Monetary policy when debt and default risk are high: lessons from Brazil *

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Brazil is a big economy, the seventh largest in the world, and so are its financial markets, but a single variable synthesizes, day by day, what investors think about the state of this economy: the Brazilian component of the Emerging Market Bond Index[1], the EMBI spread. 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 US Treasury, and 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 (bp) in February 2002 and reached a pick of 2,400 bp in July; after the October election the spread has gradually fallen, returning to 960 in the Spring of 2003 (throughout this period the Mexican spread has fluctuated between 300 and 400 bp).

Many financial variables in Brazil fluctuate in parallel with the EMBI spread, most importantly the exchange rate. One reason are capital flows: an increase in the risk premium leads to a sudden stop of capital flows and to a (real) depreciation needed to generate the trade surplus required to offset the decrease in capital flows. In turn, fluctuations in the exchange rate induce corresponding fluctuations in the ratio od public debt to gdp, since one half of Brazil's debt is denominated in dollars: the net public debt, as a percent of gdp, was below 50 in December 2001, reached 60 in July and was back to 56 in January 2003.

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

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

Domestic rates at longer maturities (where "longer" in Brazil today means one to twelve 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 the price of financial instruments of longer maturities reflect interest rate risk, term premia and default risk. The bottom line is that the cost of servicing the public debt fluctuates very closely with the Embi spread[2]. (See Figure 1 and 2)

Understanding what determines the Embi spread, how it responds to domestic macroeconomic policy and to international factors, how it interacts with the exchange rate and domestic interest rates, is thus the necessary first step to discuss macroeconomic policy in Brazil.

[Insert here Figure 1 and 2]

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 the spread between US corporate bonds and US Treasuries. In fact, Calvo goes as far as suggesting that once one accounts for the US corporate spread, domestic factors in emerging markets appear to be irrelevant in explaining the spread.

The evidence that we present for Brazil supports Calvo's observation, but with an important caveat. The Brazilian Embi spread is indeed correlated with the US corporate spread, but we find that such correlation is not constant over time, but depends on the state of domestic macroeconomic fundamentals, fiscal fundamentals in particular. When these are sound, the response of the Embi spread to the US corporate spread is muted, compared with periods when the state fundamentals is relatively weaker.

This finding has important implications for monetary policy in Brazil. It suggests that there may be two very different monetary policy regimes, depending on the state of fiscal policy. In the "good" one, the risk of default

[2] The correlation is even stronger if one includes, in the computation of the interest burden of the debt, the effect of exchange rate depreciation.

is low and monetary policy works in the usual way. Instead, when fiscal fundamentals are weak, the risk of default increases and the economy may shift to a "bad" equilibrium, where monetary policy can have perverse effects.

The dynamic effects of monetary policy 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 budget deficit 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 if 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 in the Selic further, which further raises the cost of debt service, and so on.

The idea that Brazilian inflation might be driven by the fiscal effects of monetary policy is not new. Loyo (1999) analyzed a model in the tradition of the fiscal theory of the price level, following Woodford (1994), Leeper (1991) and recently used by Sims (2003) to highlight the limits to inflation targeting. In Loyo's model higher interest rates cause the outside financial wealth of private agents to grow faster in nominal terms: this results in higher 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 a vicious circle might arise, making the fiscal constraint on monetary policy more stringent.

But the main contribution of this paper is empirical. We estimate a simple model of the Brazilian economy which focuses on a few variables: the Embi spread, the exchange rate, domestic interest rates, inflation, the survey-based measure of inflation expectations and the dynamics.of the public debt. Using this model we estimate the threshold beyond which the economy might fall into a bad equilibrium: we find that this corresponds to a level of the ratio of net public debt to gdp, close to the level it reached in the Spring of 2002, 55 percent. We then analyze the dynamics of the main variables in the bad equilibrium.

We find that in Brazil, inflation expectations are very sticky. Thus one of the main channels of the interaction between debt and inflation in the "fiscal theory" papers is hampered. However, our model shows that an increase in interest rates, in absence of fiscal stabilization, raises inflation, as in Loyo's model, but through a different channel: the effect of credit risk and term premia which respond to a monetary tightening and in turn determine the dynamics of the public debt. Finally we use our model to investigate the effectiveness of monetary policy in controlling inflation in three different fiscal environments: a mildly Ricardian one, a strongly Ricardian one, and an exogenous, constant primary deficit rule..

We start by analyzing what drives the Embi spread.

1 Explaining the Embi spread

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 US interest rates and spreads. Arora and Cerisola (2001) find that the stance and predictability of US monetray policy are also significant in determining capital market conditions in emerging markets. Herrera and Perry (2002) consider jointly the importance of US monetary policy and of the US corporate bond spreads and allow for different long and short run effetcts: their results stregthen the evidence on the importance of international factors.

Calvo (2002), as noticed above, has made a strong case for the importance of worldwide measures of investors' "appetite" for risk, such as the spread between US corporate bonds and US Treasuries, in explaining the Brazilian component of the Embi spread.[3] The correlation, pointed out by Calvo (2002), between the Brazilian Embi spread and the US corporate spread, has been mostly driven by the coincidence among three events, all occurred in February-March, 2002: the increase in US corporate spreads associated with the demise of Enron, the rise in political uncertainty in Brazil, ahead of the 2002 presidential elections and the increase in the Embi spread. The Spring of 2002 appears, however, to have been a rather special period: as shown in Figure 3, the correlation between the Embi spread and the US corporate spread is much weaker than in previous instances.

