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Indexation and Inflation in Brazil*

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1. Introduction

In Fraga (1985) we discussed the reactions of Germany and Brazil to their respective external shocks, and concluded that both experiences were characterized by what was termed "under adjustment and over borrowing", leading to balance of payments collapses. Even though both countries had to face the problem of inflation following the external disturbance, their experiences differed significantly. In the period analysed above, Germany had already eliminated its hyperinflation, whereas Brazil, having never experienced an exploding inflation, never managed to eliminate its high but relatively stable inflation.

While the German hyperinflation has been the focus of extensive analyses (see Fraga (1985)); the Brazilian inflation is just now being well understood. Recent work on the topic has pointed out that, due to the nature of the indexation laws that rule most labour and financial transactions, the rise in the inflation rate can be attributed to negative supply shocks[1]. For example, the 1979-80 acceleration of inflation (see Table 1) has been related to the change in the wage law in October 1979 and the maxi-devaluation of the Cruzeiro in December 1979; and the recent explosion of 1983 to another large devaluation, and the upward adjustment in the prices of public Services and goods. The money supply is usually assumed to react passively, accommodating the shocks, but the mechanisms of accommodation are given very little attention.

Table 1 Brazil: Economic Indicators

Year	MA/MB	GDP Growth	Money Growth	Inflation	Change in Reserves	BB Loans Growth	D/Y	RER
1972	47		18.5	18.9	62	35	6.8	88.3
1973	35	13.6	47.1	23.4	49	52	6.7	94.8
1974	29	9.7	32.9	33.5	-19	80	6.7	97.6
1975	66	5.4	36.4	35.3	18	64	7.7	100.0
1976	62	9.7	49.8	46.7	36	62	8.7	95.2
1977	73	5.7	50.7	44.7	9	50	8.1	91.0
1978	82	5.0	44.9	44.1	50	35	8.3	102.9
1979	83	6.4	84.4	57.6	-24	65	6.3	112.4
1980	97	7.2	56.9	94.6	-33	67	4.6	119.2
1981	98	-1.6	69.9	97.3	8	68	8.4	94.8
1982	96	0.9	86.8	96.4	-64	70	9.3	91.3
1983	101	-3.5	89.1	146.0	13	96	7.6	n.a.

Sources: Central Bank Bulletin, Conjuntura Econômica.

[1] See Simonsen (1980), and Lara-Resende and Lopes (1981).

Table 1 (continued)

Definitions:	MA/MB	=	movement account/monetary base (includes the 'conta-suprimentos' in 1983).
	Money Growth	=	annual rate of growth, monetary base.
	Inflation	=	annual rate of growth, implicit GNP deflator.
	Change in Reserves	=	change in dollars times the average exchange rate for the year, as a percentage of the previous year's monetary base.
	BB Loans	=	annual rate of growth, Bank of Brazil loans.
	D/Y	=	Federal government's public debt as a percentage of GNP.
	RER	=	real (WPI deflated) trade weighted exchange rate, from Fendt and Koksaka (1984). An increase denotes a real depreciation of the Cruzeiro.

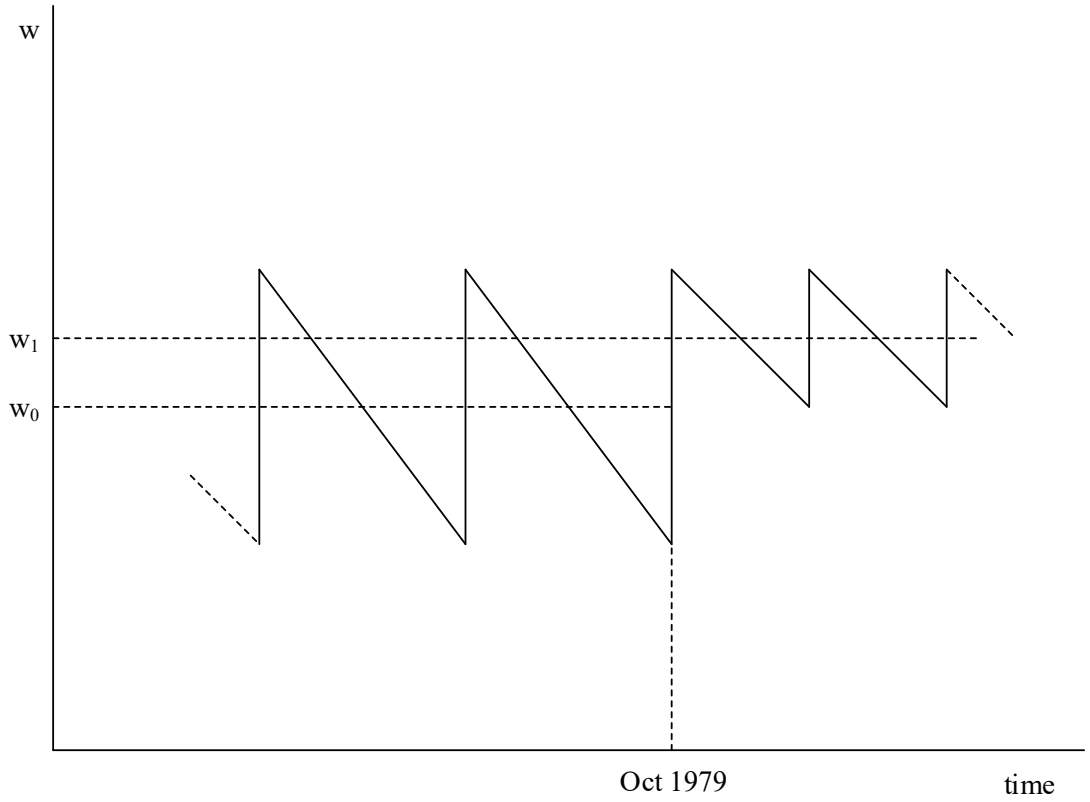
This chapter has, therefore, four objectives: to build a model of an indexed economy such as the Brazilian, and illustrate the supply- shock view of inflation; to incorporate an explicit mechanism of accommodation into this model; to discuss the particular institutional arrangement that makes this mechanism possible; and to test for the non-exogeneity of the money supply (more precisely, of the monetary base). These tasks will be undertaken in turn in the next four sections.

