Volume Title: Annals of Economic and Social Measurement, Volume 4, number 4

Volume Author/Editor: NBER

Volume Publisher: NBER

Volume URL: http://www.nber.org/books/aesm75-4

Publication Date: October 1975

Chapter Title: Notes on the Recent Monetary Policy in Brazil

Chapter Author: Affonso Celso Pastore

Chapter URL: http://www.nber.org/chapters/c10415

Chapter pages in book: (p. 489 - 508)

Annals of Economic and Social Measurement, 4/4, 1975

NOTES ON THE RECENT MONETARY POLICY IN BRAZIL*

BY AFFONSO CELSO PASTORE

This paper has two objectives. First, to build a model to measure both the short-run impact and the dynamic adjustment of the rate of inflation due to changes in money supply, wage rate, and exchange rate. Second, to evaluate the efficiency of the monetary policy, identifying the instruments used to produce a gradual reduction in the rate of growth of the money supply.

1. INTRODUCTION

The present paper has two objectives: To build a model to measure both the short-run impact and the dynamic adjustment of the rate of inflation due to changes in money supply, wage rate, and exchange rate. Second, to evaluate the efficiency of the monetary policy, identifying the instruments used to produce the gradual reduction in the rate of growth of money supply, paying specific attention to the behavior of the inflationary tax during the process of adjustment.

2. THE DYNAMICS OF INFLATION

The model developed in this paper follows the tradition of the Quantity Theory of Money[1] starting from the hypothesis that the long-run demand for money is a *stable function* of real income and the cost of holding money, whose dominant component is the expected rate of inflation. That is:

$$m_t^d = -\alpha E_t + \beta y_t \tag{2.1}$$

where m_t^d is the desired real balance, y_t is real income and E_t is the expected rate of inflation. m_t^d and y_t are expressed in natural logarithms.

The expected rate of inflation follows the adaptative expectation model suggested by Cagan.[2]

$$(1 - bL)E_t = (1 - b)\pi_{t-1} \tag{2.2}$$

where L is the lag operator, and $\pi_t = (\log P_t - \log P_{t-1})$ is the actual rate of inflation.

[1] Simonsen (1970) argues that in the last three or four years the rate of inflation would be only mildly correlated with the rate of change in money supply, and he tries to emphasize the role of feedback mechanisms (like indexation) on the price level. Morley (1970) suggests a "hybrid" explanation, emphasizing the dominant role of a cost push inflation in some periods, and of a demand-pull inflation in others.

[2] Muth (1960) showed that, under some specific hypothesis about the stochastic specification of the model, the above equation produces the best permanent predictor of the future inflation, in the sense that it minimizes the mean square error of the prediction.

* The author thanks Professors Lance Taylor, Miguel Angel Broda and Ruben Dario Almonacid for their useful suggestions. Of course, none of them is responsible for mistakes still present in this paper.

If at any moment desired and actual real cash balances are equal the demand for money model would be completed with (2.1) and (2.2). If there is a possibility of stock disequilibrium in the money market, or a flow disequilibrium, i.e., the rate of change in the actual stock of money is different from the desired rate of change of the nominal cash balances, the appropriate adjustment equation takes the form

$$m_t - m_{t-1} = (1 - d)(m_t^d - m_{t-1}) + g(\mu_t - (1 - L)\log M_t^d) \tag{2.3}$$

where m_t is the logarithm of the actual real cash balance ($\log M_t - \log P_t$), M_t^d is the desired nominal stock of money, and $\mu_t = (\log M_t - \log M_{t-1})$ is the rate of growth of the money supply. Equation (2.3) has two different adjustment mechanisms. The first term of the right hand is a "Nerlovian" type of adjustment, showing that if the real stock is greater (or smaller) than the actual, people will try to adjust their real cash balances in proportion to the gap between ($m_t^d - m_{t-1}$). It is shown that any change in the long-run demand will not lead to an immediate change in actual real cash balances, and they will react with some lags.

The second term on the right hand shows that if the rate of growth of the nominal money supply becomes greater than the rate at which people are willing to accumulate nominal cash balances, in the very short run people will hold 100 percent g of this excess in their real cash balances.

We can start from an initial situation of full equilibrium (of stocks and flows) with constant y and E. Suppose that at the time t the rate of growth of the money supply, μ_t, becomes greater than the rate of growth of the desired nominal cash balances $(1 - L)\log M_t^d$, and from $t + 1$ on both become identical again. Then at the beginning of the adjustment process, a proportion g of the difference ($\mu_t - (1 - L)\log M_t^d$) will be held as real cash balances. From the next period on we will have $m_{t-1} > m_t^d$ and the Nerlovian term of (2.3) will show how convergence to the new equilibrium will occur.

In the very short run, it is possible that the population will hold all the excess of μ over $(1 - L)M_t^d$, and in this special case $g = 1$. In a longer period we should expect $0 \leq g \leq 1$. If the period is long enough to allow full adjustment we will have g and d converging towards zero.[3]

To study the implications of our model for the analysis of inflationary dynamics, we use a simple form of (2.3). The demand for nominal cash balances can be expressed as:

$$\log M_t^d = \log P_t^e - \alpha E_t + \beta y_t$$

where P_t^e is the expected price level. The rate of change of the desired nominal cash balances will be

$$(1 - L)\log M_t^d = (1 - L)\log P_t^e - \alpha(1 - L)E_t + \beta(1 - L)y_t.$$

If the rates of change in real income and expected rate of inflation are small and assuming that the rate of change of the expected price level is the expected rate

[3] A more careful analysis of this model, comparing its relative merits in relation to alternative specifications (like the one proposed by Chow (1966), for example), is presented in another paper. See Pastore (1973a).

of inflation, we will have $(1 - L)M_t^d = E_t$, and equation (2.3) can be rewritten in the form

$$m_t - m_{t-1} = (1 - d)(m_t^e - m_{t-1}) + g(\mu_t - E_t).$$

The implication of this hypothesis for the dynamics of inflation can be analyzed closing the model with the quantity equation that, expressed in the form of growth rates, is

$$\pi_t = \mu_t - (1 - L)m_t. \tag{2.4}$$

From (2.1) and (2.3) we get

$$(1 - dL)m_t = -\alpha(1 - d)E_t + \beta(1 - d)y_t + g(\mu_t - E_t) \tag{2.5}$$

and using (2.2) we get

$$(1 - dL)(1 - bL)m_t = -(1 - b)[\alpha(1 - d) + g]L\pi_t + \beta(1 - d) \times (1 - bL)y_t + g(1 - bL)\mu_t. \tag{2.6}$$

