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BRAZILIAN INDEXING AND INERTIAL INFLATION:
EVIDENCE FROM TIME-VARYING ESTIMATES OF AN INFLATION TRANSFER FUNCTION

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This paper is a theoretical and empirical study of the relationship between indexing policy and feedback mechanisms in the inflationary adjustment process in Brazil. The focus of our study is on two policy issues: (1) did the Brazilian system of indexing of interest rates, the exchange rate, and wages make inflation so dependent on its own past values that it created a significant feedback process and inertia in the behaviour of inflation; and (2) was the feedback effect of past inflation upon itself so strong that dominated the effect of monetary/fiscal variables upon current inflation?

This paper develops a simple model designed to capture several "stylized facts" of Brazilian indexing policy. Separate rules of "backward indexing" for interest rates, the exchange rate, and wages, reflecting the evolution of policy changes in Brazil, are incorporated in a two-sector model of industrial and agricultural prices. A transfer function derived from this model shows inflation depending on three factors: (1) past values of inflation, (2) monetary and fiscal variables, and (3) supply-shock variables.

The indexing rules for interest rates, the exchange rate, and wages place restrictions on the coefficients of the transfer function. Variations in the policy-determined parameters of the indexing rules imply changes in the coefficients of the transfer function for inflation. One implication of this model, in contrast to previous results derived in analytically simpler models of indexing, is that a higher degree of indexing does not
make current inflation more responsive to current monetary shocks.

The empirical section of this paper studies the central hypotheses of this model through estimation of the inflation transfer function with time-varying parameters. The results show a systematic non-random variation of the transfer function coefficients closely synchronized with changes in the observed values of the wage-indexing parameters. Non-parametric tests show the variation of the transfer function coefficients to be statistically significant at the time of the changes in wage indexing rules in Brazil. As the degree of indexing increased, the inflation feedback coefficients increased, while the effect of external price and agricultural shocks progressively increased and monetary effects progressively decreased.
I. Introduction

This paper is a theoretical and empirical study of the relationship between indexing policy and feedback mechanisms in the inflationary adjustment process in Brazil in recent experience. An inflation feedback mechanism is a dependence of inflation upon its own past values. Arida and Lara-Resende (1985) have stated that this feedback process has been so strong in Brazil that it dominated the effects of excess demand factors on inflation, and this created inertial inflation. These authors have pointed to the Brazilian indexing system as a critical determinant of the feedback process and inertial inflation in Brazil.

This issue, of course, is of tremendous practical and policy importance. If the indexing system does create a strong feedback process, then it is necessary to reduce the degree of indexing in Brazil to make inflation more responsive to current monetary/fiscal stringency. For this reason, the Brazilian stabilization plan of February 1986, the Plano Cruzado, included disindexation. However, most models of indexing, for example, Gray (1976) and Fischer (1977), imply that a higher degree of indexing will make current inflation more responsive to current policy variables, and will thus reduce the output costs of reducing inflation. The difference between the Brazilian indexing/inertia phenomenon and the Gray/Fischer theoretical predictions is due to the distinction between lagged indexing systems, which link wages to past prices, and current or ex ante systems, which link wages to current or expected future prices. The Gray/Fischer models consider only the linkage of wages to current prices. In the Brazilian institutional setting, the indexing system is lagged, or backward-looking. Simonsen (1983) has shown
that this type of indexing system creates short-term rigidities and temporary output/inflation trade-offs, since the interval of nominal wage readjustment to past inflation is fixed by the indexing rules. An implication of this type of system is that a higher degree of indexation makes inflation less responsive to excess-demand variables, and a lower degree of indexing makes inflation more responsive, since wage adjustment transmits more of past inflation into current inflation, the higher the degree of lagged indexing.

In the following section, a transfer function for inflation is derived from a model of industrial and agricultural price dynamics, which incorporates indexing rules for wages, the interest rate, and the exchange rate. The parameters of these indexing rules enter into the coefficients of the inflation transfer function. Adding-up properties imply that the inflationary process is unstable if current excess-demand or excess-supply variables have no effects on current inflation, and if inflation only depends on its own past values. In an otherwise stable system, inflation must be determined at least partly by excess-demand variables. Since the Brazilian inflationary process has not exploded or become unstable, this model offers a different picture of the underlying structural relationships than Arida and Lara-Resende, since it leaves scope for monetary/fiscal policy for stabilizing inflation.

