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Full Length Research Paper

Transfer function and intervention models for the study of Brazilian inflationary process

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In this paper, the dynamics of the Brazilian inflationary process have been investigated using transfer function models in January, 1980 - December, 1993, considering the major determinants of inflation: monetary base, wages, federal debt, rate of interest, and rate of exchange. The effects of these exogenous variables and the intervention variables that represent structural changes and/or external shocks provoked by stabilizing plans on the inflation rate have been analyzed. The results showed that if the exogenous variables are brought under control then the inflationary process too. As a final comment, we are led to believe that the inertial component of the inflation rate is relatively low enough to be used as a guide for bringing stability to the price level. Since the inertial coefficient is much less than unity, if the exogenous variables are brought under control then inflation should subside gradually to about half of its value each month that passes. Governmental controls of the price level should be avoided since they disrupt expectations and inevitably lead to higher inflation rates.

Key words: Transfer function, inflationary process, macroeconomic variables.

INTRODUCTION

Among several problems that preoccupied the Brazilian people such as the social and economic disorder, there have always been major concerns about the ever increasing inflation since 1970, as well as the uncertainty of the future. The fact that these are multiple theories of inflation can be explained in part by recognizing that inflation differs through space and time. The causes of inflation may be different from one country to another, depending upon level of development, openness to international trade, competition within the country and with other countries, the form of government, among other factors. We propose here an approach which tends to be more statistical than theoretical for studying the Brazilian inflation of last two decades. Through methodology in time series analysis, we attempt to isolate the most significant macroeconomic variables that cause inflation in Brazil (Camargo, 1992).

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METHODOLOGIES

Transfer function model

Suppose there k exogenous variables, say X_{1t}, X_{2t}, ... , X_{kt}. Then the form transfer function model is:

$$\sum_{j=1}^{k} \frac{\varpi_j(B)}{\delta_j(B)} \qquad \frac{\theta(B)}{\phi(B)} \tag{1}$$

Where each input X_{jt} has a transfer function representation in terms of an autoregressive-type operator $\varpi_j(B)$ and moving-average-type operator $\delta_j(B)$, and has a delay b_j. If the original series are nonstationary, then differencing may be required to produce stationary. If we denote

$$y_t = \Delta^d Y_t = Y_t - Y_{t-d}$$

$$x_{j,t} = \Delta^{d'} X_{j,t} = X_{j,t} - X_{j,t-d'}$$

where d refers to the order of consecutive differencing of the dependent variable Y_t and d' refers to the order of consecutive

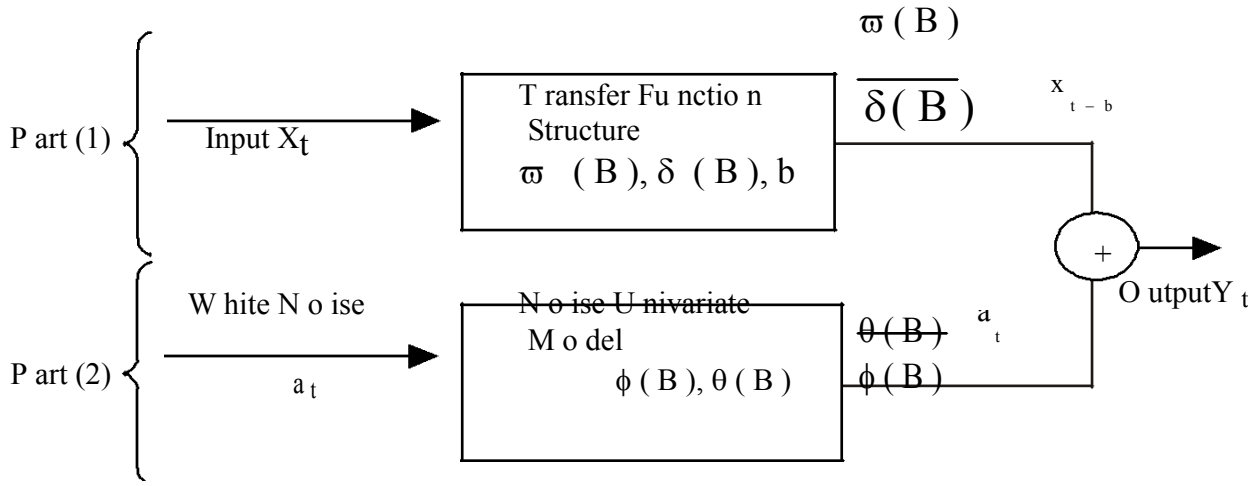

Figure 1. The transfer function model.

