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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. Until the Real Plan (1 July 1994), however, Brazil experienced inflation levels well above 1000% a year since 1988 without entering the classical hyperinflation path. Two elements played key roles in differentiating the Brazilian case from the classical hyperinflations: 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 was 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, and the non-controllability of seigniorage unlike traditional models of hyperinflations.

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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*

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inflation rate was $41.9 \times 10^{15}\%$ during the second Hungarian hyperinflation (August 1945 to July 1946); $85.5 \times 10^{6}\%$ during the Greek hyperinflation (November 1943 to November 1944); and 32 400% during the German hyperinflation (August 1922 to November 1923) (Sachs and Larrain, 1993). Such acceleration of the inflation rate has typically been accompanied by rapid substitution away from domestic currency.

Brazil, however, experienced inflation levels well above 1000% a year from 1988 (except in 1990) until the Real Plan (1 July 1994) 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 1991 (Sachs and Larrain, 1993). This was a very special period, just before the inauguration of the Collor administration (15 March 1990), when such high rates of inflation were caused by a general fear of a default of the internal government debt. Fig. 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 ultimately unsuccessful price freezing on February 1991 (Collor II Plan) and then trended upwards until the Real Plan, when it was almost reaching Cagan's 50% per month threshold. The stylized fact shown in Fig. 1 is that until the Real Plan Brazilian inflation had not been killed, nor had it displayed the explosive pattern of the classical hyperinflations. This inflation pattern will be referred to as *megainflation.* [1]

Table 1 displays the gross domestic product (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 played key roles in differentiating the Brazilian case from the classical 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 was 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. [2]

Since the mid-sixties Brazil has followed economic policies aimed at coping

[1] Carneiro and Garcia (1993) suggest this term for the Brazilian inflation since it reached the 20% per month level, although we found out later that Cardoso (1991) suggested this name first. Sturzenegger (1991) suggests the name *extreme inflation* to characterize inflationary processes with rates in excess of 15 to 20% per month, sustained for more than a few months. This corresponds to a threshold of 1000% 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, as will be made clear shortly.

[2] Fischer and Summers (1989) show that better inflation protection may end up causing more inflation.

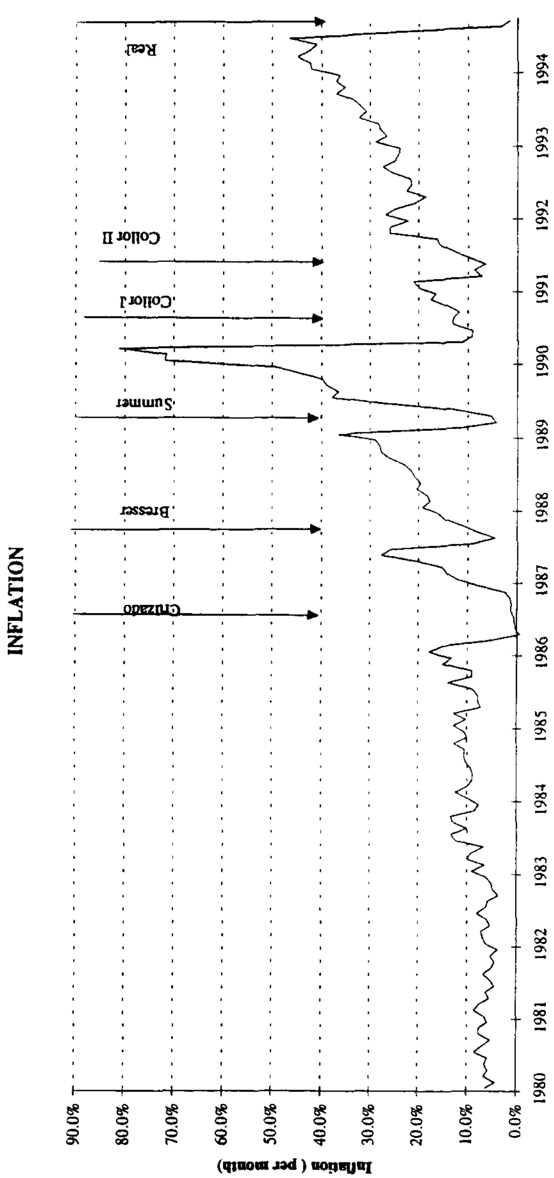

Fig. 1. Inflation.