Since the coefficients of the inflation transfer function are related to the policy-determined parameters of the indexing rules, changes in these rules imply time-varying parameters in the inflation transfer function. Thus, estimation under the conventional assumption of constant coefficients is
The following section contains a description of the model and a derivation of the transfer function for inflation. The model incorporates a decomposition of inflation into industrial and agricultural price dynamics, indexing rules for wages, the exchange rate, and the domestic interest rate, and a simplified money demand and output-growth specification. The transfer function for overall inflation is derived from the
relationships of this model. While the parameters of the indexing rules affect the size of the feedback effects of past inflation rates upon current inflation, suppression of all indexing will not completely eliminate the feedback effects in the transfer function.

Overall inflation is a linear combination of industrial and agricultural inflation rates:

\[ \Delta P_t = (1-\omega) \Delta P_{It} + \omega \Delta P_{At} \]  

where \( P, P_I \) and \( P_A \) are the indices for the overall price level, the industrial price level, and the agricultural price level. Upper case letters denote the actual values of each variable, while lower case letters denote logarithmic values. The symbol \( \Delta \) is the first difference operator.

The difference between agricultural price inflation and industrial price inflation is a function of the agricultural output gap. Hence:

\[ \Delta P_{At} - \Delta P_{It} = -\theta[\Delta y_{At} - \Delta \bar{y}_{At}] = -\theta A_t \]  

where \( A \) is simply the deviation of the actual agricultural growth rate from the trend rate of output growth in this sector.

Industrial price changes respond to changes in internal labor costs (wages) net of productivity growth, and the external costs of imported raw materials:

\[ \Delta P_{It} = \gamma(\Delta w - q) + (1-\gamma) \Delta p^* \]  

where \( \Delta p^* \), the rate of change of imported raw material prices
in terms of local currency, is simply the sum of the rate of change of the exchange rate and the world price of raw materials:

\[ \Delta p_t^* = \Delta e_t + \Delta p_{Mt} \]

(4)

The symbols \( w \) and \( q \) represent the log of the nominal wage and the productivity growth rate, respectively.

The rate of change of the exchange rate is determined by the indexing policy of the government, and is linked to the difference between domestic and foreign inflation:

\[ \Delta e_t = \phi_c [\Delta p_t - \Delta p_{ft}] + \bar{e}_t \]

(5)

With \( \phi_c = 1 \), the government follows a purchasing-power-parity (PPP) rule. With \( \phi_c < 1 \), it follows a policy of permitting the exchange rate to appreciate in real terms. The symbol \( \bar{e}_t \) represents an exogenous shift in the rate of depreciation of the domestic currency.

The rate of change of wages is a function of government indexing policy as well as excess demand. Wages adjust in the following way:

\[ \Delta w_t = \phi_w \Delta p_{t-1} - \beta h_t + \bar{w} \]

(6)

The symbol \( h \) represents the level of excess capacity in the economy, and \( \bar{w} \) is an exogenous constant component affecting wage growth. The parameter \( \phi_w \) is the policy-determined indexing parameter for wages, with \( 0 \leq \phi_w \leq 1 \).
The level of excess capacity changes with deviations of output growth from trend output growth:

$$\Delta y_t - \Delta \bar{y}_t = \Delta h_t \quad (7)$$

Combining equations (1) through (6), one obtains the following supply or cost-determined inflation equation:

$$\Delta p_t = \frac{\gamma}{1-(1-\gamma) \phi_c} (\bar{w} - q) + \frac{\gamma \phi_w}{1-(1-\gamma) \phi_c} \Delta p_{t-1} - \frac{\gamma \theta}{1-(1-\gamma) \phi_c} h_t$$

$$+ \frac{1-\gamma}{1-(1-\gamma) \phi_c} \left[ \Delta p_{Mt} - \phi_c P_{ft} + \bar{e}_t \right] - \frac{w_\theta}{1-(1-\gamma) \phi_c} A_t \quad (8)$$

