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"AVOIDING SOME COSTS OF INFLATION AND CRAWLING TOWARD HYPERINFLATION: THE CASE OF THE BRAZILIAN DOMESTIC CURRENCY SUBSTITUTE"

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Avoiding some costs of inflation and crawling toward hyperinflation:
The case of the Brazilian domestic currency substitute

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Abstract

The pattern of a classical hyperinflation is an acute acceleration of the inflation level accompanied by rapid substitution away from domestic currency. Brazil, however, has been experiencing inflation levels well above 1,000% a year since 1988 without entering the classical hyperinflation path. Two elements play key roles in differentiating the Brazilian case from other hyperinflationary experiences: indexation and the provision of a reliable domestic currency substitute, i.e., the provision of liquidity to interest-bearing assets. This paper claims that the existence of this domestic currency substitute is the main source of both the inability of the Brazilian central bank to fight inflation and of the unwillingness of Brazilians to face the costs of such a fight. The provision of the domestic currency substitute through the banking sector is modeled, and the main macroeconomic consequences of this monetary regime are derived. Those are: the lack of a nominal anchor for the price system due to the passive monetary policy; the endogeneity of seignorage unlike traditional models of hyperinflation; and the ineffectiveness of very high real interest rates.

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1. Introduction

The pattern of a classical hyperinflation is an acute acceleration of the inflation rate until it reaches extremely high levels. For example, the maximum monthly inflation rate was $41.9 \cdot 10^{15}\%$ on the second Hungarian hyperinflation (August 1945 to July 1946); $85.5 \cdot 10^{6}\%$ on the Greek hyperinflation (November 1943 to November 1944); and $32,400\%$ on the German hyperinflation (August 1922 to November 1923) (Sachs and Larrain [1993]). Such acceleration of the inflation rate is typically accompanied by rapid substitution away from domestic currency.

Brazil, however, has been experiencing inflation levels well above 1,000% a year since 1988 (except in 1990) without entering the classical hyperinflation path. Following Cagan's definition of hyperinflation (it begins in the month the inflation rate exceeds 50%, and it ends in the month before the monthly rise in prices drops below 50% and stays below for at least a year), Brazil experienced a hyperinflation between December 1989 and March 1990 (Sachs and Larrain [1993]). This was a very special period, just before the inauguration of the Collor administration (3/15/1990), when such high rates of inflation were caused by a general fear of a default of the internal government debt (the debt denominated in NCz$). Figure 1 shows that after this unusual episode inflation fell for a while due to the freezing of financial assets, resumed again, fell once more due to an eventually unsuccessful price freezing on February 1991 (Collor II plan) and has been rising ever since, having surpassed the 40% monthly level in the first quarter of 1994. The stylized fact shown in Figure 1 is that Brazilian inflation has not been killed, nor has it displayed the explosive pattern of the classical hyperinflations. This inflation pattern will be referred to as megainflation.\(^1\)

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\(^1\) Carneiro and Garcia [1993] suggest this term for the Brazilian inflation since it reached the 20% per month level. Dornbusch, Sturzenegger and Wolf suggest the name extreme inflation to characterize inflationary processes with rates in excess of 15 to 20 percent per month, sustained for more than a few months (Sturzenegger [1991]). This corresponds to a threshold of 1,000% per year. By this criterion the Brazilian case fits in the extreme inflation category. However, there are substantial differences between the Brazilian case and the characterization of extreme inflation laid out by them, as it will be made clear shortly.
displays the GDP growth and inflation rates for Brazil. Despite its decade-long crisis, the Brazilian economy has exhibited a surprising resilience to extremely high and persistent inflation rates.

Two elements play key roles in differentiating the Brazilian case from other hyperinflationary experiences: indexation and the provision of a reliable domestic currency substitute, i.e., an interest-bearing asset with near money liquidity. This paper claims that the existence of this domestic currency substitute is the main source of both the inability of the Brazilian Central Bank to fight inflation and of the unwillingness of Brazilians to face the costs of such a fight.

Since the mid-sixties Brazil has followed economic policies aimed at coping with inflation. Widespread indexation gave Brazilians the idea that it would be possible to cope with inflation by avoiding some of its costs. Besides indexation, the other fundamental mechanism used to cope with inflation is the domestic currency substitute. Brazilians that have access to such assets can be protected from the inflation tax without giving up the liquidity. Since the rich are the most influential in the political arena, the fact that the existence of this domestic currency substitute allowed them to evade a substantial part of the inflation tax plays a decisive role in explaining why Brazil has not undergone a serious anti-inflationary program for so long.

In order to sustain this provision of the domestic currency substitute, the Central Bank has no other option but to follow a highly accommodative monetary policy. Given a very high inflation rate (currently at an annualized rate of more than 5,500%), agents economize on their real balances as much as possible (M1 is currently less than 1.5% of GDP). They do so by holding money market accounts—which are believed to be protected from the inflation tax—and transferring funds from those accounts to regular demand deposit accounts whenever needed (this transfer is now done automatically by most large banks). Whenever a check is drawn on bank A, the money
market fund managed by bank A has to sell securities to get the reserves needed. These securities are mainly government bills, traded in the open market (this is the actual name in Brazil for the market where banks and the Central Bank trade bank reserves for government securities). To be able to provide inflation-protected money substitutes with overnight liquidity, banks have to be able to trade huge amounts of securities (vis-à-vis the small amount of bank reserves they hold) in the open market without incurring the risk of large capital losses. That means that the Central Bank has to target the interest rate at a level compatible with that goal, and that is indeed the monetary policy regime that has been followed in Brazil for the last 25 years with very few short exceptions.

By targeting the interest rate in the open market, the Central Bank completely loses the control of the monetary base, and consequently, of M1.\(^2\) The interest rate targeting requires the Central Bank to intervene continuously and massively in the open market. This is because the volumes traded are huge in comparison to the small bank reserves. It is not unusual for the Brazilian Central Bank to inject a whole monetary base (300% of bank reserves) in one single day! In face of such relatively large reserve needs from the financial sector, the Central Bank cannot hope to control money if it aims to sustain the banks' provision of the domestic currency substitute.