2. Devaluation and Inflation in an Indexed Economy

As mentioned above, the acceleration of inflation in Brazil in the end of 1979 is frequently associated with the change in wage policy that took place in October, and with the maxi-devaluation of December. Let us discuss the wage-policy change first. Wage readjustments in Brazil are regulated by government law.

Before 1979 the nominal wage was readjusted annually, so as to bring the real wage (at the moment of readjustment) to the level that prevailed just after the previous increase. The wage increase therefore corresponds to the inflation in the preceding year. In October 1979, the interval was reduced to six months. Leaving aside some details of the law, we can conclude that, had inflation remained constant, average real wages per period would have gone up, as Figure 1 illustrates.

Figure 1



Since real wages are always brought back to the previous peak, the shortening of the re-contracting interval implies a higher average real wage for a given inflation rate.

It is likely, however, that this increase in the real wage will lead to a macroeconomic disequilibrium. One solution is to increase inflation, bringing the average real wage down. Figure 2 illustrates the point.

This argument can also be formalized, following Arida (1982). Let the log of the real wage just after an increase be denoted by w, and let $\overline{w}$ be the log of the equilibrium real wage. Wages are readjusted at the beginning of the period, while prices are marked-up continuously.

In particular, let the (endogenous) inflation rate be constant within the period, and equal to π. Normalizing the initial price level to one, we have:

(1) $P(t) = e^{\pi t}$

The log of the real wage (flow) is given by:

(2) $w(t) = w - \pi t$

Firms set the inflation rate so as to make the average real wage in the period equal to $\overline{w}$:

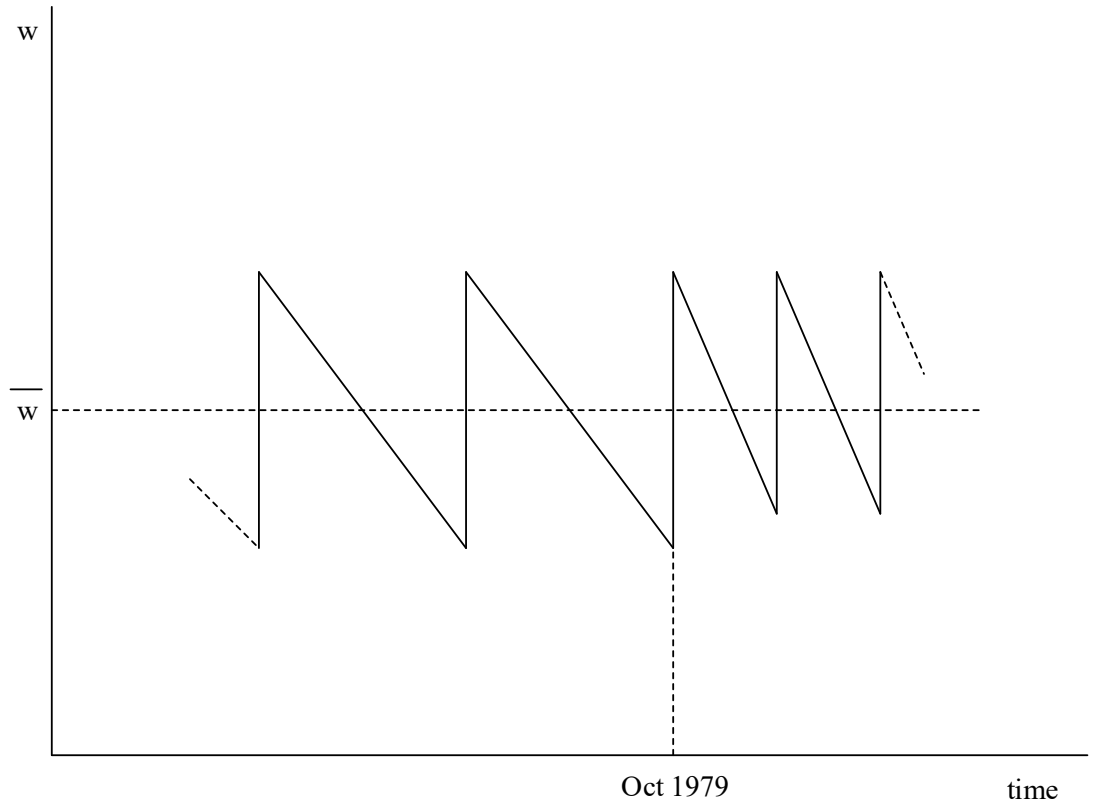
(3) $\overline{w} = \frac{1}{T}\int_0^T w(t)dt = w - \frac{\pi T}{2}$