With full indexation of wages and the exchange rates ($\phi_w = \phi_c = 1$), this equation reduces to the following relation:

$$\Delta p^*_t = \Delta p_{t-1} + (\bar{w} - q) + \frac{1-\gamma}{\gamma} \left[ \Delta p_{Mt} - \Delta p_{ft} + \bar{e}_t \right] - \frac{w_\theta}{\gamma} A_t + \beta h_t \quad (9)$$

This last equation shows that with full indexation, the feedback effect is perfect. In the absence of other mechanisms operating through the demand-side, 100% inflation today will be passed on as 100% inflation tomorrow. The three following terms reflect the three types of shocks coming from the supply-side: wage changes, increases in the prices of imported goods, and agricultural shocks. The final term reflects excess capacity effects on inflationary adjustment.

The demand-side of the economy picks up the effects of money demand as well as the adjustment of the nominal interest rate.
Money demand depends on real output and the interest rate. Demand and supply are always equal. Hence:

\[ m_t - p_t = \alpha_0 + \alpha_1 y_t - \alpha_2 i_t \quad (10) \]

The interest rate \( i_t \) depends on the policy-determined indexing parameter linking it to current inflation as well as the log of the fiscal deficit \( f_t \), as a fraction of nominal GNP:

\[ i_t = \phi_m \Delta p_t + \delta \left[ f_t - p_t - y_t \right] \quad (11) \]

Equations (10) and (11) may be combined to obtain a demand-side expression for current prices:

\[ p_t = \frac{1}{1-\alpha_2(\phi_m+\delta)} m_t - \frac{\alpha_1 + \alpha_2 \delta}{1-\alpha_2(\phi_m-\delta)} y_t - \frac{\alpha_2 \phi_m}{1-\alpha_2(\phi_m-\delta)} p_{t-1} \tag{12a} \]

\[ + \frac{\alpha_2 \delta}{1-\alpha_2(\phi_m-\delta)} f_t - \frac{\alpha_0}{1-\alpha_2(\phi_m-\delta)} \]

For money-supply changes and fiscal deficits to have the normal positive effects on prices, \( \phi_m \), the indexing coefficient for interest rates, must obey the following restriction:

\[ \phi_m < \delta + \left( \frac{1}{\alpha_2} \right) \quad (12b) \]

Equation (12a), the demand-determined price equation, may be combined with (7) describing excess capacity and (8), the supply-determined inflation equation, to yield the following
transfer function for the rate of inflation:

$$\Delta p_t = a_0 \Delta y_t + a_1 \Delta p_{t-1} + a_2 \Delta p_{t-2} + b_1 \Delta m_t + b_2 \Delta f_t$$

(13)

$$+ c_1 (\bar{w} - q) + c_2 (\Delta p_{Mt} - \Phi^e \Delta p_{ft} + \bar{e}_t) + c_3 A_t$$

The parameters of this equation are defined in Table I. [See Zellner and Palm (1974) for more information on the method of using transfer functions to test structural econometric models].

For stability, it is required that $a_1$ and $a_2$ in (13) satisfy the following inequalities:

$$1 - a_1 - a_2 > 0$$

(14a)

$$1 + a_1 - a_2 > 0$$

(14b)

$$1 + a_2 > 0$$

(14c)

Regardless of the degree of indexation of wages, the interest rate, and the exchange rate, the coefficients of the two past inflation rates and the monetary/fiscal demand variables add-up to one:

$$a_1 + a_2 + b_1 + b_2 = 1$$

(15)

With or without full indexation, if the monetary and fiscal policy variables are totally ineffective in controlling inflation (with $b_1 = b_2 = 0$), then the inflation process is unstable, since the adding-up property ($a_1 + a_2 = 1$) does not satisfy stability condition (14a). This model indicates that
there may be scope for monetary/fiscal policy even with a high degree of indexation, if the inflation process appears stable.

Table I also shows that even if all forms of indexation are abolished, with $\phi_c = \phi_w = \phi_M = 0$, the feedback effect would still remain. While indexing may significantly increase the feedback effects in the inflationary process, it is not the sole determinant of these effects. In this model, the parameters of the money demand function as well as the sensitivity of the interest rate to current fiscal deficits also affect the magnitude of the feedback effects.