Section 2 contains a three-period model that represents the banks' problem of providing liquidity to interest-bearing assets. This model is used to show the limits imposed on monetary policy in a context of megainflation. In Section 3, a few macroeconomic consequences of the provision of the domestic currency substitute are derived and the main peculiar characteristics of megainflation are presented. Among the later, one important feature is that the dynamics of megainflation are not driven by

\(^2\) The Central Bank has no control on the other monetary aggregates either, because there are no reserve requirements on other components of M2, M3 or M4. Those aggregates are composed of securities that are either indexed to inflation or already incorporate inflation expectations in the nominal rate. Therefore, the non-M1 part of those aggregates grows with inflation irrespective of the action of the government in the open market.
a need of financing a given budget deficit through seignorage as it is usually assumed in models of hyperinflation (Bruno and Fischer [1990]). Section 4 concludes and lays out topics for future research.

<table>
<thead>
<tr>
<th>REAL GDP GROWTH %</th>
<th>INFLATION % per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1981</td>
<td>-4.40</td>
</tr>
<tr>
<td>1982</td>
<td>0.60</td>
</tr>
<tr>
<td>1983</td>
<td>-3.50</td>
</tr>
<tr>
<td>1984</td>
<td>5.30</td>
</tr>
<tr>
<td>1985</td>
<td>7.90</td>
</tr>
<tr>
<td>1986</td>
<td>7.60</td>
</tr>
<tr>
<td>1987</td>
<td>3.60</td>
</tr>
<tr>
<td>1988</td>
<td>-0.10</td>
</tr>
<tr>
<td>1989</td>
<td>3.30</td>
</tr>
<tr>
<td>1990</td>
<td>-4.40</td>
</tr>
<tr>
<td>1991</td>
<td>0.90</td>
</tr>
<tr>
<td>1992</td>
<td>-1.00</td>
</tr>
<tr>
<td>1993</td>
<td>4.96</td>
</tr>
</tbody>
</table>

Source: Brazilian Central Bank Economic Department
2. The constraints to monetary policy imposed by liquid interest-bearing assets

The model has three periods—1, 2 and 3—and 3 agents: a single bank (representing the whole financial system), the Central Bank and the households. The households' aggregate financial wealth in period 1, $W_1$, is entirely deposited at the bank in the form of demand deposits, $M_1$, and money market deposits, $MM_1$. The demand deposits do not pay any interest and are subject to reserve requirements of $\frac{\delta \cdot 100}{100}$. There is no currency. The money market deposits pay a real rate of interest $r_1$, between period 1 and period 2. The money market nominal continuous rate $(\pi + r_1)$ is contracted between the bank and the households in period 1. The inflation rate $\pi$ is assumed known and constant for all the periods.

The liability side of the bank's balance sheet in the first period is therefore composed of $M_1$ and $MM_1$ (a total of $W_1$). The asset side is composed of bank reserves (a minimum of $\delta \cdot M_1$) and two-period government securities (call them T-bills). These T-bills pay one nominal monetary unit in period 3, and are sold in period one at the unitary price of $U_{1,2} = \exp(-2\pi - r_{1,2})$, where $r_{1,2}$ is the "long" real rate between period 1 and period 3. The bank buys $B_1$ of those T-bills (a maximum of $\{W_1 - \delta \cdot M_1\} \cdot U_{1,2}$).

For simplicity it is assumed that: a) the bank pays a rate of interest on its money market liabilities equal to the rate paid on government bonds; b) the expectations hypothesis of the term structure of interest rates holds, i.e., $r_{1,2} = r_1 + E_1(r_2)$; and c)

---

3 Since the focus of this model is on the banks' problem, no explicit microfoundation is offered for why the households demand money. A sequel to this paper will attempt to complete the model, incorporating an explicit cash-in-advance rationale for money demand.

4 The first subscript refers to the period in which the variable enters for the first time in the bank's information set, and the second subscript refers to the number of periods involved in the variable's definition. The second subscript is omitted when the variable refers to one period only; for example $r_1$ has no second subscript because it is a one period rate, namely from period 1 to period 2.
the yield curve is flat, i.e., \( r_{1,2} = 2 \cdot r_1 \). These assumptions imply that \( E_1(r_2) = r_1 \). By Jensen's inequality, this implies that \( E_1[U_{1,2}/(U_1 U_2)] \geq 1 \), where \( U_i = \exp(-\pi - r_i) \), \( i=1,2 \). In words, under the above three assumptions, because of negative convexity (i.e., concavity), a strategy of buying two-period bonds and selling the same nominal amount of one-period deposits to be automatically renewed from period 2 to period 3 should yield a negative expected profit in period 3. The results, however, will not crucially depend on the three above hypotheses.

The interest rate in period 2, \( r_2 \), is set by the Central Bank through open market interventions, and is not known as of period 1. In period 2 there is a shock to money demand, \( \varepsilon_2 \). In expected value terms, money demand grows at rate \( \pi \), i.e., \( E_1[M_2] = \exp(\pi) \cdot M_1 \). This assumption about money demand is adequate for short periods under high inflation. Given the new money demand, the households deposit the remaining assets in the money market, i.e., \( \text{MM}_2 = (\text{MM}_1 U_1 - \text{M}_1) \).

The bank's problem is, therefore, one of transforming maturities. The bank's deposits may be withdrawn in period 2, but its assets are redeemable at face value only in period 3. Since the open market operates in all periods, the bank can always sell in period 2 its "long" securities for its market price, \( U_2 \), which is determined by the Central Bank. After trading in the open market, the bank holds \( B_2 \) in T-bills that matures in period 3. The reserve requirements in period 2 are \( R_2 = (\delta \cdot M_2) \).

In the last period, period 3, the bank pays the families \( (\text{M}_2 + \text{MM}_2 U_2) \) and receives from the Central Bank the reserve requirements \( R_2 \) and the bonds \( B_2 \). The focus of this analysis is the expected discounted value of the bank's profits in period 3. Figure 2 displays the bank's cash flow.