The system (2.4)–(2.6) can be expressed in the matrix form,

$$\begin{bmatrix} (1 - bL)(1 - dL) & (1 - b)[\alpha(1 - d) + g]L \\ (1 - L) & 1 \end{bmatrix} \begin{bmatrix} m_t \\ \pi_t \end{bmatrix} = \begin{bmatrix} \beta(1 - d)(1 - bL) & g(1 - bL) \\ 0 & 1 \end{bmatrix} \begin{bmatrix} y_t \\ \mu_t \end{bmatrix}$$

The model has a solution in the form of "rational distributed lags" that is

$$m_t = \frac{A_1^1(L)}{P(L)} y_t + \frac{A_2^1(L)}{P(L)} \mu_t \tag{2.7}$$

$$\pi_t = \frac{B_1^1(L)}{P(L)} y_t + \frac{B_2^1(L)}{P(L)} \mu_t. \tag{2.8}$$

$P(L)$ is the determinant associated with the matrix of the coefficients of the endogenous variables, it also gives the characteristic equation of the two difference equations (2.7) and (2.8), thus permitting the analysis of the stability conditions.

To analyze the initial impact on π of movements in μ or y, we can use the polynomials in (2.7) and (2.8) given by

$$A_1^1(L) = \beta(1 - d) - \beta b(1 - d)L$$

$$A_2^1(L) = g - \{gb + [\alpha(1 - d) + g](1 - b)\}L$$

$$B_1^1(L) = \beta(1 - d) + \beta(1 - d)(1 + b)L - \beta b(1 - d)L^2$$

$$B_2^1(L) = (1 - g) - [b + d - g(1 + b)]L + b(d - g)L^2.$$

In the stationary equilibrium, when y and μ have been constant for a period long enough to permit full equilibrium (if it is stable), we will have:

$$\frac{A_1^1(1)}{P(1)} = \beta; \frac{A_2^1(1)}{P(1)} = -\alpha; \frac{B_1^1(1)}{P(1)} = 0; \frac{B_2^1(1)}{P(1)} = 1.$$

That is, a rate of monetary expansion of 1 percent will produce a 1 percent rate of inflation. A rise of real income from one constant level to another will show its effect on the rate of inflation only in the intermediate period.

But real cash balances will change by β times the change in the income level. The stability of equilibrium will depend on the two roots of $P(L)$ given by

$$\frac{\{b + d + (1 - b)[\alpha(1 - d) + g]\} \pm \sqrt{\{b + d + (1 - b)[\alpha(1 - d) + g]\}^2 - 4bd + (1 - b)[\alpha(1 - d) + g]\}}}{2}.$$

The rate of inflation will oscillate or not depending upon

$$\{b + d + (1 - b)[\alpha(1 - d) + g]\}^2 \gtreqless 4\{bd + (1 - b)[\alpha(1 - d) + g]\}.$$

Once b and d can only take values between zero and one, the stability condition of the model is given by[4]

$$bd + (1 - b)[\alpha(1 - d) + g] < 1.$$

3. Empirical Evidence

The demand for money expressed by (2.5) was estimated assuming different values for the coefficient of expectation $(1 - b)$ in the equation

$$(2.9) \qquad m_t = -[\alpha(1 - d) + g]E_t + \beta(1 - d)y_t + g\mu_t + dm_{t-1} + e_t$$

where e_t is the disturbance term assumed to be serially uncorrelated.

The difficulty of using the iterative method in this case is due to the presence of the lagged real cash balances as an independent variable in the model, which makes R^2 quite insensitive to the variations in $(1 - b)$.

The results are presented on Table 1. As we see all the coefficients are highly significant, and the R^2 reaches the maximum approximately at the point where $(1 - b) = 0.4$, that is taken as an estimate of the coefficient of expectations.

There are no reasons to reject the hypothesis that the equilibrium is stable, and the the convergence path is an oscillatory one.

Table 2 and Figure 1 show the typical path of the rate of inflation due to a 1 percent change in the rate of monetary expansion. Part (A) of the figure shows the path of the rate of inflation.

The rate of inflation will take something like 3 to 4 quarters to overshoot the rate of monetary expansion, meaning that the initial effects of the money supply on prices are quite small and that the lags are long.

In the reduced form of the model, the rate of inflation can be expressed as a function of the past rates of growth of the money supply and real income: that is,

$$\pi_t = \sum_{j=0}^{\infty} w_j^1 \mu_{t-j} - \beta \sum_{j=0}^{\infty} w_j^2 (1 - L) y_{t-j}$$

[4] See Goldberg (1961, pp. 169–172).

where the w are the "weights" of the implicit model of distributed lags between π and the past values of μ and $(1 - L)y$ (independent variables). The pattern of the weights is presented on Table 2 and part (B) of Figure 1, showing that after some time lag we get negative weights.

TABLE 1
DEMAND FOR MONEY

Value of $(1 - b)$	Constant	E_t	y_t	m_{t-1}	μ_t	R^2	DW
	Coefficient						
0.2	0.759	−0.691	0.130	0.847	0.605	0.950	1.354
		(3.756)	(2.077)	(10.027)	(3.874)		
0.3	1.202	−0.917	0.178	0.773	0.666	0.958	1.530
		(5.075)	(2.986)	(9.494)	(4.585)		
0.4	1.505	−1.059	0.185	0.736	0.676	0.962	1.814
		(5.917)	(3.342)	(9.391)	(4.953)		
0.5	1.464	−0.945	0.177	0.745	0.640	0.962	1.932
		(5.904)	(3.233)	(9.580)	(4.736)		
0.6	1.384	−0.854	0.165	0.760	0.607	0.962	2.031
		(5.810)	(3.041)	(9.850)	(4.504)		
0.7	1.277	−0.777	0.150	0.779	0.571	0.960	2.118
		(5.607)	(2.772)	(10.128)	(4.211)		
0.8	1.160	−0.706	0.135	0.800	0.561	0.959	2.180
		(5.472)	(2.525)	(10.488)	(4.101)		
0.9	1.040	−0.645	0.120	0.821	0.553	0.959	2.233
		(5.300)	(2.261)	(10.822)	(4.000)		

Note: The numbers in parenthesis right below the coefficients are Student t values.

