributed to a rise in foreign inflows.

[8] During the period 2007-2013 Brazil taxed with different IOF tax rates the foreign-exchange transactions related to foreign capital inflows towards local capital and financial markets. The rates in percent and dates at which they were established are the following: 1.5, in March 2008 (Decreto 6.391); zero, in October 2008 (Decreto 6.613); 2.0, in October 2009 (Decreto 6.983); 4.0, in October 4, 2010 (Decreto 7.323); 6.0 in October 18, 2010 (Decreto 7.323); and zero in June 2013 (Decreto 8.023).

Fund Research (EPFR), shows that increased capital controls during 2006 to 2011 caused investors to reduce the share of their portfolios allocated to Brazil.

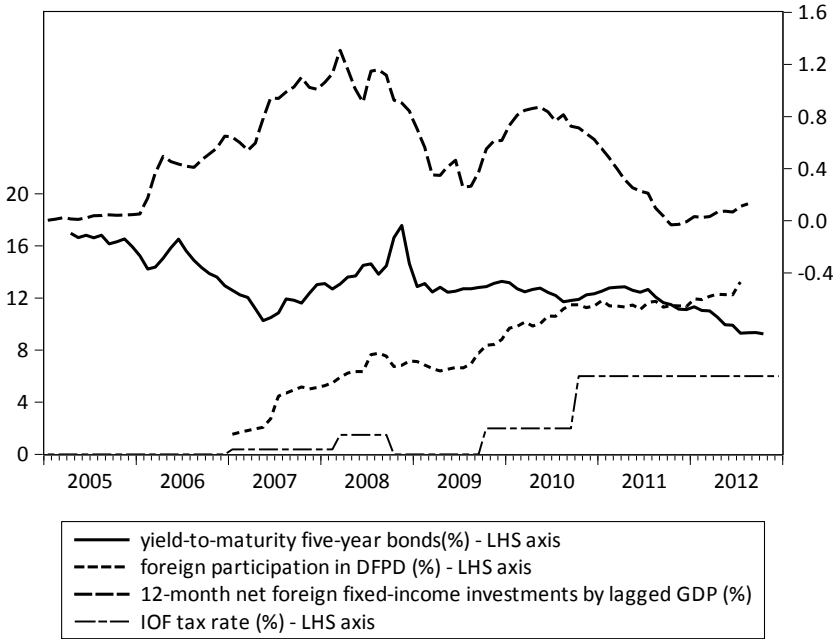
Foreign investors' portfolio in Brazil have been mainly constituted of investments in equities during the period 2000 to 2011 (see Table A1, in the Appendix), but the shares of their total assets allocated in public debt bonds and in investment funds have also been meaningful. In particular, between 2006 and 2011, the share of investments in public debt bonds increased from 11 to 28 percent in the total assets of foreign investors. The higher demand for federal public debt bonds since 2006 has taken advantage of a reduction to zero of the income tax rate on the returns accrued to investments, made by nonresident investors, in DFPD bonds or in mutual funds that are comprised of 98 percent of these bonds [9,10]. According to the Brazilian National Treasury data, when nonresidents' investments in public debt bonds and in funds constituted of public debt bonds are added, their share in the DFPD rises almost linearly, from 1.8 percent in December 2000 to 15.4 percent eleven years later. The public debt bonds that are mainly held by nonresident investors are the fixed-rate bonds, represented by the NTN-F and the LTN bonds (see Figure A1, in the Appendix).

A negative relation between the yields of five-year fixed-rate local-currency Brazilian domestic public debt bonds and the participation of foreign investors in the total DFPD is indicated in Figure 2. A stronger negative relation between the two series is more evident after August 2009. Yields are obtained from the term structure of interest rates (ETTJ PRE) estimated by *Associação Brasileira das Entidades dos Mercados Financeiro e de Capitais* (ANBIMA), which are similar to the "generic local currency domestic government bonds", published by Bloomberg and used in Peiris (2010).

[9] This decision was taken by the Brazilian federal government under Medida Provisória 281, from February 16, 2006. It was converted into Lei 11.312 in June 27, 2006. See Costa (2008, p. 8) and http://www.planalto.gov.br/ccivil_03/_Ato2004-2006/2006/Lei/L11312.htm.

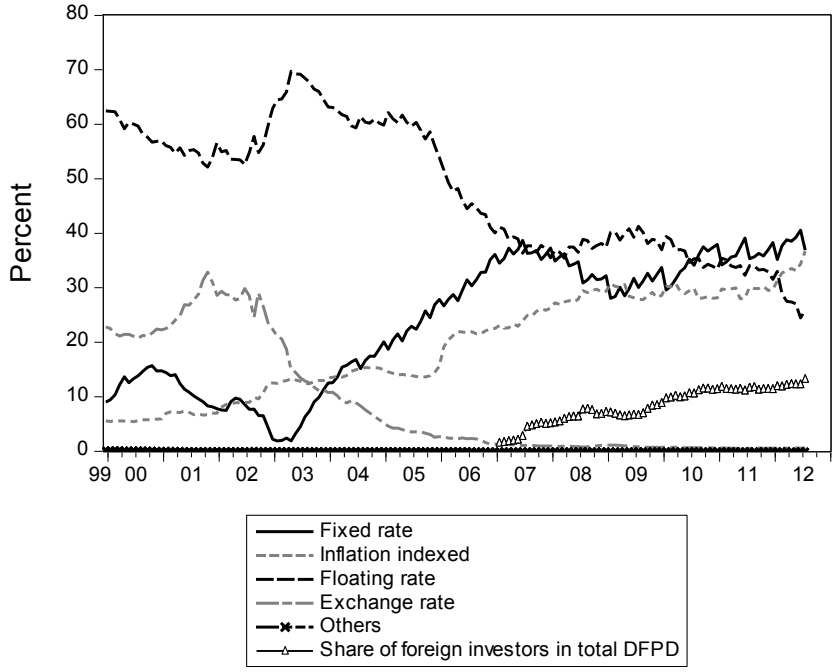
[10] Moreira and Rocha (2010) mention that a report made by the *Associação Nacional das Instituições do Mercado Financeiro* (ANDIMA), at the time this government decision was taken, forecasted that the increase in the demand for DFPD bonds would cause a reduction in long-term interest rates, since foreign investors have a preference for long-term bonds. However, Moreira and Rocha (2006) showed a fall in prices, which is opposed to what is expected by the ANDIMA's report. They attribute their result to a simultaneous rise in the public offerings of public bonds.