The statement of the bank's maximization problem is:
\[
\max_{a_i, b_i, r_i, r_2} \left\{ U_{1,2} \cdot \left[ R_2 + B_2 - \left( M_2 + MM_2/U_2 \right) \right] + \right.
\]
\[
\left. \left( \left[ R_1 - R_2 \right] + \left( B_1 - B_2 \right) \cdot U_2 + \left( M_1 - M_2 \right) + \left( MM_1 - MM_2/U_2 \right) \right) \right\}^{\infty}
\]

subject to:

Balance sheet identities

\[
R_2 + B_2 = M_2 + MM_2/U_2 + \text{Profit}
\]

\[
B_1 \cdot U_2 + R_1 + M_2 + MM_2 = M_1 + MM_1/U_1 + R_2 + B_2 \cdot U_2
\]

\[
M_1 + MM_1 = R_1 + B_1 \cdot U_{1,2}
\]

Reserve requirements

\[
R_i \geq \delta \cdot M_i, \quad i=1,2
\]

Household's budget constraints

\[
M_1 + MM_1 = W_i
\]

\[
M_2 + MM_2 = M_1 + MM_1/U_1
\]

Demand for money (demand deposits)

\[
M_1 = P_1 \cdot \left[ y \cdot \exp(-\alpha \cdot \pi) + \varepsilon_1 \right]
\]

\[
M_2 = P_1 \cdot \exp(\pi) \cdot \left[ y \cdot \exp(-\alpha \cdot \pi) + \varepsilon_2 \right]
\]

The balance sheet identities say that for each of the three periods, all entries add up to zero. Therefore, the expected discounted value of the bank's profits in period 3 may be written simply as \( E_1 \left\{ U_{1,2} \cdot \left[ R_2 + B_2 - \left( M_2 + MM_2/U_2 \right) \right] \right\}. \)

To obtain further insight about this problem, we first solve its deterministic version. Since the stochastic variables not known in period 1 are \( r_2 \) and \( \varepsilon_2 \), we set both to their
expected values, \( r_1 \) and \( 0 \), respectively. With these simplifying assumptions, we have \( U_{1,2} = (U_1)^2 = (U_2)^2 = U^2 \). We also normalize \( P_1 = 1 \) and \( \varepsilon_1 = 0 \).

The discounted value of the bank's profit under certainty is therefore:

\[
\psi = M_1 \cdot \left[ (1 - \delta) + U \cdot (1 - \delta) \cdot (\exp(\pi) - 1) - (U)^2 \cdot \exp(\pi) \cdot (1 - \delta) \right].
\]  

(6)

The above expression is the gain the bank has for being able to buy securities with the costless funds of its demand deposits, i.e., the part that is not transferred to the Central Bank as required reserves. The middle term occurs because of the increase in money demand from period 1 to period 2.

Under uncertainty, the bank's problem is the one of choosing the amount of bank reserves it will hold from period 1 to period 2. Depending on the distribution of the stochastic variables \( r_2 \) and \( \varepsilon_2 \), it may be optimal even for a risk-neutral bank to hold excess reserves. This is because if \( r_2 \) is set by the Central Bank at too high a level, it may be the case that holding bonds from period 1 to period 2 may yield a nominal loss, i.e., \( U_{1,2} > U_2 \).\(^5\) A risk-averse bank would have more incentives to hold excess reserves. Although it may be optimal for the bank to hold excess reserves, we will assume that the bank only holds required reserves. Several arguments justify this assumption. The main argument is that reserves are extremely expensive under megainflation; the opportunity cost of holding excess reserves is the nominal interest rate, which under megainflation is of the order of at least 1,000 percent per year.\(^6\) To

\(^5\) If there were more than one bank in the model, there could be an additional reason to hold excess reserves. With several banks, each bank would monitor the other bank's actions to infer whether they will be short of reserves in the next period. If one bank believes that the actions of its competitors will prompt a shortage of bank reserves in the open market, significantly raising interest rates so that \( U_{1,2} > U_2 \), it may hold excess reserves to make a profit by selling the excess reserves to other banks in period 2. It remains a key necessary condition for this process to happen that the Central Bank does not decide to provide liquidity to the banks short in reserves, i.e., that the interest targeting procedure followed by the Central Bank allows for the interest rate to rise.

\(^6\) Even under the "normal" nominal rates, similar effects seem to hold. Hodrick, Kocherlakota and Lucas [1991] calibrate a cash-in-advance model to mimic US statistics. Their finding is that the model predicts essentially constant velocity.

Why a precautionary demand for cash balances fails to generate variation in velocity in the calibrated model can be understood by considering the choice between holding an additional unit of
be sure, when a bank holds excess reserves for a single day, it loses the overnight nominal interest rate. To be able to profit from this strategy, the real interest rate has to rise enough to compensate the full overnight nominal rate that was lost. Since under megainflation the inflation expectation component is by far the most important one of the nominal rate, a very substantial increase of the real interest rate is required. Table 2 performs a simple exercise to illustrate the above point. We assume that the bank has T-bills with 11-business-day maturity (half a month). The real interest rate is 20% per year. Table 2 computes the required yearly real interest rate that would have to hold for the following 10 days to compensate the bank from holding a single day of excess reserves. Clearly, under megainflation, the increases required may be too high to be expected.

TABLE 2
REQUIRED INCREASES IN THE REAL INTEREST RATE IN ORDER TO COMPENSATE A SINGLE DAY HOLDING EXCESS RESERVES

<table>
<thead>
<tr>
<th>Inflation % per month</th>
<th>Inflation % per year</th>
<th>Nominal Interest Rate - % per year</th>
<th>Required Real Rate - % per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.00</td>
<td>20.00</td>
<td>22.21</td>
</tr>
<tr>
<td>1</td>
<td>12.68</td>
<td>35.22</td>
<td>23.68</td>
</tr>
<tr>
<td>2</td>
<td>26.82</td>
<td>52.19</td>
<td>25.15</td>
</tr>
<tr>
<td>5</td>
<td>79.59</td>
<td>115.50</td>
<td>29.58</td>
</tr>
<tr>
<td>10</td>
<td>213.84</td>
<td>276.61</td>
<td>37.02</td>
</tr>
<tr>
<td>20</td>
<td>791.61</td>
<td>969.93</td>
<td>52.10</td>
</tr>
<tr>
<td>30</td>
<td>2,229.81</td>
<td>2,695.77</td>
<td>67.43</td>
</tr>
<tr>
<td>40</td>
<td>5,569.39</td>
<td>6,703.27</td>
<td>83.00</td>
</tr>
<tr>
<td>50</td>
<td>12,874.63</td>
<td>15,469.56</td>
<td>98.80</td>
</tr>
</tbody>
</table>

class and investing in an interest-bearing bond. In this model, the benefit of the former is that the money provides liquidity services in the next period, while the bond cannot be converted into consumption until two periods hence. Velocity varies when agents hold more cash than necessary for current expenditures in some states. However, if nominal interest rates are sufficiently high and if the variation in the marginal utility of consumption across future states is sufficiently small, agents economize on cash balances and hold just enough money to cover purchases in all future states.

