Inflation targeting and debt: lessons from Brazil *

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1 Introduction

A single variable describes, day by day, what investors think about the state Brazil's economy: the Brazilian component of the Emerging Market Bond Index, the *Embi* spread [1]. This spread is the difference between the yield on a dollar-denominated bond issued by the Brazilian government and a corresponding one issued by the U.S. Treasury: it is thus a measure of the markets' assessment of the probability that Brazil might default on its debt obligations. The Brazilian *Embi* spread was 700 basis points (b.p.) in February 2002 and reached a peak of 2,400 b.p. in July; after the October 2002 elections the spread has gradually fallen: it was 450 b.p. in December 2003, after Brazil's rating was raised from B to B+. (For a comparison, throughout this period the Mexican spread hovered around 300-400 b.p.).[2]

All financial variables in Brazil fluctuate in parallel with the *Embi* spread, most notably the exchange rate. The channel through which fluctuations in the *Embi* spread are transmitted to the exchange rate are capital flows: an increase in the country risk premium leads to a sudden stop of capital flows and to a (real) depreciation which is needed to generate the trade surplus required to offset the decrease in net capital inflows. In turn, fluctuations in the exchange rate induce corresponding fluctuations in the ratio of public debt to gdp, since one half of Brazil's debt (See Table 1) is either denominated in dollars or indexed to the dollar, though payable in the domestic currency: the net public debt, as a share of gdp, was 0.54 January 2002, reached 0.62 in July and was back to 0.55 in October.

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[1] The EMBI index is computed by J. P. Morgan.

[2] For a persepctive on economic developments in Brazil during 1999-2003, the period studied in this paper, see Pastore and Pinotti (2004).

Table 1
Composition of the Brazilian public debt (percent of total), December 2002

\$-denominated bonds issued abroad	*25.8*
domestic bills indexed to the dollar	*23.9*
inflation indexed bonds	*8.5*
fixed-rate bonds	*3.0*
domestic floaters linked to the Selic	*31.1*
other	*7.7*

Domestic interest rates at all maturities are also affected by fluctuations in the *Embi* spread. In the case of the policy rate, the *Selic*, the mechanism works via the exchange rate: exchange rate fluctuations move inflation expectations, and the central bank, as we shall document in this paper, looks at inflation expectations when deciding on the level of the *Selic*. An increase in the *Embi* spread can also affect inflation expectations directly, if it is accompanied by concerns about the possibility of future monetization of part of the public debt.

Domestic interest rates at longer maturities (where "longer" in Brazil today means one to 18 months) are affected by the *Embi* spread in two ways: indirectly, through the *Selic*, because fluctuations in the *Selic* move the term structure, and directly because long term interest rates reflect term premia which are affected by default risk even at relatively short maturities.

The bottom line is that the cost of servicing the public debt fluctuates very closely with the *Embi* spread. Understanding what determines this spread, how it responds to domestic monetary and fiscal policies and to international factors, how it interacts with the exchange rate and domestic interest rates, is thus the necessary first step in order to understand macroeconomic developments in Brazil.

In a number of papers Guillermo Calvo (Calvo et al., 1993, Calvo 2002) has observed that emerging market risk premia are correlated with international factors, in particular with worldwide measures of investors' "appetite" for risk, such as, for instance, the spread between the yield on U.S. corporate bonds and that on U.S. Treasuries. In fact, Calvo goes as far as suggesting that once one accounts for international financial shocks, domestic factors in emerging markets have a limited role in explaining variables such as *Embi* spreads: "Volatility could partly be explained by financial vulnerability in the EMs themselves, but the global nature of the phenomenon raises the suspicion that there are systemic problems largely independent of each individual country. [...] Contagion could stem from the way the capital market operates, *e.g.*, crises generated by margin calls." (Calvo, 2002, p. 1) [3]

[3] While the empirical evidence consistently shows that one of the main determinants of emerging market spreads are international factors, there are different views as to what such factors might be. Kamin and von Kleist (1999) and Eichengreen and Mody (2000) report a negative relationship between the level of long term U.S. interest rates and spreads. Arora and Cerisola (2001) find that the stance and predictability of U.S. monetary policy are also

The experience of Brazil supports Calvo's observation. The Brazilian *Embi* spread is indeed correlated with the U.S. corporate spread, but this correlation is not constant over time. Figure 1 shows the two variables in the top panel, and, in the lower panel, the time profile of their correlation: the coefficients of recursive regressions of the *Embi* spread on the U.S. corporate spread. One of the findings of this paper is that this non-linearity depends on the state of domestic fiscal policy: when the level of the primary budget surplus is large enough to keep the debt-to-gdp ratio stable, the response of the *Embi* spread to the U.S. corporate spread is muted; when instead fiscal fundamentals are weaker the response is amplified. .

[Insert here Figure 1]

The role of domestic fiscal policy in determining the response of the *Embi* spread to international shocks suggests that the effectiveness of inflation targeting may depend on the fiscal policy regime.[4] Consider the effects of a shock to the risk premium which depreciates the exchange rate and raises inflation expectations. When the primary surplus is constantly adjusted so that its level is always large enough to keep the debt ratio stable, inflation targeting works: an increase in the *Selic* offsetts the initial exchange rate depreciation, at least partially. With one half of the debt denominated in dollars, the partial stabilization of the exchange rate limits the impact of higher short rates on the cost of debt service: the increase in the primary surplus needed to stabilize the debt is thus correspondingly small.

Instead, in a fiscal policy regime that keeps constant the level of the primary surplus, an international financial shock may put the debt ratio along an unstable path: in such a situation the economy may fall in a "bad equilibrium" where monetary policy has perverse effects.

The dynamics in the bad equilibrium can be described as follows. With a short duration of the public debt an increase in the *Selic* raises the cost of debt service: if the primary surplus remains unchanged, the debt level rises, and so does the *Embi* spread. The increase in the spread adds to the initial increase in debt, especially since it is accompanied by a depreciation of the exchange rate, which raises the value of dollar-denominated bonds in terms of domestic gdp. The exchange rate depreciation also affects inflation expectations and, eventually, inflation itself. This induces the central bank to increase the *Selic* further, which further raises the cost of debt service, and so on.