[Insert here Figure 3]

What one observes in Brazil, since 1999, is a steady increase in the debt-gdp ratio, in part because the primary surplus, though rising, has never been

[3] Blanco (2001) and Codogno et al.(2003) find that US corporate spreads are also important in in determining yield spreads among Euro area government bonds. Dungey et al. (2000) using a multivariate latent factor decomposition find that most of the variability of world spreads is explained by a common international factor.

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. This suggests that the debt level might be a factor influencing the response of the Brazilian risk premium to international factors.

We have thus tested for the possibility that the response of the Embi spread to the US corporate spread is non-linear[4], and depends on the level of the debt-gdp ratio, by estimating, on monthly data from February 1991 to January 2003, the following equation:

$$\begin{aligned} Embi_t &= \gamma_1 + \gamma_2 Embi_{t-1} + \gamma_3 \left(1 + e^{(b-\gamma_4)}\right)^{-1} spread_t^{US} \\ &\quad + \gamma_5 \Delta spread_t^{US} + u_{1,t} \end{aligned} \tag{1}$$

where *Embi* is the Brazil component of the Embi spread, $spread^{US}$ is the spread between the yield on US corporate bonds rated BAA with a maturity between 10 and 20 years, and a 10-year US Treasury bond, and Δx denotes the first difference of x. All spreads are measured in basis points. The equation allows for a non-linearity in the response of the Embi spread the US corporate bond spread: for levels of the debt-gdp ratio (b) larger than γ_4 (a parameter estimated in the regression) the response of the Embi spread to the US corporate spread increases (non-linearly) above γ_3,while for levels of b smaller than γ_4 it rapidly decreases to γ_3.[5]

The debt variable, on the right-hand-side of the Embi equation, is obviously endogenous: the debt-gdp ratio is strongly influenced by the exchange rate, which in turn, as we discussed in the introduction, is correlated with the Embi spread. We take care of this simultaneity by instrumenting b with its trend, estimated using a Hodrick-Prescott filter. This instrument, $\widetilde{b}$, is no longer correlated with the exchange rate. The results, obtained using non-linear two-stage-least squares, are:

[4] 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 US term spread and the country's rating.

[5] 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, since it allows for the response of Embi spreads to international factors to vary depending, in our case, on the level of the debt ratio relative to an estimated threshold.

Explaining Brazil's Embi spread: 1991:02 to 2003:01 [6]

γ_1	γ_2	γ_3	γ_4	γ_5
1.71	0.77	.78	55.0	4.05
(0.43)	(0.05)	(0.32)	(1.44)	(0.71)

When $b = \gamma_4$, the elasticity of the Embi spread with respect to the US corporate spread is $\gamma_3/2$, that is about 0.4, and falls asymptotically to γ_3 as b rises above γ_4. The value of γ_4 we estimate is 55 per cent, the level of net debt, as a percent of GDP, in April 2002 (See Figure 4). The estimate of γ_4 is rather stable: for instance, if we restrict the sample and only use data from July 1999, the estimate of γ_4 reamains virtually unchanged; is the shorter sample, however, the estimate of γ_3 increases to 2.25.

Explaining Brazil's Embi spread: 1999:07 to 2003:01

γ_1	γ_2	γ_3	γ_4	γ_5
3.18	0.44	2.25	54.89	4.30
(0.96)	(0.14)	(0.70)	(0.72)	(1.11)

[Insert here Figure 4]

The econometric model of the Banco Central do Brazil also has an equation for the Embi spread: this equation includes reserves and the current account, but not the US corporate spread, nor the debt level. When we add to our specification the variables included in the central bank model, 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 is important, as it suggests that monetary policy affects the risk premium indirectly, through its effects on the debt level–an issue to which we shall return.

We have investigated the robustness of our specification by replacing the US corporate spread with the alternative measures of international factors used in the empirical literature: the level of US long term interest rates and the Federal Funds rate. While the estimate of γ_4 remains unaffected, the overallk performance of the estimated equations worsens. In particular, short run effects are much more poorly estimated.

[6] More complete statistics for each of the equations we estimate are reported in the Appendix.

2 The Embi spread and domestic interest rates

The Embi spread is just one element determining the cost of the Brazilian public debt. (Table 1 shows the composition of the debt). To study how the risk premium and monetary policy affect the cost of debt service we thus need to understand how they affect domestic interest rates as well. We start from the Selic.

Table 1

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

$-denominated bonds issued abroad	*25.7*
domestic floaters linked to the Selic	*33.4*
domestic swaps (from 1 to 18 months)	*7.4*
inflation indexed	*7.5*
domestic swaps indexed to the dollar	*26.0*

The Selic

The best way to describe Brazilian monetary policy is through a Taylor rule where the Selic responds to one-year ahead inflation expectations:

$$Selic_t = \rho Selic_{t-1} + (1-\rho)\left(\beta_o + \beta_1\left(\pi^e_{t,t+12} - \pi^*_t\right)\right) + u_{2,t} \qquad (2)$$

where $\pi^e_{t,t+12}$ is the one-year ahead expected inflation rate, measured from the central bank surveys on inflation expectations and π^*_t the central bank target. We estimate the Taylor rule in a sample that starts in January 2000. Both the monetary and the fiscal policy regimes changed sharply after the 1999 devaluation: monetary policy shifted form 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. The results are:

Estimating a Taylor rule for Brazil

ρ	β_0	β_1
0.84	16.79	2.36
(0.06)	(0.71)	(0.76)

.