Table II shows the effects of changes in the indexing parameters on the coefficients of the inflation transfer function coefficients. An increase in wage indexing increases past period's feedback effect, but decreases the effect of inflation two periods ago on current inflation. Wage indexing changes do not affect the coefficients of the policy variables nor the supply shock coefficients in the transfer function. Increases in exchange rate and interest rate indexing, on the other hand, have ambiguous effects on one of the feedback effects and positive effects on the demand and supply shock coefficients. It thus matters quite a bit which indexing parameter is changed or reduced, if policy-makers are interested in reducing inflationary inertia or in making inflation more responsive to current demand. Table II shows that a system-wide reduction of indexing may have ambiguous effects on the feedback coefficient of past period's inflation rate, and will make inflation less sensitive to demand-management policies.

The effect of changes in indexing policies for wages,
### TABLE I

#### The Determinants of Inflation

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta \dddot{y_t}$</td>
<td>$a_0 = \frac{(a_1 + \delta_2 \delta) \gamma \beta}{\Omega}$</td>
</tr>
<tr>
<td>$\Delta p_{t-1}$</td>
<td>$a_1 = \frac{(a_w + a_2 \delta)[1-(1-\gamma)\phi_c + \gamma \phi_w] - a_2 \gamma \phi_m \beta}{\Omega}$</td>
</tr>
<tr>
<td>$\Delta p_{t-2}$</td>
<td>$a_2 = \frac{(a_1 + a_2 \delta) \gamma \phi_w}{\Omega}$</td>
</tr>
<tr>
<td>$\Delta m_t$</td>
<td>$b_1 = \gamma \beta / \Omega$</td>
</tr>
<tr>
<td>$\Delta f_t$</td>
<td>$b_2 = a_2 \delta \gamma \beta / \Omega$</td>
</tr>
<tr>
<td>$(\dddot{w-q})$</td>
<td>$c_1 = \frac{(a_1 + a_2 \delta) \gamma (1-L)^*}{\Omega}$</td>
</tr>
<tr>
<td>$(\Delta p_m t - \phi_c \Delta p_f t + \ddot{e}_t)'$</td>
<td>$c_2 = \frac{(a_1 + a_2 \delta)(1-\gamma)(1-L)^*}{\Omega}$</td>
</tr>
<tr>
<td>$A_t$</td>
<td>$c_3 = \frac{-(a_1 + a_2 \delta) \omega \theta (1-L)^*}{\Omega}$</td>
</tr>
</tbody>
</table>

$\Omega = [1-a_2 (\phi_m - \delta)] \gamma \beta + (a_1 + a_2 \delta) 1-(1-\gamma) \phi_c$ |

* L appearing in $c_1$, $c_2$, $c_3$ is the lag operator.
TABLE II

The Effects of Indexing Parameter Changes on the Inflation Transfer Function Coefficients

<table>
<thead>
<tr>
<th>Indexing Parameter</th>
<th>Inflation Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( a_1 )</td>
</tr>
<tr>
<td>Wages ( (\phi_w) )</td>
<td>+</td>
</tr>
<tr>
<td>Exchange Rate ( (\phi_C) )</td>
<td>?</td>
</tr>
<tr>
<td>Interest Rate ( (\phi_m) )</td>
<td>?</td>
</tr>
</tbody>
</table>

+ positive effect  
- negative effect  
? ambiguous  
N.A. not applicable

the interest rate, and the exchange rate on the parameters of the Brazilian inflationary process are the subjects of the following sections. While it is clear that indexing parameters do indeed affect the coefficients of a transfer function for inflation, it is known how much of an effect and which type of indexing policy change or disindexation have the greatest consequences for the feedback process and for reducing overall inertia. The case of Brazil, where indexing policy changes have been frequent, gives information on this matter.
III. **Empirical Results**

This section contains the estimation results of the model presented in the previous section. The purpose of this paper is to study the time profile of the coefficients in the inflation transfer function across regime changes in indexing policy. For this reason, we abstained from splitting the sample into different subperiods for differing indexing regimes. For the sake of comparison with the time-varying parameter estimates, we first discuss the results of the model estimated with ordinary least squares (OLS) under the assumption of time-invariant parameters. Then we discuss the results estimated by Kalman filtering under the assumption of time-varying parameters. We examine these results with tests for randomness as well as with an assessment of their sensitivity to the *a priori* specification of the estimation process.