The difficulties of running monetary policy in an environment where financial markets think that fiscal policy is unsustainable—in the sense that it violates the conditions for the sustainability of the public debt–are well known. Sargent

significant in determining capital market conditions in emerging markets. Herrera and Perry (2002) consider jointly the importance of US monetary policy and of US corporate bond spreads and allow for different long and short run effects: their results strengthen the evidence on the importance of international factors.

[4] Sims (2003) argues that fiscal policy may render an inflation trageting regime ineffective.

and Wallace (1981) were among the first to point out that a reduction in the growth rate of money can result in higher, rather than lower inflation if the government relies on seigniorage as a source of revenue and the budget surplus is not adjusted after the fall in seigniorage revenue. Sometimes, and often with specific reference to Latin America, this situation has been referred to as a regime of “fiscal dominance” [5]. More recently, but in the same vein, the "fiscal theory" of the price level (as first discussed in Woodford, 1994) has argued that, if the primary budget surplus is exogenous, the price level is the only variable that can balance the government’s intertemporal budget constraint: given an exogenous sequence of budget surpluses, there is only one price level which makes the stock of nominal bonds inherited from the past consistent with the present value of those primary surpluses. Thus, following a shock that raises the cost of debt service, if the sequence of primary surpluses does not change, the price level will have to rise for the government’s intertemporal budget constraint to keep being balanced: this may result in an inconsistency between inflation targeting and fiscal policy (a point shown in Uribe, 2003).[6] [7]

While pointing in the right direction, the fiscal theory of the price level runs into a problem in countries, such as Brazil, where a significant fraction of the public debt is either denominated in a foreign currency, or indexed to a foreign currency. In such a situation a jump in the price level may not be sufficient to balance the government’s intertemporal budget constraint if the primary surplus is exogenous. When debt is dollar-denominated and risk premia are volatile, the channel through which–if the primary budget surplus is exogenous–international financial shocks can destabilize the economy is credit risk.[8] This is what our paper shows with specific reference to the experience of Brazil in 2002-03.

The paper proceeds in three steps. We first document the non-linearity in the response of the *Embi* spread to international financial shocks. Then we study how the *Embi* spread affects the cost of debt service and thus the dynamics of the public debt: we estimate risk premia on various financial instruments and on the exchange rate, and we show that they all move in parallel with the *Embi* spread. Finally, we analyze a small short run model of the Brazilian economy to show how the effectiveness of monetary policy depends on the fiscal policy regime.

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[5] See Tanner and Ramos (2002) for a discussion of fiscal dominance in the context of Brazil.

[6] In the context of Brazil a model with these features is analyzed by Loyo (1999). In Loyo’s model higher interest rates cause the outside financial wealth of private agents to grow faster in nominal terms: this raises inflation. If the central bank responds by raising nominal rates, so that real interest rates increase as well, then a vicious circle might arise. In Loyo’s model there are only one-period bonds. As we show in this paper, term premia and credit risk reinforce the possibility that such a vicious circle might arise, making the fiscal constraint on monetary policy more stringent.

[7] Niepelt (2004) shows, however, that in a rational expectations equilibrium the fiscal theory of the price level does not introduce fiscal effects beyond those suggested by Sargent and Wallace.

[8] Extensions of the fiscal theory to allow for the presence of credit risk are studied in Uribe (2003).

2 Fiscal fundamentals and Brazilian risk

Since 1999, Brazilian public debt, as a fraction of gdp, has steadily increased–in part because the primary surplus, though rising, has never been sufficient to stabilize the debt, in part because, over time, the government has recognized previously hidden liabilities–"skeletons" in Brazilian jargon, particularly in the balance sheets of state-owned banks (see Figure 2) [9].

[Insert here Figure 2]

Looking for domestic factors that might explain Brazilian risk–beyond its correlation with international factors, it is thus natural to start from the level of the debt and of the primary surplus that would be required to keep the debt ratio stable. We have analyzed the possibility that the response of the Brazilian *Embi* spread to the U.S. corporate bond spread is non-linear, and depends on the state of fiscal policy, by estimating the following model which relates the *Embi* spread to fiscal variables [10]:

$$Embi_t = \gamma_0 + \gamma_1 Embi_{t-1} + \gamma_{2,t}^{'} \; Spread_t^{U.S.} + \gamma_3 \Delta Spread_t^{U.S.} + \epsilon_{1,t} \qquad (1)$$

where *Embi* is the Brazil component of the *Embi* spread, $Spread^{U.S.}$ is the spread between the yield on U.S. corporate bonds rated BAA with a maturity between 10 and 20 years, and a 10-year U.S. Treasury bond, and $\Delta Spread^{U.S}$ denotes the first difference of the corporate bond spread. All spreads are measured in basis points. We also include $\Delta Spread^{U.S}$ to capture the effect of jumps in the *Embi* spread, independently of the non-lineraity. The time-varying response of the *Embi* spread to the U.S. spread, $\gamma_{2,t}^{'}$, is non-linear and depends on the state of fiscal policy[11].

$$\gamma_{2,t}^{'} = \gamma_2 \left(1 + e^{-(x_t^* - x_t)}\right)^{-1}$$

[9] For an analysis of the recent dynamics of the public debt in Brazil see Favero and Giavazzi (2002).

[10] The idea of a non-linear response builds on the intuition of Kamin and von Kleist (1999) who find that spreads respond to the interaction between the U.S. term spread and the country's rating.