where T is the length of the interval between wage increases. From equation (3) we obtain the inflation rate:

(4) $\pi = \frac{2(w-\overline{w})}{T}$

Since the peak real wage is determined by law, equation (4) tells us that inflation will be higher the lower the equilibrium real wage, and the shorter the contract length. In particular, when the period is reduced by half, the inflation rate doubles.

Figure 2



This simple framework can also be used to analyse the effect of a supply shock on inflation. Let domestic output be produced by a domestic input and an imported input. If we make the standard assumption (see, e.g., Marion and Swensson, 1984) that inputs are cooperative in the sense that an increase in the use of one input increases the marginal product of the other, then an increase in the price of the imported input will require a decrease in the price of the domestic input (wages), to maintain full- employment.

Formally, let $y = F(L, I)$, where L is labor and I is the imported input. The first-order conditions for profit maximization are:

$$F_L(L, I) = w$$
$$F_I(L, I) = e$$

Keeping L constant (full-employment), we can calculate the impact on w of an exogenous change in e by differentiating the conditions above:

$$dw = \frac{F_{LI}}{F_{II}} de$$

and if $F_{LI} > 0$ and $F_{II} < 0$ an increase in e calls for a reduction in w. Thus, in terms of equation (4),

a supply shock can be identified with a drop in $\overline{w}$, and consequently, with an increase in π.

For a small country (one that takes the price of imported inputs as given), a devaluation of the exchange rate and an increase in the imported input price will have the same impact on prices.

The preceding analysis of wages and inflation focused on the cost-push effects of broadly defined supply shocks. To study the effects of discrete exchange-rate devaluations, let us turn to a complete macro model. Its main features will be the indexation of wages and interest rates, as in Brazil.

On the supply side, production is assumed to be Cobb-Douglas in labour and the imported input (those foreign currency price is fixed and normalized at unity). Prices are then given by:

(5) $\quad p_t = aw_t + (1-a)e_t$

where all variables are in logs, 'a' is the share of labour, 'w' is the nominal wage, and 'e' is the nominal exchange rate in units of home currency per foreign currency.

Consumption is divided between the domestic and imported goods, and consumers are assumed to have constant consumption shares. The log of the CPI is therefore given by:

(6) $\quad q_t = bp_t + (1-b)e_t$

where 'b' is the share of the home good in consumption. Substituting (5) into (6) we get:

(6') $\quad q_t = \alpha w_t + (1-\alpha)e_t \qquad \alpha \equiv ab$

Wage behaviour is characterized by the following equation:

(7) $\quad w_t = w_{t-1} + \pi_{t-1} + y_{t-1}$

Nominal wages increase by the previous period's rate of inflation, plus (or minus) a factor that depends on labour market conditions, here represented by deviations of output from trend. This is an approximate characterization of Brazilian wage behaviour, and follows Simonsen (1984).

Equations (8) and (9) define the rate of CPI inflation, and the real exchange rate, respectively:

(8) $\quad \pi_t \equiv q_t - q_{t-1}$

(9) $\quad c_t \equiv e_t - q_t$

Using these definitions, and equations (6') and (7), we obtain a reduced form for price dynamics:

(10) $\quad \pi_t = \pi_{t-1} + \gamma y_{t-1} + \delta x_t$

$x_t = c_t - c_{t-1}$

$\delta \equiv (1-\alpha)/\alpha$

The change in the real exchange rate (x_t) will be interpreted as a policy parameter, given that the *lagged* indexation rule allows for some real wage flexibility. This is consistent with the policy of pegging the real dollar exchange rate (i.e., the crawling nominal peg) followed in the 1968-79 period. We can already see two important characteristics of the inflationary process in Brazil: real devaluations imply increases in inflation, as discussed above, and these increases will be permanent

unless they indirectly lead to unemployment (the only factor in this model, apart from positive supply shocks, that can lower inflation).