Figure 2: Nominal yields, international capital flows and the IOF tax rate



Source: Bloomberg, Secretaria do Tesouro Nacional and Banco Central do Brasil.

Figure 3: Composition of the DFPD relative to different types of bonds



Source: Tesouro Nacional - Anexo Relatório Mensal da Dívida Jul. 2012 – Table 2.5

The share of foreign investors in total DFPD rose during the period 2007-2012 as their demand increased. In Figure 3, since 2002-2003, the share of fixed-rate bonds and the share of inflation-indexed bonds in the total DFPD increased significantly, meanwhile the share of floating rate bonds substantially decreased. However, these movements smoothened starting in 2006 and the share of the three main types of bonds (fixed-rate, inflation-indexed and floating-rate) in the total DFPD has been maintained in the interval between 20 and 40 percent. As their shares did not fell significantly during this period, the higher share of foreign investors reflects the rise in their demand.

4. Estimation

Our model specification is based on the following linear reduced-form equation:

$$r_t^{LT} = c + \beta_1 r_t^{ST} + \beta_2 \pi_t^e + \beta_3 x_t^e + \beta_4 \rho_t + \beta_5 f_t + \beta_6 y_t^e + \beta_7 d_t + \beta_8 r_t^* + \beta_9 \theta_t + \beta_{10} B_t + \varepsilon_t$$

where, r_t^{LT} denotes nominal yields of five-year fixed-rate local-currency Brazilian federal government bonds, expressed in percentage points. To capture the effect of local monetary policy on long-term rates, the target short-term (Selic) interest rate, r_t^{ST}, is used. As nominal interest rates are function of expected inflation, the one-year ahead expected inflation rate, π_t^e, is included as explanatory variable. Besides, foreign investors calculate their expected returns, not only in real terms, but also denominated in their local currency. Therefore, the expected depreciation of the local currency over the next 12 months, x_t^e, is considered as a determinant of long-term bond yields. As a rise in expected depreciation of the local currency reduces the demand for local-currency bonds, then their yield-to-maturity rises. The interest-rate risk premium, ρ_t, conveys the idea that its decline contributes to lower long-term yields. The fiscal balance, f_t, also influences the yield-to-maturity of long-term government bonds: when it improves, then interest rates decrease; when it deteriorates, they rise. Furthermore, to take into consideration the cyclical position of a country, two alternate variables, y_t^e, are included in the model: the expected economic growth over the next 12 months and the output gap. To control for liquidity effects, the effective rate of reserve requirements, d_t, is used. Whenever this rate is reduced by the government, the amount of public bonds supplied to the market rises, because fewer bonds are needed to fulfill the monetary

authority rule and, as such, their yields increase. As in Miyajima (2012), the yield of an international safe asset, r^*_t, is also included in our model specification to take into account its co-movement with the local-currency bond yield. The IOF tax rate on foreign fixed-income investments, θ_t, is also considered in the estimations and, finally, the share of nonresidents in the DFPD, B_t , is employed to capture the effect of foreign investors demand on the price of fixed-rate domestic government bonds. An alternate variable is also tested: the 12-month net foreign long-term fixed-income investments negotiated in the country scaled by lagged GDP.

Figure 2 shows that foreign participation in DFPD clearly has a trend. Different results are obtained depending on the hypothesis made about this trend. When it is considered trend stationary, it becomes non-significant to explain the behavior of the bond yields in a model of two-stages least squares. Its coefficient shows opposite sign, while the time trend is highly significant. There is an indication that a time trend should be included in the regression. The correlation of the nominal yields of fixed-rate bonds with the time trend is -0.73 and of the foreign participation in DFPD with the time trend is 0.96[11]. However, Enders (1995, p. 252) alerts that it might be difficult to distinguish between a trend stationary and a unit root plus drift process, which is difference stationary. Since there is no theoretical or empirical reason to assume a trend stationary process, the difference stationary hypothesis is also evaluated and produces more appropriate results.

4.1 Data

The sources of the data used in the estimations are as follows. As mentioned before, long-term nominal bond yields, r_t^{LT} , for Brazil are from ANBIMA. The short-term interest rate, r_t^{ST} , is described by the Brazilian monetary policy target rate in the last day of the month, in annual terms[12]. The one-year ahead expected inflation rate and expected devaluation of the local currency are obtained from market expectations time

[11] Greene (1990, p. 178-179) remarks to the danger of drawing conclusions from regressing two variables that have a time trend, but the time trend is not included in the regression.
[12] Series 432, from Banco Central do Brasil - Time Series (http://www.bcb.gov.br/?TIMESERIESEN), hereinafter referred to as BCB Time Series.

series produced in Banco Central do Brasil[13]. The risk premium is proxied by the Brazilian Credit Default Swaps (CDS) spreads, the Emerging Market Bond Index (EMBI) stripped for Brazil and the Chicago Board Options Exchange Market Volatility Index (VIX)[14]. The fiscal balance is the monthly public sector borrowing requirements (PSBR) in percent of GDP[15]. The expected economic growth in the next year is the expected growth of the industrial production and also, the Brazilian output gap measured by the IBC-Br[16,17]. The yield of the international safe asset is the monthly average yield of five-year U. S. Treasury Constant Maturity Rate, from the Board of Governors of the Federal Reserve System. The share of nonresident investors as DFPD holders is available from Tesouro Nacional and the net foreign investment in long-term fixed-income investment negotiated in the country, from Banco Central do Brasil[18, 19].