[11] The non-linearity makes our estimated equation a specific case of the LSTAR (Logistic Smooth Transition Autoregressive) model discussed for instance in Tong (1983). The LSTAR specification is more flexible than a simple interaction term: in our case, for instance, since it allows for the response of term premia to international factors to vary depending on the level of the debt ratio relative to an estimated threshold.

x_t is the primary budget surplus, and x_t^* is the level of the primary surplus that keeps the debt-to-gdp ratio constant.[12] For $x_t = x_t^*$, $\gamma_{2,t}^{'} = \gamma_2/2$; $\gamma_{2,t}^{'}$ rises as x_t falls below x_t^*.

We estimate (1) using lagged variables as instruments to take care of the endogeneity of x_t^*: the debt-stabilizing primary surplus is influenced by the exchange rate, which in turn, as we discussed in the introduction, is correlated with the *Embi* spread. The results are reported in Table 2.

We have also considered an alternative measure of fiscal fundamentals, the deviation of the debt-gdp ratio from an endogenously estimated threshold γ_4: that is $\gamma_{2,t}^{'} = \gamma_2 \left(1 + e^{-(b_t - \gamma_4)}\right)^{-1}$. For debt levels above γ_4 the response of *Embi* to *Spread* $^{U.S.}$ increases (non-linearly) above γ_2. Since the debt ratio is also correlated with the exchange rate, we instrument b with its trend, estimated using a Hodrick-Prescott filter: the filtered variable is no longer correlated with fluctuations in the exchange rate. The value of γ_4 we estimate is about 54 per cent, the level of the net public debt, as a percent of gdp, in April 2002. (see Table 2.) The estimate is rather stable: when we restrict the sample and only use data from August 1999, it remains virtually unchanged; in the shorter sample, however, the elasticity of the *Embi* spread with respect to the U.S. corporate spread is significantly higher. Figure 3 shows the estimated values of $\gamma_2^{'}$, for the specification that makes this coefficient a function of $x_t - x_t^*$.[13]

In the econometric model of the Banco Central do Brazil [14] the equation for the *Embi* spread includes foreign reserves, the current account and debt, all as a fraction of gdp, but not the U.S. corporate spread. The debt variable is significant at the 10 percent level. When we add to our specification foreign exchange reserves and the current account, we find that they are not significant. We also tried including in this regression the *Selic* rate, to test whether monetary policy affects the risk premium directly: it is not significant. This finding suggests that monetary policy affects the risk premium only indirectly, through its effects on the debt level.

We have investigated the robustness of our specification by replacing the U.S. corporate spread with alternative measures of international factors used in the empirical literature: the level of U.S. long term interest rates and the Federal Funds rate. The main result, that is the non-linearity, is preserved.

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[12] $x_t^* \equiv (\frac{\bar{i}_t - n_t - \pi_t}{1 + n_t + \pi_t}) b_{t-1}$ where b is the debt-gdp ratio, π the infaltion rate, n real gdp growth and $\bar{i}$ is the average interest cost of the debt. $\bar{i}_t = (1-\mu)((1+i_t)^{\frac{1}{12}} - 1) + \mu((1 + i_t^{US} + Embi_t)^{\frac{1}{12}} - 1)\frac{S_t}{S_{t-1}}$ where μ is the share of public debt denominated in dollars, or indexed to the dollar, $(1-\mu)$ the share that is linked to the *Selic* rate, i_t, and S_t is the level of the exchange rate. We thus include in the cost of debt service the amortization of $-denominated bonds.

[13] In building Figure 3 we have computed x_t^* assuming that the nominal growth rate of the economy and the average nominal cost of debt service, remain costant over time.

[14] See Kfoury and Lago Alves (2003).

Table 2
Explaining Brazil's Embi spread

Using the level of the deviation of the primary surplus from the debt-stabilizing level
Sample 1999:08 to 2004:01 (TSLS)

γ_0	γ_1	γ_2	γ_3	σ
–	0.85	0.88	4.50	2,05
	(0.06)	(0.44)	(01.10)	

Using the debt level
Sample 1991:02 to 2003:06 (LS using an HP filter for b)

γ_0	γ_1	γ_2	γ_4	γ_3	σ
1.38	0.81	0.44	53.3	4.17	1,63
(0.40)	(0.05)	(0.22)	(2.15)	0.69	

Using the debt level
Sample 1999:07 to 2003:06 (LS using an HP filter for b)

γ_0	γ_1	γ_2	γ_4	γ_3	σ
1.12	0.74	0.71	54.4	4.85	2,17
(0.86)	(0.10)	(0.35)	(1.94)	(1.20)	

[Insert here Figure 3]

3 The *Embi* spread and other risk premia

In economies like the U.S., expected future interest rates account for the bulk of the spread between long-term rates and policy rates: this is because the volatility of future expected policy rates is low and credit risk is not an issue. In emerging markets, on the contrary, the volatility of policy rates is much higher and default risk generates sizeable risk premia. The technique we show in this section allows to identify the role of credit risk in determining the slope of the yield curve.

We start by estimating a monetary policy rule, which we then use to predict the path of future *Selic* rates: comparing these forecasts with observed long term yields (from swap contracts), and assuming no expetational errors, we can build an estimate of the credit risk component of the slope of the yield curve. We shall close the section showing that our estimates of credit risk premia at various maturities are highly correlated with the *Embi* spread.

3.1 *The monetary policy rule*

The best way to describe Brazilian monetary policy since the adoption of a floating exchange rate regime, in February 1999, is through a simple monetary policy rule where the *Selic* rate responds to one-year ahead inflation expectations:

$$Selic_t = \rho Selic_{t-1} + (1-\rho)\left(\beta_o + \beta_1\left(E_t\pi_{t,t+12} - \pi_t^*\right)\right) + \epsilon_{2,t} \quad (2)$$

$E_t\pi_{t,t+12}$ is the one-year ahead expected inflation rate, measured from the daily survey conducted by the central bank and π_t^* is the central bank inflation target. We estimate this rule over a sample that starts in January 2000. [15] The results are:

Table 3
Parameters of the estimated monetary policy rule
Sample 2000:01 to 2004:01

ρ	β_0	β_1	σ
0.92	15.5	4.03	0.59
(0.02)	(1.66)	(1.36)	

β_1, the response of the *Selic* rate to a deviation of inflation expectations from the target, is greater than unity: this indicates that monetary policy does not accommodate inflation, and that real interest rates are raised when inflation expectations increase. The *Selic* rate also appear to be rather persistent, with an autocorrelation coefficient of 0.92.[16].