In Favero and Giavazzi (2002) we report dynamically simulated and actual policy rates, showing that this rule performs rather well.[7] Note that β_1, the coefficient on the deviation of expected inflation from the target, is greater than 1.0, consistently with a policy that does not accomodate inflation and thus raises real interest rates when inflation expectations increase.

Interest rates at longer maturities

The Brazilian government does not issue long-dated securities directly, but enters into swap contracts where it receives the Selic and pays a fixed rate for maturities up to 18 months. The term premium on these swaps includes two components: an interest rate risk, the risk associated with the volatility of short-term interest rates, and a credit risk, *i.e.* a risk of default. Swaps are contracts where what gets exchanged are two flows of interest payments on a notional principal: the principal itself is never exchanged. "Default", in a swap contract, means that one of the two parties stops paying its flow: if that 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 vale of the contract which was interrupted. In other words, there is a loss, but only because investors loose 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.

We describe the credit risk on domestic swaps with the same variables that were significant in explaining the Embi sprea. We describe the interest rate risk with the current Selic rate, as in a normal yield curve regression. We use the equilibrium, rather than the actual Selic rate: this is the right variable if financial markets are forward looking and recognize the gradual adjustment in the Taylor rule. The equation we estimate is thus:

$$\begin{aligned} Swap_t^{12} &= \gamma_1 + \gamma_2 Swap_{t-1}^{12} + \gamma_3 \left(1 + e^{(b-\gamma_4)}\right)^{-1} spread_t^{US} \\ &\quad + \gamma_5 Dspread_t^{US} + \gamma_6 (1-\gamma_2) Selic_t^{eq.} + u_{3,t} \end{aligned} \tag{3}$$

[7] In that paper we also experimented adding to the Taylor Rule more arguments, such as the output gap and the realized change in the exchange rate. The coeffcients on these variables were not significant and the dynamic simultations of the extended version of the rule did not provide any substantial improvement on the baseline with expectations only.

We obtain the following results using data starting in July 1999 for the reasons described above:

Explaining the 12-months swap rate

γ_1	γ_2	γ_3	γ_4	γ_5	γ_6
2.28	0.63	0.61	55.23	2.63	0.76
(3.74)	(0.14)	(0.72)	(3.02)	(1.26)	(0.57)

The estimate of γ_4 is very close to the value obtained in the Embi equation. The estimated coefficient on the equilibrium Selic rate is close to 1 as in a well-behaved term structure regression. The significance of the debt variable suggests that swap contracts too are affected by fiscal fundamentals. This may be either because even on swaps the default risk is not negligible, or because fiscal fundamentals affect interest rate risk, quite independently of default premia, which is the main tenet of the Loyo's model: the vicous circle between rising debt and the monetary policy rule generates policy rates volatility and hence interest rate risk.

3 The Embi spread, inflation and the exchange rate

We next consider how the risk premium affects inflation and the exchange rate.

Inflation depends positively on growth, this is the standard effect of activity on prices, positively on exchange rate depreciation, this is pass-through, and positively on the probability of default–because default may be accompanied by monetization of part of the debt. Finally, inflation expectations may also affect inflation, if price setters take the survey data into account when setting prices. These priors are confirmed by the equation we estimate, which is [8]:

$$\pi_t = \alpha_1 \pi_{t-1} + \alpha_2 outputgap_t + \alpha_3 \pi^e_{t,t+12} + \alpha_4 \left(\frac{e_{t-6}}{e_{t-12}} - 1 \right) + \alpha_5 Embi_{t-2} + u_{4,t} \tag{4}$$

[8] The lags for exchange rate depreciation and the Embi spread are those that remain statistically significant strating from a more general lag structure.

The inflation equation

α_1	α_2	α_3	α_4	α_5
0.75	0.09	0.25	1.05	0.05
(0.54)	(0.07)	(0.08)	(0.65)	(0.02)

The exchange rate

Uncovered interest rate parity tells us that the change in the exchange rate depends on the interest rate differential (Selic minus US Federal Funds) plus an exchange rate risk premium. In the data, as we have seen in Figure 2, there is a strong correlation between the Embi spread and the change in the exchange rate: one mechanism, as discussed above, are capital flows. We thus used the Embi spread to capture the exchange rate risk premium. The equation is estimated with instrumental variables (instruments include: the US corporate spread, a variable measuring Lula's relative standing in the polls, [9] and lagged variables).

$$\Delta e_t = \delta_1 Selic_t + \delta_2 i_t^{US} + \delta_3 \Delta(Embi)_t + \delta_4 Embi_t + +u_{5,t} \tag{5}$$

The exchange rate equation

δ_1	δ_2	δ_3	δ_4
−0.30	0.66	1.74	0.47
(0.08)	(0.22)	(0.24)	0.10

The coefficient on the Selic is negative: a one percent increase in the Selic appreciates the exchange rate by 0.3 percent. The Embi spread is postive: 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 effect of monetary policy. 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. As we illustrate in the following section this effect is crucial for determining how monetary policy works.

[9] The polls are available from October 2001 to October 2002.

4 Monetary policy under different fiscal rules

Before using our model, we need to complete it with a rule for fiscal policy and an equation for inflation expectations[10].