4.2 Unit root and cointegration tests

Three conventional unit root tests (ADF, KPSS and PP) are used to evaluate if each one the series is stationary[20]. The results (Table A2, in the Appendix) are not so conclusive among the three tests, but we do not reject the null hypothesis that the yield of five-year

[13]Market expectations are obtained at https://www3.bcb.gov.br/expectativas/publico/en/serieestatisticas. The expected inflation is the median of the IPCA-inflation accumulated during the next 12 months and the expected exchange rate is the median of the last day of the month for the next 12 months. The calculation of the expected nominal devaluation rate of the Brazilian Real takes into account the spot rate given by the purchase rate, end of the period, BRL/USD, code series 3695, from the BCB Time Series.

[14] They refer to codes CDS USD SR 5Y Corp PX_LAST in basis points and VIX USA PX LAST, respectively, from Bloomberg. The CDS is a measure of the cost of insuring against default and the VIX, of the investors' risk aversion. Both series correspond to monthly arithmetic average of daily data and are quoted in percentage points. EMBI Stripped series is also from Bloomberg.

[15] See spreadsheet NFSPP.xls, spreadsheet Mensal - % PIB, in http:///www.bcb.gov.br/?SERIEFINPUB to obtain the series for PSBR nominal and primary. These series are seasonally adjusted by X-12.

[16] The expected economic growth in the following year is the median of market expectations obtained at https://www3.bcb.gov.br/expectativas/publico/en/serieestatisticas.

[17] The output gap is calculated as the log-difference between the IBC-Br seasonally adjusted series (series 17632 from BCB Time Series) and this same series filtered with the HP filter.

[18] Nonresident holders of federal public bonds include accounts of nonresidents created by Circular Letter No. 3278 of 18.6.2007. (See Table Annex 2.7 – Holders of Securities Public, of the Federal Public Debt Monthly Report, April 2012, published by Secretaria do Tesouro Nacional at http://www.tesouro.fazenda.gov.br/hp/relatorios_divida_publica.asp). According to footnote 4 of Table 2.7, nonresident investors are physical persons or legal entities and funds and other collective investment entities resident, domiciled or headquartered abroad. It includes securities held by nonresidents through investment funds.

[19] It corresponds to the 12-month moving sum of the net portfolio investment in long-term fixed-income investment negotiated in the country (series 8226 from BCB Time Series) scaled by lagged GDP accumulated in the last 12 months (series 4192 from BCB Time Series).

[20] ADF, PP and KPSS stands for Augmented Dickey-Fuller, Phillips-Perron and Kwiatkowski-Phillips-Schmidt-Shin univariate unit root tests.

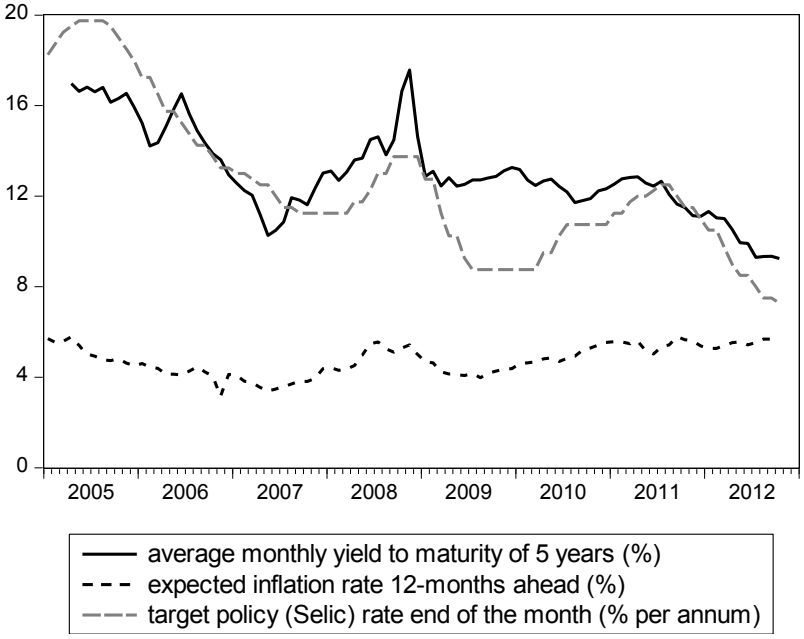
local-currency bonds, the target Selic rate, the participation of foreign investors in the DFPD, the 12-month foreign flows in fixed-income investments relative to lagged GDP and the yield of five-year United States Treasury bonds have a unit root[21]. The tests also indicate that the effective rate of reserve requirements is nonstationary, however a structural break after 2008 (Figure A2, in the Appendix) could help accept a false unit root. The output gap, the fiscal balance in percent of GDP (seasonally adjusted), the expected exchange rate variation 12 months ahead, the VIX, the EMBI country risk premia for Brazil and the Brazilian CDS are all stationary. Furthermore, the unit root tests indicate that the 12-month-ahead inflation expectations possess a unit root. Gomes da Silva and Leme (2011), achieve the same result when the possibility of structural breaks is not taken into account, otherwise, they are stationary with mean reversion. Given their evidence, inflation expectations are considered stationary.

Warnock and Warnock (2005, p.12-13) make the hypothesis that the long-term Treasury yields are cointegrated with both the expected inflation and the Federal funds rate. Figure 4 shows similar variables for Brazil: the nominal yield of NTN-F bonds, the expected inflation rate for IPCA and the target Selic rate. In the present paper, Johansen test is applied to the nonstationary variables. The results are shown in Table 5.