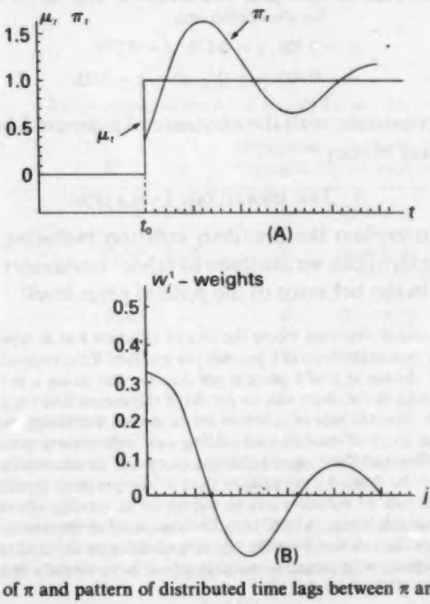

Figure 1 Time path of π and pattern of distributed time lags between π and the past values of μ

TABLE 2

WEIGHTS OF THE IMPLICIT DISTRIBUTED LAGS MODEL AND THE TIME PATH OF π_t

Lags j	Weights w_j	π_t in Relation to Trajectory of π
0	0.324	0.324
1	0.316	0.640
2	0.311	0.951
3	0.273	1.224
4	0.211	1.435
5	0.135	1.570
6	0.055	1.625
7	−0.020	1.605
8	−0.083	1.522
9	−0.129	1.393
10	−0.155	1.238
11	−0.161	1.077
12	−0.149	0.928
13	−0.123	0.805
14	−0.087	0.718
15	−0.046	0.672
16	−0.006	0.666
17	0.029	0.695
18	0.056	0.751
19	0.074	0.825
20	0.082	0.907
21	0.080	0.987
22	0.070	1.057
23	0.054	1.111
24	0.034	1.145
25	0.013	1.158

Note: The weights and the time path were calculated with the following values for the coefficients:

$$\beta = 0.701; g = 0.676; d = 0.736;$$

$$b = 0.600; \alpha = (1 - d) + g = 1.059.$$

This result is consistent with the existence of a demand for money depending on the cost of holding money.[5]

4. THE BRAZILIAN INFLATION

Is it possible to explain the Brazilian inflation including only the monetary variables? To what extent can we attribute to other "nonmonetary variables" some explanatory power in the behavior of the general price level?

[5] Let us assume an initial situation where the rate of inflation was in equilibrium (with a constant real cash balance) with $\mu = \pi$ at the level of 0 percent per quarter. If the monetary authorities decided to make a once-and-for-all change in μ of 1 percent per quarter and fixing μ at this new level, the public would probably not be able, in the short run, to get rid of the excess flow supply of money.

After some time the expected rate of inflation starts to rise, increasing the cost of holding money, reducing the desired real stock of money, and adding new inflationary pressures. At the end of the process, the rate of inflation and the cost of holding money will be necessarily higher giving an actual stock of money (equal to the desired one) smaller than in the previous equilibrium. So, at some time after the change in μ the rate of inflation has to overshoot μ, staying above this rate the necessary time to reduce actual real cash balances until they become equal to the desired stock. This mechanism of adjustment implies that the relation between the rate of inflation in t and the past rates in μ shapes a distributed time lag pattern with negative weights which have already been found by Diaz (1970) for Argentina and Pastore (1973a) for Brazil.

There is a certain degree of agreement that the rate of inflation in Brazil is influenced by at least three additional variables: (a) the wage rate readjustments (average wages and "minimum wage" in particular); (b) exchange rate correction; (c) fluctuations of the agricultural output. We could add a fourth variable that was probably important during the first part of the Brazilian stabilization program, which consisted in decontrol of some prices that were frozen by the practice of repressing inflation. Some of these variables can have their effects quantified while some others cannot. In particular, data are only available for minimum wages and exchanged rates, but there is no information about the quarterly agricultural output and the form of processing the so-called "corrective inflation." Using $\hat{\pi}$ for the estimated rate of inflation as a function of monetary components only, that is, $\hat{\pi}_t = \mu_t - (1 - L)\hat{m}_t$, where $\hat{m}_t$ is the estimated real cash balances in equation (2.5), we can test the influence of the other variables by the relation

$$\pi_t = f(\hat{\pi}_t, \dot{c}_t, \dot{w}_t) + v_t \tag{4.1}$$

where $\dot{w}_t$ and $\dot{c}_t$ are the rates of change in minimum wage and exchange rate.

Table 3 gives the main results. The first relation is a simple regression between the quarterly rates of inflation, actual and estimated. The second is the same relation but defining π_t as the yearly rate of inflation at the end of quarter t.

The regression coefficient between π and $\hat{\pi}$ is lower than one, and only by reducing the significance below 5 percent would the confidence interval include unity (in the case of quarterly rates only).

The last two equations show the introduction of wage rate and exchange rate. Both have the highly significant hypothesis that at least two of the "remaining" variables are influencing the rate of inflation.

The explanatory power of the model is higher when we include wages and exchange rates.[6]

TABLE 3

RATES OF INFLATION ACTUAL AND ESTIMATED

constants	Coefficients $\dot{w}$	$\dot{c}$	R^2	Dw	Dependent variable	Rate definitions	Equation (2.9) originated m_t
0.028	0.668 (5.782)	—	—	0.406	2.407	π	Quarterly	with $(1 - b) = 0.4$
0.015	0.966 (21.094)	—	—	0.901	1.180	π	Annual at the end of quarter	with $(1 - b) = 0.4$
0.031	0.607 (5.782)	—	—	0.405		$\hat{\pi}$	Quarterly	with $(1 - b) = 0.4$
0.031	0.479 (5.091)	0.151 (4.417)	—	0.577		$\hat{\pi}$	Quarterly	with $(1 - b) = 0.5$
0.022	0.494 (5.694)	0.126 (3.893)	0.120 (3.080)	0.648	2.070	$\hat{\pi}$	Quarterly	with $(1 - b) = 0.5$

Note: The numbers in parenthesis below the coefficients are the values of Student t.