7 Monetary policy in Brazil is usually done through purchases and sales of 28-day BBCs (Central Bank Bonuses). We assume that the average maturity of the bank's portfolio is half a month.
The second argument to assume zero excess reserves is that this simplification allows us to draw the highest possible profit as a function of the unknown $r_2$, except when $r_2$ gets so high that $U_{1,2} > U_2$ hold. Since we believe that the later condition is very unlikely, such function will be very useful in analyzing the bank’s problem. In other words, the no excess reserves solution is indeed the maximizing strategy under risk-neutrality when $E_1(U_2/U_{1,2}) \geq 1$. The third argument is that banks in Brazil do not hold excess reserves.

However, all that was said depends crucially on the Central Bank’s reaction function, and one of its policy goals is to keep the financial system in good health. With such goal, the Central Bank may smoothen interest rates to avoid capital losses for the banks. If the banks know this criterion, they will not hold excess reserves, because they will believe that the Central Bank will not allow the interest rate to significantly rise. This is then self-reinforcing, because if banks do not hold excess reserves, the Central Bank will have then more incentives not to let steep increases in the interest rate to occur.

Note that in this model with $\varepsilon_2 = 0$ the bank knows for sure that it will need to trade T-bills for reserves in period 2. This is because positive inflation causes the nominal demand for demand deposits to grow. Since the Central Bank is the only supplier of bank reserves, this amounts to the problem of a monopolist facing a completely inelastic demand curve, i.e., in the limit, the Central Bank may set the interest rate wherever it deems fit. We will explain shortly why the Central Bank never chooses to exercise this extreme power.

When we assume no excess reserves, the bank’s maximization problem becomes a trivial one. The bank invests everything in T-bills after fulfilling the reserve requirements. The discounted expected profit then becomes:
We may decompose the bank's discounted expected profit in four sources, namely:

1) The household's wealth: $W_1 \cdot \left[ V/U_{1,2} - V(U_1 \cdot U_2) \right] U_{1,2}$ represents the bank's gain by performing the maturity transformation;

2) The (costless) demand deposits:

   $$\left[ \frac{M}{U_2} \cdot \left( \frac{1}{U_1} - 1 \right) + M \cdot \exp(\pi) \cdot \left( \frac{1}{U_2} - 1 \right) \right] U_{1,2}$$

   represents the gains by investing the costless demand deposits in periods 1 and 2, respectively;

3) The bank's required reserves:

   $$\left[ \delta \cdot M_1 \cdot \left( \frac{1}{U_{1,2}} + \frac{1}{U_2} \cdot \frac{\exp(\pi)}{U_2} + \exp(\pi) \right) \right] U_{1,2}$$

   represents the (negative) gains by fulfilling the reserve requirements in period 1 (the first two terms) and period 2 (the last two terms);

4) The unexpected shock to money demand:

   $$\varepsilon_2 \cdot \left[ \exp(\pi) \cdot (1 - \delta) \cdot \left( \frac{1}{U_2} - 1 \right) \right] U_{1,2}$$

   represents the gains of a positive shock to money demand (demand deposits). The changes in the profit function of a shock to money demand are the following:
4.1) the bank no longer has to pay interest from period 2 to period 3 on the amount $E_2 \cdot \exp(\pi)$, representing a gain of $E_2 \cdot \left[ \exp(\pi) \cdot \left( \frac{1}{U_2} - 1 \right) \right] \cdot U_{1,2}$.

4.2) the bank has to sell securities to fulfill reserve requirements of $\delta \cdot E_2 \cdot \exp(\pi)$, representing a (negative) interest gain of:

$$-E_2 \cdot \delta \cdot \left[ \exp(\pi) \cdot \left( \frac{1}{U_2} - 1 \right) \right] \cdot U_{1,2}.$$

Expression (7) can be better interpreted if we use a Taylor approximation for $1/U_2$ around $1/U_1$ and then use the expectation operator (together with $E_2(r_2) = r_1$) to obtain $E_1[U/U_2] = (U/U_1) \cdot \left( 1 + \sigma^2_{r_2} / 2 \right)$, where $\sigma^2_{r_2}$ is the conditional variance of $r_2$ in period 1. We also assume that there is no shock to money demand, i.e., $E_2 = 0$. In this case the discounted expected profit is:

$$\psi - \frac{\sigma^2_{r_2}}{2} \cdot \left[ W_1 - M_i - M_i \cdot \left( U_1 \cdot (1 - \delta) \cdot (\exp(\pi) - 1) \right) \right] \tag{8},$$

where $\psi$ is the discounted profit under certainty derived above. The last term in brackets represents the discounted value of the increase in costless funds to the bank in period 2 because of the increase in money demand (remember that here $E_2 = 0$). Therefore, the expression in brackets represents the discounted value of the maximum amount of funds the households may wish to withdraw from their money market accounts in period 2. In other words, it represents the size of the funds with unmatched maturities. The whole expression tells us that under uncertainty about future interest rates, the discounted expected profit falls below the discounted profit under certainty. This gap is wider the larger the interest variance is and the larger the size of the funds with unmatched maturities is. Expression (8) tells us that a very uncertain monetary policy could prompt the banks to leave the business of providing the domestic currency substitute. However elegant it may be, expression (8) relies solely on the concavity of the profit function to make a Jensen’s-inequality-type
argument under risk-neutrality. The argument that the Central Bank has its ability to conduct monetary policy, i.e., to change the real interest rate, severely hampered by the need of providing liquidity is much more robust.

Figure 3 exemplifies how the profitability of the bank is affected by inflation and monetary policy (changes in the second period interest rate). The only source of the bank's profit analyzed here is the investment in T-bills of costless demand deposits. With zero inflation (the inflation=0% line), the bank's profit is positive at the expected second period real interest rate \( r_2 = 20\% \). The profit line is negatively related to \( r_2 \). As inflation rises, the profit per unit of demand deposit rises, but the demand deposits fall. Figure 3 shows the profit lines for inflation=791.6% (a monthly inflation of 20%), and inflation=12,874.6% (Cagan's hyperinflation threshold of 50% per month). The fact that the inflation=12,874.6% profit line lies below the inflation=791.6% one represents the so-called Laffer curve in the present context. The households' economize their real demand deposits (the tax base) to the point that banks profit begin to fall despite the increase in the inflation rate, and consequently, the nominal interest rate (the tax rate) for a given real rate. Of course, the exact shape of those profit curves would have to be empirically determined from the basic parameters of the model. The curves drawn in Figure 3 are merely a very rough calibration.