Both the trace and the maximum eigenvalue statistics reject the hypothesis of no cointegration between the yield of five-year Brazilian bonds, target interest rate, foreign participation in DFPD and effective rate of reserve requirements. Following previous studies that find the target interest rate stationary, the Johansen tests also reject no cointegration, when the target interest rate is excluded. Another experiment reintroduces the target interest rate and eliminates the reserve requirement, but it also does not reject one cointegrating vector at 5% level. When the yield of five-year U. S. Treasury bonds is added, a counterintuitive negative sign for this variable shows up, except when 12-month foreign flows in fixed income investments relative to lagged GDP is substituted for the foreign participation in DFPD.

[21] Medeiros *et al.* (2011, p.10-11) applied conventional unit root tests for the annualized monthly nominal Selic interest rate for the period Dec. 2001 to Dec. 2010, and also used other unit root tests that considered breakpoint of unknown date and found that the Selic rate is stationary.

Figure 4: Nominal yield, policy rate and 12-month expected inflation in Brazil



Source: ANBIMA and Banco Central do Brasil - Time Series.

Table 5: Cointegration Tests

Johansen Cointegrating Tests	Between yield, target interest rate, foreign participation and reserve requirement	Between yield, foreign participation and reserve requirement	Between yield, foreign participation and reserve requirement	Between yield, target interest rate and foreign participation	Between yield, target interest rate and foreign participation	Between yield, target interest rate, five-year Treasury and foreign flows relative to GDP
	Model (I)	Model (II)	Model (III)	Model (IV)	Model (V)	Model (VI)
Trace statistic	30.84	32.83	33.40	41.79	31.40	67.34
p-value	0.0377	0.0217	0.0184	0.00133	0.0324	0.00029
Number of cointegrating vectors	2	1	1	1	1	1
Max eigenvalue statistic	35.42	23.22	23.66	37.83	28.61	39.18
p-value	0.00404	0.0250	0.0216	0.00010	0.00369	0.0011
Number of cointegrating vectors	1	1	1	1	1	1

Note: Results are not equal for the same set of nonstationary variables, because of different exogenous variables.

4.3 Cointegration and error correction model

The short-term time path of cointegrated variables is influenced by the deviation from the long-run equilibrium and this effect is represented in an error correction model. The long-run relationship between cointegrated variables is given by the cointegrating vector. Considering the vector found between the yield of five-year Brazilian

bonds, r_t^{LT}, the target interest rate, r_t^{ST}, and the participation of foreign investors in DFPD, B_t, the corresponding vector error correction representation is specified as:

$$\Delta r_t^{LT} = \alpha_0 + \alpha_1\left(r_{t-1}^{LT} - \beta_0 - \beta_1 r_{t-1}^{ST} - \beta_2 B_{t-1}\right) + \xi_1^{(1)}\Delta r_{t-1}^{LT} + \xi_2^{(1)}\Delta r_{t-1}^{ST} + \xi_3^{(1)}\Delta B_{t-1} +$$
$$+ \ldots + \xi_1^{(p-1)}\Delta r_{t-(p-1)}^{LT} + \xi_2^{(p-1)}\Delta r_{t-(p-1)}^{LT} + \xi_3^{(p-1)}\Delta B_{t-(p-1)} + \Theta Z + \varepsilon_t$$

The cointegrating vector is (1,-β_1,-β_2) and the cointegrated variables are r^{LT}, r^{ST} and B, β_0 is a constant. The VEC representation says that changes in the yield of five-year Brazilian bonds are regressed on a constant, (p - 1) lags of its own changes, (p - 1) lags of the other variables in the cointegrated system, an error correction term, a vector Z of control variables and the error term, ε_t. After experimenting with a broad set of control variables, the models ended up with six of them: the fiscal balance in percent of GDP, the volatility index (VIX), the output gap, the IOF tax rate, the first difference of the five-year U.S. Treasury yield and the rate of reserve requirements. A dummy variable for December 2008 is also used. The five-year yield on U.S. Treasury bonds is included in first difference in models (I) to (V), because of its counterintuitive sign, when it is in a cointegrating equation. Table 6, which presents the results from VEC estimations of the six models, shows that, in models (I) to (V), a rise in the monthly rate of change of the yields of five-year U.S. Treasury bonds has a positive and significant effect on the rate of change of the yield of five-year Brazilian bonds, as expected. Both the Schwarz and the Hannan-Quinn information criteria indicate that the model with just one lag should be selected in all cases.

Table 6 also indicates that models (IV) and (V) are the ones with highest adjusted R^2 and with the coefficient of foreign participation in DFPD presenting the expected sign and magnitude similar to previous studies. In particular, the cointegrating relation suggests that a one-percentage point increase in foreign participation in DFPD reduces the five-year Brazilian bonds by 7 bps in the long run (β_2 = -0.0712 in model (IV) and β_2 = -0.0700 in model (V))[22]. Pradhan *et al.* (2010) estimate 4 bps and Vale (2011), 6.58 bps. Peiris (2010), working with quarterly data, finds a reduction of 6 bps[23]. Model (IV)

[22] 100 bps = 1 percentage point = 1%

[23] In order to compare the estimated coefficients in each model with the ones obtained in previous works, the last column of Table A4 shows the results of Warnock and Warnock (2005), Baldacci and Kumar (2010), Pradhan *et al.* (2011), Peiris (2010) and Miyajima *et al.* (2012).

also shows that the coefficient of the cointegrating equation (known as the speed of adjustment after deviations from long-run equilibrium) is significant at one percent level, negative and with absolute value less than unity. Therefore, the disequilibrium error is corrected at a reasonable pace and the short-term changes in the yield of five-year Brazilian bonds are affected by the foreign participation in DFPD. The significance of speed of adjustment coefficient assures that the Model (IV) has an error correction representation. Analogous inference is obtained with Model (V).