3.2 *Term premia on"long-term" interest rates*

Since the market for long-dated bonds is very thin, we study domestic long term interest rates using data on swap contracts. These are contracts where one party receives the *Selic* and pays a fixed rate for maturities up to 18 months. What gets exchanged in a swap contract are two flows of interest payments on a notional principal: the principal itself is never exchanged. "Default", in a swap

[15] Both the monetary and the fiscal policy regimes changed sharply after the 1999 devaluation: monetary policy shifted from an exchange rate peg to an inflation target, and the primary budget moved in a few years from balance to a sizable surplus. These policy shifts make the data up to 1999 of limited use for our purposes.

[16] In Favero and Giavazzi (2002) we experimented adding to this monetary policy rule more arguments, such as the output gap and the realized change in the exchange rate. The coeffcients on such variables were not significant and the dynamic simulations of the extended version of the rule did not provide any substantial improvement on the baseline with expectations only. We also experimented estimating the rule with daily data: even at this very high frequency the results are virtually identical. The following Table shows the results using daily data and also adding the survey-based measure of exchange rate expectations and the *Embi* spread on the right-hand side of the monetary policy rule.

Estimation of a monetary policy rule on daily data (January 3, 2000 to February 11, 2004)

	ρ	β_o	β_1	β_2	σ
$-$	0.994	16.6	3.10	$-$	0.20
	(0.002)	(1.40)	(1.05)		
$Embi_t$	0.994	16.2	3.00	$3.17E-06$	0.21
	(0.002)	(2.67)	(1.12)	$(1.72E-05)$	
Δs^e_{t+260}	0.994	16.84	3.2	-0.011	0.21
	(0.003)	(1.72)	(1.47)	(0.034)	

contract, happens when one of the two parties stops paying: if this happens, the other side will do the same, with no loss of principal. There is a loss, but this is limited to the present discounted value of the contract which was interrupted. In other words, there is a loss, but only because investors lose the protection they thought they had bought by entering the swap contract. The default risk on swaps is therefore much smaller than that on bonds, as measured by the *Embi* spread, though both may be affected by the same factors.

To construct a measure of term premia on swaps we start from a no-arbitrage condition. Consider, for simplicity, zero-coupon bonds and define a term premium per period, rather than over the entire life of the bond: then the difference between the one-period expected return of a multi-period bond and the risk-free rate can be written as:

$$E_t\left(p_{t+1,T} - p_{t,T}\right) = i_{t,t+1} + \phi_{t,T}$$

where $p_{t,T}$ is the (log of) the price at time t of a bond maturing at T ; $i_{t,t+1}$ is the one-period return on the safe asset, the *Selic* [17]; $\phi_{t,T}$ is the term premium, defined over a one-period horizon, on the bond maturing at T. As the relation between $p_{t,T}$ and the continuously compounded yield to maturity of a bond with maturity T, $i_{t,T}$, is

$$p_{t,T} = -\left(T-t\right) i_{t,T}$$

we have

$$i_{t,T} - \left(T-t-1\right) E_t\left(i_{t+1,T} - i_{t,T}\right) = i_{t,t+1} + \phi_{t,T}$$

By recursive substitution, we can write:

$$\begin{aligned} i_{t,T} &= \frac{1}{T-t}\sum_{j=1}^{T} E_t i_{t+j-1,t+j} + TP_{t,T} \\ TP_{t,T} &= \frac{1}{T-t}\sum_{j=1}^{T-1} E_t \phi_{t+j-1,T} \end{aligned}$$

We apply this decomposition to fixed interest rates on swaps. The term premium on a T-month Brazilian fixed rate swap reflects, as discussed above, two components: the risk associated with the volatility of policy rates over the life of the swap and some credit risk. We shall proceed as follows. We assume that the central bank inflation target remains unchanged and we use the survey-based expectations to construct a path for expected one-year-ahead inflation. Simulating the estimated monetary policy rule forward we then construct future *Selic* rates, i^F_{t+h} , as:

$$i^F_{t+h} = \hat{\rho} i^F_{t+h-1} + \left(1-\hat{\rho}\right)\left(\hat{\beta}_o + \hat{\beta}_1\left(\pi^e_{t+h+12} - \pi^*_t\right)\right)$$

[17] We assume that the policy rate is a safe asset: the period-return of such an asset thus coincides with its yield to maturity.

where the parameters are those estimated in (2) and h can extend up to 12 months, the longest horizon over which we observe 12-month ahead inflation expectations.

The difference between the yield on a T-period swap, $i_{t,T}^{SW}$, and the appropriate average of future *Selic* rates thus includes two components: the pure term premium and a term which measures how the stream of our interest rate forecasts compares with market expectations, i_{t+j}^{E}:

$$i_{t,T}^{SW} - \frac{1}{T-t}\sum_{i=1}^{T} i_{t+j}^{F} = TP_{t,T}^{SW} + \frac{1}{T-t}\left(\sum_{i=1}^{T} i_{t+j}^{E} - \sum_{i=1}^{T} i_{t+j}^{F}\right) \tag{3}$$

Assuming no expectational errors, we can use (3) to build an observable proxy of the term premium on T-period swaps.

To consider a concrete example of how swap rates decompose between expected future *Selic* rates and term premia, we compare the data for two dates: October 15, 2002, at the peak of the latest Brazilian crisis, and May 19, 2003, after the resolution of political uncertainty and a remarkable tightening of monetary policy. On October 15 the *Selic* rate was 20.90 per cent, while the yield on a 12-month fixed interest rate swap was 32.69 per cent. The total spread, 1.179 b.p., decomposed in a decreasing pattern of expected policy rates coupled with a risk premium as high as 1.315 points. On May the *Selic* was 26.32 while the yield on a 12-month fixed interest rate swap was 23.19 per cent. The inverted yield curve is explained by a decreasing pattern of expected *Selic* rates coupled with a value of the risk premium which had fallen to 275 b.p.