We find that the survey expectations are very sticky and are well described by the following backward-looking model:

$$\pi_t^e = 0.83\pi_{t-1}^e + 1.57\left(\frac{e_{t-6}}{e_{t-12}} - 1\right) + 0.10Embi_{t-4} \tag{6}$$

We assume that the primary (non cyclically adjusted) surplus, d, responds to the output gap and to deviations of the debt-gdp ratio from a threshold: we use our estimated threshold (55 per cent of gdp) as the target. Estimation of such a rule over the interval February 1999 to December 2002 yields:

$$d_t = \gamma_0 + \gamma_1 d_{t-1} + (1-\gamma_1)\left[\gamma_2(\widetilde{b} - 0.55) + \gamma_3 outputgap\right] + u_{6,t} \tag{7}$$

The fiscal policy rule

γ_0	γ_1	γ_2	γ_3
-0.44	0.89	-0.06	0.23
(0.16)	(0.042)	(0.09)	(0.40)

The primary surplus is rather persistent and neither the response to fluctuations in the debt, nor to fluctuations in the output gap are very significant. In other words, the behaviour of Brazilian fiscal authorities over the sample we have considered, can be characterized as only mildly "Ricardian", borrowing from Woodford's (1994) terminology.

Monetary with the estimated fiscal rule

We use these seven equations (plus a bridge equation between the rate of growth of the economy and the outptut gap, and the government budget constraint[11]) to run the following experiment.

[10] In order to simulate the model we also need an equation for the output gap. This is: $gap_t = -0.005\,(swap12_{t-12} - \pi_{t-6}) + 3.57e_{t-5} - 3.48e_{t-6} + 0.88gap_{t-1}$

[11] See Table 1 in the Appendix for a full description of our simulated model.

We start from macroeconomic conditions at the beginning of 2003: at the time the debt level was 57 percent, above our estimated threshold; the primary surplus was 4 percent of gdp, inflation 12 percent, and the central bank target had just been raised to 8.5 percent; the Selic was 25 percent. We then simulate the model from January 2003 using, for the inflation target, the path announced by the central bank: 8.5 percent in 2003 and 5.5 percent in 2004.[12]. The results are shown in Figure 5.

The Taylor rule brings the Selic as high as 32 percent, but the jump in the risk premium prevents monetary policy from stabilizing the exchange rate: the debt level rises. Although the debt does not spiral out of control and inflation does not diverge, the risk premium effect has important consequences and monetary policy has a perverse effect on the exchange rate. Inflation fluctuates at very high levels, despite the aggressive monetary policy. The increase in the debt ratio induces a tighter fiscal stance, but the increase in the primary surplus from 3.9 to 4,1 per cent of gdp, is insufficient to stabilize the economy.

This exercize does not display the explosive inflation behaviour described in Loyo (2002) and Sims (2003) in the case of a "non-Ricardian" fiscal : regime. This is beacuse, though weakly, the estimated fiscal policy reaction function does imply an increase in the primary deficit as the debt ratio rises: it is thus, though weakly, "Ricardian". However, the fact that the Embi spread remains high prevents monetary authority from bringing inflation close to the target.

Monetary policy with a more aggressive fiscal rule

Next we ask whether a change in the fiscal rule would be sufficient to make monetary policy effective. The answer is yes. In the second exercise we modify the fiscal rule in three ways:

- we increase (from 0.06 to 0.20) the response of the primary deficit to deviations of the debt-gdp ratio from 55%;
- we reduce (from 0.89 to 0.60) the persistence of the degree of primary deficit;

[12] We keep the traget constant at 8.5 throughout 2003; in 2004 we allow the target to fall gradually, reaching 5.5 in December. Moreover we set the federal funds and the 10-year US interest rates at the constant level given by their last available observation(respectively of 1.25 and 3.36).

- we increase the long run surplus from 4.3 to 5 per cent.

The results are reported in Figure 6. With the new fiscal rule a small increase in the Selic is enough to appreciate the exchange rate. This is because, as opposed to the previous case, now in the exchange rate equation the effect of the Selic dominates and the exchange rate appreciates. The appreciation lowers the debt ratio immediately, and is accompanied by a fall in the Embi spread. Inflation also falls.

In this exercise a rather minor change in the fiscal rule is sufficient to eliminate the perverse effect of monetary policy. This is because in early 2003 the Brazilian debt level was very close to the turning point we have estimated.

Monetary policy with an exogenous primary surplus

Finally we study the consequences of a fiscal rule that keeps the primary surplus constant at a level (3.5 percent of gdp) incosistent with debt stabilization. The results are reported in Figure 7. The macroeconomic outcome is, not surprisingly, worse. Inflation, however, does not diverge, contrary to the debt level. This finding–which is apparently at odds with Loyo (2002) and Sims (2003)–depends on two features of our specification. First, because of the particular specification of the non-linearity in the Embi equation–the logistic function we use implies that the response of.the Embi spread to the US corporate spread reaches a level of 2.25 when the debt ratio is 60 percent, and no longer increases as the debt rises further. Second because expected inflation in our model, is backward-looking. Interestingly, the presence of long-term debt and the explicit modelling of the term and risk premia, prevents the central bank from controlling inflation, when fiscal policy is non-Ricardian, even in the presence of backward-looking inflation expectations.

5 Conclusions

As originally recognized by Sargent and Wallace (1981), and further discussed by Sims (2003) and Loyo (1999), 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 that term premia and credit risk reinforce the possibility that a vicious circle might arise, making the fiscal constraint on monetary policy more stringent. In particular, inflation stabilization may fail , if policy is non-Ricardian, even when, as the Brazilian survey data suggest, inflation expectations are not forward-looking.