The demand side will take a simple IS-LM form. In spite of the pegging of the exchange rate, the rate of growth of the money supply (denoted by μ) will be taken for the moment as a policy parameter, in view of strict trade and capital flow Controls. Formally, we have:

(11) $y_t = hc_t - fr_t$

(12) $m_t - q_t = y_t - \ell i_t$

(13) $i_t = r_t + \pi_{t+1}$

Equation (11) is an IS curve, where r_t is the real rate of interest, known in advance because of interest rate indexation. Equation (12) is the LM, with income elasticity equal to one, and i^ the nominal interest rate. Equation (13) links real and nominal interest rates, and perfect foresight is assumed to hold.

Substituting (11) and (13) into (12), and taking first differences, we obtain:

(14) $y_t = y_{t-1} + \beta(\mu_t - \pi_t) + (1-\beta)hx_t + \beta\ell(\pi_{t+1} - \pi_t)$

$\beta \equiv f/(f+\ell)$

Thus, an increase in the rate of growth of money, a devaluation of the currency, and an increase in expected inflation will all generate an increase in aggregate demand.

Equations (10) and (14) can be solved for the paths of output and inflation, given the paths of the money supply and the real exchange rate. When money growth and the real exchange rate remain constant, the system has a steady State with $y = 0$ and $\pi = \mu$.

Let us now turn to the analysis of a devaluation, i.e., a one- period blip in x_t. Assuming the system was in steady State before the policy change, we will calculate the effects of a one period ahead, anticipated, unitary x_t shock. For simplicity, let us assume for the moment that monetary policy is calibrated to maintain full employment.

From equations (10) and (14) we have that, when the devaluation is announced, current output and inflation are:

$$y_0 = \beta(\mu_0 - \pi_0) + \beta\ell(\pi_1 - \pi_0)$$

$$\pi_0 = \mu$$

Next period's inflation, given that monetary accommodation sets $y_1 = 0$, will rise by δ, the cost-push effect of higher imported input costs. Thus, at $t = 0$ the money growth that stabilizes current employment is given by:

$$\mu_0 = \mu - \ell\delta$$

With an expected rise in inflation, the current stock of real balances is too high, so some contraction is required to keep aggregate demand from rising above equilibrium.

At the time the devaluation actually takes place ($t = 1$), inflation rises to $\mu + \delta$, and remains

there, given that output is kept at the full employment level. To compensate for the impact of the devaluation on aggregate demand, however, monetary growth accommodates less than fully:

$$\mu_1 = \mu + \delta - \frac{\ell h}{d}$$

After that, inflation and money grow at $\mu + \delta$, and output remains in equilibrium. Thus, in an economy with wage and interest rate indexation a devaluation of the real exchange rate requires a permanent increase in the rate of inflation, if output is to remain in equilibrium.

This requires that monetary policy be accommodative and may require explicit government action. In an indexed economy, however, accommodation may take place endogenously, given the indexation of government debt. The next section will examine this possibility.

3. Monetary Accommodation and the Government Budget Constraint

Standard discussions of inflation, such as those usually attributed to the International Monetary Fund, view the problem as one of excess demand and excess money. The logical prescription is then to cut the government budget deficit, as it reduces aggregate demand, and also slows down the rate of money creation. The IMF program that was implemented in Brazil in early 1983 follows exactly this theory, and, as one would expect, led to a continuation of the recession of 1981-82. The initial impact of the IMF's policies in Brazil, as well as a discussion of its budget deficit definitions and targets, have been the subject of a recent paper by Edmar Bacha (1983). This section will, therefore, focus mainly on clarifying some of the issues related to the interaction between government deficits and money growth[2] in a lagged-index economy.

The government budget constraint can be written as follows:

(15) $$P_t g + i_{t-1} D_{t-1} = D_t - D_{t-1} + M_t - M_{t-1}$$

where

P_t - price level

D_t - stock of (one-period) debt held by the public

i_t - nominal interest rate

M_t - high powered money

g - the real non-financial government deficit

Under the Brazilian indexation scheme, the nominal interest rate is not known in advance, but ex post it is given by equation (13) above.

[2] I am assuming that the money supply multiplier (Ml/MB) is constant, and that therefore the monetary base and the money supply grow at the same rate. In the case of Brazil in the 1970-1983 period, the money multiplier does not exhibit a statistically significant trend.

Therefore, we can rewrite (15) as:

(15') $P_t g + r_{t-1} D_{t-1} = D_t - (1 + \pi_t) D_{t-1} + M_t - M_{t-1}$

Equation (15') says that the real government deficit is financed via money creation, and growth in the level of *real* debt.