$n = 51$

[6] It is recognized that the introduction of $\dot{w}$ and $\dot{c}$ in the model was done on a very *ad hoc* basis, without the specification of the underlining model. The theory could be developed through many ways, but I find the most attractive the one suggested by Harberger (1966).

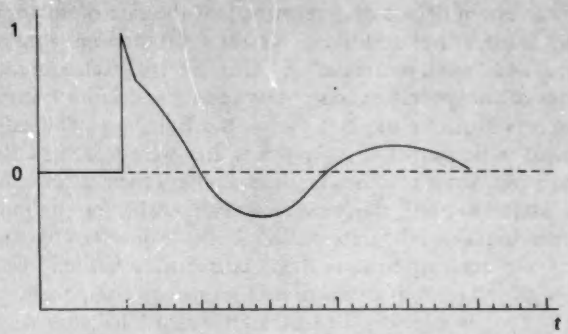

Figure 2 Impact of a wage or exchange rate correction on the rate of inflation

It can be shown that a change in wages or exchange rate will have lagged effects on the rate of inflation.[7]

Figure 2 presents the typical distributed lag effects of a change in wages or exchange rate calculated, using the estimated coefficients in (2.5).

Note that not only because of an initial impact but also because of the feedbacks (generated by the expectations) the "cost-push" remains positive for many periods ahead. Then, it oscillates around the assumed equilibrium value of zero.

A succession of shocks can produce a strong effect, not only when each one of them occurs but also in many periods ahead. If the "repressed inflation" is substantial, the economy will face an "autonomous" inflationary process that will not only occur at the moment of the correction, but will generate effects on π for a longer period.

Figure 3 shows the comparison between the actual and predicted values of π and m.

[7] In fact we can re-write (2.4) in the form:

(4.2)
$$\pi_t = \mu_t - (1 - L)\hat{m}_t + \sigma_t$$

where

(4.3)
$$\sigma_t = a_1 \dot{w}_t + a_2 \dot{c}_t + e_t$$

is a linear combination of effects of the "other variables" influencing π and the coefficients a_1 and a_2 are the ones estimated on Table 3. The system (4.2), (4.3) can be expressed in the matrix form, giving

$$\begin{bmatrix} (1 - dL)(1 - bL) & (1 - b)[\alpha(1 - d) + gL] \\ \\ (1 - L) & 1 \end{bmatrix} \begin{bmatrix} m_t \\ \\ \pi_t \end{bmatrix} = \begin{bmatrix} \beta(1 - d) & (1 - dL)(1 - bL) & 0 \\ \\ 0 & 1 & 1 \end{bmatrix} \begin{bmatrix} y_t \\ \mu_t \\ \sigma_t \end{bmatrix}$$

that permits finding the expression for the rate of inflation given by

$$P(L)\pi_t = B_1^1(L)y_t + B_2^1(L)\mu_t + B_3^1(L)\sigma_t$$

where all the polynomials have already been defined previously, except for $B_3^1(L)$, that is:

(4.4)
$$B_3^1(L) = 1 - (b + d)L + bdL^2.$$

It is easy to see that $P(1)/B_3^1(1) = 1$, what indicates that the final effect of salaries and exchange rate readjustments on π will be given, in each case by the respective coefficient of the relation (4.1). However, a change in wages or exchange rate will cause lagged effects on the rate of inflation whose time path can be easily calculated, *ceteris paribus*, by

(4.5)
$$P(L)\pi_t = B_3^1(L)\sigma_t.$$

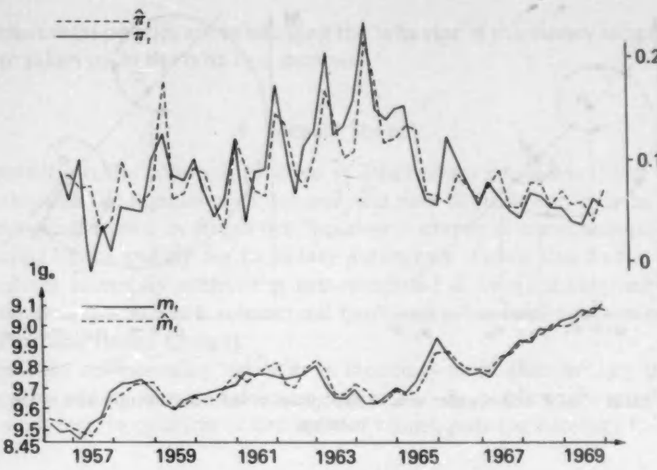

Figure 3 Actual and estimated values of π and m

5. Aspects of the Stabilization Strategy

An important implication of the previous anaiysis is that from the point of view of the rate of inflation money only matters in the long run. Even though I do not wish to dispute the precision of the estimated time lags,[8] there is evidence that such time lags are quite long, and this is probably one of the main reasons for the presence of cycles of large amplitude in income velocity and real cash balances. A rise in the actual rate of the monetary expansion will, in the very short run, increase real cash balances above the previous equilibrium level, and the "measured" income velocity of money will drop, simulating a behavior similar to the one at the "liquidity trap".

When μ starts to rise it is quite probable that the rate of inflation stays below μ for a while. Then expectations start to be revised and the public will get rid of real cash balances. If the monetary authorities eventually stabilize μ at a constant level in some future period, π will overshoot μ.

This shows that the monthly or even quarterly contemporaneous correlation between π and μ will probably be very small and the monetary authorities can suffer the illusion that money does not matter at all, thinking of inflation as a pure cost-push phenomenon.

Due to the general tendency of governments to fight inflation through its manifestations and not through its main causes, when an open inflation starts, the repressed inflation also starts. This is done through the control of several prices (in general the most "political prices", i.e., of those goods and services that have larger weights in some index that is believed to measure inflation). Such a procedure introduces distortions in relative prices causing inefficiencies, and shows that at some time this repressed inflation has to be absorbed by the economy. When

[8] Griliches's analysis (1967) shows that the lags are highly sensitive to estimated values of the coefficients of the model.