Table 1
Real GDP growth and inflation

	Real GDP growth (%)	Inflation per year (%)
1981	−4.4	95.2
1982	0.6	99.7
1983	−3.5	211.0
1984	5.3	223.8
1985	7.9	235.1
1986	7.5	65.0
1987	3.5	415.8
1988	−0.1	1037.6
1989	3.2	1782.9
1990	−4.4	1476.6
1991	0.2	380.3
1992	−0.8	1157.8
1993	4.1	2708.6
1994 [a]	5.7	7350.8

[a] The inflation datum is the annualized rate from the first semester (before the Real Plan). The actual annual figure was 1094%.
Source: Brazilian central bank, economics department (Banco Central do Brasil, 1993, 1994).

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 was the domestic currency substitute. Brazilians that had access to such assets could be protected from the inflation tax without sacrificing liquidity. Since the rich were the most influential in the political arena, it is most likely that the existence of this domestic currency substitute – which allowed them to avoid paying a substantial part of the inflation tax – played 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 had no other option but to follow a highly passive monetary policy. Given a very high inflation rate (Cagan's threshold corresponds to an annualized rate of 12 875%), agents economized on their real balances as much as possible (immediately before the Real Plan, M1 was less than 1.5% of GDP). They did so by holding money market accounts – which were believed to be protected from the inflation tax – and transferring funds from those accounts to regular demand deposit accounts whenever needed (this transfer was done automatically by most large banks). Whenever a check was drawn on bank A, the money market fund managed by bank A had to sell securities to get the reserves needed. These securities were mainly government bills, traded in the open market. To be able to provide inflation-protected money substitutes with overnight liquidity, banks had to be able to perform the maturity transformation involved *without incurring the risk of large capital losses.*

Maturity transformation is at the core of the banking business (see Diamond and Dybvig, 1983). Nevertheless, under the uncertainty about *nominal* interest rates generated by megainflation, the degree of maturity transformation necessary to provide an inflation-protected asset with daily liquidity becomes too large a risk for banks alone to bear. As a consequence, one of the goals of the interest targeting procedure followed by the Brazilian central bank since the seventies has been to avoid large portfolio losses for the banks. This goal has almost always received implicit priority over the usual goal of inflation control, which guides the majority of interest rate targeting procedures followed by other central banks.

This peculiar way of targeting the interest rate in the open market led the Brazilian central bank to lose control completely over the monetary base, and consequently, over M1. [3] It also required the central bank to intervene continuously and massively in the open market, because the volumes traded were huge in comparison to the small bank reserves. It was not unusual for the Brazilian central bank to inject a whole monetary base (300% of bank reserves) in one single day! Those relatively large reserve needs from the financial sector further jeopardized the central bank's ability to control monetary aggregates.

Section 2 contains a three-period model that represents the bank's 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, the two most important macroeconomic consequences of the provision of the domestic currency substitute are derived and the main peculiar characteristics of megainflation are presented. Among the latter, one important feature is that the dynamics of megainflation are *not* driven by a need to finance a given budget deficit through seigniorage as is usually assumed in models of hyperinflation (Bruno and Fischer, 1990). Section 4 concludes and lays out topics for future research.

2. The constraints to monetary policy imposed by liquid interest-bearing assets

The model has three periods – 1, 2 and 3 – representing the one-month life of typical government security used for monetary policy. There are three agents: a single bank (representing the whole financial system), the central bank and the households. Given the focus on monetary policy, only the bank's problem is fully

[3] The central bank had no control over the other monetary aggregates either, because until the Real Plan there were no reserve requirements on other components of M_2, M_3 or M_4. Those aggregates were composed of securities that were either indexed to inflation or already incorporated inflation expectations in the (short-term) nominal rate.

