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The indexation of wages and bonds in Brazil

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This paper analyses the dynamic relationship between the degrees of indexation of wages and public bonds in Brazil. A simple model is constructed to show that both degrees of indexation are determined simultaneously. We apply cointegration techniques and estimate error-correction representations to assess the temporal causality between them. Our results provide empirical support for the existence of simultaneity in the degrees of indexation in Brazil in the period 1980–93.

I. INTRODUCTION

Indexing for inflation has become a widespread practice in high-inflation countries. Brazil is an example of such a country; Since it has experienced different schemes of indexation which have actually helped the economy to prosper even under an environment of accelerating inflation (Siqueira, 1983). Widespread indexation was introduced in the country in 1964 to reduce the effects of unanticipated inflation on the real side of the economy (Barbosa, 1993) and to coordinate increasing wage demands in the labour market through the introduction of an official wage policy (Macedo, 1983, Simonsen, 1983, 1988).

Many are the arguments in favour of indexation. Friedman (1974), for example, argues that the indexation of government bonds reduces the need to collect the inflationary tax. Calvo (1988) also points out that full indexation of bonds might be the best option to deal with the government's time inconsistency problem. The idea is that when public debt contracts are written in nominal terms, the government is encouraged to use the inflation tax to reduce the real value of its liabilities, but with indexation, the link between public debt and inflation is broken as the real debt burden becomes independent of the inflation rate (Guidotti, 1993). In the same vein, Devereaux (1989) argues that indexation of wages might have an anti-inflationary effect by making the Phillips curve steeper.

However, economists far from agree on the advantages of indexation. In this regard, Stockman (1993) argues that if the practice of indexation were so attractive it would be widespread around the world. Viard (1993) contends that there are no significant welfare gains from the introduction of indexed bonds since agents can combine the existing assets to protect themselves from inflation. The least controversial position which one can draw from this discussion is that indexation makes life easier under inflation. Nevertheless, it can also contribute to higher future inflation, as it reduces the real cost of inflation (Fischer and Summers, 1989).

An issue which has not received a great deal of attention in the literature is whether debt indexation leads to other forms of indexation, particularly that of wages, which is often considered one of the main causes of inflation persistence. It could be argued that a relationship between bonds and wage indexation should exist as a matter of strategic behaviour. For example, by indexing bonds the government is signalling future inflation and this would encourage wage setters to seek appropriate protection against future price increases; on the other hand, in the event of wage indexation the government may assume that this will have a spillover effect on prices, fuelling inflation and leading to further bond indexation.

Guidotti (1993) was the first to formalize this relationship, by introducing policy endogeneity into the Gray (1976) wage indexation model and extending the Calvo and Guidotti (1990) public debt indexation approach. The general conclusion is that the relationship between wages and bond indexation may be positive, from the government's standpoint, or either positive or negative, as far as the private sector is concerned.

This paper examines the relationship between bond and wage indexation for the case of Brazil, a country where the indexation of bonds has been seen as the main indicator of inflation. We formalize this relationship with a model in

which two agents (government and wage setters) decide, in a simultaneous game, the optimal degree of wage and bond indexation. We assume that indexation is a feedback mechanism of inflation and that the optimizing behaviour of agents takes into consideration both past and expected inflation. Thus, future equilibrium inflation corresponds to the inflation which satisfies simultaneously both agents' optimal decisions. This equilibrium inflation relates the degrees of indexation and operates as a transmission mechanism, yielding a bi-directional relationship by which the degree of wage indexation causes the indexation of bonds and *vice versa*. We test this hypothesis for the period 1980–93 through a standard Granger causality test.

The paper is organized as follows. First, we describe the theoretical model which establishes the basis of the relationship between the indexation of bonds and wages in the context of related work. Then we discuss the results of the empirical analysis using cointegration and error correction estimates and speculate on some of the possible implications of our results. Finally, we present the conclusions of the paper.

II. THE BASIC MODEL

Our model is simple enough to explain the relationship between the degrees of indexation of bonds and wages. We are not concerned with the form of the objective function of each agent as, for example, loss functions, used in some cases in the related literature (e.g., Van Hoose and Waller, 1991). We consider two agents, government and unions. First, both agents try to find the equilibrium inflation, which is a function of the degree of indexation of wages and bonds. Once this equilibrium is found, the government and the wage setters play a simultaneous game in which the degrees of indexation are related through their reaction functions, making inflation and the degrees of indexation endogenous in our model.[1]

Let $U = U\ (q, p^u, \boldsymbol{Z})$ be the union's payoff, where q is the degree of wage indexation, p^u is the inflation expected by wage setters and $\boldsymbol{Z}$ represents a vector of exogenous variables that influence the labour market. Note that this objective function may also be related to different demands by the trade unions, as discussed in Pencavel (1991).[2] Let $g = g\ (d, p^g, \boldsymbol{K})$ be the government's payoff,[3] where d is the degree of indexation of bonds, p^g is the inflation expected by the government and $\boldsymbol{K}$ is a vector of exogenous variables that influence the bonds market.