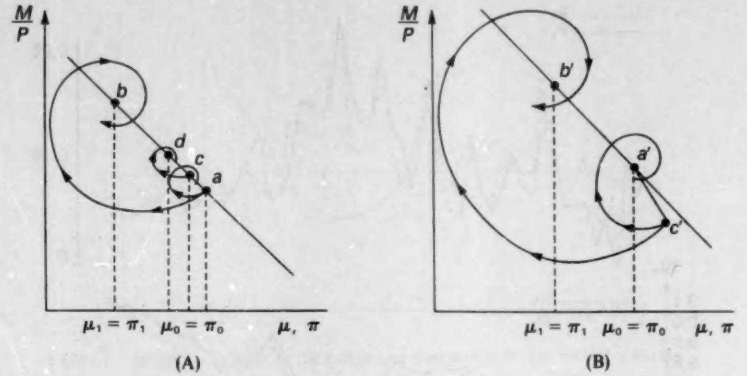

Figure 4 Paths of M/P and π under several hypotheses of the behavior of μ and of the corrective inflation

the government decides to pursue its stabilization program it must absorb the repressed inflation, freeing the prices that were controlled. We can analyze with Figure 4 the possible governmental stabilization policies when repressed inflation is present and when it is absent.

Figure 4A represents the strategies of "gradual approach" and "shock treatment" if there is no repressed inflation. We start from an initial equilibrium position where the monetary expansion was fixed at μ_0, with the rate of inflation at the same level (assuming constant real income). The path of (M/P) and π is presented in the Figure between points *a* and *b*, with the inflation rate and real cash balance following a cyclical path. If the monetary authorities can sustain μ on the new level μ_1 for a long enough period, the rate of inflation will decrease, but with large cyclical fluctuation in real cash balances. The gradualistic path implies a small reduction, the monetary authorities wait until the rate of inflation approximately converges to equilibrium and only then a new reduction in μ is done. The reduction of the rate of inflation will be slow, but the oscillation in (M/P) will be smaller.

The Figure 4B presents at first the shock treatment in an economy that has to absorb the repressed inflation. If the monetary authorities decontrol prices the rate of inflation will increase, reducing real cash balances. Two alternatives can happen in this case. First, μ is kept at the same level π_0, until the rate of inflation converges to an equilibrium around point *a*′. In this case, some cycles of liquidity will occur. In the second alternative, the monetary authorities would proceed to a corrective inflation, but try to avoid a bigger increase of the inflation rate, through a reduction in μ. In this case π and (M/P) will oscillate around *b*′. This Figure shows the paths followed by π and (M/P); it is easy to see that the cycles in these two variables are of a much bigger amplitude than those in Figure 4A.

It is understandable that the corrective inflation cannot occur simultaneously with the monetary shock, and the government has first to absorb the repressed inflation and then start the gradual reduction of the rate of inflation. This will in turn depend on what the determinants of the money supply are and how effective the governmental policies are in affecting the behavior of the money supply. These issues are taken up in the next two sections.

6. Money Supply

Contrary to the common practice of other countries where the creation of money through the expansion of demand and time deposits can only be done by the commercial banks, in Brazil this function is exercised simultaneously by the commercial banks and by the monetary authorities. This is due to the fact that in Brazil the monetary authorities are composed of two banking institutions: Banco do Brasil, which is a commercial bank and a financial agent of monetary authorities, and Banco Central.

Then, the net monetary liabilities of monetary authorities held by the public are given by adding time and demand deposits of the public in Banco do Brasil, plus the net reserve position of commercial banks, plus the currency held by the public:

$$B = D^{BB} + R + M_p. \tag{6.1}$$

With B designating the monetary base and k the money multiplier, we can express:

$$M = kB. \tag{6.2}$$

The expression for the money multiplier can be obtained by defining money as:

$$M = M_p + D \tag{6.3}$$

and then

$$k = \frac{1}{1 - (1 - h)(1 - r)(1 - b)} = \frac{1}{1 - \delta} \tag{6.4}$$

where M_p is the total currency; D is the total deposits in the commercial banks and Banco do Brasil, $D = D^{BB} + D^{BC}$; r is the reserve ratio (voluntary plus compulsory), $R/D^{BC} = r$; where $r = r_v + r_c$; h is the ratio of currency of the total money supply, $M_p/M = h$; b is the average propensity of the public to make deposits in the Banco do Brasil, $b = D^{BB}/D$.

In this model the two instruments of monetary policy are the total monetary base and the compulsory reserve requirements r_c; the other coefficients, h, r_v and b, depend on the behavior of the public and the banking system.

Given the values of the instruments under control of the monetary authorities, and predicting the values of the coefficients that depend on the behavior of the public and the banking system, we can get a reasonable prediction of the behavior of the nominal money supply.

Starting from relation (6.2), we can write:

$$\frac{1}{M}\frac{dM}{dt} = \frac{1}{m}\frac{dm}{dt} + \frac{1}{B}\frac{dB}{dt}$$

that splits the rate of change in money supply into the rate of change of the money multiplier and the rate of change in the monetary base.

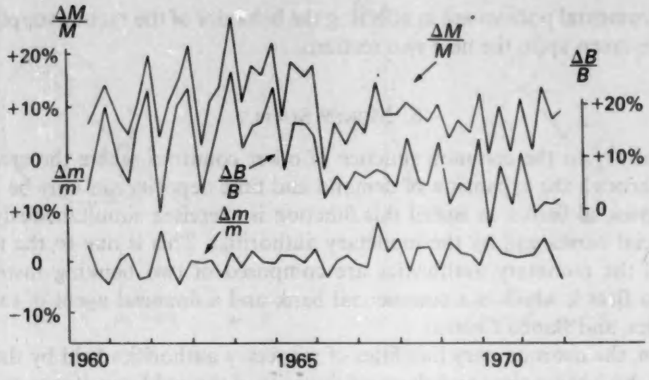

Figure 5 Decomposition of the quarterly rate of the monetary expansion

Figure 5 shows the rates of growth of the monetary base, total money supply, and the money multiplier. We can see that the rate of change of the money multiplier is not small, and that the dominant component of the rate of change of the money supply is the rate of change of the monetary base.[9] The relevant questions are: what are the sources of growth of the monetary base? and what are the mechanisms of control used during the several phases of the Brazilian stabilization program?