modeled, i.e. the model lacks households' utility maximization, as well as a consideration of the government's objectives and budget constraint (both represented by the central bank's reaction function). The households' aggregate financial wealth in period 1, W_1, is entirely deposited at the bank in the form of demand deposits, M_1, [4] and money market deposits, MM_1. The demand deposits do not pay any interest and are subject to reserve requirements of $\delta \times 100\%$. 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 π is assumed known and constant for all the periods. The assumption of a constant inflation is justified by the principal objective of the model, which is to analyze the constraints to monetary policy imposed by the provision of liquidity to interest-bearing assets. Since the three periods cover only one month, the level of inflation is actually given. The shocks to inflation given this short horizon actually strengthen the conclusions of the model, as will be made clear shortly. [5]

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 δM_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. [6] The bank buys B_1 of those T-bills (a maximum of $[(W_1 - \delta M_1)/U_{1,2}]$).

For simplicity it is assumed that: (a) the bank pays a rate of interest on its money market liabilities equal to the (expected one-period) rate paid on government bonds; [7] (b) the expectations hypothesis of the term structure of interest rates

[4] Since the focus of this model is on the bank's problem, no explicit micro-foundation is offered for why the households demand money. A sequel to this paper will incorporate an explicit cash-in-advance rationale for money demand.

[5] At the present stage it is *not* yet an objective of this model to explain the dynamics of the Brazilian megainflation, i.e. the upward movement displayed in Fig. 1. Nevertheless, it will be argued that the resulting monetary policy is a necessary condition of the megainflationary trajectory.

[6] The first subscript refers to the period in which the variable enters for the first time 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.

[7] Given that demand deposits do not receive any interest, this is *not* a zero profit condition. The absence of such a condition may be justified by the fact that the model does not account for all the bank's costs in the banking business. Banks in Brazil could not pay interest in the demand accounts, but they offered many 'free' services as a competition device. As will become clear, the addition of a zero profit condition would not modify the model's results.

holds, i.e. $r_{1,2} = r_1 + E_1(r_2)$; and (c) the yield curve is flat, i.e. $r_{1,2} = 2r_1$. 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 $U_i = \exp(-\pi - r_i)$, $i = 1,2$. The results, however, do 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, ε_2. In expected value terms, money demand grows at rate π, i.e. $E_1[M_2] = \exp(\pi)M_1$. This assumption about money demand is adequate for short periods under megainflation, because agents have already reduced their *real* money holdings to a bare minimum. Given the new money demand, the households deposit the remaining assets in the money market, i.e. $MM_2 = (M_1 + MM_1/U_1 - M_2)$.

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 (minimum) reserve requirements in period 2 are $R_2 = (\delta M_2)$.

In the last period, period 3, the bank pays the families $(M_2 + MM_2/U_2)$ 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. Fig. 2 displays the bank's cash flow.

The statement of the bank's maximization problem is:

$$\max_{B_1,B_2,R_1,R_2} E_1 \begin{Bmatrix} U_{1,2}[R_2 + B_2 - (M_2 + MM_2/U_2)] + \\ U_1[(R_1 - R_2) + (B_1 - B_2)U_2 + (M_2 - M_1) + (MM_2 - MM_1/U_1)] + \\ (M_1 + MM_1 - B_1 U_{1,2} - R_1) \end{Bmatrix} \tag{1}$$

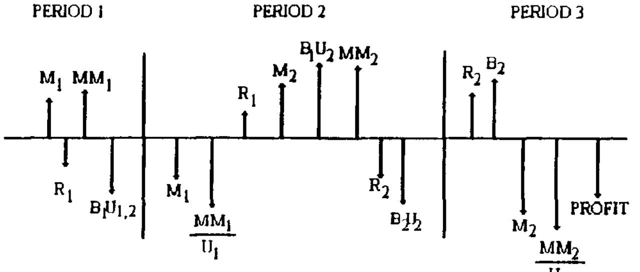

Fig. 2. The bank's cash flow.