differencing of the exogenous variables X_t, and d' and d are not necessarily of the same order.
Then;

$$y_t = \mu_j + \sum_{j=1}^{k} \frac{\varpi_j(B)}{\delta_j(B)} x_{j,t-b_j} + \frac{\theta(B)}{\phi(B)} a_t \qquad (2)$$

Again we assume that the roots of all the polynomials $\varpi_j(B)$, $\delta_j(B)$, $\theta(B)$, and $\phi(B)$ lie outside the unit circle. Where:

$\varpi_j(B)=w_{0,j}-w_{1,j}B-w_{2,j}B^2-\ldots-w_{s,j}B^{sj}$: the numerator parameters;
$\delta_j(B) = 1-\delta_{1,j}B-\delta_{2,j}B^2-\ldots-\delta_{r,j}B^{rj}$: The denominator parameters;
μ_j : mean of the input variables;
δ_j : lead of time;
$\frac{\theta(B)}{\phi(B)} a_t$ = noise ARMA;
a_t : White noise with mean 0 and variance σ^2_a ;
$\theta(B)$: moving average parameters;
$\phi(B)$: autoregressive parameters.

This transfer function model is represented in Figure 1. At the top of the Figure we have the Transfer Function structure determining the nature of the influence of the exogenous variables on the dependent variable. In the lower part we have the noise model representing a standard univariate ARIMA process.

Finally, these two parts are put together to form the complete transfer function model (Box and Jenkins, 1976).

Intervention model

Suppose we have a time series Y_1, Y_2, ..., Y_{N-1}, Y_N of N observations measured at equal time intervals. A intervention model may be written in the following general form:

$$y_t = \Psi(B)I_t^T + \eta_t \qquad (3)$$

$\Psi(B)I_t^T$ = represents the intervention model;
I_t^T = intervention function (S_t^T = step function; P_t^T = pulse input variable; SP_t^T = seasonal pulse);
$x_{t,j}$, j = 1, 2, ... k, are indicator series (interventions) ;
d' = order of consecutive differencing of the dependent variable
Y_t; η_t = the stochastic noise component.
The intervention model is represented in Figure 2.

APPLICATION

In this section the determinants of the Brazilian inflation are analyzed through the transfer function methodology of Box and Jenkins (1976) and intervention analysis (Box and Tiao, 1975), for the period from January of 1980 to December of 1993. The exogenous variables in the equation are those which were used above in the transfer function analysis: Monetary Base (MB_t), Exchange Rate (ER_t) and Interest Rates (IR_t) . One of the by- products of this section is a discussion of inertial inflation. The idea is that long-standing inflation tend to set up institutional mechanisms which result in projecting past inflation rates into the future. Oftentimes this is the result of the distributive conflict between workers and capital that interact as opponents in a wage- price spiral (Camargo, 1990). However, it may also occur between any economic agents who are intertwined through prices and costs, who attempt to increase the price of their own product in order to protect themselves from the price increases of others. These price spirals need not occur exclusively through formal contract arrangements, the kind that are common in collective bargaining, where formal indexing schemes based on past inflation may be set up.

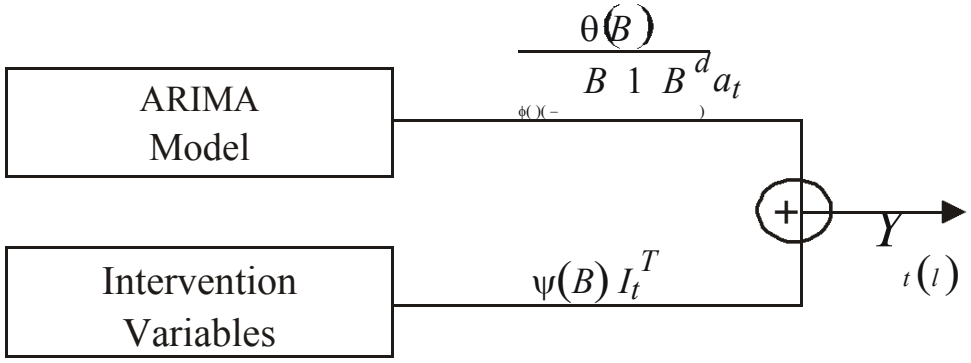

Figure 2. Intervention model.

Table 1. Observed and predicted values of inflation rates for the 7 – month period, 1994.