In principle, we could add a government spending term to the *IS* equation above, and incorporate the budget constraint into the model summarized by equations (10) and (14). Unfortunately, we run into non-linearities that preclude the explicit solution of the complete model.

One alternative would be the one followed by Fischer (1984), who linearizes the constraint around trend levels. For my purposes, however, this procedure is not satisfactory, because it does not allow for a sensible discussion of changes in the trend of price increases, i.e., it is not suitable for a discussion of changes in the level of inflation. The alternative followed here is to carry the analysis as far as possible without using any approximation, and consequently, without obtaining an explicit solution for the complete model.

If the operational budget is in deficit ($g > 0$), and the real level of debt remains constant (and equal to d), equation (15') leads to:

(16) $\mu_t = \frac{g(1+\pi_t)+rd}{M_{t-1}/P_{t-1}}$

It then follows that the rate of monetary expansion increases with current inflation, and money is 'ceteris paribus' endogenous. Moreover, if the increase in inflation is anticipated, real equilibrium money balances (at $t-1$) will decline, leading to an even higher rate of money growth as the inflation-tax base shrinks. This is a standard component of explanations of hyperinflations.

One peculiarity of the Brazilian institutional setting that fits nicely into this framework is the provision of subsidized credit by the government (more on this ahead). These loans, denoted below by S_t, carry an interest rate (s_t) defined as a fraction of the "coefficient of monetary correction" (the lagged indexation factor). The government's budget constraint can be rewritten as:

(17) $P_t g + i_{t-1} D_{t-1} + S_t = D_t - D_{t-1} + M_t - M_{t-1} + (1 + s_{t-1}) S_{t-1}$

$$s_{t-1} = \lambda \pi_t, \quad 0 < \lambda < 1$$

Substituting s_{t-1} and i_{t-1} into (17) we obtain:

(17') $P_t g + r_{t-1} D_{t-1} + (1-\lambda)\pi_t S_{t-1} = D_t - (1 + \pi_t) D_{t-1} + M_t - M_{t-1} - S_t + (1 + \pi_t) S_{t-1}$

Now the *real* government deficit increases with inflation. This follows from the fact that the subsidy increases with inflation, as the equation makes clear.

Keeping the real level of subsidized loans constant (and equal to a as well as the deficit and the level of debt, we get another expression for money growth.

(18) $\mu_t = \frac{g+rd+[g+(1-\lambda)\sigma]\pi_t}{M_{t-1}/P_{t-1}}$

In addition to the previous factors, money growth now responds positively to a higher subsidy rate (λ), and to a higher level of subsidized credit (σ).

We can also look at steady-state inflation. Equating μ and π, and remembering that in equilibrium real balances depend on the level of inflation, we get:

$$\pi = \frac{g + rd}{m(\pi) - g - (1 - \lambda)\sigma}$$

Thus, steady-state inflation increases with the real operational deficit (g), with real interest payments on debt (rd), and with the provision of subsidized loans, $(1 - \lambda)\sigma$.

In the case of Brazil in the late 70's and early 80's, it seems clear that the pre-conditions for automatic monetary accommodation were present, as will be argued ahead. Note for the moment that subsidized loans were being provided throughout the period, and that the federal government debt as a percentage of GNP remained roughly constant (Table 1).

Let us now turn to a brief discussion of disinflation. From equation (15'), we see that if the real government deficit ($Pg + rD$) is zero, which means taxes are raised to cover real interest payments on the debt, and if the real stock of debt remains constant (i.e., there are no roll-over problems), then the money stock will be constant. In this case, zero will be the *only* inflation rate consistent with macroeconomic equilibrium. This is probably behind the standard adjustment policies prescribed by the IMF, and indeed is where one should end up after disinflation. It does not, however, tell us anything about the transition. If inflation is inertial, as it is in Brazil given indexation, then a zero rate of money growth will imply a liquidity squeeze, and will generate unemployment.

4. The Monetary Authorities in Brazil

In the previous section we saw that the system of lagged interest rate indexation can lead to automatic monetary accommodation in the presence of a government deficit. This mechanism, however, is not enough to explain why money growth has increased *pari-passu* with inflation, because counter-measures could have been taken in order to maintain monetary stability. This did not happen because, as Simonsen (1980, p. 14) pointed out, "the Brazilian monetary system is a very peculiar one, with a built-in bias toward the expansion of the money supply". This section will attempt to explain why this is the case.

In most countries the term "Monetary Authorities" is used to denote the institution(s) that performs the function of a textbook central bank. Its assets are usually composed of government securities and foreign exchange, and its liabilities are constituted almost solely of the monetary base. In Brazil, however, the institutions that have the power to create money also function jointly as a

development bank, providing direct subsidies and subsidized loans, and as a commercial bank.