subject to identities derived from the bank's balance sheet

$$\begin{aligned} &R_2 + B_2 = M_2 + MM_2/U_2 + \text{Profit} \\ &B_1U_2 + R_1 + M_2 + MM_2 = M_1 + MM_1/U_1 + R_2 + B_2U_2 \\ &M_1 + MM_1 = R_1 + B_1U_{1,2}, \end{aligned} \tag{2}$$

reserve requirements

$$R_i \geq \delta M_i,\ i = 1,2, \tag{3}$$

household's budget constraints

$$\begin{aligned} &M_1 + MM_1 = W_1 \\ &M_2 + MM_2 = M_1 + MM_1/U_1, \end{aligned} \tag{4}$$

demand for money (demand deposits)

$$\begin{aligned} &M_1 = P_1[\gamma \exp(-\alpha\pi) + \varepsilon_1] \\ &M_2 = P_1 \exp(\pi)[\gamma \exp(-\alpha\pi) + \varepsilon_2]. \end{aligned} \tag{5}$$

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

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 ε_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:

$$\psi = M_1\left[(1-\delta) + U(1-\delta)(\exp(\pi) - 1) - (U)^2\exp(\pi)(1-\delta)\right]. \tag{6}$$

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. [8]

Under *un*certainty, the bank's problem is one of choosing the amount of bank reserves it will hold from period 1 to period 2. Although it may be optimal for the bank to hold excess reserves, we will assume that the bank only holds required reserves. Three main arguments justify this simplification. The main argument is that reserves are extremely expensive under megainflation; the opportunity cost of

[8] To quickly apprehend the intuition behind Eq. (6) without having to derive it, note that $\psi(U = 1) = 0$. This is because with a zero interest rate ($U = 1$), the bank makes zero profits.

Table 2
Required increases in the real interest rate in order to compensate a single day holding excess reserves

Inflation per month (%)	Inflation per year (%)	Nominal interest rate per year (%)	Required real rate per year (%)
0	0.00	20.00	22.21
1	12.68	35.22	23.68
2	26.82	52.19	25.15
5	79.59	115.50	29.58
10	213.84	276.61	37.02
20	791.61	969.93	52.10
30	2229.81	2695.77	67.43
40	5569.39	6703.27	83.00
50	12874.63	15469.56	98.80

holding excess reserves is the nominal interest rate, which under megainflation is of the order of at least 1000% [9] To 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). [10] The real interest rate is 20% per year (this was roughly the actual real interest in Brazil in 1993). 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.

The second argument to assume zero excess reserves is that this simplification

[9] Even under the 'normal' nominal rates, similar effects seem to hold. Hodrick et al. (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 cash 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.

[10] Monetary policy in Brazil was usually conducted 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.

allows us to draw the highest possible profit as a function of the unknown r_2.[11] This function will be very useful in analyzing the bank's problem. The third argument is that banks in Brazil do not actually hold excess reserves.

However, all that was said depends crucially on the central bank's reaction function (not modeled here), and one of its policy goals is to keep the financial system in good health. With such a goal, the central bank may smooth 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 rise significantly. This is self-reinforcing, because if banks do not hold excess reserves, the central bank will then have more incentives not to let steep increases in the interest rate 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:

$$E_1\left\{\begin{array}{l} W_1(1-U_{1,2}/(U_1U_2))+ \\ M_1\left[-\delta\left(1-\frac{U_{1,2}}{U_2}\right)+\exp(\pi)U_{1,2}(1-\delta)\left(\frac{1}{U_2}-1\right)+\frac{U_{1,2}}{U_2}\left(\frac{1}{U_1}-1\right)\right]+ \\ \varepsilon_2\left[\exp(\pi)U_{1,2}(1-\delta)\left(\frac{1}{U_2}-1\right)\right] \end{array}\right\}. \tag{7}$$

We may decompose the bank's discounted expected profit in four sources, namely:

1. The household's wealth: $W_1[1/U_{1,2} - 1/(U_1U_2)]U_{1,2}$ represents the bank's gain by performing the maturity transformation;
2. The (costless) demand deposits: $\{(M_1/U_2)[(1/U_1) - 1] + M_1 \exp(\pi)[(1/U_2) - 1]\}U_{1,2}$ represents the gains by investing the costless demand deposits in period 1 and 2, respectively;
3. The bank's required reserves: $[\delta M_1(-1/U_{1,2} + 1/U_2 - \exp(\pi)/U_2 + \exp(\pi))]U_{1,2}$ 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: $\varepsilon_2\{\exp(\pi)(1-\delta)[1/U_2 - 1]\}U_{1,2}$ represents the gains of a positive shock to money demand (demand deposits).