Table 6 also presents the results from other VEC estimations related to alternate cointegrating vectors. Models (I), (II) and (III) that include the apparent nonstationary effective rate of reserve requirements, d_t, produce long-run equilibrium equations with the expected negative sign for both the foreign participation in DFPD and the effective rate of reserve requirements, but with a much higher magnitude than models (IV) and (V). The plausible assumption that the effective rate of reserve requirements could be unsuitably considered nonstationary and its elimination from the group of cointegrated variables ended up adjusting successfully the magnitude of the coefficient of the foreign participation in DFPD to levels obtained previously in other papers.

Comparing all models, the results from Model (VI) have some distinguishing features. The coefficient of foreign flows relative to GDP is significant at the 10% level in the cointegrating vector, as well as, the coefficient of its lagged first difference in the error correction model. These characteristics are not found in the other models that include the foreign participation in DFPD as explanatory variable. According to the cointegrating relation, a 0.1 percentage point (10 bps) increase in the ratio of the 12-month foreign flows relative to GDP reduces the yield of five-year fixed-rate Brazilian bonds by 0.124 percentage points (or 12.4 bps) in the long run[24]. The rate of change of foreign flows relative to GDP also affects with similar magnitude the rate of change of the yield in the short run. Warnock and Warnock (2005, Table 2), applying a different estimation procedure for the United States, find that 0.1 percentage point rise in 12-month foreign flow into Treasury bonds relative to GDP decreases the 10-year yield by 0.023 percentage points, which is almost one-fifth of the result found for Brazil.

[24] Foreign flows relative to GDP have a maximum absolute monthly change of 0.24 percentage points. Following this magnitude, we evaluate the effect of a 0.1 percentage point rise, not 1 percentage point.

However, they consider gross inflows and not, net inflows, which may be causing a negative bias in the estimated coefficient for the U.S. Furthermore, in model (VI), the coefficients of the exogenous variables in the error correction have magnitude and significance levels similar to the other five models, except for the IOF tax rate, which turns out not significant.

To complete our analysis of the error correction models, Table A3 in the Appendix presents the tests to evaluate the normality of the residuals of the estimated models. Normality of the residuals is not rejected at the 10% significance level for the six models. Besides, the hypothesis that skewness and kurtosis of the distribution is not different from those of normal distribution is not rejected at the 10% percent level.

5. Conclusion

To evaluate the effect of international capital flows on the price of Brazilian assets, the present paper considers the foreign participation on the Brazilian DFPD and its impact on monthly yields of five-year fixed-rate bonds for the period from January 2007 to July 2012. An alternate explanatory variable used for this evaluation is the 12-month net foreign flows in fixed-income investments scaled by lagged GDP.

The results show that the effect of foreign participation in the DFPD has a magnitude similar to previous estimations and with the expected negative sign. The present study finds that a one-percentage point increase in foreign participation in DFPD reduces the yields of five-year fixed-rate Brazilian DFPD bonds by 7 bps in the long run, while there are six variables that affect the rate of change of this yield in the short run: the fiscal balance in percent of GDP, the volatility index (VIX), the output gap, the IOF tax rate, the first difference of the five-year U.S. Treasury yield and the rate of reserve requirements. The alternate explanatory variable also affects significantly the yield of Brazilian public debt bonds, not only in the long run, but also, in the short run.

Table 6: VEC Estimates

Cointegrating equation	(I)	(II)	(III)	(IV)	(V)	(VI)
constant	-14.2	-18.8	-19.07	-9.68	-8.67	-9.77
yield	1	1	1	1	1	1
foreign participation DFPD	**0.132**	**0.161**	**0.155**	**0.0712**	**0.0700**	
	1.34	*1.07*	*0.96*	*0.578*	*0.565*	
foreign flows relative to GDP						**1.237***
						1.77
reserve requirements	**0.139*****	**0.183****	**0.194****			
	3.98	*2.45*	*2.42*			
target policy rate	**-0.283****			**-0.309****	**-0.399****	**-0.272**
	-2.08			*-2.00*	*-2.29*	*-1.62*
yield five-year U.S. Treasury						**-0.200**
						-0.633
Error correction						
constant	-1.15	-1.06***	-1.032***	1.088*	0.736	1.236**
	-1.58	*-3.34*	*-3.29*	*1.93*	*1.23*	*2.29*
cointegrating equation	**-0.217****	**-0.280*****	**-0.263*****	**-0.253*****	**-0.159****	**-0.214*****
	-2.37	*-4.34*	*-4.50*	*-3.58*	*-2.27*	*-3.40*
lag D(foreign participation DFPD)	**-0.115**	**-0.153**	**-0.156**	**-0.175**	**-0.106**	
	-0.729	*-0.974*	*-1.00*	*-1.12*	*-0.731*	
lag D(foreign flows relative to GDP)						**-1.287***
						-1.94
D(target policy rate)		**0.0965**				
		0.544				
fiscal balance in percent of GDP	**-0.0758****	**-0.0781****	**-0.0788**	**-0.0707****	**-0.0512***	**-0.0979*****
	-2.41	*-2.55*	*-2.58*	*-2.33*	*-1.78*	*-3.30*
Volatility index	**0.0340*****	**0.0432*****	**0.0422*****	**0.0321*****	**0.0283*****	**0.0273*****
	4.64	*4.96*	*4.92*	*4.13*	4.08	*3.55*
output gap	**21.20*****	**21.34*****	**22.33*****	**27.25*****	**21.82*****	**26.65*****
	5.04	*5.02*	*5.58*	*6.10*	*4.88*	*5.80*
expected inflation	**0.0957**					
	0.704					
iof				**0.0737****		**0.0336**
				2.01		*0.979*
Lag(iof)		**0.06878****	**0.0652****		**0.0533**	
		2.12	*2.08*		*1.41*	
D(yield five-year U.S.Treasury)	**0.562****	**0.505****	**0.493****	**0.534****	**0.351**	
	2.26	*2.08*	*2.04*	*2.18*	*1.52*	
reserve requirements				**-0.0711*****	**-0.0539****	**-0.0674*****
				-3.33	*-2.36*	*-3.29*
dummy Dec 2008					**-1.771*****	
					-3.38	
Observations	65	65	65	65	65	65
Adjusted R^2	0.557	0.574	0.578	0.593	0.653	0.577
Log-likelihood	-31.86	-30.60	-30.90	-29.09	-23.36	-30.35
F-statistic	9.054	9.625	10.74	10.34	11.93	9.74
Lag interval for endogenous	1	1	1	1	1	1