For this purpose we have to analyze the side of the assets of the consolidated balance sheet of monetary authorities. We start from

$$B = \sum_{j=1}^{n} B_j$$

where B_j is one of the possible assets of the monetary authorities. The rate of change of the monetary base can be written as:

$$\frac{1}{B}\frac{dB}{dt} = \sum_{j=1}^{n} \delta_j \left(\frac{1}{B} \cdot \frac{dB_j}{dt}\right)$$

where $\delta_j = B_j/B$ is the share of each asset on the total base and each term $\delta_j(1/B_j)(dB_j/dt)$ is the contribution of the rate of change of each asset on the monetary base.

We could aggregate the several assets on the standard form: total credit to the government; total credit to the private sector and net foreign exchange position. But due to some peculiarities of the Brazilian institutional system, we will disaggregate the assets, giving now a brief explanation of the meaning of each of them. In Table 4, the magnitudes of the components of the monetary base for the period 1962 to 1970 are shown.

(a) Treasury Deficit: it is the net accumulated cash position of the Federal Government.

[9] Some of the coefficients of the money multiplier (h and r) are "behavioral parameters", depending on the profit maximizing decisions of the banking system and the public. I did not try to include a sub-model to explain r_v and h due to the fact that the high-powered money is the dominant component of M.

(b) Index Bonds: this is the net position of a set of operations whose nature has been changing through time. Before the creation of the monetary correction there were no readjustable bonds, and it was not possible to sell bonds on a long-term basis due to the high level of inflation and to the freeze of interest rates. However, there were the so-called "Treasury Bonds" which were placed primarily in the commercial banks as a substitute for the compulsory deposits. Actually, this account includes the sales of indexed bonds plus Treasury Bonds, which is a short-term debt mechanism for Open Market Operations.

(c) Loans from Banco do Brasil to the Private Sector: in this account we include all the loans to industrial and agricultural sectors of the economy. We are adding also the loans of Banco do Brasil to the state enterprises.

(d) Rediscount: it is also an account that includes several kinds of operations. We have all the accumulated net position of rediscount for liquidity. However, in the case of Brazil the rediscount policy has been used to direct the credit towards the agricultural sector, coffee operations, promotion of exports for minimum price policy, etc.

(e) Price Support Policy: The Minister of Agriculture is in charge of fixing the price support for the agricultural products. The management of the funds needed for the purchase of the excess supply of the agricultural products is done by Banco do Brasil, and the ceilings to fix the resources for these operations are proposed by the Minister of Agriculture and approved by the Monetary Council.

(f) Coffee Operations: it is the net position of operations under the responsibility of the Ministry of Industry and Commerce (which contains the Brazilian Institute of Coffee). The revenues of this account are derived from the retention quota (a kind of export tax on coffee administered by the National Monetary Council) and also from the sales of coffee from the IBC inventories abroad, and the expenditures are due to purchases of excess supply and rediscounts policies to coffee producers.

(g) Net Foreign Reserves: this account shows the cruzeiro value of the net purchase (or net sales) of foreign currency due to a surplus or a deficit (or surplus) in foreign currency, but also by the current exchange rate.

There is a whole set of accounts which are not included in our analysis. The National Monetary Council can give advances to the National Development Bank, to Caixa Economica Federal, and to many other financial agencies of the government, in order to supply funds for certain types of operations. Finally, we have to recognize that the National Monetary Council can capture resources from any of the institutions belonging to the national financial system that eventually are facing an excess of resources over investments or, in the reverse, they can give resources to each one of them. The instruments used for this purpose are the indexed bonds. It is important to note the flexibility which is built into the financial system, showing that there are some degrees of freedom, not only to control the total money supply, but also to shift resources from one financial agency to the other, or prevent the expansionary impact of each asset on the rate of growth of high-powered money.

TABLE 4

Annual Rates (in Final Quarter) of the Monetary Base Variation and Components

1		2	3	4	5	6	7	8	9	10
1962	I	0.451	0.317	−0.002	0.222	0.017	0.002	−0.027	0.078	−0.156
	II	0.565	0.350	−0.002	0.227	0.014	0.007	−0.009	0.064	−0.085
	III	0.648	0.379	−0.004	0.238	0.010	0.008	0.057	−0.008	−0.033
	IV	0.626	0.391	−0.038	0.291	0.021	0.005	0.029	−0.049	−0.025
1963	I	0.687	0.462	−0.039	0.286	0.050	0.003	0.024	−0.003	−0.096
	II	0.677	0.432	−0.054	0.301	0.042	0.011	0.003	−0.083	0.026
	III	0.647	0.442	−0.083	0.252	0.044	0.012	−0.075	−0.049	0.103
	IV	0.703	0.490	−0.056	0.210	0.015	0.011	−0.040	−0.015	0.087
1964	I	0.881	0.626	−0.061	0.265	0.021	0.006	−0.038	−0.040	−0.102
	II	0.977	0.677	−0.015	0.308	0.042	0	−0.018	−0.012	−0.005
	III	0.931	0.656	0.042	0.314	0.032	0.002	−0.009	0.057	−0.162
	IV	0.887	0.423	0.029	0.316	0.060	0.004	−0.076	0.132	−0.017
1965	I	0.797	0.373	0.015	0.268	0.003	0.007	−0.066	0.214	−0.016
	II	0.816	0.323	−0.016	0.208	−0.015	0.054	−0.072	0.275	0.059
	III	0.819	0.244	−0.056	0.151	−0.007	0.108	−0.066	0.260	0.183
	IV	0.675	0.184	−0.101	0.101	−0.015	0.079	0.042	0.212	0.174
1966	I	0.600	0.136	−0.124	0.099	0.016	0.064	0.039	−0.008	0.380
	II	0.458	0.101	−0.154	0.126	0.033	0.035	−0.009	−0.063	0.368
	III	0.300	0.115	−0.131	0.121	0.041	0.013	−0.028	−0.084	0.253
	IV	0.216	0.106	−0.094	0.155	0.031	−0.001	−0.066	−0.113	0.198
1967	I	0.274	0.194	−0.124	0.142	0.002	−0.005	−0.069	−0.012	0.147
	II	0.279	0.241	−0.088	0.121	−0.021	0.007	−0.060	−0.061	0.139
	III	0.312	0.216	−0.132	0.145	−0.003	0.004	−0.018	−0.080	0.179
	IV	0.264	0.198	−0.117	0.149	0.002	0.007	0.007	−0.082	0.099