Analyzing the recent 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 experience of Brazil also shows how critical the behaviour 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 the new administration in January 2003, has been enough to bring the economy back to normal conditions, and rapidly stabilize the spread, 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, the fixed interest rates on 12-month swaps and the Selic rate

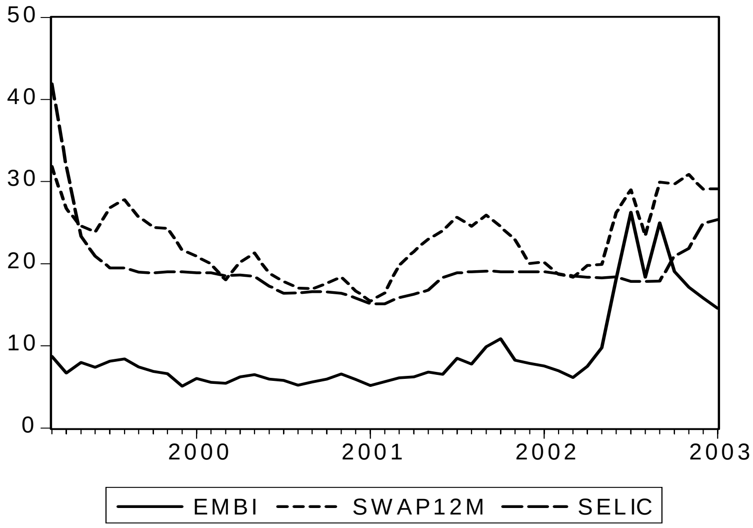


Figure 2
Inflation and the dollar exchange rate

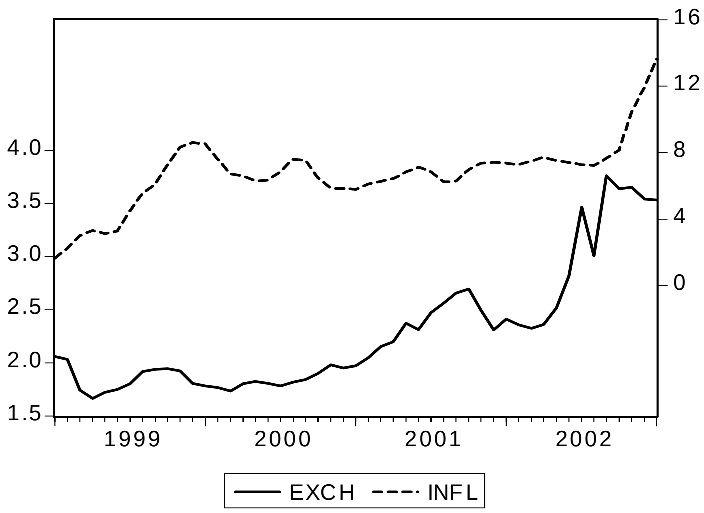


Figure 3
The Embi Spread and the spread between BAA corporate
and the US government bonds

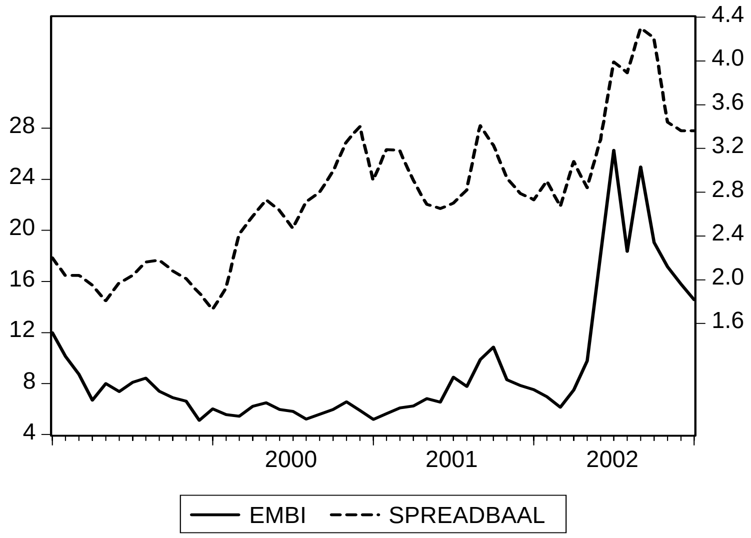


Figure 4
Brazil's net public debt, 1991 - 2003

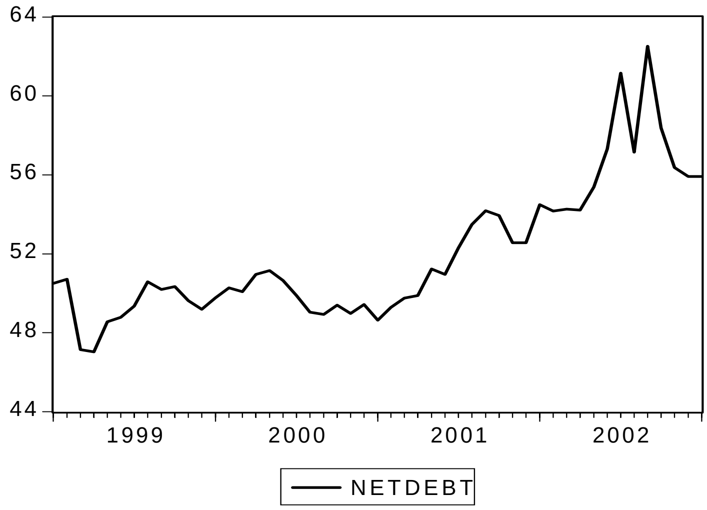


Figure 5
The simulated effects of targeting inflation in the presence of a "mildly" Ricardian fiscal policy rule