Note: t-statistics in italics and below coefficients. *, ** and *** denote statistical significance at the 10%, 5% and 1% confidence levels, respectively.

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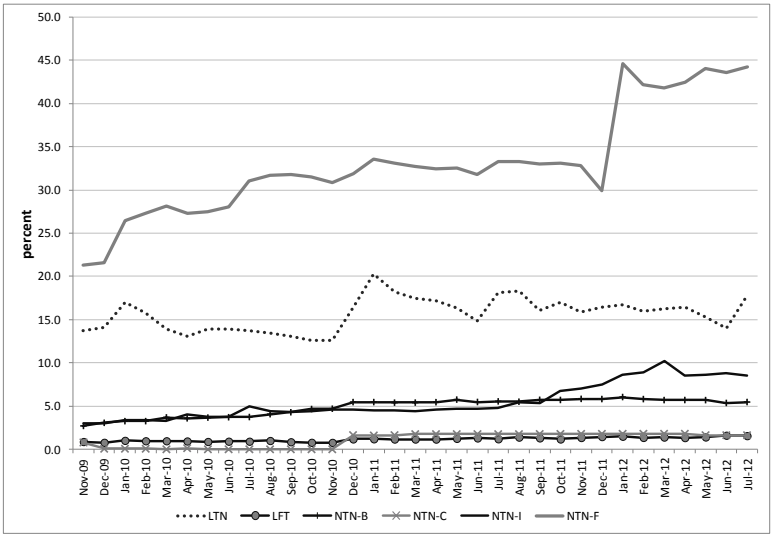
7. Appendix

Table A1: Composition of foreign investors' portfolio - nominal BRL millions and share (italics)

Types of assets	Dec-00	Dec-01	Dec-02	Dec-03	Dec-04	Dec-05	Dec-06	Dec-07	Dec-08	Dec-09	Dec-10	Dec-11
Equities	33306	31812	27450	50452	69515	113812	177440	293519	166745	357222	423538	411598
	79.5%	*73.3%*	*63.5%*	*67.8%*	*69.8%*	*77.1%*	*73.2%*	*71.9%*	*54.0%*	*65.2%*	*62.0%*	*59.4%*
Private debt bonds	360	698	498	564	393	2201	2151	10367	13155	19913	5748	9271
	0.9%	*1.6%*	*1.2%*	*0.8%*	*0.4%*	*1.5%*	*0.9%*	*2.5%*	*4.3%*	*3.6%*	*0.8%*	*1.3%*
Banking deposits	29	29	29	46	62	100	173	303	230	423	506	732
	0.1%	*0.1%*	*0.1%*	*0.1%*	*0.1%*	*0.1%*	*0.1%*	*0.1%*	*0.1%*	*0.1%*	*0.1%*	*0.1%*
Public debt bonds	609	1772	2768	4494	5235	6973	26814	48987	72492	107215	175292	194650
	1.5%	*4.1%*	*6.4%*	*6.0%*	*5.3%*	*4.7%*	*11.1%*	*12.0%*	*23.5%*	*19.6%*	*25.7%*	*28.1%*
Investment funds (public bonds)	7592	9104	12495	18855	24451	24536	35819	55214	56113	63509	77515	76655
	18.1%	*21.0%*	*28.9%*	*25.3%*	*24.5%*	*16.6%*	*14.8%*	*13.5%*	*18.2%*	*11.6%*	*11.4%*	*11.1%*
Total of assets	41896	43415	43239	74410	99656	147623	242397	408390	308734	548283	682600	692905
	100%	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*

Source: CEMEC - Centro de Estudos de Mercado de Capitais, Contas Financeiras CEMEC: Retrospecto 2000 a 2011,Tabelas 8A e 8D, Mar. 2012.

Figure A1: Percentage share of federal securities held by the public in the hands of non-resident clients



Source: Banco Central do Brasil, Notas Econômico-Financeiras para a Imprensa: Mercado Aberto[25], [26].

[25] These shares do not include nonresident participation in investment funds.

[26] The NTN-I are employed for fundraising resources for the payment of interest rate equalization in export financing of domestic goods and services supported by the Programa de Financiamento às Exportações – PROEX. Its nominal value is corrected by the dollar exchange rate. The NTN-B are price-indexed bonds that use the IPCA price index (See Decreto Nº 3.859, July 4, 2001 http://www3.tesouro.gov.br/tesouro_direto/download/legislacao/DECRETO3859.pdf).