[11] Technically, the no excess reserves solution is indeed the maximizing strategy under risk-neutrality of the bank when $E_1[U_2/U_{1,2}] \geq 1$.

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 $\varepsilon_2 \exp(\pi)$, representing a gain of $\varepsilon_2\{\exp(\pi)[1/U_2 - 1]\}U_{1,2}$;

4.2. the bank has to sell securities to fulfill reserve requirements of $\delta\varepsilon_2 \exp(\pi)$, representing a (negative) interest gain of: $-\varepsilon_2 \delta\{\exp(\pi)[1/U_2 - 1]\}U_{1,2}$.

Eq. (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 $E_1(r_2) = r_1$) to obtain $E_1[1/U_2] = (1/U_1)(1 + \sigma_{r_2}^2/2)$, where $\sigma_{r_2}^2$ is the conditional variance of r_2 in period 1. We also assume that there is no shock to money demand, i.e. $\varepsilon_2 = 0$. In this case the discounted expected profit is:

$$\psi - \frac{\sigma_{r_2}^2}{2}\{W_1 - M_1 - M_1[U_1(1-\delta)(\exp(\pi) - 1)]\}, \tag{8}$$

where ψ 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 $\varepsilon_2 = 0$). Therefore, the whole 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/or the larger the ratio between money market and demand deposits is. Eq. (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, Eq. (8) relies solely on the concavity of the profit function to make a Jensen's inequality-type argument under risk-neutrality. [12] 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.

Fig. 3 displays a rough calibration that is used to exemplify 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

[12] The concavity of the profit function arises because of the exponential discount used between periods. Another, and perhaps more plausible, justification for the concavity of the profit function is the fact that the whole banking system is subject to aggregate inflation shocks, against which there is no way to hedge without the central bank's help. Therefore, the utility function of the banking sector, defined over its profits, should exhibit risk aversion, at least for shocks that affect profits substantially so as to threaten the stability of the financial system. I thank Scott Freeman for pointing this out to me.

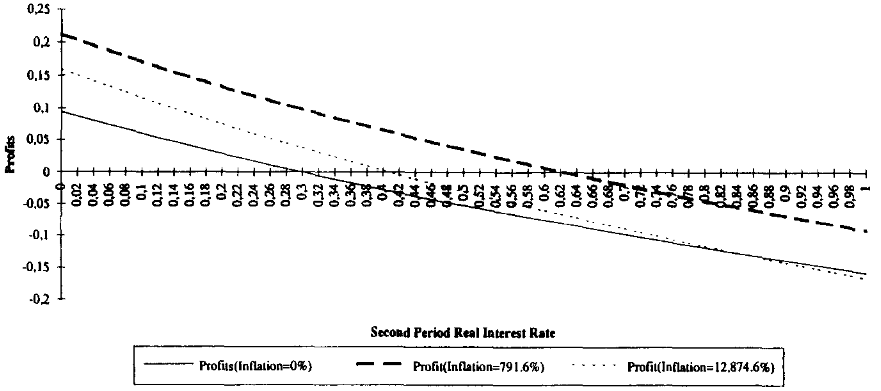

Fig. 3. The bank's profits with increasing inflation.

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. Fig. 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 analogue of the tax base) to the point that the bank's profits begin to fall despite the increase in the inflation rate, and consequently, the nominal interest rate (the analogue of the tax rate) for a given real rate. The exact shape of those profit curves would have to be empirically determined from the basic parameters of the model.

The point made by Fig. 3 is that even without uncertainty about the liquidity needs in period 2 ($\varepsilon_2 = 0$), 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 (if some sort of Fisher effect holds for short rates). Given the inflation pattern displayed in Fig. 1 (inflation is usually rising), the uncertainty about rising inflation (not modeled here) compounds the problem, further constraining the monetary policy. One clear piece of 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 et al., 1993).