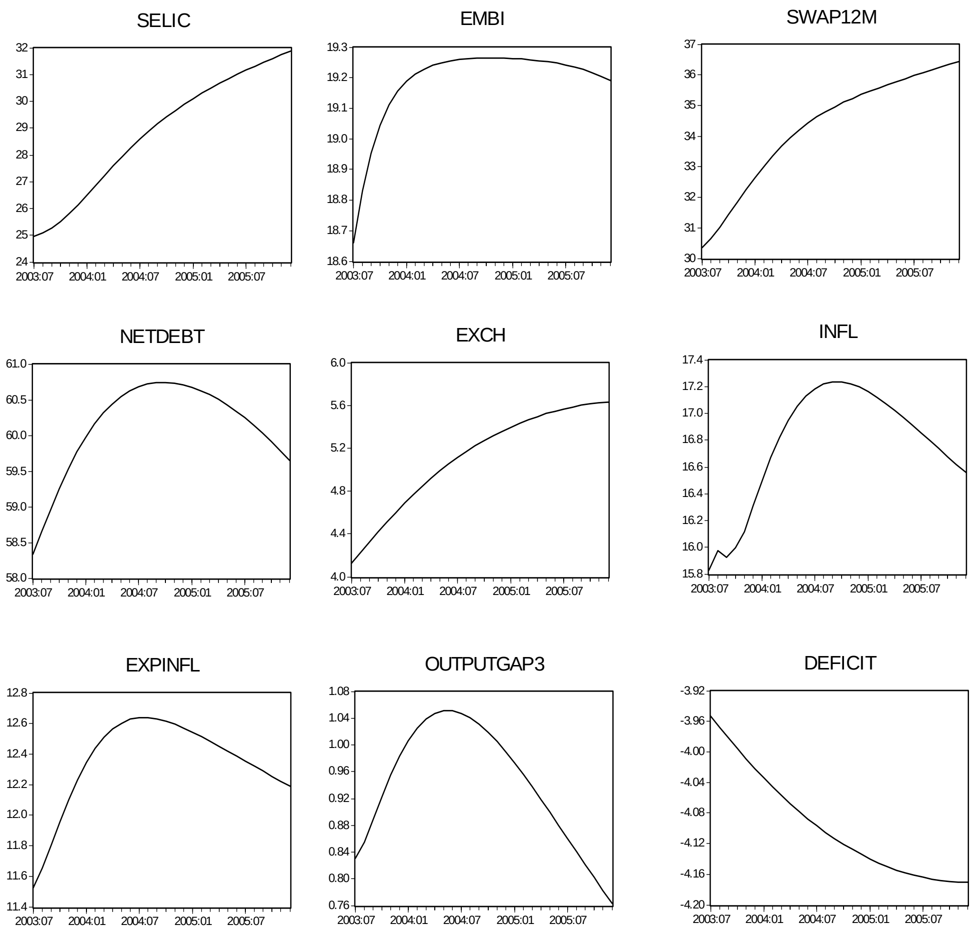


Figure 6
The simulated effects of targeting inflation with a Ricardian fiscal policy rule