Figure A2: Some explanatory variables

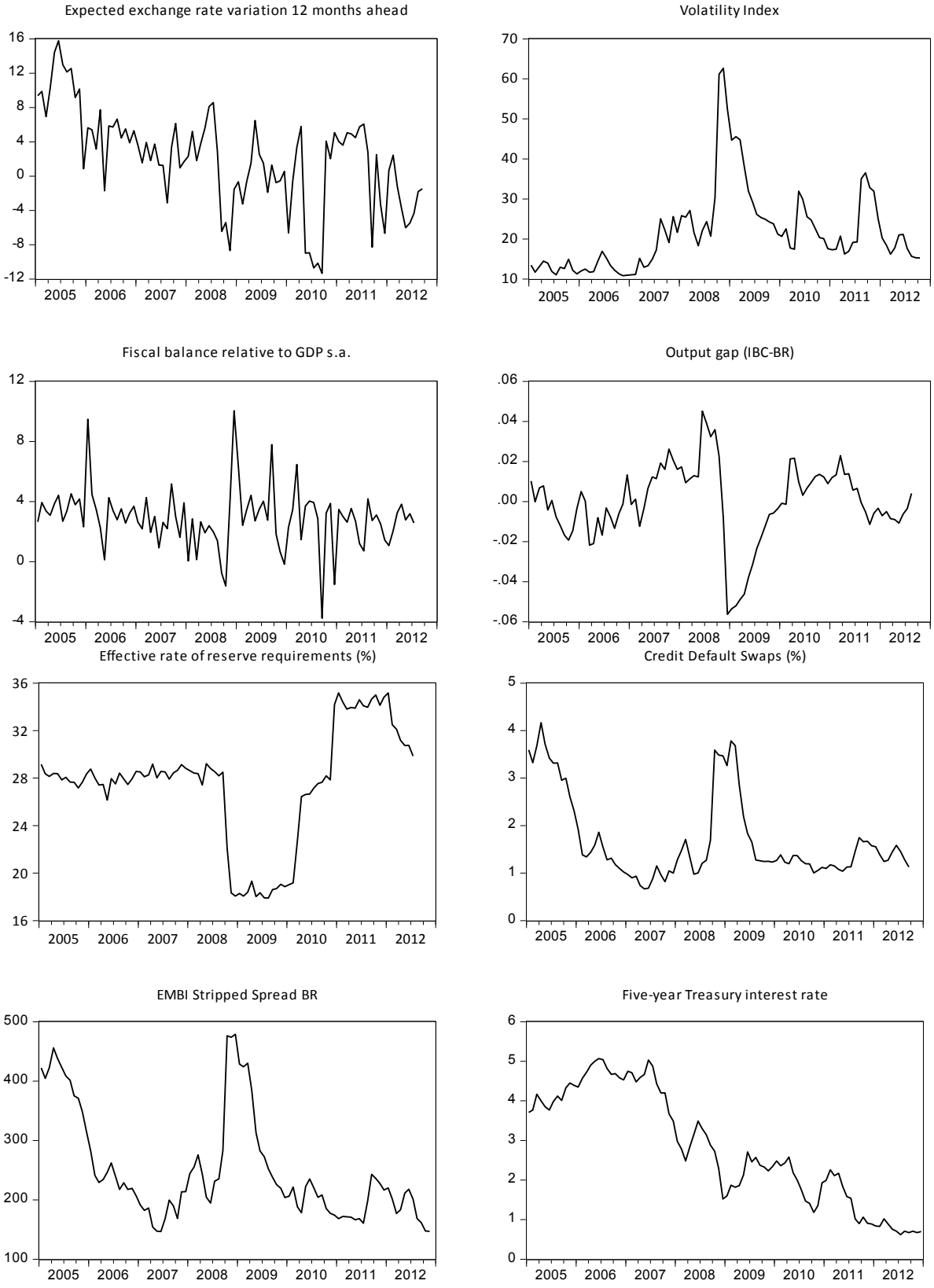


Table A2: Conventional Unit Root Tests

Series	ADF H0: has unit root				PP H0: has unit root				KPSS H0: is stationary			
	Test statistics	Lag	Critical values 5%	Critical values 10%	Test statistics	Band with	Critical values 5%	Critical values 10%	Test statistics	Band with	Critical values 5%	Critical values 10%
Yield to maturity 5-year local currency bonds	-1.610**	2	-1.94	-1.61	-1.55	8	-1.94	-1.61	0.106	6	0.15	0.12
Target interest rate	-4.058*	3	-3.48	-3.17	-1.097	6	-1.95	-1.61	0.0823	6	0.146	0.119
One-year ahead inflation expectation	-0.819	1	-1.94	-1.62	-0.600	3	-1.94	-1.62	0.198*	8	0.146	0.119
Expected industrial production growth over the next year	-2.581**	4	-2.91	-2.59	-4.146*	0	-2.91	-2.59	0.0914	5	0.463	0.347
Fiscal balance in percent of GDP s. a.	-9.201*	0	-3.45	-3.15	-9.161*	4	-3.45	-3.15	0.0987	0	0.146	0.119
Primary fiscal balance in percent of GDP s.a.	-9.394*	0	-3.45	-3.15	-9.484*	4	-3.45	-3.15	0.0817	5	0.146	0.119
Foreign Participation in DFPD (%)	-2.27	0	-3.48	-3.17	-2.27	0	-3.48	-3.17	0.116	6	0.146	0.119
Effective rate of reserve requirements (%)	-0.681	0	-1.94	-1.61	-0.661	3	-1.94	-1.61	0.185*	9	0.146	0.119
Federal funds rate	-3.231**	9	-3.46	-3.16	-2.11	6	-3.46	-3.16	0.143**	7	0.146	0.119
Expected exchange rate devaluation in the next 12 months	-5.282*	0	-3.45	-3.15	-5.319*	2	-3.45	-3.15	0.0745	6	0.15	0.12
VIX	-3.038*	1	-2.89	-2.58	-2.463	0	-2.89	-2.58	0.152*	8	0.15	0.12
Brazilian CDS	-2.531*	1	-1.94	-1.61	-1.492	2	-1.94	-1.61	0.192*	8	0.15	0.12
EMBI BR Stripped	-3.124	1	-3.45	-3.15	-1.629**	5	-1.94	-1.62	0.220*	9	0.15	0.12
12-months foreign flows in fixed-income investments scaled by lagged GDP	-1.372	4	-1.94	-1.62	-1.053	6	-1.94	-1.61	0.233*	9	0.15	0.12
Output gap (IBC-Br)	-3.700*	1	-1.94	-1.61	-3.434*	1	-1.94	-1.61	0.0407**	7	0.46	0.35
5-Year United States Treasury Constant Maturity Rate	-3.135	1	-3.46	-3.15	-2.992	3	-3.46	-3.15	0.109	6	0.146	0.119

The sample sizes are not the same for all series.
* and ** Rejection of the null at 5% and 10% level respectively.