1968	I	0.360	0.214	−0.064	0.186	0.016	0.008	−0.014	−0.027	0.041
	II	0.340	0.155	−0.026	0.224	0.021	0.009	−0.012	−0.022	−0.038
	III	0.307	0.140	0.017	0.249	0.039	0.015	−0.035	0.113	−0.131
	IV	0.435	0.149	−0.018	0.260	0.050	0.014	−0.072	0.024	0.029
1969	I	0.264	0.056	−0.017	0.210	0.062	0.011	−0.089	0.001	0.029
	II	0.262	0.061	−0.119	0.215	0.051	0.004	−0.090	0.065	0.076
	III	0.258	0.017	−0.183	0.200	0.036	0.003	−0.060	0.109	0.136
	IV	0.267	0.064	−0.151	0.208	0.011	−0.001	−0.054	0.141	0.050
1970	I	0.208	0.035	−0.227	0.226	0.023	−0.006	−0.046	0.199	0.004
	II	0.249	0.051	−0.187	0.234	0.004	0.022	0	0.198	−0.072
	III	0.212	0.050	−0.154	0.207	0.018	0.030	−0.093	0.135	0.018
	IV	0.183	0.055	−0.133	0.196	0.014	0.022	−0.074	0.110	0.006

Notes: 1 = Periods
2 = Base
3 = Treasury deficit
4 = "Open market operations"
5 = Loans of Banco do Brasil to the private sector
6 = Rediscount
7 = Minimum price policy
8 = Coffee account
9 = Net foreign reserves
10 = Other accounts (net position)

Until 1964, the dominant elements in the growth of high-powered money was the fiscal deficit and the loans by Banco do Brasil to the private sector. This shows that probably the government was using the inflationary finance as a way to get resources. We can see that despite the fact that some short-term Treasury Bonds were sold to the public, its deflationary effect was relatively small. Eventually the lack of coordination between Banco do Brasil and SUMOC (The "Superintendence of Money and Credit," which was the imperfect institutional substitute for the Central Bank till 1964) could be blamed for the excessive expansion of the loans of Banco do Brasil to the private sector. Probably this was very important in explaining the fact that the expansion of high-powered money was almost out of control at that period.

After 1964, the Treasury pressure is slowly going down and at the end of the analyzed period this account is only responsible for about 1/5 of the total growth of the base. The monetary authorities started to utilize the sales of bonds to the public as a way to control the expansion of high-powered money. The expansionary impact of the Banco do Brasil never declined. After 1968, the big inflow of net foreign currency starts to dominate the expansion of high-powered money. The inflows and outflows of foreign currency created a kind of stop and go monetary policy until 1968, when the crawling peg system was introduced. Between 1964 and the early months of 1968, when the exchange rate was fixed, speculative capital movements in the balance of payments created for some time sharp expansions of the money supply (like the one during 1965) and sometimes also sharp reductions (like the one in 1966). It is recognized that a fixed exchange rate in an inflationary environment provokes these kinds of inflows and outflows of reserves, and probably the sudden reduction in the rate of expansion of money supply in 1966, which can be blamed by the recession that occurred in the early months of 1967, was caused almost entirely by the outflow of foreign currency. It is true that in 1966 the government had a target rate of inflation of about 10 percent and they tried to reduce the increasing prices with a sharp reduction in the monetary expansion. This was due simultaneously to a reduction on the fiscal treasure pressure, to an increase of the sales of indexed bonds in the open market operations and also due to the big outflow of foreign reserves. In the early months of 1967 the economy was already in a deep depression. The monetary authorities increased the rate of expansion of money supply mainly through the increase in the fiscal deficit and also through a certain release of loans of Banco do Brasil to the private sector. From 1968 on we see that first: the expansionary impact of the treasury keeps going down; second: the expansionary effect of loans of Banco do Brasil to the private sector are more or less kept under straight control. After the introduction of the crawling-peg system combined with the maintenance of domestic interest rates above the level of international interest rates, there is a control of inflow of foreign currency which is in great part sterilized by the sales of indexed bonds to the public.

Two further problems require analysis: first, in increasing the share of indexed bonds in the total of high-powered money, the government is giving back to the public a part of the revenue from inflation. This phenomenon acts as an element inhibiting the government in using the inflationary tax as a way to mobilize more resources. In the second place, due to the fact that most of the net inflow of foreign capital was in the form of loans channelled through the banking system, the ratio of loans to total money supply increased from 1968 on.[10]

In this sense the government not only tried to reduce the rate of expansion of the money supply in order to turn consistent the goal of the gradual reduction of inflation, but also tried to change the ratio of loans to money in order to provoke expansionary effect on the aggregate supply of the economy. This was certainly one of the key issues in the Brazilian stabilization policy which together with the generalization of indexation, permitted a gradual reduction of inflation and minimization of the social cost.

7. Government Revenue from Inflation

For a long period before 1964, the Brazilian Government made a massive use of the inflationary tax as a way to mobilize resources. The utilization of only one instrument (monetary policy) to attain two objectives (stabilization and increase of public savings) has an obvious inconsistency that can only be removed if monetary policy is assigned to internal stabilization (assuming a "closed" economy), letting the fiscal policy and the financial market take care of savings.

In the present section it is shown that: (a) due to the lags in response of π in relation to changes in μ, the government revenue from inflation will converge very fast to the new equilibrium, tempting the government to use this mechanism as an additional instrument to mobilize resources; (b) when the decision to stabilize is taken, the gradual approach is shown to be better, avoiding massive losses of inflationary tax in the very short run; (c) when the share of indexed bonds in high-powered money increases, a substantial part of the inflationary tax will be redistributed to the public, thus reducing the incentives to utilize this form of financing.

If the banking system were non-existent, with the central government having the monopoly of creation of money, it would internalize all the tax revenues from inflation given by

$$R = \frac{1}{P}\frac{dM}{dt} = \left(\frac{M}{P}\right)\frac{1}{M}\frac{dM}{dt}. \tag{7.1}$$

In full equilibrium (with $M/P = (M/P)^d$; $\pi = \mu = E$) and constant real income the revenue would be

$$R = \left(\frac{1}{P}\frac{dP}{dt}\right)\left(\frac{M}{P}\right)^d \tag{7.2}$$

which is the product of the "tax rate" $1/P\, dP/dt$, by the "tax base" $(M/P)^d$.