Table 3 displays the averages and standard deviations for lending (discount) and borrowing (certificates of deposit) 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 Fig. 1) not only the average spread increased, but its variability became much greater. This

Table 3
Mean and variance of interest rates per month (%)

	CD rate	Discount rate	Spread [a]
Pre-1980 mean	2.62	3.65	1.00
1980-1985 mean	7.53	11.06	3.27
Post-1985 mean	18.51	24.60	4.76
Pre-1980 standard deviation	0.64	1.12	0.52
1980-1985 standard deviation	2.78	3.44	1.00
Post-1985 standard deviation	14.06	20.59	5.07

[a] The spread was computed geometrically. This is why the mean spread is not equal to the difference between the mean discount rate and the mean CD rate.

result is consistent with the familiar mean–variance analysis: the extremely high and volatile inflation and the economic shocks turned the Brazilian economy into a much riskier, and therefore more profitable, environment for the banking business.

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. [13] In the model, this means that the central bank will provide the bank with the necessary additional reserves in period 2 without raising interest rates too much. [14] 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 requirement. [15] 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.''

[13] Derivative markets have evolved very rapidly in Brazil (Carneiro et al., 1993). There is an interest rate futures market, which could be used to hedge the interest rate risk. However, such a 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.

[14] 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).

[15] The *zerada automática* also gives banks with excess reserves the last opportunity to buy repurchase agreements in order not to incur 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*.

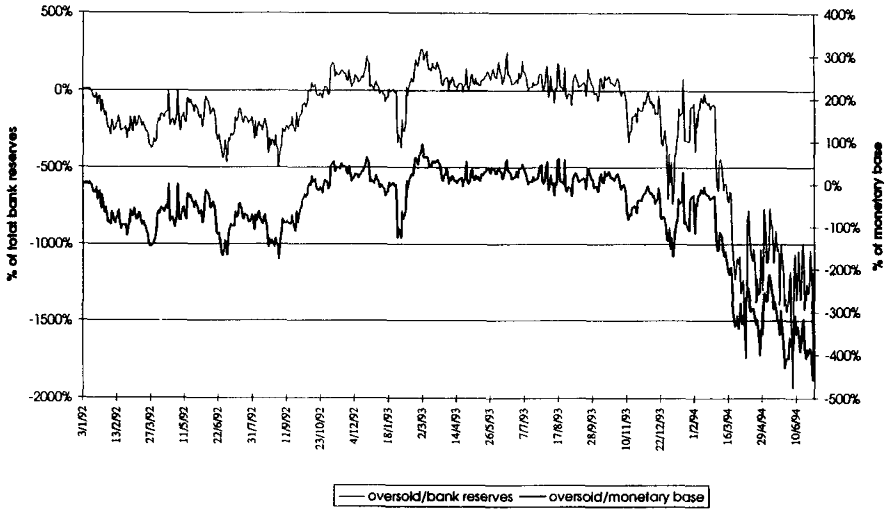

Fig. 4. Oversold (+) and undersold (−).

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. Fig. 4 shows the amount of the central bank's daily interventions in the open market. The negative values mean the selling of repurchase agreements, which was what the central bank did in times of great uncertainty to avoid paying a prohibitive risk premium on the longer (one month) maturity T-bill. The positive values represent the central bank's purchases of government securities. The central bank is said to be undersold in the former case and oversold in the latter. The size of the central bank interventions (relative to the monetary base or to the aggregate of bank reserves) is several times greater than those 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 it 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 Fig. 3, one may doubt whether monetary policy is truly constrained. After all, the profit line the most sensitive to the interest rate risk is that of inflation = 0%. 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 modeled 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 et al., 1993). A recent study showed that 41% of the financial revenues of the largest six Brazilian banks in 1993 came from those 'inflationary' gains (Carvalho, 1994). 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 latter 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%) are unlikely to happen in countries with low inflation. In the Brazilian economy, however, large increases in interest rates may be necessary to achieve inflation control. The next section analyzes the main macroeconomic consequences of the domestic currency substitution regime.