To understand this situation, one must come to grips with the relationship between the Central Bank and the Bank of Brazil ('Banco do Brasil'). The former is a product of the incomplete monetary reform[3] of 1965, and is ultimately responsible for the introduction of money into the system. Its balance sheet can be summarized as follows:

Figure 3

Central Bank

Assets	Liabilities
Government securities	Currency
Foreign Exchange	Bank Reserves
Loans and Subsidies	Time Deposits
Movement Account	

Some of these items merit discussion, so let us begin with the Movement Account ('Conta de Movimento'), an item which is now as large as the monetary base (see Table 1). The best way of clarifying its meaning is to look at the balance sheet of the Banco do Brasil, a state-controlled commercial bank.

Figure 4

Banco do Brasil

Assets	Liabilities
Loans	Deposits
Securities	Time Deposits
	Movement Account

The Movement Account is thus a credit line from the Central Bank to the Banco do Brasil. The interest charge on the balance of this account is equal to one percent a year, regardless of the inflation rate. For reasons that will be discussed below, the existence of the Movement Account means that the Banco do Brasil has *de facto* access to the printing press[4]. In addition to that, the Banco do Brasil is not required to hold reserves at the Central Bank. For these reasons, the Monetary Authorities in Brazil are composed by the Central Bank and The Banco do Brasil. Their combined balance sheet is depicted in Figure 5.

[3] The ratio D/Y does not exhibit a statistically significant trend in the period.
[4] See Ribeiro (1973), for a discussion.

Figure 5

Monetary Authorities

Assets	Liabilities
Government securities	Currency
Foreign Exchange	Bank Reserves
Loans and Subsidies	Demand Deposits at the BB
	Time Deposits

The first three items in the liability side are economically equivalent, and hence the inclusion of Demand Deposits at the Banco do Brasil into the definition of the monetary base.

In general, in an environment of high inflation, one would expect an infinite demand on the part of the Banco do Brasil for Movement Account loans. To prevent this from happening the Monetary Authorities are subject to a "Monetary Budget", which determines the size of its assets and non-monetary liabilities. The monetary base is therefore determined as residual.

Lest the reader conclude that monetary control could be attained, let me make three points on the Monetary Budget: First, it should be part of an overall government budget, but it is not. Second, it is controlled not by an independent Central Bank president, but by a "National Monetary Council" composed of government officers, ministers, and private sector individuals. This council is naturally subject to constant political pressures, usually in favour of monetary expansion. Finally, as Simonsen (1980, p. 16) points out:

> ...in theory the Banco do Brasil can only use [the Movement Account] to the extent that its assets do not exceed monetary budget ceilings. For a period of time, when due respect was paid to monetary policy, excesses were penalized with heavy discount rates, which strongly deterred the expansionary tendencies of the Banco do Brasil. This rediscount rate penalty was abolished in August 1979. (...) [Thus], in practice a number of public expenditures and subsidies can run through the monetary budget, escaping the fiscal budget which is subject to Congress approval. (...) In a word, the system is too flexible and too exposed to political pressures.

It is implicit in the above discussion that even if monetary control had been desired, it would not have been attained. Also, it is clear that because of their lending role the Monetary Authorities had to use credit as one of their Instruments. The next question is then to what use was the instrument put; whether by choice of the Central Bank president or by his lack of total control.

The following passage, written by Simonsen (1980, pp. 11-12) shortly after he resigned from his post as Minister of Planning in August 1979, demonstrates that throughout the 1974-1979 period no consistent policy rule was in place:

> Anti-inflationary policies were subject to varying degrees of priority, and inflation rates thus became extremely volatile. A price outburst, due to the previously repressed inflation, occurred in the first few weeks of the Geisel Government. Then, the expansion of money was restricted to 23% in the first twelve months of the new Government. Tight monetary policies limited the general price increase to 23% from May 1974 to May 1975. They also abated the industrial rate of growth. Emphasis was then shifted to growth targets. Money growth thus increased to 42.8% in 1975 and an ambitious program of public investment was implemented. Inflation soared again, reaching the 46.3% rate in 1976. Tight monetary and fiscal policies were then re-established. Yet, inflation now appeared more rigid, perhaps because of adverse supply shocks, perhaps because of full wage indexing which had been implemented in January 1975. The general price level increased by 38.7% in 1977 and by 40.8% in 1978.
>
> President Figueiredo, who took office in March 15, 1979, formally announced that his main economic objective would be to reduce inflation to the pre-oil crisis rates. Yet, in August 1979 a number of unorthodox policies were introduced, under the principle that inflation was to be fought through accelerated growth. Administered prices were quickly adjusted, since policy-makers believed that a high rate of inflation in 1979 would automatically be followed by a low rate in 1980. This was called corrective inflation. The money supply expanded rapidly, especially to provide abundant and cheap credit to agriculture, since it was also announced that a super-crop would bring inflation to a halt. Interest rates were controlled, since policy makers preferred Tooke to Wicksell. Wages became indexed on a six-month basis, free negotiation of a real increase, labelled productivity gain, being superimposed on the automatic nominal adjustment. Moreover, a 10% real bonus on a six-month basis was granted on all salaries up to three minimum wages. In December, 7, 1979, the Cruzeiro was maxi devalued, the Dollar/Cruzeiro rate being increased 30%.