We can then solve the model, beginning with the optimal behaviour in relation to the expected inflation. The government's problem can be represented by $\text{Max}_{p^g}\ g\ (d, \boldsymbol{K}, p^g)$ which gives us the following first-order condition:

$$p^g = p^g(d, \boldsymbol{K}) \tag{1}$$

The union's problem, represented by $\text{Max}_{p^u}\ U\ (q, \boldsymbol{Z}^u, p^u)$, yields the following first-order condition:

$$p^u = p^u(q, \boldsymbol{Z}) \tag{2}$$

Equilibrium inflation (p), is obtained when $p^g = p^u = p$ which implies from (1) and (2) that

$$p = p(d, q, \boldsymbol{K}, \boldsymbol{Z}) \tag{3}$$

Equation 3 describes the feedback mechanism from d and q over the inflation rate, p. By replacing the equilibrium inflation (3) into the objective functions we can see how the agents decide simultaneously the optimal degrees of indexation; Equation 4 describes the transmission mechanism (since it relates both degrees of indexation):

$$\text{Max}_d\ g\ (d, p(d, q\ \boldsymbol{K}, \boldsymbol{Z}), \boldsymbol{K})$$

$$\text{Max}_q\ U\ (q, p\ (d, q, \boldsymbol{K}, \boldsymbol{Z}), \boldsymbol{Z}) \tag{4}$$

Note that from (4) the optimal decisions between the degrees of inflation are directly related through the reaction functions, which are obtained from the following first-order conditions:

$$d^* = d(q^*, \boldsymbol{Z}, \boldsymbol{K})$$

$$q^* = q(d^*, \boldsymbol{Z}, \boldsymbol{K}) \tag{5}$$

From (5) we have the simultaneous relationship between the degrees of indexation, which implies a bi-directional causality between them. By solving (5) we obtain the optimal degrees of indexation which, when substituted into (3), yields the optimal inflation associated with the strategic behaviour of each agent.

III. EMPIRICAL VALIDATION

Our theoretical model has formalized a situation in which the indexation of wages and bonds is simultaneously determined. It has been claimed that higher inflation, which in our case is the common transmission mechanism for both agents of the model, would cause the prevalence of wage and

[1] Fiorencio (1995) presents a two-sector model in which the degrees of indexation of each agent are determined simultaneously, but with inflation appearing exogenously.

[2] Christofides and Stark (1996) present empirical evidence showing that, in Canada, the intensity of indexation is negatively influenced by bargaining strength variables such as the unemployment rate and union density (p. 234).

[3] This function can also assume any other form, including the oft-used loss function.

bonds indexation to increase, but higher indexation could also cause further inflation (Ball and Cecchetti, 1991; Mourmouras, 1993). In our empirical analysis of the data we are not concerned with identifying purely causal relationships between degrees of indexation in the bond and labour markets. Instead, we set out to investigate the *temporal causality* between these two variables. In the context of our analysis, therefore, causality implies precedence.

In the presence of price sluggishness, if indexation of bonds caused wage indexation, the former would change first because renegotiation of indexation clauses would be time-consuming. On the other hand, if wage indexation caused bond indexation, the former would change first because policymakers must become aware of the greater incentive to inflate before they react to it. Holland (1995) has found evidence of unidirectional causality between inflation and wage indexation for the case of the USA. His results show that increases in inflation precede wage indexation, but that reductions in inflation do not precede reductions in wage indexation; that is, there is no evidence that wage indexation affects inflation. Our theoretical section, however, suggests that in a situation in which both agents have similar expectations about the inflation rate, the indexation of wages and bonds should be simultaneously determined, which actually implies a bi-directional causality.

A comprehensive test of temporal causality, which specifically allows for a causal linkage between two variables stemming from a common trend, is provided by the error correction model proposed by Engle and Granger (1987). This method examines whether lagged values of a variable X may help to explain the current change in another variable Y, even if past changes in X do not, assuming that both X and Y are stationary. The intuition is that if the two variables are cointegrated, then part of the current change in X results from Y moving into alignment with the trend value of X. As long as X and Y have a common trend, causality must exist at least in one direction. So it is possible to find reverse causality or even two-way causality.

In more formal terms, to test for causality when variables are cointegrated, one uses the following error correction equation:

$$\Delta X_t = \alpha_0 + \sum_{i=1} \beta_i \Delta X_{t-i} + \sum_{i=0} \Phi_i \Delta Y_{t-i} + \lambda e_{t-1} + u_t \quad (6)$$

where e_{t-1} is the lagged value of the residuals from a cointegration vector such as

$$\boldsymbol{X}^t = \tau Y_t + e_t \quad (7)$$

From (6), the null hypothesis that Y does not Granger-cause X is rejected either if the coefficient on e_{t-1} is significant or the Φ_is are jointly significant. In other words, the value of e in one period represents the error to be corrected in the next period. If X and Y are positively related, then λ would be negative, which means that an extremely high value of X relatively to Y provokes a reduction in X.

Results of temporal ordering tests

Our empirical analysis uses monthly data for the period January 1980 to December 1993. The variables are in logarithmic form and measured in nominal terms. Wage indexation is proxied by an index of monthly nominal wages in Brazilian manufacturing. Bond indexation is proxied by the end-of-month price of public bonds (*OTNs*). The sources of the data are the Federation of Industries of the State of Sao Paulo (FIESP) and the Central Bank of Brazil, respectively.