3. A few macroeconomic consequences of the domestic currency substitute

3.1. The non-controllability of seigniorage

One important consequence of the mechanism of providing liquidity to interest-bearing assets is that the amount of seigniorage collected, which is represented in the model of Section 2 approximately by the bank's losses by holding required reserves, is not *controllable* by the monetary authority, as in some of the models of *exogenous* seigniorage (Blanchard and Fischer, 1989, p. 198; Bruno and Fischer, 1990). [16] In those models, the fiscal authority sets the deficit that is financed through seigniorage; i.e. if the deficit increases, so does seigniorage. This cannot be the driving force behind the Brazilian megainflation, because the interest rate targeting pursued by the central bank precludes it from monetizing too much the economy in search for more seigniorage. 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 can no longer be used as an instrument not to pay the inflation tax, the households may look for other assets

[16] Pastore (1993) refers to the endogeneity of seigniorage. He suggests monetary and exchange policy rules (interest rate or real exchange rate targeting) that force the government to fully monetize the fiscal deficit, therefore making seigniorage *endogenously* equal to the deficit. This is observationally equivalent to *exogenous* seigniorage models (Blanchard and Fischer, 1989, p. 198; Bruno and Fischer, 1990), where the dynamics stem from extracting enough seigniorage to finance the deficit. I tried to avoid such semantic confusion by using the expression controllable.

that could perform this function. In that case, the economy would undergo a typical currency substitution process. [17]

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 seigniorage 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. [18] The amount of seigniorage cannot be controlled by the monetary authority, but may be extracted as long as the domestic currency substitute is alive.

In summary, the dynamics of the Brazilian megainflation were *not* driven by a need to finance a given budget deficit through seigniorage as is usually assumed in models of hyperinflation (Bruno and Fischer, 1990). This is not equivalent to saying that the Brazilian megainflation was *not* caused by fiscal imbalances. What is emphasized here is that the dynamics of megainflation were not the usual 'print more money to finance a higher deficit' textbook explanation. The link between fiscal imbalances and inflation cannot be this direct one by the reasons just explained.

Indeed, the numbers in Table 4 show how seigniorage remained fairly stable despite huge movements on the deficit. [19] 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 seigniorage for longer, although it has very little control on the amount it can collect. Large increases in the fiscal deficit under the domestic currency substitution regime must be financed through debt and not through seigniorage.

3.2. The lack of a nominal anchor

The provision of the domestic currency substitute endogenizes money supply, providing automatic sanction to any increase in money demand. Price increases

[17] A sequel to this paper will incorporate a foreign asset to formally model the currency substitution process. See also Lopes (1994).

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

[19] Under high inflation, the operational deficit is the least flawed indicator of the fiscal situation. The nominal deficit is very misleading, as shown by the following example. Suppose an economy with 1000% yearly inflation and a debt/GDP ratio of 50%. The real interest rate is 0% and GDP is normalized in year zero to 100. The government always issues new debt to pay for interest payments. After one year, if the debt/GDP ratio is still the same (with no GDP growth), the government paid 500 of interest (1000% over 50). If this is evaluated as a ratio of the year's end GDP (1100), the *nominal* deficit (if the *primary* deficit is zero) becomes 45% of GDP (= 500/1100)! But the debt/GDP ratio remained the same, namely 550/1100 = 50%, signaling that *no* new debt financing was required. Therefore, the *nominal* deficit cannot be a good proxy for the fiscal situation of a megainflationary economy.

Table 4
Brazil: deficit and seigniorage (percentage of GDP)

Inflation		Deficit [a]			Seigniorage	
	% a.a.	Primary	Operational	Nominal	S_1 [b]	S_2 [c]
1985	235.00	−2.8	4.7	28.6	2.30	1.90
1986	65.04	−2.3	3.9	13.3	3.70	3.60
1987	415.83	0.8	5.9	32.3	2.80	2.00
1988	1037.56	−0.4	5.1	52.9	3.60	2.70
1989	1782.90	0.3	7.4	83.0	5.50	4.00
1990	1476.56	−2.4	−1.4	29.6	5.20	5.40
1991	480.18	−3.0	−1.4	24.5	3.00	2.30
1992	1157.94	−2.4	2.2	44.3	3.70	2.70
1993	2708.60	−2.6	−0.2	58.4	3.50	2.40
1994 [d]	7350.78	−4.0	−1.0	82.9	2.70	2.50

[a] Figures pre- and post-1991 are not comparable due to a methodology change. Before 1991, the deficits were computed with annual flows, while starting in 1991, monthly flows were used, leading to a more precise estimate. The primary deficit excludes interest payments. The operational deficit is the primary deficit plus the real interest rate payments. The nominal deficit includes interest payments. These figures refer to the three levels of government and the state companies. Negative numbers indicate surpluses.
[b] Computed with annual flows.
[c] Computed with monthly flows.
[d] Annualized rates from the first semester (before the Real Plan).
Sources: the deficit numbers were computed by the Brazilian central bank, economics department. The seigniorage numbers were computed from central bank data by Fabio Giambiagi (IADB and BNDES).