The last paragraph uncovers causes of the inflationary acceleration of 1979: a series of supply shocks accompanied by an expansionary monetary policy. Note in particular, that the explosion in the monetary base that took place at the end of 1979 was a product of Delfim Netto's version of supply-side economics, implemented via an increase in the supply of subsidized loans[5].

Overall, it seems clear that during the period in question much of the upward pressure on the monetary base carne from the provision of direct subsidies and subsidized loans by the Monetary Authorities, in the manner demonstrated formally in the previous section. For Banco do Brasil loans, for example, 1978 was the only year in which inflation exceeded nominal loan growth (Table 1).

After 1979 the external sector of the economy assumed the driver's seat, as has been argued in Chapter 3 above. In 1980 Brazil experienced a small balance-of-payments crisis, while inflation was being fuelled by indexation and money growth (in spite of a second consecutive reserve loss, see Table 1). In the second half of 1980 Delfim finally decided to switch gears, and implemented a very tight monetary policy, obtained via a reduction in the (real) rate of growth of BB loans. As the figures for money growth in Table 1 show, this tightness persisted until the end of 1983. In spite of a long recession, inflation did not come down, confirming the widespread belief among economists in Brazil that the Phillips curve in Brazil is almost vertical (see Lara-Resende and Lopes, 1981), and that the

[5] Simonsen, 1980.

inertia introduced into the system by the indexation of wages is the predominant factor in the propagation of inflation. Finally, the inflationary acceleration of 1983 has been attributed to another maxi-devaluation of the Cruzeiro in February, and to the large- scale elimination of subsidies, following the agreement with the IMF (see the last paragraph of Section 2 for a discussion of disinflation).

Summarizing this section, we can conclude that the provision of subsidized loans by the Monetary Authorities has been an important factor in the expansion of the money supply in Brazil. The peculiar structure of the Monetary Authorities and of the budgetary process leads to strong pressures in favour of monetary financing of deficits, and the result is a system which allows for passive accommodation of increases in inflation.

The next section uses the methodology of vector auto-regressions (VAR's) to test for the exogeneity of money, as well as other key variables.

5. Statistical Results

This section uses the method of Granger to test for intertemporal causality among prices, output, money and credit in Brazil. As it is well known, there are many objections to the use of these tests, the most obvious one being related to the temporal, or sequential, nature of the definition. Variable X Granger-causes variable Y if innovations in X *precede* innovations in Y. With this in mind, we say that variable X Granger-causes variable Y if lagged values of X help in the prediction of Y, relative to a given information set.

The main obstacle to the implementation of these tests for Brazil is the absence of a long enough series on GNP. Cardoso (1977) attempted to overcome this problem by constructing a quarterly series based on various measures of economic activity, such as the consumption of energy, the production of cement, etc. Using the test developed by Sims (1972), Cardoso found that:

i) money and nominal GNP Granger-cause each other.

ii) money and inflation Granger-cause each other.

These results were seen as providing support for the hypothesis that money is passive in Brazil.

Contador (1978) extended these results by looking at the monetary base. It was also pointed out that, in face of the problems related to the GNP series, perhaps the rate of inflation could be used as a good proxy for aggregate demand. Summarizing his results, we have:

i) money and inflation Granger-cause each other.

ii) the monetary base Granger-causes inflation.

iii) inflation does not Granger-cause the monetary base.

The last two results were presented by Contador as evidence for the exogeneity of monetary policy in Brazil. His results, however, still suffer from the lack of a better measure of economic activity. The alternative now available is the Industrial Production Index which has been provided by the IBGE (Brazilian Institute of Geography and Statistics) since 1971 (44 quarters).

A different econometric technique is also used here: I use what Pierce and Haugh (1977, p. 228) call in their survey "a 'direct' method" of testing the original definition of causality by Granger (1969).

It consists of estimating a regression of each variable on lagged values of itself and of the other variables, and testing for the significance of each group of lagged variables. For example, in a two-variable case we would estimate:

$$x_t = a(L)x_t + b(L)y_t + e_t$$
$$y_t = c(L)x_t + d(L)y_t + u_t$$

where $a(L)$, $b(L)$, $c(L)$ and $d(L)$ are polynomials in the lag operator. We would then apply an F-test for the presence of each polynomial in the regression, rejecting the hypothesis of Granger-causality if the hypothesis that the polynomial is zero could not be rejected. The procedure generalizes to a higher number of variables in straightforward fashion.