The point made by Figure 3 is that even without uncertainty about the liquidity needs in period 2 (\( \varepsilon = 0 \)), the bank's profitability in the business of providing the domestic currency substitute is very sensitive to changes in the real interest rate. This is also true for the nominal interest rate. Therefore, similar effects to the ones obtained by increases in the real interest rate are also obtained by unexpected increases in the inflation rate. Given the inflation pattern displayed in Figure 1 (inflation is usually rising), the uncertainty about rising inflation (not modeled here) compounds to the problem, further constraining the monetary policy. One clear evidence of how higher inflation levels induce higher risks, as well as higher profitability, in the banking
business is shown in Table 3 (reproduced from Carneiro, Werneck, Garcia and Bonomo [1993]).

**TABLE 3**

MEAN AND VARIANCE OF INTEREST RATES (% PER MONTH)

<table>
<thead>
<tr>
<th>Period</th>
<th>CD Rate</th>
<th>Discount Rate</th>
<th>Spread$^8$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-1980 Mean</td>
<td>2.62</td>
<td>3.65</td>
<td>1.00</td>
</tr>
<tr>
<td>1980-1985 Mean</td>
<td>7.53</td>
<td>11.06</td>
<td>3.27</td>
</tr>
<tr>
<td>Post-1985 Mean</td>
<td>18.51</td>
<td>24.60</td>
<td>4.76</td>
</tr>
<tr>
<td>Pre-1980 Standard Deviation</td>
<td>0.64</td>
<td>1.12</td>
<td>0.52</td>
</tr>
<tr>
<td>1980-1985 Standard Deviation</td>
<td>2.78</td>
<td>3.44</td>
<td>1.00</td>
</tr>
<tr>
<td>Post-1985 Standard Deviation</td>
<td>14.06</td>
<td>20.59</td>
<td>5.07</td>
</tr>
</tbody>
</table>

Table 3 displays the averages and standard deviations for lending (discount) and borrowing (CD) rates during three periods: the “low-inflation” period (1973-1979), the high-inflation period without economic shocks (1980-1985), and the extremely high-inflation period with economic shocks (post-1985). Table 3 shows clearly that in the post-Cruzado era (see Figure 1) not only the average spread increased, but its variability became much greater. This result is consistent with the familiar mean-variance analysis: the extremely high and volatile inflation and the economic shocks turned the Brazilian economy in a much riskier, and therefore more profitable, environment for the banking business.

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8 The spread was computed with the correct compound interest arithmetic. This is why the mean spread is not equal to the difference between the mean discount rate and the mean CD rate.
Nevertheless, the perceived risk cannot increase to the point that banks will no longer want to be in the business of providing the domestic currency substitute. If the Central Bank wants to keep alive the mechanism that provides liquidity to interest-bearing securities, it has to target interest rates with the objective of protecting the bank from large capital losses.\(^9\) In the model, this means that the Central Bank will provide the bank with the necessary additional reserves in period 2 without raising too much interest rates.\(^10\) In Brazil this is done by an automatic mechanism, called *zerada automática*, which provides at the end of day the reserves banks need to fulfill their reserve requirements.\(^11\) The *zerada automática* acts as an early discount window when it provides (cheap) reserves for the banks. As Diamond and Dybvig [1983] point out in their model of bank runs and deposit insurance, the *discount window can, as a lender of last resort, provide a service similar to deposit insurance. It would buy bank assets with (money creation) tax revenues (...) for prices greater than their liquidating value.*

Therefore, in spite of the smallness of M1, the perception of liquidity is much larger. Banks trade an enormous amount of securities to clear the daily transactions in the economy. Figure 4 (reproduced from Carneiro and Garcia [1993]) shows the amount of the Central Bank's daily interventions in the open market. The negative values mean the sales of repurchase agreements, which is what the Central Bank does in times of

\(^9\) Derivative markets have evolved very rapidly in Brazil (Carneiro, Werneck, Garcia and Bonomo [1993]). There is an interest rate futures market, which could be used to hedge the interest rate risk. However, such market is not large enough to allow the banks to hedge the interest rate risk under megainflation. Even if the futures market were larger, there would be the question of who would be willing to bear the interest rate risk under a non-interest-rate-targeting monetary policy regime.

\(^10\) The Central Bank could raise the interest rate in period 3 without harming the bank's profit. In practice, however, the banks hold T-bills of several maturities at any given moment. Therefore, the staggered structure of those securities constrains the monetary policy at any given time. For an alternative model, see Lopes [1994].

\(^11\) The *zerada automática* also gives banks with excess reserves the last opportunity to buy repurchase agreements in order not to incur in the high opportunity cost of excess reserves. One would expect that only one side of the *zerada automática* would be used in any given day, depending on whether the aggregate of banks is short or long on reserves. However, it is not uncommon for the Central Bank to sell both reserves and repurchase agreements at the *zerada automática.*
great uncertainty to avoid paying a prohibitive risk premium on the longer (one month) maturity T-bill. The positive values represent Central Bank's purchases of government securities. The Central Bank is said to be undersold in the former case and oversold in the later. The size of the Central Bank interventions (relatively to the monetary base or to the aggregate of bank reserves) is several times greater than that observed in countries with low inflation. Those constant interventions aimed at targeting the interest rate are the support of the provision of liquidity to interest-bearing securities, and, ultimately, what makes possible for an economy to live with such small M1. The mechanism just described provides an automatic way of increasing the money supply in line with expected inflation, as in the model of frictionless inflation described in Patinkin [1993] for the Israeli economy before 1985.

By looking at Figure 3, one may doubt whether monetary policy is truly constrained. After all, the profit line the most sensitive to the interest rate risk is the inflation=0% one. Furthermore, however imprecise the calibration may be, the increases in the real interest rate necessary to cause a negative profit seem very large to imply a constraint to monetary policy.

In order to answer the first argument, one has to bear in mind what is the relative importance of the profits modelled here on a real bank's aggregate profits. In megainflationary economies, the banking sector relies very heavily on the profits created by non-interest-bearing demand deposits (Carneiro, Werneck, Garcia and Bonomo [1993]). Cysne [1993] calculates that 2% of the Brazilian GDP has been yearly transferred on average to the banking system in that form. Therefore, the interest rate risk described above should affect a Brazilian bank much more than a US bank, because the later does not depend so much on the profitability stemming from non-interest-bearing demand deposits. It is clear that large increases in the interest rate would affect the portfolio of any country's bank. However, large increases in real interest rates (of 10 or 20 percentage points) are unlikely to happen in countries with low inflation. In the Brazilian economy, however, large increases in interest rates may
be necessary to achieve any meaningful economic policy goal. The next Section
analyzes this issue among others.