Month	Actual values	Forecast values	
		TFM	IM
January	42.2	38.10	37.81
February	42.4	35.00	36.88
March	44.8	32.08	36.31
April	42.5	29.54	35.83
May	41.0	27.39	35.61
June	46.6	25.60	35.31
July	24.7	24.11	35.22

Indexation may be, and oftentimes is, also informal without written agreements, but is just as effective as the formal kind.

The estimated transfer function models are the following

$$\underset{(217.58)}{{}_{n}\mathrm{Y_t} - 3.1270} = \underset{(2.80)}{0.2252\ \mathrm{MB}_{\mathrm{t-3}}} + \underset{(7.92)}{1.4579\ {}_{n}ER_{t}} - \underset{(-2.64)}{0.3194\ {}_{n}ER_{t-19}} + \underset{(9.01)}{1.7457\ {}_{n}\mathrm{IR_t}} + \underset{(2.40)}{0.3068\ {}_{n}\mathrm{IR_{t-22}}} + \frac{\underset{(2.76)}{a_t}}{1 - 0.2371B}$$

$R^2 = 0.92$ AIC = -4.1076 BIC = -3.9844

The estimated intervention model

$$\underset{(43.95)}{\ln \mathrm{Y_t} - 2.8985} = \underset{(15.23)}{\frac{1-11.672B}{0.4165B^2}}\ a_t - \underset{(-5.53)}{0.5329X_1(75)} + \underset{(4.05)}{0.3804X_2(109)} + \underset{(3.50)}{0.4018X_3(114)} + \underset{(7.04)}{0.6870X_4(123)} - \underset{(-3.79)}{0.3624X_5(135)}$$

$R^2 = 0.88$ AIC= -3.73 BIC = -3.56

Table 1 presents the observed and the predicted values of the inflation rate for the future seven months in 1994. The mean Absolute Percentage Error of the inflation rate is 23.81% for Transfer Model and 7.50% for Intervention Model.

The inertial component of inflation is represented by the auto-regressive terms in the residual with a value of about 24%. In an article by Cardoso (1983), she argues that Brazilian inflation is a random walk for the period 1968 - 1982. This result of hers does not contradict ours because the periods are not precisely the same Brandão (1985); Cardoso (1977).

For the 80's in Brazil there are two kinds of factors that can explain inflation. One is the course of exogenous variables most of which are controllable by the government that feed the inflation rate by means well-known in the macroeconomics literature. Monetarists