The first step in the procedure is to determine the lag lengths to be employed. Each variable (in logs) was regressed on its past twelve values, and it was found that in all cases the last four lags were not significant, as the prob-values (12) for the F(4,23) test in Table 2 indicate.

Table 2

Testing for Lag Length

Variable	Prob-value 12	Prob-value 8
Output (Y)	.3510	.0003
Prices (P)	.3717	.2392
Monetary Base (H)	.2812	.0025
BB Loans (B)	.4343	.0694
Total Credit (TB)	.3558	.1402

The null hypothesis in both cases is that the last four lags jointly do not add to the explanatory power of the equation. Each number shown corresponds to the minimum level of significance at which the null hypothesis is still rejected.

Sources: Central Bank Bulletin, and IBGE. "Total credit" is the total of loans provided to the private sector by the financial sector, including the Monetary Authorities.

The last four lags were therefore dropped, another regression was estimated, and again the hypothesis that the last four lags (5th to 8th) were not in the regression was tested. The prob-values (8) for this F(4,27) test are shown in the last column of Table 4.2. Now we see that no more lags can be dropped in three of the five cases: output, money, and loans by the BB.

Therefore, for the Granger-causality tests each equation will include eight lagged values of itself, and four lagged values of each of the other variables. In addition, I will again use the log of each variable, and will include a trend and four seasonal dummies, to account for potential non-stationarities.

Two sets of vector auto-regressions were estimated: the first included the monetary base, output, prices, and BB loans, the second substituted total credit to the private sector for BB loans, to account for the fact that the Monetary Authorities have other means of regulating overall credit availability in the economy.

Table 3 presents the results of the first VAR. As one would expect, all variables G-cause themselves. Let us then focus on the other relationships. First, the monetary base is G-caused by prices, and by BB loans, in accordance with the arguments presented in the previous sections. The causation from prices to money must be taken with a grain of salt, however, because the reverse relationship holds. BB loans are G-caused (at the 9.3% significance level only) by output, indicating that credit policy has, if anything, been targeted at economic activity and not at inflation. Finally, output is not G-caused by any of the variables considered here.

Table 3

VAR on H, B, P, Y; Brazil 1971-1 to 1981-4

	F(L)B	F(L)Y	F(L)P	F(L0H
dependent variable				
B	.0011	.0926	.2627	.2158
Y	.4407	.1009	.2442	.2675
P	.0055	.0081	.0001	.0677
H	.0112	.2050	.0089	.0018

Each number shown is the prob-value for the F-test (with (8,11) d.f. for own lagged values, and (4,11) d.f. for the others) of the hypothesis that the lag polynomial in question does not add to the explanatory power of the equation. In other words, each number shown corresponds to the minimum level of significance at which the null hypothesis is still rejected, i.e., “the probability that the polynomial is zero”.

When we substitute total credit to the private sector for BB loans the same basic results emerge (see Table 4). Prices and credit still G-cause money, and output G-causes credit. But now money does not G-cause prices, and the broader credit variable does G-cause output.

Finally, it is interesting to note that in addition to the lagged relationship between BB loans and the monetary base, we also observe a positive contemporaneous correlation (.13) in between these two variables, as the institutional arrangement would lead us to suspect.

Table 4

VAR on H, TB, Y, P; Brazil 1971-1 to 1981-4

	F(L)TB	F(L)Y	F(L)P	F(L)H
dependent variable				
TB	.0009	.0293	.1535	.0916
Y	.7426	.3509	.9388	.2364
P	.0877	.1679	.0001	.2894
H	.0990	.4177	.0464	.0059

See the notes in Table 3.

6. Concluding Comments

In this chapter I have argued that, given the Brazilian institutions and indexation laws, the "supply shock with monetary accommodation' view of inflation is consistent with events of the late 70's and early 80's.

On the supply side, the existence of lagged indexation of wages implies that a devaluation of the currency leads to a permanent increase in inflation if monetary accommodation takes place. In particular, if unemployment is to be avoided, the inflation rate increases by a factor directly related to the supply shock.

In general, however, one should not take the passive behaviour of the money supply for granted. A monetarist view of the world would blame the monetary increase for the inflation, and nothing else. In the case of Brazil, however, we can argue that the "inflation as a purely monetary phenomenon" view is false, because given pre-existing budget deficits, the rise in inflation leads automatically, i.e., other things equal, to a higher rate of money creation.

Still, one may argue that the "other things equal" assumption of the preceding paragraph is too strong. To counter this point, I discussed the institutional design of the monetary system in Brazil, arguing that it facilitates, or even induces, the adoption of a passive monetary rule. In particular, the

argument was supported by the widespread presence of unfunded loan subsidies, by the peculiar budget process, and by the existence of the Movement Account.

Finally, given all the above priors, I tested for the exogeneity of output, prices, credit, and money in Brazil, and found that the passive- money view is not rejected by the data, money being Granger-caused by Banco do Brasil loans and by prices.

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