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 aimed at fixing the real exchange rate, the system completely lacked a nominal anchor. Any inflation rate, provided it was expected, qualified as an equilibrium. It is not surprising that, as a consequence, inflation has exhibited the upward trend shown in Fig. 1.

Again, this is not meant as an argument against the fiscal causes of the Brazilian inflation. The argument here stresses the importance of the monetary rule to validate inflation expectations. Fiscal balance alone is not sufficient to curb inflation; the monetary rule must also be changed.

The absence of a nominal anchor has been pointed out for a long time in the so-called 'inflation inertia' literature. In that literature, indexation plays the principal role in perpetuating inflation (see Arida and Lara-Resende, 1985; Simonsen, 1986). What was done in this paper was to specifically address the workings of the monetary policy that is required for inflation inertia to exist.

4. Conclusion

Since the mid-sixties Brazil has undertaken 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 of as a good solution. [20] The other key factor was the provision of liquidity to interest-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 Brazilian domestic currency substitute, and analyzes its two main 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 Fig. 1).

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 it 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 in line with inflation.

In Section 3, the consequences of this automatic monetization are analyzed. Automatic monetization together with the lack of other nominal anchors (e.g. an exchange rate) means that the economy has an undetermined equilibrium with respect to the inflation rate. The monetary policy associated with the domestic currency substitute does not pin down the inflation rate.

However, a distinctive macroeconomic feature of the domestic currency substitution regime is that the dynamics of megainflation are *not* driven by the attempt of the government to collect seigniorage by printing more money, as is usually assumed in models of hyperinflation (Blanchard and Fischer, 1989, p. 198; Bruno and Fischer, 1990). This does *not* imply that the Brazilian megainflation was not

[20] "At least before the first oil shock in 1973–1974, 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 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).

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.

Those dynamics are important because fiscal control is a necessary but not a sufficient condition to achieve inflation stabilization. The monetary policy associated with the domestic currency substitute must also be changed – or an alternative exchange-rate anchor established – so that the economy has a nominal anchor.

The provision of the domestic currency substitute slowed down the currency substitution process that is always associated with hyperinflations. This made it possible for the government to collect seigniorage for longer, although it had 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 of supply of reserves, and interest rates would fall. Given the smallness of the stock of bank reserves, any significant increase in the deficit that needed to be financed through seigniorage would drive interest rates down by a large amount. This drop in interest rate would 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 seigniorage, and, as a consequence, the dynamics of megainflation were not the usual 'print more money to finance a larger deficit' explanation.

Table 4 shows a rather unusual set of stylized facts. In the nineties, the fiscal deficits decreased substantially, while inflation grew enormously and seigniorage was kept fairly constant. Existing macroeconomic models of hyperinflation cannot account for this combined behavior of these three variables. Even in models where the expected stabilization plan drives the dynamics (Drazen and Helpman, 1990), one has the deficit increasing and inflation decreasing, but not the other way around as in the Brazilian case. The next research issue is to enlarge the current model in order to account for these stylized facts.

When inflation reaches the levels it did in the last decade in Brazil, it also becomes highly volatile, greatly jeopardizing economic activity. After many years of very high inflation, it became clear to most Brazilians that the costs of coping with inflation were higher than those of fighting it. [21] The lessons of the Brazilian case are important for countries such as those in Eastern Europe, which may entertain the elusive possibility of an easy way out of fiscal and monetary controls to fight inflation.

[21] Simonsen and Cysne (1993) estimate that the welfare costs of inflation before the Real Plan hover around 7.56% of GDP ($34 billion per year). Similar numbers are obtained by Pastore (1993).

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