Having constructed a measure of the term premium on swaps, we can now study how it correlates with the *Embi* spread. Before doing that, however, we complete the analysis of term premia studying the exchange rate risk premium.

3.3 *The exchange rate risk premium*

Using the uncovered interest rate parity condition and survey data on exchange rate expectations, we construct a measure of the exchange rate risk premium. For both Brazilian and U.S. interest rates we use swap rates since, as discussed above, the market for Brazilian bonds is too thin to be significant.

$$i_{t,T}^{SW} - i_{t,T}^{SW,US} = (E_t s_{t+T} - s_t) + \textit{exchange rate risk premium} \tag{4}$$

where $i_{t,T}^{SW}$ and $i_{t,T}^{SW,US}$ are, respectively, the interest rates on Brazilian swaps of maturity T and on similar dollar-denominated swaps, and $(E_t s_{t+T} - s_t)$ denotes the survey-based expectations of the percent change in the exchange rate over the life of these swaps. The Brazilian central bank collects, as for inflation expectations, a daily survey of one-year ahead exchange rate expectations: using such surveys, and 12–month U.S. and Brazilian swaps, we are able to measure the exchange rate risk premium.

3.4 *Term premia and the* Embi *spread*

Table 4 shows the correlation between the *Embi* spread, the one-year ahead exchange rate risk premium and the term premia on domestic swaps at three different maturities, 3, 6 and 12 months. For comparison we report an alternative measure of Brazilian default risk derived from credit default swaps. A credit default swap (CDS) is a derivative contract in which a bondholder buys a guarantee that covers him in the event of default: if the underlying bond defaults the buyer of the insurance receives an amount equal to the difference between the face value of the defaulted bond and a conventional recovery rate[18]. From such contracts it is possible to compute the risk premium. The main advantage of CDS's over *Embi* spreads is that CDS's also exist for relatively short maturities and are thus more directly comparable with swaps.

There is a remarkable degree of correlation among the four series. Risk premia measured by CDS's and the *Embi* spread are larger than the term premium implicit in 12-month fixed interest rates swap, consistently with the smaller exposure of swaps to default risk discussed above. The correlation between the risk premium on swaps and the *Embi* spread rises as the maturity of the swaps increases: this is because the longer the life of a swap, the higher the probability that a default event might hit it. On 12-month swaps the correlation is surprisingly high (0.70) especially since the *Embi* spread is computed on 10-year bonds, while swaps have a maturity of just 12 months. The correlation is high also with the one-year ahead exchange rate risk premium indicating that default risk is an important determinant of exchange rate fluctuations

Table 4
Correlation between default risk, term premia and exchange rate risk premia
Sample: 1999:2 - 2003:1

	Embi	e.r. r.p. 12-m	TP 3-m	TP 6-m	TP 12-m	CDS 3-m	CDS 6-m	CDS 12-m	CDS 36-m
Embi	1	0.84	0.31	0.56	0.82	0.88	0.92	0.96	0.98
e.r. r.p. 12-m		1	0.63	0.79	0.89	0.73	0.76	0.80	0.83
TP 3-m			1	0.91	0.66	0.26	0.27	0.29	0.29
TP 6-m				1	0.88	0.51	0.54	0.56	0.55
TP 12-m					1	0.75	0.78	0.82	0.82
CDS 3-m						1	0.97	0.95	0.94
CDS 6-m							1	0.98	0.96
CDS 12-m								1	0.99
CDS 36-m									1

[18] After a default most bonds continue to be traded at positive prices which reflect the expectation of a settlement in which the entity which has defaulted will pay a fraction of the bond's face value. CDS are priced on the basis of conventional post-default trading prices, based on past experience.

4 Inflation targeting, country risk and fiscal policy

The analysis carried out so far helps us understand the way in which domestic fiscal policy and international financial shocks contribute to determine the *Embi* spread and thus the cost of servicing the debt. The next step consists in analyzing the channel through which country risk determines the interaction between monetary and fiscal policy, and how it may prevent the central bank from effectively targeting inflation.

We shall do this by means of a small short run model of the Brazilian economy which focuses on risk, debt, the exchange rate and two policy rules, one for the central bank, the other for the fiscal authorities. Because our focus is on the short run, we take output as given–not an innocuous assumption, since output growth is a critical factor in determining debt dynamics, but unavoidable to keep the analysis simple.[19]

4.1 The exchange rate, the risk premium and the monetary policy rule

We start by showing the effects of the interaction between the exchange rate, the risk premium and the monetary policy rule assuming, for the moment, that the risk premium is exogenous. The result–a negative correlation between the change in the exchange rate and the interest rate differential–has been shown by McCallum (1994) and discussed in the context of inflation targeting by Alexius (2002). The model consists of three equations:

$$i_t = \rho\, i_{t-1} + (1-\rho)\left(\beta_o + \beta_1\left(E_t\pi_{t+12} - \pi^*\right)\right) \tag{5}$$

$$E_t s_{t+1} - s_t = (i_t - i_t^*) + \xi_t \tag{6}$$

$$E_t\pi_{t+12} - \pi^* = \delta_1\left(E_{t-1}\pi_{t+11} - \pi^*\right) + (1-\delta_1)\left[\delta_2(s_t - s_{t-1}) - \pi^*\right] + \epsilon_{3,t} \tag{7}$$

- (5) is the monetary policy rule estimated in section 3.1;
- (6) is the uncovered interest rate parity condition (UIRP) where ξ_t represents the exchange rate risk premium;
- (7) describes the inflation expectations that enter (5). In the case of Brazil these expectations are observed: we can analyze their statistical properties. When we do this, we find that they are autocorrelated and respond to the observed deviation of the rate of exchange rate depreciation from π^*. This motivates (7)

[19] The evidence on the effect of interest rates on output is weak in Brazil. The central bank model finds a (negative) effect of real 12-month swap rates, but the significance of this variable is rather weak. This does not mean that one is allowed to assume the effect away, but the evidence does not suggest a very strong impact, at least in the short run.