A. **OLS Results: Constant Coefficient Assumption**

Table III presents the OLS estimates for the transfer function for inflation given by equation (13). There are two differences. The variables for the change in the fiscal deficit and the average wage component do not appear in the estimated equation, due to the unavailability of data. The monetary growth rate, however, does register the effects of fiscal deficit changes, to the extent that fiscal deficits are financed by new money creation.
The major findings of the OLS estimates show that all variables except the second lag on inflation and the constant term are significant, and that the adding-up restrictions of equation (15) do indeed hold. One cannot reject the hypothesis that the coefficients of the lagged inflation rates and the monetary growth rate add-up to one. Stability of the transfer function is assured, since the two feedback coefficients sum to a value less than unity. Finally, the results show the strong feedback mechanism or inertial element in the Brazilian inflation process: past period's inflation accounts for more than 80% of current inflation, while current monetary growth explains less than 30%.

B. Time-Varying Parameter Estimates

Anderson and Moore (1979), Chow (1984), and McNelis-Neftci (1982) have presented descriptions and applications of Kalman Filter estimation techniques. Estimation proceeds in three steps: (1) specification of starting values for the time-varying regression coefficients, the coefficient variance-covariance matrix and the variance of the disturbance term of the regression model at time t=0. (2) specification of stochastic processes for the evolution of the time-varying coefficients, as well as specification or estimation of the autoregressive parameters and the variances of the disturbance terms of these stochastic processes; and finally (3) an iterative solution to find the best one-period predictor of the dependent variable at each period. Intuitively, the Kalman filter may be described as on "optimal discounting" of past data to find the best one-
### TABLE III

**The Determinantes of Inflation With Time-Invariant Parameters**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter Estimate</th>
<th>Std Error</th>
<th>T-Stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta p (t-1)$</td>
<td>0.83</td>
<td>0.094</td>
<td>8.832</td>
</tr>
<tr>
<td>$\Delta p (t-2)$</td>
<td>-0.017</td>
<td>0.096</td>
<td>0.174</td>
</tr>
<tr>
<td>$m_t$</td>
<td>0.25</td>
<td>0.06</td>
<td>4.20</td>
</tr>
<tr>
<td>$(\Delta p_m - \phi_c \Delta p_f + \tilde{e_t})$</td>
<td>0.11</td>
<td>0.044</td>
<td>2.521</td>
</tr>
<tr>
<td>$A_t$</td>
<td>0.162</td>
<td>0.055</td>
<td>3.258</td>
</tr>
<tr>
<td>Const.</td>
<td>-0.005</td>
<td>0.006</td>
<td>0.907</td>
</tr>
</tbody>
</table>

$R^2 = 0.890$ \hspace{1cm} $\sigma = 0.031$ \hspace{1cm} $DW = 2.311$

Range: 1962.2 - 1985.1

Number of Observations: 92
period forward predictors. Rolling regressions, on the other hand, give equal weight to past and present data in giving the one-period forecasts.

The results of Kalman Filter estimation, not surprisingly, are often quite sensitive to the specifications of step (2). In our analysis, we first set the autoregressive transition matrix for the first-order autoregressive process at the identity matrix. We thus estimate the coefficients under the assumption that the "true coefficients" follow a random walk process. This assumption would bias the Kalman-Filter estimates toward greater instability. However, we set the initial values of the coefficients, the starting variance/covariance matrix, and the variance of the regression model disturbance term at the ordinary least squares (OLS) estimates of these parameters. Since the OLS estimates of the transfer function are consistent estimates, the use of these estimates as starting values may impart a downward bias in the coefficient variation. Finally, the variances of the disturbance terms for the stochastic processes driving the time-varying coefficients are initially set at the OLS estimate of the variances of the coefficients. This specification was systematically varied in order to determine the sensitivity of the results to this specification.