3. A few macroeconomic consequences of the domestic
currency substitute

3.1. The endogeneity of seignorage

One important consequence of the mechanism of providing liquidity to interest-bearing
assets is that seignorage, which is represented in the model of Section 2 approximately
by the bank’s losses by holding required reserves, becomes endogenous.\footnote{Pastore [1993] also refers to the endogeneity of seignorage, although what he means by endogenous seignorage is quite different from what is meant in this paper. He refers to monetary and exchange policy rules (interest rate or real exchange rate targeting) that force the government to fully monetize the fiscal deficit, therefore making seignorage endogenously equal to the deficit. This is observationally equivalent to exogenous seignorage models (Bruno and Fischer [1990], Blanchard and Fischer [1989], p. 198), where the dynamics stem from extracting enough seignorage to finance the deficit.} The interest
rate targeting pursued by the Central Bank precludes it from monetizing too much the
economy in search for more seignorage. We can see this in the model of Section 2 by
noting that an attempt to issue too many reserves in period 2 would drive down the
interest rate, $r_2$. While this would give the holders of T-bills handsome profits, it
would also drive down the rate paid on the bank’s money market deposits. If the
money market deposits may no longer be used as a mean to evade the inflation tax, the
households may look for other assets that could perform this function. In that case, the
economy would undergo a typical currency substitution process.\footnote{A sequel to this paper will incorporate a foreign asset to formally model the currency substitution process. See also Lopes [1994].}

This is the basis for the claim in Carneiro and Garcia [1993] that in the domestic
currency substitution regime, hyperinflation is the most likely outcome of an isolated
(i.e., without fiscal adjustment) attempt by the Brazilian Central Bank to control
money. What precludes agents from moving into foreign assets is the assurance of the inflation protection and liquidity of the domestic currency substitute. An attempt by the Central Bank to control the nominal amount of reserves in the system will certainly make impossible for the banks to keep offering the domestic currency substitute. Either the returns or the liquidity will have to be curtailed. Sure enough, interest rates will rise and that would attract funds. The point is that without a credible fiscal adjustment, the increase in interest rates necessary to keep agents from moving into foreign currency and assets may be too high to be sustainable and believed. The situation may be similar to speculative attacks against currencies, as in the September 1992 episode when the Sveriges Riksbank (the Swedish central bank) raised the overnight marginal lending rate to 500% per year, in an ultimately failed attempt to keep the krona’s parity (Svensson [1993]).

One does not see foreign currency circulating in Brazil in large proportions as in other countries that lived through similar inflation rates precisely because of the domestic currency substitute. The small M1 has in recent years provided more than 3% of GDP in seignorage revenues, as well as an additional 2% of GDP share for the banks (Cysne [1993]). These figures, however large they may be, do not seem enough to justify a hyperinflation. The amount of seignorage is endogenous, and may be extracted as long as the domestic currency substitute is alive. With an already troubled fiscal situation, the loss of seignorage revenue will certainly make the fiscal deficit significantly higher. Therefore, if the Central Bank decided in isolation to control money, this could indeed spark a hyperinflation, in spite of very high interest rates. The point here is one of credibility and sustainability.

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14 Based on available evidence from historical cases, it seems that a persistent money-financed deficit must be about 10 to 12 percent of GNP to generate a hyperinflation (Sachs and Larrain [1993], p. 737).

15 Not to mention that there would be an increase in the budget deficit because of the reverse Olivers-Tanzi effect. This refers to the fact that in Brazil fiscal revenues are believed to be better indexed to inflation than outlays. Therefore, inflation stabilization, ceteris paribus, would increase the actual deficit. For an analysis of this effect, see Bacha [1993].
In summary, the dynamics of the Brazilian megainflation are not driven by a need of financing a given budget deficit through seignorage as it is usually assumed in models of hyperinflation (Bruno and Fischer [1990]). The provision of the domestic currency substitute slows down the currency substitution process that is always associated with hyperinflations. This makes possible for the government to collect seignorage for longer, although it has very little control on the amount it can collect.

3.2. The lack of a nominal anchor

The provision of the domestic currency substitute endogeneize money supply, providing automatic sanction to any increase in money demand. Price increases increase money demand, and, because of the interest targeting procedure, eventually increase money supply, validating the initial price increases. Widespread indexation then perpetuates the new inflation level. Since the exchange-rate policy in Brazil has been one of trying to fix the real exchange-rate, the system completely lacks a nominal anchor. Any inflation rate, provided it is expected, may be an equilibrium. It is not surprising that, as a consequence, inflation has exhibited the upward trend shown in Figure 1.

3.3. The relative ineffectiveness of high real interest rates

Real interest rates in Brazil have exceeded the 20% level in 1993. Nevertheless, GDP grew almost 5% in real terms while inflation rose from the mid-20s to almost 40% per month by the end of 1993. These figures suggest a rather ineffective monetary policy.

The relative ineffectiveness of monetary policy to control inflation and/or to affect real activity is due to two factors. The first one, which we will not analyze in this paper, has to do with the transmission mechanism of monetary policy in Brazil. Megainflation destroyed many financial markets, most importantly the market for long term financing (Carneiro, Werneck, Garcia and Bonomo [1993]). Indexation proved to be all but a satisfactory mechanism to support long term financial markets (Garcia [1993]).
Furthermore, after many years of very high real interest rates, most firms finance all their investments and working capital needs out of retained earnings, without resorting to bank credit (the stock market is of small importance in Brazil). The same applies to consumer credit, which is unbearably expensive. The only aggregate demand item that seems to be very responsive to increases in interest rates is inventory.\textsuperscript{16} Therefore, the stylized fact is that the real sector’s response to increases in interest rates is quite small, also because of the income (wealth) effect associated with high real interest rates when households and firms are net creditors. It should also be noted that there is a strong asymmetry, since the effects of a decrease in interest rates are quite powerful in boosting activity (and also inflation).

The second factor that accounts for the relative ineffectiveness of monetary policy is the uncertainty about the relevant real interest rate. This is due to two factors. With megainflation, the dispersion of different price indices substantially increases, especially when inflation is accelerating. Also, agents’ ability in forecasting inflation is severely jeopardized. Therefore, when one looks at a series of ex post real interest rates, one may be quite far from the relevant ex ante real rates that guided the agents’ decisions.