Assume, to save notation, $\beta_o = \delta_1 = \epsilon_{3,t} = i_t^* = \pi^* = 0$, and substitute (5) and (7) in the UIRP condition to get:

$$E_t s_{t+1} - s_t = \rho \, i_{t-1} + (1-\rho)\, \beta_1 \delta_2 (s_t - s_{t-1}) + \xi_t \tag{8}$$

Defining $\Delta s_t \equiv s_t - s_{t-1}$ we can re-write (8) as:

$$E_t \Delta s_{t+1} = \lambda \Delta s_t + \rho i_{t-1} + \xi_t$$

where $\lambda \equiv (1-\rho)\beta_1\delta_2$. Assuming rational expectations, the reduced form solution of this equation is:

$$\Delta s_t = -\frac{\rho}{\lambda} i_{t-1} + \frac{1}{\lambda + \rho} \xi_t \tag{9}$$

As discussed in McCallum (1994), the co-movement between chnages in the exchange rate and the interest rate differential described in (9), which is the result of the central bank following a rule such as (5), is one of the ways to explain the UIRP puzzle.

4.2 Inflation targets, country risk and fiscal policy

We now extend the model of the previous section by adding the determinants of the exchange rate risk premium, ξ_t, which, based on our analysis, we assume to coincide with the *Embi* spread and thus to be determined as in (1). We also add a fiscal policy rule, which is needed to determine $(x_t - x_t^*)$ and thus the response of the *Embi* spread to international shocks:

$$x_t = \varphi x_{t-1} + (1-\varphi) x_t^* + \epsilon_{4,t} \tag{10}$$

for $\varphi = 0$ the primary budget surplus keeps the debt ratio constant at all times; for $\varphi = 1$ the primary surplus is exogenous.[20].

When we add to the model of equations (5) through (7) equation (1), the non-linear equation for the *Embi* spread, we are no longer able to derive analytically a reduced form solution such as (9): we have thus estimated (9) using the *Embi* spread as an explanatory variable and allowing for an error term reflecting

[20] Following the terminology used by Woodford (1994), the two rules can be labeled *Ricardian* and *Non Ricardian,* respectively.

deviations from UIRP other than the risk premium.[21] Using lagged variables as instruments we obtain the following estimates:

Table 5
A reduced form exchange rate equation
Sample 1999:02 to 2003:12 (TSLS)

$$\Delta s_t = \alpha_1 \left(Selic_{t-1} - i^{US}_{t-1} \right) + \alpha_2 Embi_{t-1} + \alpha_3 \Delta (Embi)_t + \epsilon_{5,t} \tag{11}$$

α_1	α_2	α_3	σ
-0.16	0.38	2.64	3.74
(0.06)	(0.11)	(0.42)	

The coefficient on the interest rate differantial is negative: for a given U.S. Fed Fund rate, a one percent increase in the *Selic* appreciates the exchange rate by 0.16 percent. The *Embi* spread enters with a positive coefficient: a higher risk premium induces a depreciation. Note, however, that these are partial equilibrium effects. Both the *Selic* and the *Embi* spread are endogenous: it is impossible, from this equation, to conclude what is the overall effect of monetary policy on the exchange rate. In the bad equilibrium, following an increase in the *Selic*, the additional cost of debt service could induce a large increase in the default risk–large enough so that the net effect is a depreciation of the exchange rate. This effect is crucial for determining how monetary policy works.

Consider now the effect of an increase in *Spread* $^{U.S.}$. The direct effect of the shock is an exchange rate is a depreciation: $\left(\gamma_2^{'} + \gamma_3\right)(\alpha_2 + \alpha_3)$ The extent to which monetary policy responds to the shock depends on its effect on expectations. The increase in the *Embi* spread, and the accompanying exchange rate depreciation, raise inflation expectations: the reaction of the central bank dampens the initial depreciation, so that the overall effect on the exchange rate remains ambiguous–it is $(\alpha_2 + \alpha_3)\left[1 - \alpha_1 \delta_2 (1 - \delta_1) \beta_1 (1 - \rho)\right]^{-1}$ with $\alpha_1 < 0$.

This, however, is not the end of the story. The shock raises x_t^*, both because the exchange rate depreciation raises the debt stock, measured in units of domestic goods, and because domestic interest rates also increase. If $\varphi = 0$, x_t will adjust one to one to match the increase in x_t^*: the burden of adjusting to the financial shock falls entirely on the fiscal authorities, while the central bank maintains the control of inflation. For $\varphi = 1$, x_t remains constant and $(x_t^* - x_t)$ increases. This raises $\gamma_2^{'}$ and amplifies the effect of the financial shock on the risk premium. The result is further exchange rate depreciation, a further rise in

[21] An alternative consists in estimating (8) directly. This is the route followed by Blanchard (2004): he also finds a violation of UIRP.

A simple example helps understanding why we may observe a negative correlation between the expected depreciation and the interest rate differential. Assume $E_t s_{t+1} - s_t = i_t + \xi_t$, and $i_t = -\alpha \xi_t$, that is monetary policy responds directly to the exchange rate risk premium: an increase in,ξ_t leads to lower domestic interest rates. Then $E_t s_{t+1} - s_t = -\left[(1-\alpha)/\alpha\right] i_t$: in other words, the reason for the negative correlation is the deviation from UIRP (ξ_t), coupled with a monetary policy rule that responds to ξ_t.

the debt ratio, a further increase in x_t^*, and so on. The economy settles along an unstable path, where debt increases and the central bank is unable to control inflation.