The Kalman Filter estimates for the coefficients of the transfer function for inflation, equation (13), appear in Figures I and II.

Figure I shows considerable variation in the one-period feedback coefficient of the transfer function. The first increase occurs in 1965, when the indexing laws were introduced. The other major jump occurs in 1979, when the wage indexing
FIGURE 1
TIME-VARYING FEEDBACK COEFFICIENT
IN INFLATION TRANSFER FUNCTION
FIGURE II
TIME-VARYING COEFFICIENTS IN INFLATION TRANSFER FUNCTION

- - - - - time-varying coefficient of monetary growth variable
- - - - - time-varying coefficient of external shock variable
- - - - - time-varying coefficient of agricultural price shock variable
adjustment interval was lowered from one year to six months. However Figure I shows that after the first jump in the feedback coefficient, occurring at the time of the indexing regime change, there is a gradual decline in the value of the time-varying coefficient.

Figure II depicts the variation of the coefficients of the external shock variable, the monetary growth variable, and the agricultural price shock variable in the transfer function.

The coefficient of the external shock variable is represented by the solid curve. It does not show much variation until 1979. The broken curve represents the effects of the monetary growth variable. It shows a gradual and relatively smooth decline throughout the period. Finally, the dotted curve represents the effects of the agricultural price shock variable. There is a moderate and steady increase in the value of the coefficient during the estimation period. By the end of the sample, the effects of external and agricultural price shocks are about equal to the effect of monetary factors on inflation.

C. Tests for Randomness

Two issues arise about the variability of the coefficients: first, are the coefficients simply random deviations around a constant mean and secondly, if the variation is not random around a constant mean, does their behavior indicate a systematic pattern or a simple random process?

The results of the non-parametric runs test for a random distribution of the coefficients appear in Table IV. This test,
FIGURE III
TIME-VARYING ESTIMATES OF INFLATION FEEDBACK COEFFICIENT UNDER ALTERNATIVE PRIORS ON STOCHASTIC PROCESS VARIANCE

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- Solid line: high variance assumption
- Dashed line: low variance assumption
<table>
<thead>
<tr>
<th>Coefficient</th>
<th>No. of Runs</th>
<th>Expected Value</th>
<th>Std Dev</th>
<th>Z-Stat.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lagged Inflation</td>
<td>7</td>
<td>41.4</td>
<td>4.18</td>
<td>8.22</td>
</tr>
<tr>
<td>External Price Shock</td>
<td>4</td>
<td>46</td>
<td>4.68</td>
<td>8.97</td>
</tr>
<tr>
<td>Monetary Growth</td>
<td>7</td>
<td>47</td>
<td>4.76</td>
<td>8.40</td>
</tr>
<tr>
<td>Agricultural Price Shock</td>
<td>8</td>
<td>44</td>
<td>4.44</td>
<td>8.10</td>
</tr>
<tr>
<td>Coefficient</td>
<td>No. of Autocorrelations</td>
<td>Degree of Differencing</td>
<td>Q-Stat</td>
<td>Prob. Value</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>-------------------------</td>
<td>------------------------</td>
<td>--------</td>
<td>-------------</td>
</tr>
<tr>
<td>Lagged Inflation</td>
<td>12</td>
<td>0</td>
<td>295.74</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>9.27</td>
<td>.68</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>0</td>
<td>313.02</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>16.40</td>
<td>.87</td>
</tr>
<tr>
<td></td>
<td>36</td>
<td>0</td>
<td>342.37</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>19.05</td>
<td>.99</td>
</tr>
<tr>
<td>External Price Shocks</td>
<td>12</td>
<td>0</td>
<td>207.82</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>16.27</td>
<td>.179</td>
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<td></td>
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<td>0</td>
<td>224.63</td>
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<td>20.93</td>
<td>6.43</td>
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<td>0</td>
<td>226.86</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>23.17</td>
<td>.952</td>
</tr>
<tr>
<td>Monetary Growth</td>
<td>12</td>
<td>0</td>
<td>745.65</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>14.88</td>
<td>.248</td>
</tr>
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<td>.661</td>
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<td>36</td>
<td>0</td>
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<td></td>
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<td>1</td>
<td>21.58</td>
<td>.972</td>
</tr>
<tr>
<td>Agricultural Price Shock</td>
<td>12</td>
<td>0</td>
<td>158.49</td>
<td>0.00</td>
</tr>
<tr>
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<td>1</td>
<td>5.84</td>
<td>.924</td>
</tr>
<tr>
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<td>0</td>
<td>185.64</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>9.82</td>
<td>995</td>
</tr>
<tr>
<td></td>
<td>36</td>
<td>0</td>
<td>192.94</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>10.43</td>
<td>1.000</td>
</tr>
</tbody>
</table>