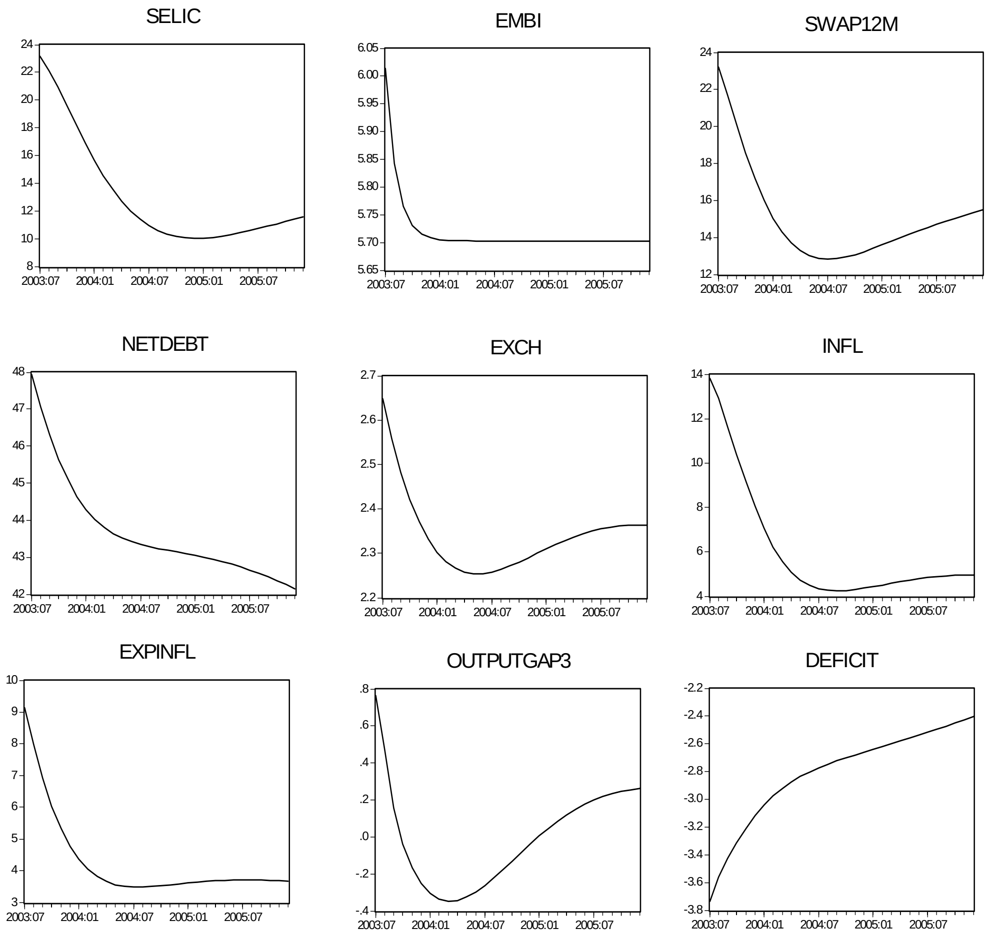
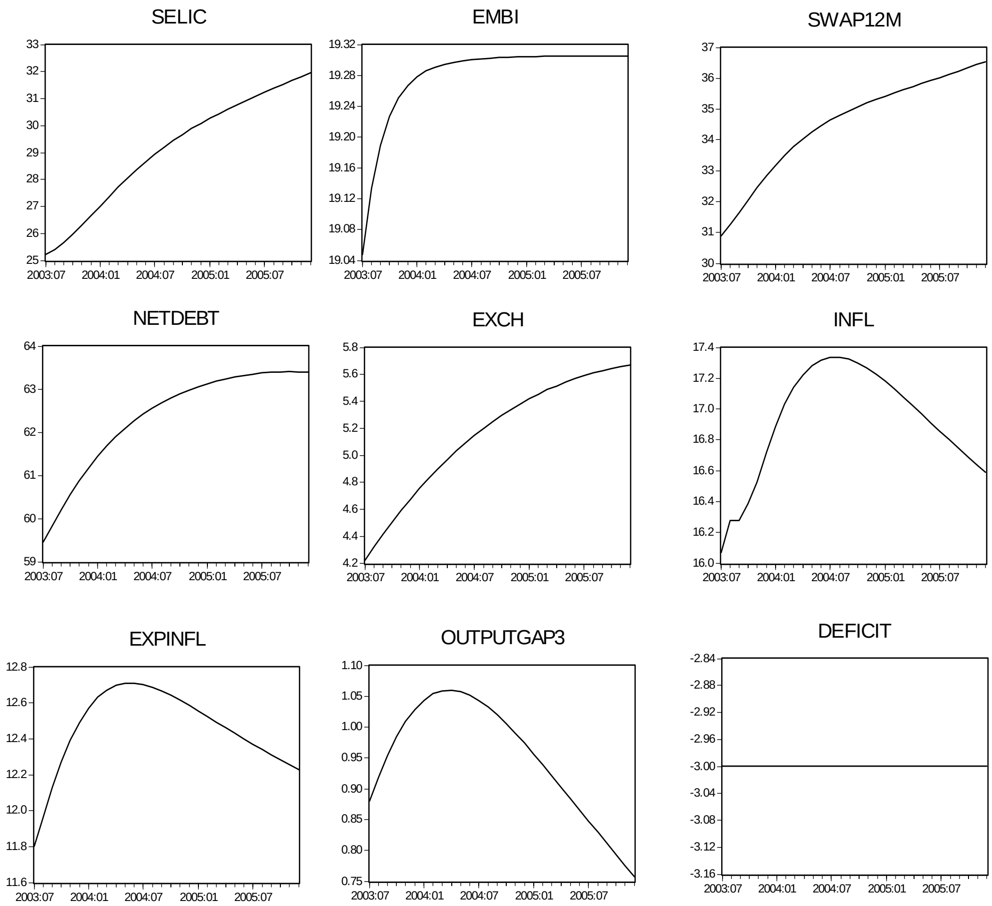


Figure 7
The simulated effects of targeting inflation with a non-Ricardian fiscal policy rule



7 Appendix

Description of the model used in the simulation exercises and statistics for the regressions reported in the text.