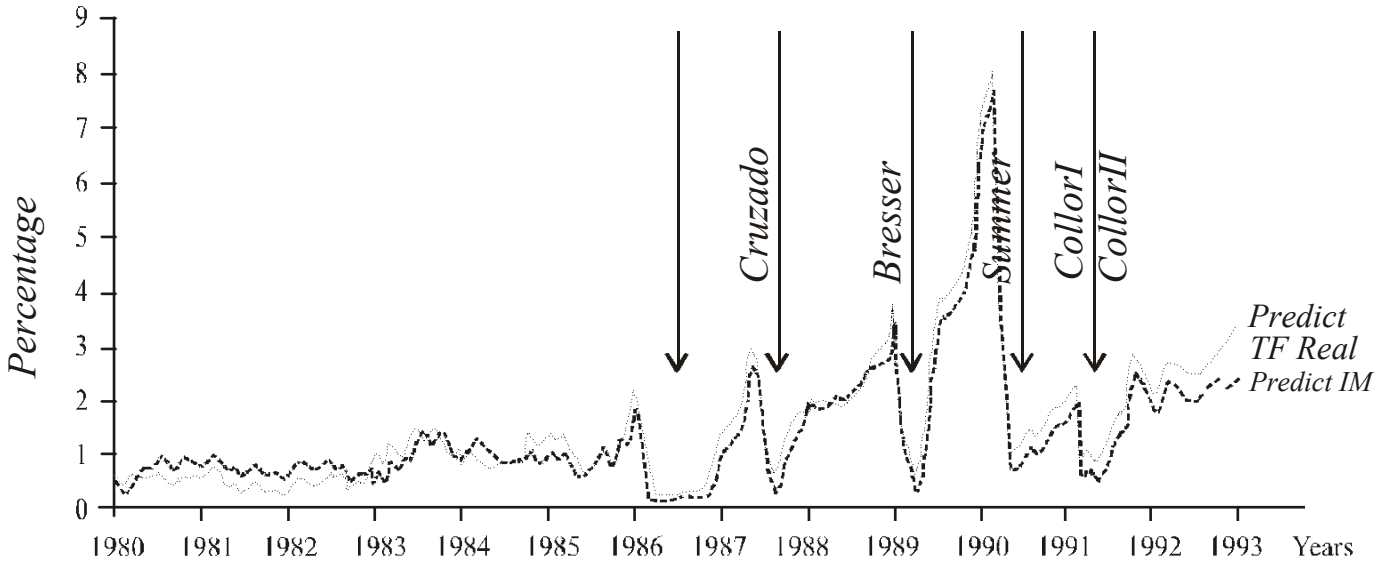

Figure 3. Real and predicted values of the inflation rate.

would concentrate on the demand side of the equation emphasizing the role of the monetary base and other monetary aggregates, while structuralists would find blame in exogenous shocks and supply side variables such as the interest rate and the exchange rate. Our results are eclectic in that both Monetarists and Structuralists would find some room for satisfaction. However, the balance does tip in favor of the Structuralists due to the larger coefficients for the supply side and a small coefficient for the base. The other kind of factor which determines the inflation rate, or, more precisely, perpetuates it, is the backward looking nature of price indexation, the inertial component. As we saw above, about one half of the inflation rate in the previous period is automatically projected to the next.

Eclectic results as the ones argued here should lead logically to eclectic policy suggestions. Certainly one should not suggest the impossible. Monetary aggregates which act as means of exchange react to the price level. Since they are an effect and not a cause of the inflation rate, trying to control them is irrelevant to anti-inflationary policy. The aggregate that should be controlled is the monetary base which, in our research, always appeared as exogenous and therefore a cause of the inflation rate. Controlling the monetary base is a Monetarist policy and does have its place in the policy scheme. The other variable that must be controlled and brought down in value is the interest rate. It also appears as an exogenous variable and is relatively important as a determinant of the inflation rate. Traditionally, the macroeconomics texts discuss controlling the interest rate through the money supply trade-off. More money supply (more monetary base) circulating in the economy brings the interest rate down and vice versa. For the Brazilian case this kind of policy is not appropriate because increasing the base to bring down the interest rate would be counter-productive. We propose bringing down the interest rate through market oriented policies that would increase the level of competition in the banking sector which is one of the most concentrated industries in Brazil. The larger banks exercise monopoly power in the government bond market and this fact maintains interest rates at internationally high levels. These high interest rates make government finance extremely difficult, being today one of the largest components of government expenditures. These expenditures are, of course, a contributing factor to the government's deficit, financed through the sale of bonds at high interest rates. The vicious circle is inevitable and chronic inflation results (Samohyl, 1993).

The other exogenous variables that should be taken into consideration are the rate of exchange and the wage rate. Our suggestion is to let these two variables ride along with the inflation rate, adjusting them as often as possible so that instability in their real values is avoided. In that way, the real value of wages would be protected and international trade would not be disrupted. As the economy settled down to lower and more stable inflation rates, wage rate increases could be contemplated, coming about as a result of firm economic growth and advances in productivity.

As we have seen, the inertial component of inflation translates about half of last month's inflation rate to this month's. If it were possible to somehow liquidate the effect on inflation of the exogenous variables, then the fall in the rate would be guided by the inertial factors present in the inflation rate about 24% for each month that passed. If this kind of scenario were acceptable, then inflation would fall gradually through time without government policies that attempt to bring the inflation rate to zero from one month to the next by outright controls or

other measures devised to break expectations. Abrupt government policies against inflation have historically in Brazil caused more harm than good to the economy and, in fact, have never been successful in controlling the inflation rate.

Conclusion

The 1980's is turbulent with inflation almost constantly at the 3 and 4 digit annual level. These results point to eclectic policies for combating inflation in the Brazilian case. The monetary authorities should attempt to control the monetary base but not the other monetary aggregates since they were not seen as causes of inflation. Furthermore, the government should attempt to bring down the interest rate not through Central Bank open market operations but rather by restructuring the competitiveness of the banking sector which is one of the most monopolistic and protected areas of the Brazilian economy.

As a final comment, we are led to believe that the inertial component of the inflation rate is relatively low enough to be used as a guide for bringing stability to the price level. Since the inertial coefficient is much less than unity, if the exogenous variables are brought under control then inflation should subside gradually to about half of its value each month that passes. Governmental controls of the price level should be avoided since they discrupt expectations and inevitably lead to higher inflation rates.

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