Prob. Value indicates the probability of a type I error, under the null hypothesis of randomness.
described in Gujarati (1982), is approximately normally distributed. The results allow rejection of the null hypothesis of random coefficients with a constant mean.

Table V presents the results of the Ljung-Box Q test of randomness, based on the estimated autocorrelations of the time-varying parameters. This test appears in Ljung and Box (1978). The distribution of the test statistic is approximated by the Chi-square distribution, with the degrees of freedom set at the number of estimated autocorrelations. The results of this test also allow rejection of randomness at the one per cent level of significance or less.

The results of the Ljung-Box test do not allow rejection of randomness in the first differences of the time-varying parameters. Hence, a simple stochastic process may explain the movement of the time-varying coefficients. However, the evidence is not overwhelming. The error probability of rejecting randomness in the external price coefficient is less than 20%, and it is less than 25% if we reject randomness in the monetary growth coefficient. Moreover, the trend process in the time-varying coefficients may be synchronized with a gradual phasing-in process of indexing throughout the Brazilian economy. Since the "degree of indexing" is not easily quantified, however, this proposition cannot be econometrically tested. Instead, the variability of the coefficients must be compared with information about systematic policy changes which occurred during the estimation period, to determine the qualitative relationships between coefficient movements and policy changes. This is the task of Section IV. While the results of the Ljung-Box test do
not beg for this type of analysis and interpretation of the coefficient movement, neither do they preclude such an analysis and interpretation.

D. Sensitivity Analysis of the Time-Varying Estimates

Figure III pictures the time profile of the inflation feedback coefficient under two alternative assumptions about the a priori specified variance of the error term for the time-varying coefficients. The solid curve represents the estimated coefficient under the high variance assumption, when the a priori variance was set at a value twice as large as the variance in the base estimation. The broken curve represents the same coefficient estimated under the low variance assumption, when the a priori variance was set at a value one-half as large as the base-estimation variance.

Figure III shows that the general profile of the time-varying feedback coefficient is the same under the alternative assumption. Breaks occur about the same time, and there is the same general upward process after 1979. The major difference appears to be in the range of values of the kalman filter estimates under the alternative assumptions. As the pre-specified variances are lowered, the range of the estimated coefficients values narrows, while the mean, in this case, progressively increases and approaches the OLS estimates.

Systematic changes in the remaining pre-specified parameters produced the same patterns of the time-varying coefficients obtained in the base estimation. For this reason we believe that our Kalman Filter results give non-trivial
still be a useful channel for neutralizing supply shocks even when indexing has created a strong inertial inflation.

The results of Figures I and II imply that the higher wage indexing especially after 1979, much more than exchange rate or interest indexing, is connected with strong feedback effects and a reduced scope for anti-inflationary demand management policy.

V. Conclusion

This paper has presented results which link the spread and increasing degree of wage indexing with progressively stronger feedback effects in the Brazilian inflationary process. Financial sector indexing and exchange rate indexing policies through passive crawling peg regimes appear to have relatively minor or insignificant effects on the degree of inertia in the inflation process.

The model used to derive the transfer function for inflation neglects exchange rate expectations, changes in current and capital account openness, and tax indexing on the inflationary process. A more complex model explicitly treating these phenomena would provide more detail and perhaps give more accurate measures of the movements of the inflation transfer function coefficients. Despite these limitations, this study provides evidence linking the wage indexing system with the observed inertia in the Brazilian inflationary process. The evidence is consistent with an anti-inflation program based on wage disindexation (and not necessarily exchange rate or financial sector disindexation) and monetary/fiscal stringency.
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