Table A3: Test of residuals - Null Hypothesis (residuals of equation are normal)

Models	(I)	(II)	(III)	(IV)	(V)	(VI)
Skewness (chi^2)	-0.372	0.101	0.0735	0.191	0.167	0.0310
	0.221	*0.751*	*0.786*	*0.662*	*0.683*	*0.860*
Kurtosis (chi^2)	2.61	1.28	1.48	0.705	2.04	0.188
	0.522	*0.257*	*0.224*	*0.401*	0.116	*0.664*
Normality (Jaque- Bera)	1.91	1.39	1.55	0.896	2.64	0.219
	0.385	*0.500*	*0.461*	*0.639*	*0.267*	*0.896*

Note: Number in italics are probability values.

Table A4: Results from Other Estimations

Authors	Country study	Dependent Variable	Sample	Explanatory Variables	Suggested Signs	Empirical results
Warnock and Warnock (2005) *1	EUA	Nominal ten-year U.S. Treasury yield in percentage points.	Jan 1984 - May 2005	long-term (10-year) inflation expectations	positive	A one percentage-point increase in long-term inflation expectations tends to increase nominal yields by 60 basis point.
				short-term (one-year) expected inflation rate relative to long-term one	positive	A one percentage-point increase in long-term inflation expectations tends to increase nominal yields by 50 basis point.
				expected GDP growth in the subsequent year	positive	A one percentage-point increase in expected GDP growth tends to increase nominal by 21 basis point.
				interest rate risk premium	positive	The coefficient is 4.50.
				target federal funds rate	positive	A one percentage point of Fed tightening results in a 40 basis point increase.
				budget deficit as percent of lagged GDP	positive	A one-percentage point increase in the deficit-to-GDP ratio increases rates by 25 bps.
				12-month flows in U.S bonds scaled by GDP	negative	The coefficient is -0.23.
Baldacci and Kumar (2010)	31 advanced and emerging market economies	Nominal yields on 10-year government bonds	Annual frequency from 1980-2007	short-term nominal interes rate	positive	A one percentage point increase in short-term monetary policy rate raises long term bond yields by 70 basis points.
				inflation expectations	positive	A one percentage point increase in inflation expectationd increases long-term bond yields by 10 bps.
				overall fiscal balance in percent of GDP	negative	A one percent increase of the overall fiscal deficit relative to GDP pushes up bond yields by 17 basis points.
				primary fiscal balance in percent of GDP	negative	A one percent increase of the overall fiscal deficit relative to GDP pushes up bond yields by 13 basis points.
				level of gross general government debt in percent of GDP	positive	Varies over time.
				output growth	negative	Not significant, except when primary balance is used.

*1 - The results refer to foreign flows into Treasury bonds.

Authors	Country study	Dependent Variable	Sample	Explanatory Variables	Suggested Signs	Empirical results
Pradhan et al. (2011)	Eight emerging markets	Ten-year bond yields	2 samples: monthly - 2006 m1 to 2010 m12	nonresident participation on local bond matket	negative	A one percentage point increase in nonresident participation reduces long-term bond yields by 4 bps.
				policy rate	positive	A one percentage point increase in the policy rate increases long-term bond yield by 65 bps.
				economic growth	positive	A one percent increase in the year-on-year growth of the 3 month moving average industrial production increase long term yields by 8 bps.
				fiscal balance		Not significant.
				expected exchange rate depreciation	negative (contrary to expected)	A one percentage point depreciation agains the U.S. dollar lower long-term rates by 5 bps.
				risk coefficeint (VIX)	positive	A one percentage point increase in the VIX index adds 4 bps to the bond yields.
				expected inflation	positive	A one percentage point increase in expected inflation increases bond yields by 50 bps.
Peiris (2010)	10 emerging market economies	nominal yield on long-term local currency gov't bonds	Quarterly data from 2000-2009	foreign participation in domestic bond market	negative	A one-percentage point increase in the share of foreign investors in the government bond market tends to lower yields by 6 bps on average.
				short-term nominal policy interest rate	positive	
				inflation	positive	
				fiscal deficit as percent of GDP	positive	A one percent rise in the fiscal deficit to GDP 20 bps.
				level of gross general government debt in percent of GDP		Excluded from the baseline model because it is found to be I(1).
				broad money growth		Not statistically significant.
				real GDP growth		Not statistically significant.
				U.S. long-term nominal Treasury bond yield (UIP)	positive	
				current account deficit (currency risk)	positive	
Miyajima et al. (2012)	11 emerging market economies	nominal local currency government yield	Monthly data from Jan. 2000 to Dec. 2011	one year ahead short rate forecast	positive	A one percentage point increase in short-rate expectations raises yields by 89 bps.
				one year ahead inflation forecast		Not statistically significant.
				one year ahead GDP growth forecast	negative (contrary to expected)	The authors conclude that stronger GDP growth attracts foreign capital inflows, diminishing yields (See Miyajina et al. 2012, p. 10)
				one year ahead forecasts of fiscal balance as percentage of GDP	negative	A one GDP percentage point increase in the fiscal balance reduces yields by 26 bps
				US 10 year yields		Not statistically significant.
				VIX		Not statistically significant.