4.3 *The experience of Brazil*

In this section we use the model just described to understand the interaction between country risk and monetary and fiscal policies in Brazil. We do this by simulating the model under two alternative fiscal rules: one that keeps the primary surplus constant [22], and an "almost Ricardian" rule, such as (10) for $\varphi = 0.75$ [23]. We take as starting conditions those prevailing in June 2002. We choose this date because this is when the *Embi* spread jumps above 1,000 b.p.–a level the spread had never reached after the 1999 devaluation–,the exchange rate starts depreciating and, most importantly, inflation expectations start rising. Since, as we have seen, monetary policy reacts to inflation expectations, this is when the action starts.

The model is composed of four equations: (5), (7), (11) plus the fiscal policy rule. To run the simulation under the "Ricardian" rule we also need estimates of $x_t^* \equiv \left(\frac{i_t - n_t - \pi_t}{1+n_t+\pi_t}\right) b_{t-1}$. This requires that we specify the dynamics of inflation and output growth. One way would be to calibrate these two equations using, for example, the demand and supply equations estimated in the small econometric model of the Banco do Brazil. We choose the alternative route of fitting a very simple autoregressive process for real GDP growth [24], and for inflation a model that is consistent with (7), the statistical properties of the observed inflation expectations.

We run the two dynamic simulations proceeding as follows:

- As already mentioned, we take as initial conditions those prevailing in June 2002: $b = 0.55$, $x = 0.035$, $\pi^e = 0.0049$, $\pi^* = 0.055$, $i = 0.184$, $i^{US}_{FedFund} = 0.018$, $Spread^{\,US} = 350\ bp$;
- In the simulation we keep all exogenous variables constant, except for π^* which we allow to follow the path announced, in January 2003, by the central bank: 0.085 in 2003 and 0.05 in 2004 [25].

[22] This is essentially the fiscal rule followed by the Brazilian authorities since the 1999 devaluation and up to the 2002 election. When we estimate such a rule we find: $x_t = 3,86(1-0,75)+0,75x_{t-1}$. There is no evidence of a reaction of x_t to x_t^*: the primary surplus is very persistent and the estimated long run level (3.86 per cent of gdp) is below the sample average for x_t^*.

[23] This exercize clearly defies the Lucas critique.

[24] The evidence on the effect of interest rates on output is weak in Brazil. The central bank model finds a (negative) effect of real 12-months interest rates, but the significance of this variable is rather weak. This does not mean that one is allowed to assume the effect away, but the evidence does not suggest a very strong impact, at least in the short run. The output growth equation we estimate is $n_t = \gamma_1 + \gamma_2 n_{t-1} + u_t$.

[25] We keep the target constant at 0.085 throughout 2003; in 2004 we allow it to fall gradually, reaching 0.05 in December.

The results of the dynamic simulations under the two fiscal rules are shown in Figure 4.

In June 2003 12-months ahead inflation expectations rise above the target and the central bank raises interest rates. Under the "Non Ricardian" fiscal rule (the dotted line in each of the six panels) the *Selic* eventually rises above 30 percent, and the *Embi* spread increases: the sharp monetary tightening cannot prevent the depreciation of the exchange rate and inflation expectations stabilize around 12 percent. The debt ratio explodes. [26]

When fiscal policy reacts (with $\varphi = 0.75 < 1$) to fluctuations in x^*, monetary policy is effective at stabilizing inflation expectations: this happens because the *Embi* spread, after the initial shock stabilizes. The fiscal rule tightens the primary surplus, but eventually, as the economy stabilizes, the budget can be gradually relaxed. The fiscal tightening is particularly severe because the rule is not fully Ricardian: for $\varphi = 1.0$ the primary surplus would not need to increase so much. [27]

[Insert Figure 4 here]

5 Conclusions

Studying the recent experience of Brazil we have understood how default risk is at the centre of the mechanism through which a central bank that targets inflation might lose control of inflation–in other words of the mechanism through which the economy might move from a regime of "monetary dominance" to one of "fiscal dominance". The literature, from Sargent and Wallace (1981) to the modern fiscal theory of the price level has discussed how an unsustainable fiscal policy may hinder the effectiveness of monetary policy, to the point that an increase in interest rates can have a perverse effect on inflation. We have shown (consistently with the findings of Blancahrd in this volume) that the presence of default risk reinforces the possibility that a vicious circle might arise, making the fiscal constraint on monetary policy more stringent.

In the experience of Brazil we believe we have identified an interesting episode where this might have happened, at least for a short period during 2002. But the episode also shows how critical the behavior of fiscal policy is. Brazil, during 2002, had probably fallen into a bad equilibrium, where fiscal policy was hindering the effectiveness of monetary policy. But the economy was just over the edge: a small change in the fiscal rule, such as that announced by

[26] In this exercise inflation does not display the explosive behavior described in Loyo (1999) and Sims (2003) in the case of a "non-Ricardian" fiscal regime. This is because the nonlinearity in the response of the Embi spread to the corporate bond spread eventually dies out in our specification.

[27] We also computed the impulse responses to a shock to the corporate bond spread, starting from the same initial conditions. This exercise, however, is not very informative, since it is the non linearity of the model (which impulse responses fail to capture) that is responsible for the sharp difference in results between the Ricardian and non Ricardian case.

the Lula government in January 2003, was enough to bring the economy back to normal conditions, and rapidly reduce the *Embi* spread, stabilize the exchange rate and, through these two variables, inflation expectations, inflation and the dynamics of the public debt.