The argument of a very disperse distribution of inflation forecasts does not explain why agents would react less in the aggregate to high interest rates. It only means that some agents will see a very high real rate where others may even see a negative one. They should still react according to their own perception of the real interest rate. Prudent behavior may help explain why a more disperse distribution of inflation forecasts leads to actions consistent with a lower interest rate (higher expected inflation) than each agent’s own forecast. When faced with high future inflation

\textsuperscript{16} Even with inventories, there seems to be a perverse effect of high real interest rates on inflation. Because of long periods of high interest rates, firms reduce inventories to a minimum. Therefore, when there is a positive demand shock, firms tend to raise prices quicker than they would in the presence of larger inventories. I thank Edward Amadeo for pointing out this effect.
uncertainty,\textsuperscript{17} agents may want to play safe, and choose a conservative (i.e., high) inflation forecast. If this is indeed the case, a mean-preserving spread of each agent's inflation forecasts may lead to actions consistent with a higher inflation forecast.

We demonstrate that agents' perceptions of the real interest rate are very disperse (because of the large dispersion of inflationary expectations) by looking at two alternative sources. The first one is a collection of price indices. We show that the distribution of those indices is very disperse. The second one is the inflation futures market. We show that the forecasting errors of this market, even at very short horizons, are quite substantial. We now turn to the empirical evidence.

3.3.1. Different price indices

Figure 6 shows results from seven of the price indices most commonly used in Brazil. They may differ in methodology, period of data collection and geographical coverage. Therefore, one could account for the differences among the several indices. Nevertheless, we contend that the large dispersion of the indices may be used to infer the dispersion of inflation forecasts. The standard deviations, computed each month from the seven measures of inflation, are very high.

Figure 7 shows the real rates that arise when we use the different price indices. The bands for the real interest rate are quite large. If one takes the extreme view of always considering the minimum real rate (for each month) as the relevant one, the average real rates of 32.0\% and 17.1\% in 1992 and 1993, respectively, fall to 12.7\% and -0.0\%. Therefore, the large dispersion among the price indices may lead to very different perceptions of what the real interest rate is. Megainflation in this respect is

\textsuperscript{17} Dow, Simonsen and Werlang [1993] conclude that uncertainty (in the sense of Knight), rather than irrationality is the driving force behind the existence of inflationary inertia and the non-neutrality of monetary policy. The prudent behavior referred above may conceivably be modeled by non-additive probabilities.
very different from hyperinflation, because in a hyperinflation all agents focus on the exchange rate.

Figure 7 also shows the standard deviations, which are very high (left-hand-side scale). Taking these estimates seriously, one could perform the following thought experiment. Assume that the Central Bank decides to send a clear signal of non-negative real rates. Without further knowledge of the distribution of inflation forecasts, and assuming that agents are distributed homogeneously among the different forecasts, the Central Bank would have to raise the real interest rate to twice the standard deviation in order send a signal of a positive real rate to 7/8 of the population (using Chebyshev inequality). With an average standard deviation of 13.3\%\textsuperscript{18} for the period analyzed in Figure 7, this would mean that the Central Bank would have to target the real interest rate above 26.6\%! In ex post terms, one would observe a very high real rate, but that resulted merely from the attempt to signal a non-negative real rate to most agents.\textsuperscript{19}

3.3.2. The inflation futures market

Figure 8 shows the results from the futures market for inflation (OTN / BTN), for the period it was allowed to operate. The line is actual monthly inflation, which is measured by the left-hand-side scale in percent per month. The errors refer to monthly inflation percentage points, i.e., if a futures price implied an inflation "forecast"\textsuperscript{20} of 18\% per month while actual inflation was 20\% per month, the error was 2\% per month. After computing the errors for each day of the last 30 days for each contract (the last month before inflation was known), we calculate the average mean absolute

\begin{itemize}
  \item Each standard deviation is computed with the seven observations of the real rate (one for each price index) for each month. Then we compute the arithmetic average standard deviation for all months.
  \item I thank Marco Bonomo for suggesting this thought experiment, and Thadeu Keller for suggesting the use of Chebyshev inequality. (The use of this inequality assumes that the distribution is symmetric.)
  \item The use of quotes accounts for the fact that futures prices are not necessarily unbiased predictors of spot prices (in the present case, of inflation). Bias may arise for several reasons (see García [1991, 1992]). We nevertheless define the error as the deviation from actual inflation.
\end{itemize}
error and the square root of the mean squared error along the month. These two measures are the bars, with scale in the right-hand-side, also in percent per month. Note that those measures include “forecasts” up to the day before inflation was actually announced. Figure 9 shows the same results when only the data for the first fortnight of the month is used, i.e., when the “forecasts” included range from 30 to 15 days before inflation was known.

Taking the square root of the mean squared error (first fortnight) as a proxy for the standard deviation, and using Chebyshev inequality, Figure 10 displays the bands where 75% and 89% of the inflation forecasts should lie. Figures 8 to 10 corroborate the point that inflation forecasts are very imprecise, even for very short horizons.

In summary, the ineffectiveness of monetary policy to control inflation and output may be due to the two factors mentioned above, namely the very small response of aggregate demand to increases in the real rate, and the extremely high dispersion of inflation forecasts among agents. Such high dispersion refers both to the fact that agents cannot accurately forecast a given price index, and to the fact that different agents care about different indices and the distribution of those indices is very disperse.

4. Conclusion

Since the mid-sixties Brazil undertook a rather deliberate attempt to live with inflation by building a comprehensive system of inflation indexation. Inflation indexation was aimed at reducing some of the welfare costs of inflation, and was then widely thought as a good solution. The other key factor was the provision of liquidity to interest-

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21 At least before the first oil shock in 1973-74, widespread indexation was often praised as a second best to price stability. It appeared to minimize the welfare losses caused by inflation. Among other virtues, widespread escalator clauses would make contracts independent of inflationary expectations, thus leading to a vertical Phillips curve even in the very short run. This would
bearing assets, i.e., the supply of substitutes to M1 that were protected from the inflation tax without giving up the liquidity. Carneiro and Garcia [1993] suggest the name domestic currency substitute for this class of financial instruments because they slow down the usual process of currency substitution associated with hyperinflations. This paper models the working mechanism of the domestic currency substitute, as well as analyzes a few of its macroeconomic consequences. The most important macroeconomic consequence is that this mechanism allows the economy to sustain for quite a long time an extremely high inflation level without jumping to hyperinflation, although the economy slowly drifts toward hyperinflation (see Figure 1). Carneiro and Garcia [1993] suggest the name megainflation for this process.