$$
\begin{aligned}
Embi_t &= \beta_1 + \beta_2 Embi_{t-1} + \beta_3 \left[1 + (\exp -(b - \beta_4))\right]^{-1} spread_t^{US} + \beta_5 \Delta spread_t^{US} + u_{1,t} \\
Sw_t^{12} &= \beta_6 + \beta_7 Sw_{t-1}^{12} + \beta_8 \left[1 + (\exp -(b - \beta_9))\right]^{-1} spread_t^{US} + \beta_{10} Dspread_t^{US} \\
&\quad + \beta_{11}(1 - \beta_7) Selic_t^{eq.} + u_{2,t} \\
\pi_t &= \beta_{12}\pi_{t-1} + \beta_{13} outputgap_t + \beta_{14}\pi_{t,t+12}^e + \beta_{15}\left(\frac{e_{t-6}}{e_{t-12}} - 1\right) + \beta_{16} Embi_{t-2} + u_{3,t} \\
\pi_{t,t+12}^e &= \beta_{17} + \beta_{18}\pi_{t-1,t+11}^e + \beta_{19}\left(\frac{e_t}{e_{t-6}} - 1\right) + \beta_{20} Embi_{t-4} + u_{4,t} \\
outputgap_t &= \beta_{21}(Sw_{t-6}^{12} - \pi_{t-6}) + \beta_{22}\ e_{t-5} + \beta_{23}\ e_{t-6} + \beta_{24} outputgap_{t-1} + u_{5,t} \\
Selic_t &= \rho Selic_{t-1} + (1-\rho)\left(\beta_{25} + \beta_{26}\left(\pi_{t,t+12}^e - \pi_t^*\right)\right) + u_{6,t} \\
growth_t^{gdp} &= \beta_{27} + \beta_{28} growth_{t-1}^{gdp} + (1 - \beta_{28}) outputgap_t + u_{7,t} \\
\Delta e_t &= \beta_{29} Selic_t + \beta_{30} i_t^{US} + \beta_{31}\Delta(Embi)_t + \beta_{32} Embi_t + u_{8,t} \\
b_t &= \frac{\beta_{33}(1 + [(1 + 0.8Sw_{t-6}^{12})^{\frac{1}{12}} - 1]) + (1 - \beta_{33})(1 + [(1 + y10_{t-6}^{BR})^{\frac{1}{12}} - 1])(\frac{e_t}{e_{t-1}})}{(1 + \frac{growth_t^{gdp}}{12} + \frac{\pi_t}{12})} b_{t-1} \\
&\quad + \frac{d_t}{12} + u_{9,t} \\
d_t &= \beta_{34} + \beta_{35} d_{t-1} + (1 - \beta_{35})[\beta_{36}\,(b_t - 0.55) + \beta_{37} outputgap] + u_{10,t}
\end{aligned}
$$

Table 1: **The estimated model, sample 1999:02 2003:01**						
	Coeff	**S. E.**	**t-ratio**	**Adj. R^2**	**S. E. eq.** *S.E.dep.var*	**DW**
β_1	3.18	0.96	3.31	0.86	1.98 5.32	2.05
β_2	0.44	0.14	3.24			
β_3	2.25	0.70	3.23			
β_4	54.89	0.72	75.8			
β_5	4.30	1.11	3.87			
β_6	2.28	3.74	0.61	0.78	2.04 4.41	1.82
β_7	0.63	0.14	4.61			
β_8	0.61	0.72	0.84			
β_9	55.23	3.02	18.24			
β_{10}	2.63	1.26	2.09			
β_{11}	0.76	0.57	1.35			
β_{12}	0.75	0.54	13.91	0.87	0.42 1.19	1.11
β_{13}	0.09	0.07	1.28			
β_{14}	0.26	0.08	3.06			
β_{15}	1.05	0.65	1.60			
β_{16}	0.05	0.02	2.27			
β_{17}	0.0	0.19	0.03	0.98	0.25 1.81	1.38
β_{18}	0.83	0.05	16.61			
β_{19}	1.57	0.30	5.25			
β_{20}	0.10	0.01	6.78			
β_{21}	-0.005	0.006	-0.77	0.91	0.33 1.12	1
β_{22}	3.57	1.02	3.50			
β_{23}	-3.48	1.09	-3.19			
β_{24}	0.88	0.05	16.56			
ρ	0.84	0.06	12.88	0.93	0.56 2.20	1.83
β_{25}	16.79	0.71	23.78			
β_{26}	2.36	0.76	3.12			
β_{27}	0.22	0.14	1.58	0.92	0.63 2.28	0.55
β_{28}	0.91	0.07	13.50			
β_{29}	-0.30	0.08	-3.94	0.76	3.21 6.54	2.13
β_{30}	0.66	0.22	2.98			
β_{31}	1.74	0.24	7.41			
β_{32}	0.47	0.10	4.56			
β_{33}	0.63	0.04	17.68	0.94	0.83 3.43	1.5
β_{34}	-0.44	0.16	-2.67	0.94	0.22 0.93	1.92
β_{35}	0.89	0.04	20.79			
β_{36}	-0.06	0.09	-0.71			
β_{37}	0.23	0.40	0.58			

1.We estimate each equation of the model considering always the largest available sample: 1999:02 2003:1. The differences in the specificatiosn and in the lag structures, however, lead to three main groups of equations with different samples:

a. 1999:07 2003:01 for equation 1, 5 and 9 (mainly due to lag 6 in $Swap^{12}$)

b. 2000:01 2003:01 for equation 2 and 6, 2000:01 2002:12 for equation 3, 2000:02 2003:01 for equqtion 4 (the series of $\pi^e$is available only from 00:01)

c. 1999:02 2002:12 for equation 7 and 10, 1999:02 2003:01 for equation 8

2. In order to close the model in the simulation, we add the identity: $Embi_t = y10_t^{BR} - y10_t^{US}$. In this way we obtain the long term Brazilian rate for bonds issued in USD ($y10_t^{BRA}$) that we use in the equation of the debt's dynamics.

3. All the equations have been estimated byh OLS, with the exception of:

a. the equation for Δe_t, for which we run a TSLS using as instruments the following variables: $c, (Selic_t - i_t^{US}), e_{t-1}, Embi_{t-1}, spread_t^{US}, spread_{t-1}^{US}$, $Selic_{t-1}$, i_t^{US}, i_{t-1}^{US},

b. those equations with the non-linear threshold component in b, for which we used a non-linear TSLS instrumenting b with its Hodrick-Prescott trend $\widetilde{b}$.