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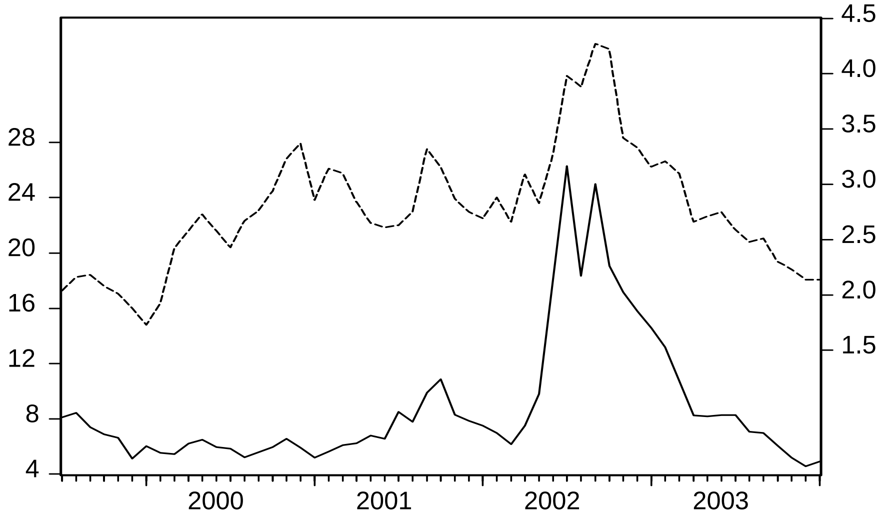
Figure 1

The *Embi* Spread (left scale, percentage points) and the spread between BAA corporate
and the US government bonds (right scale, percentage points)



Coefficients of recursive regressions of the *Embi* spread on the U.S. corporate bond spread

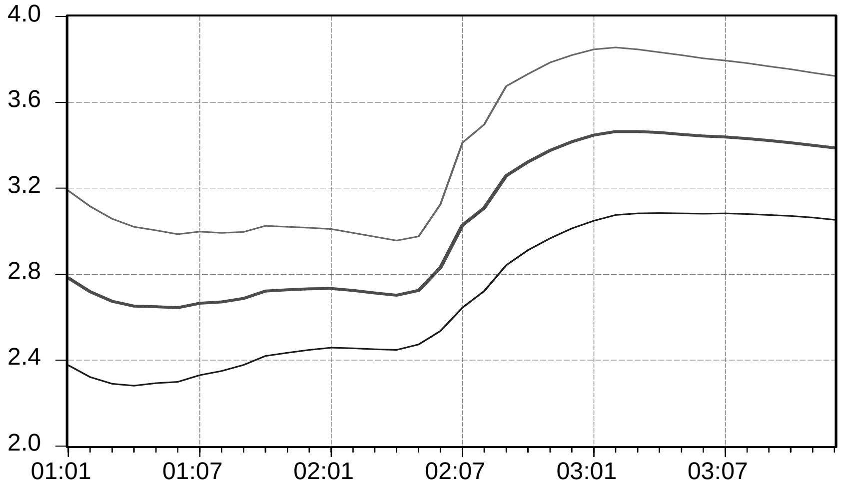


Figure 2
Brazil's net public debt, per cent of GDP

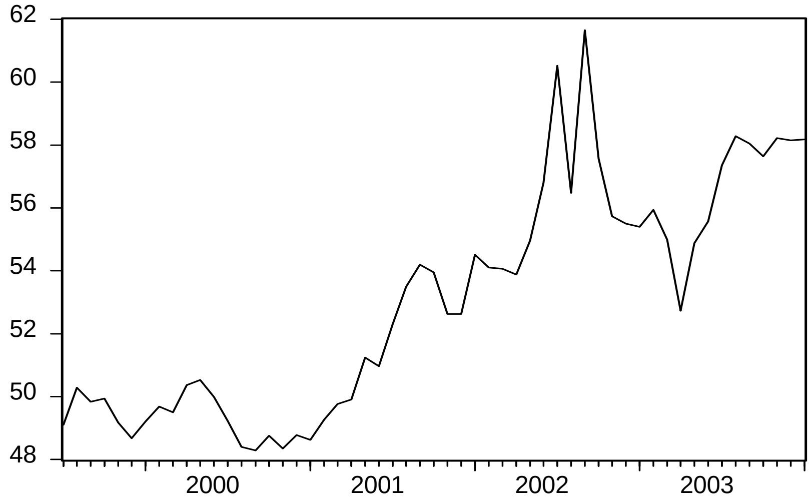


Figure 3
Elasticity of the *Embi* spread with respect to the U.S. corporate bond spread, as a function of $(x - x^*)$

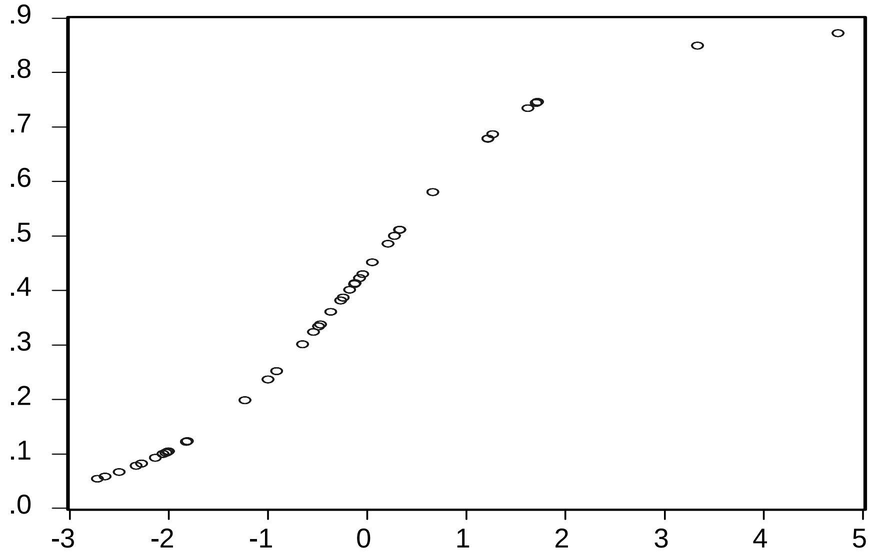


Figure 4
Targeting Inflation with an Exogenous Primary Budget Surplus and a "Ricardian" Fiscal Policy Rule