The model of the domestic currency substitute (Section 2) shows that the provision of liquidity to interest-bearing assets severely constrains the monetary policy. This is because the very existence of the domestic money (M1) depends on the supply of the domestic currency substitute. Abrupt movements in interest rates, as those that would happen if the Central Bank decided to target a nominal monetary aggregate, would make impossible for the banks to keep offering inflation protection with overnight liquidity. As a result, the monetary policy becomes passive, and the monetary base grows rather automatically with inflation.

In Section 3, the consequences of this automatic monetization are analyzed. Automatic monetization together with the lack of other nominal anchors (exchange rate) means that the economy has an undetermined equilibrium. If a given inflation rate is expected to happen, it will happen.

The other macroeconomic consequence of the domestic currency substitution regime is that the dynamics of megainflation are not driven by the attempt of the government to eliminate any temporary inflation-output trade-off, and all the uncomfortable side effects of anti-inflationary policies. In fact this was Milton Friedman’s central argument in his enthusiastic defense of indexation (Dornbusch and Simonsen [1986]).
to collect seignorage by printing more money, as it is usually assumed in models of hyperinflation (Bruno and Fischer [1990] and Blanchard and Fischer [1989], p. 198). Note, however, that this does not imply that the Brazilian megainflation was not caused by a fiscal imbalance. At this point, we are not able to present a full-blown general equilibrium model that explains how megainflation originated and evolved. What we are concerned with in this paper is the dynamics implied by the domestic currency substitute once megainflation is already running. The provision of the domestic currency substitute slows down the currency substitution process that is always associated with hyperinflations. This makes possible for the government to collect seignorage for longer, although it has very little control on the amount it can collect. With the domestic currency substitute, the Central Bank cannot issue money to pay for the fiscal outlays. If it did that, the market for bank reserves would be in excess supply of reserves, and interest rates would fall. Given the smallness of bank reserves, any significant increase in the deficit that needed to be financed through seignorage would drive interest rates down by a large amount. This drop in interest rate will eventually be reflected in the rates paid by banks on the money market accounts, jeopardizing the ability of the domestic currency substitute to remain competitive with foreign currency. Therefore, all increases in the fiscal deficit must be financed through debt and not through seignorage.

On the other side, if the Central Bank decided to make the bank reserves grow at a much smaller rate that inflation, it could risk to spark a hyperinflation. This could happen because in a regime where the Central Bank no longer is concerned with smoothing the interest rate, it would probably vary so much as to preclude banks from offering an asset that could at the same time protect from inflation and offer overnight liquidity. The economy would then move to a path of massive currency substitution, i.e., a hyperinflation. Whether or not the very high interest rates that would emerge from this liquidity squeeze would sustain the demand for domestic government securities, and consequently to the domestic money, would depend on the fiscal
situation. Without a previous credible fiscal adjustment, it is very unlikely that the government could sustain an interest rate high enough to avoid the currency substitution process that the demise of the domestic currency substitution regime would entail.

The last issue analyzed in Section 3 is the effects of very high real rates on inflation and output. The stylized fact is that very large and positive real interest rates are quite ineffective to lower inflation and output. We suggest two ways to explain this one way ineffectiveness of high real interest rates. The first link, which is next in the research agenda, is the transmission mechanism of monetary policy. After a long period of megainflation and high real rates, most households and firms already refrain from going into debt. Therefore, further increases of interest rates face a very inelastic demand for credit, while decreases face a rather elastic one. The second link is the excessive dispersion of inflation forecasts. This is due both to the inability of agents to accurately forecast inflation and to the existence of several price indices, with a distribution whose dispersion grows with inflation. Under high uncertainty about future inflation, agents may behave prudently and act accordingly to a more conservative (i.e., higher) estimate of inflation. This would mean that very high ex post real rates would not have a very large effect in aggregate demand.

The very nature of the domestic currency substitution regime requires a positive ex ante real rate. This is what ultimately precludes agents from going into foreign currency and assets. When faced with a very disperse distribution of price indices, the Central Bank may be forced to raise its expected real rate to very high levels only to send a clear signal of non-negative real interest rates to most agents.

When inflation reaches the current extremely high level (5500%), it is also highly volatile, greatly jeopardizing economic activity. After many years of very high inflation, it is becoming clear to most Brazilians that the costs of coping with inflation
are higher than those of fighting it. The lessons of the Brazilian case are important for countries like Russia, which may entertain the elusive possibility of an easy way out of fiscal and monetary controls to fight inflation.

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22 Simon and Cysne (1994) estimate that the current welfare costs of inflation hover around 7.56% of GDP ($34 billion per year). Similar numbers are obtained by Pastore (1993).
References


Banco Central do Brasil, Brazil Economic Program, 39, 1993.


FIGURE 1

INFLATION

Source: Macrométrica Database
FIGURE 2
THE BANK'S CASH FLOW

PERIOD 1

PERIOD 2

PERIOD 3

$M_1$, $M_{M1}$

$R_1$, $B_{1J_{1,2}}$

$M_1$

$M_2$, $B_{1U_2M_{M2}}$

$R_2$, $B_2$

$R_2$, $B_2$

$M_2$, $\frac{M_{M2}}{U_2}$

$\frac{M_{M1}}{U_1}$

$\frac{M_{M1}}{U_1}$

$\frac{M_{M2}}{U_2}$

PROFIT
THE BANK'S PROFITS WITH INCREASING INFLATION

Second Period Real Interest Rate

- Profit(Inflation=0%)
- Profit(Inflation=791.6%)
- Profit(Inflation=12,874.6%)

Source: Author's simulations
FIGURE 4

Oversold (+) and Undersold (-)

Source: Carneiro and Garcia (1993)
FIGURE 5

REAL MONEY AND INFLATION

Source: Brazilian Central Bank Economic Department
INFLATION

Source: Macrométrica Database
FIGURE 7

REAL INTEREST RATE

Source: Brazilian Central Bank Economic Department
FORECASTS ERRORS - INFLATION FUTURES MARKET (MONTH)

Source: BMF
FIGURE 9

FORECASTS ERRORS - INFLATION FUTURES MARKET (FIRST FORTNIGHT)

Source: BMF
FIGURE 10

INFLATION FORECAST BANDS

Source: BMF
Author: Garcia, Marcio Gomes Pinto.
Title: Avoiding some costs of inflation and crawling

N. Cham. P/EPGE SPE G216av

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