When there is a private banking system, the government revenue is

$$R_G = \frac{1}{K}R \tag{7.3}$$

[10] In another paper we develop a theory showing that the credit in real terms to the private sector is a very important factor affecting the aggregate supply of the economy. See Pastore and Almonacid (1974).

where K is the money multiplier, and the banks will collect

$$R_B = \frac{K-1}{K} R \tag{7.4}$$

provided that they are able to adjust the nominal interest rates on loans to the expected rate of inflation.

With the money multiplier around 2, the government will collect 50 percent of the total revenue. Table 5 shows the levels of this revenue as a proportion to real income (at the average quarterly value of 1970), for several rates of inflation, in full equilibrium.

TABLE 5

GOVERNMENT REVENUE FROM INFLATION

Rate of Inflation (Quarters) π	Real Cash Balances M^d	Revenue πM^d	R/y
0.05	208.7	10.4	0.04
0.10	193.6	19.4	0.07
0.20	166.5	33.3	0.11
0.30	143.3	43.0	0.14
0.40	123.2	49.3	0.16
0.50	106.2	53.1	0.18
0.60	93.6	56.2	0.19
0.70	78.6	55.0	0.18
0.80	67.7	54.2	0.18

For rates of inflation between 40 to 50 percent per year the revenue would be around 10 percent of real income.

A more interesting exercise, however, is to evaluate how the revenue converges to the new equilibrium, when the monetary authorities decide to make a once-and-for-all change in μ. The path of π estimated in Section 3 yields the data included in Tables 6 and 7.

In the first table we assume that $\mu = \pi$ was at 5 percent per quarter, and the monetary authorities increase μ to 10 percent per quarter. The ratio R/y, which was 4 percent, will be, at the new situation of full equilibrium, 8 percent. However,

TABLE 6

GOVERNMENT REVENUE FROM INFLATION

	μ	π	$\mu - \pi$	M/P (actual)	R	R/y
Initial equilibrium	0.05	0.050	0	160.6	8.03	0.040
	0.05	0.050	0	160.6	8.03	0.040
	0.10	0.066	0.034	166.1	16.60	0.085
	0.10	0.082	0.018	169.05	16.91	0.086
	0.10	0.097	0.003	169.6	16.96	0.087
	0.10	0.111	−0.011	167.7	16.77	0.086
Final equilibrium	0.10	0.10	0	149.4	14.90	0.080

TABLE 7
GOVERNMENT REVENUE FROM INFLATION

	μ	π	$\mu - \pi$	M/P (actual)	$(M/P)\mu = R$	R/y
Initial equilibrium	0.20	0.20	0	128.5	25.7	0.13
	0.20	0.20	0	128.5	25.7	0.13
	0.05	0.15	−0.10	116.8	5.8	0.03
	0.05	0.10	−0.05	111.2	5.6	0.03
	0.05	0.06	−0.01	110.1	5.5	0.03
	0.05	0.03	0.02	112.3	5.6	0.03
Final equilibrium	0.05	0.05	0	160.6	8.0	0.04

at the quarter where μ increased R/y will go to 8.5 percent, and then will oscillate converging to the new equilibrium. It shows that the government internalizes immediately a revenue higher than the one at the new equilibrium position.

In Table 6 we show the reverse exercise. Assuming $\mu = \pi = 0.20$ per quarter, and that μ is reduced to 5 percent per quarter, the ratio R/y, which was 13 percent will decline immediately to 3 percent, and then will oscillate until the new equilibrium is reached, at the level of $R/y = 0.04$.

A monetary shock will imply a substantial cut in public expenditures, and if cost expenditures are inflexible downwards this cut will affect entirely public investments, reducing the rate of growth.

The banking system will be internalizing a part of this revenue, which will be growing if π grows (up to the point where the cost elasticity of the demand for money is 1). But a monetary shock will affect their revenues, and depending on their cost structure probably some banks will go bankrupt.

Finally, as the share of indexed bonds in the total assets of monetary authorities in increasing, the government redistributes to the public a part of their revenue from inflation, creating a trap that makes the inflationary tax self-destructing.

University of Sao Paulo, Brazil

BIBLIOGRAPHY

Cagan, P., "The Monetary Dynamics of Hyperinflations" in M. Friedman ed. *Studies in the Quantity Theory of Money*. The University of Chicago Press, 1956.

Chow, G. C., "On the Long-Run and Short-Run Demand for Money," *Journal of Political Economy*, vol. 74, April 1966.

Dhrymes, P. J., *Distributed Lags: Problems of Estimation and Formulation*, Holden-Day, Inc., 1971.

Diz, A. C., "Money and Prices in Argentina, 1935–1962," in D. Meiselman ed., *Varieties of Monetary Experiences*. The University of Chicago Press, 1970.

Goldberg, S., *Introduction to Difference Equations*. J. Wiley & Sons, New York, 1961.

Griliches, Z., "Distributed Lags: A Survey," *Econometrica*, vol. 35, Jan. 1967.

Harberger, A. C., "The Case of the Three Numeraires." Paper presented at the Annual Meeting of Sociedade Econométrica, December 1966.

Morley, S. A., "Inflation and Stagnation in Brazil," *Economic Development and Cultural Change*, Jan., 1971.

Muth, J. F., "Optimal Properties of Exponentially Weighted Forecasts." *Journal of the American Statistical Association*, vol. 55, 1960.

Nerlove, M., "Estimates of the Elasticities of Supply of Selected Agricultural Commodities," *Journal of Farm Economics*, vol. 38, 1956.

Pastore, A. C. and Almonacid, R. D., "Inflação: Gradualismo ou Tratamento de choque. Considerações em torno dos custos da Estabilização, mimeo, 1974.
Pastore, A. C., "Observações sobre a política monetária no programa Brasileiro de Estabilização"— Tese de Livre Docencia não publicada, São Paulo, (1973a).
Pastore, A. C., "A Oferta de Moeda no Brasil—1961/72" Pesquisa e Planejamento Econômico, vol. 3, dez. de (1973b).
Simonsen, M. H., "Inflação: Gradualismo vs. Tratamento de choque" APEC, Rio, 1970.