Each time series is first examined for the order of integration. For that purpose we use the widely accepted Dickey–Fuller (DF) and augmented Dickey–Fuller (ADF) tests to check for stationarity. It is known that these tests have low power, and one should be particularly concerned about that in contexts of accelerating inflation which tend to affect greatly the behaviour of time series (see, for example, the discussion in Campbell and Perron, 1991). Accordingly, we have tested for stationarity in three distinct periods: the full sample, January 1980 to December 1993 (with a dummy for the whole year of the 1989 hyperinflation); an earlier period, which covers the months between January 1980 and December 1988; and the most recent years, which includes the period between January 1990 and December 1993. The year 1989 was intentionally excluded from the analysis since it was characterized by great uncertainty regarding the formal wage indexation rule.[4] The results are summarized in Table 1, and in general we cannot reject non-stationarity for the levels of the variables. In contrast, when the data are differenced, non-stationarity is rejected[5]. Thus, we estimate the cointegration regressions with the variables in levels,

[4] In early 1989 there were actually two competing proposals on the rules of the wage policy. The first, proposed by the government, allowed for a 6% real gain every two months for all salaries up to 1 minimum wage (MW) and less generous adjustments for salaries in excess of 1 MW. The second, supported by the Congress, indexed salaries to the monthly change in National Treasury bills (BTN). The lack of consensus provoked a void in the country's wage legislation for most of the year, in a context of very high rates of inflation.

[5] Results of Perron's (1989) test for unit roots in the presence of structural break have also confirmed these findings. Using the methodology proposed by Perron we found that, for the data in levels, the coefficient for the lagged dependent variable detrended was not statistically different from unity, and therefore we could not reject the null of a unit root. The same test for the data in first-differences yielded coefficients statistically different from unity, thus allowing the rejection of the null of a unit root. The level dummy variable used in the estimations was such that $D_L = 1$ if $t > 1989(1)$ and zero otherwise.

Table 1. *Unit root tests*

	I(1) Jan/80–Dec/93	I(1) Jan/80–Dec/88	I(1) Jan/90–Dec/93
Wage indexation (ln W_t)			
DF	− 4.897**	− 5.61**	− 3.28*
ADF	− 4.255**	− 6.24**	− 3.06*
Bond indexation (ln B_t)			
DF	− 3.575**	− 4.13**	− 3.42*
ADF	− 4.049**	− 4.82**	− 3.00*

* and **Significant at the 10% and 5% levels, respectively.

and the error correction equations with the first-differenced data.

Estimates of Equation 7 using the Johansen maximum likelihood method for the full sample[6] yielded values of τ of 0.83 when ln B_t was the dependent variable, and 1.87 with ln W_t as the dependent variable. Using a likelihood ratio test, we could not reject the null hypothesis that the long-run elasticity of the indexation of public bonds with respect to the indexation of wages was unity. This is suggestive of a constant long-run relationship between the two variables. We have also calculated the speed of adjustment of the two variables to their equilibrium value in the event of relative changes. As Phylaktis and Kassimatis (1994) have shown, the speed of adjustment is equal to one minus the first-order autoregressive coefficient; in our case, this coefficient assumed the value 0.85, implying that the speed of adjustment is 15% per month.

However, the above analysis does not tell us which variable adjusts to restore the long-run equilibrium relationship. This information is obtainable by estimating an error correction model using the first-differenced variables, as in Equation 6. The coefficient of the error correction term for the equation of the indexation of bonds on the indexation of wages was negative and strongly significant (-0.138, $t = -4.079$). On the other hand, the coefficient of the error correction term of the equation of the indexation of wages on the indexation of bonds was positive and not statistically significant (0.042, $t = -0.041$), but the lagged values of changes in the indexation of bonds were jointly significant ($F(4, 74) = 8.032$). This would be sufficient to establish the two-way causality postulated by our theoretical model, which also implies the simultaneity of both degrees of indexation. But we proceed to check the robustness of our results by repeating this analysis in the different subsamples identified earlier.

Figure 1 plots the rate of change of nominal wages and public bonds and also the path of the ECM term obtained with the equation of bonds on wages. From the path described by the variables, it becomes very clear that a change in regime occurred in 1989. In this regard, the most important fact to be noticed is concerned with the change in the periodicity of wage adjustments, which changed from a six-month rule to monthly adjustments after 1986.[7] This is quite apparent in the graph of the wage series, which shows a sequence of ups and downs at the beginning of the sample and a more stable pattern in the most recent period. The equation for changes in the indexation of bonds estimated for the first subsample actually reflected this feature of the period's wage policy, since the fifth and sixth lags on changes in the indexation of wages were significant and assumed negative coefficients, while the first and fifth lags of the dependent variable were significant with positive coefficients. In the equation for changes in the indexation of wages, the fifth and sixth lags of both the dependent and independent variables were significant, with positive coefficients for the former and negative for the latter.[8]

Estimating the same equations for the latter sub-period (January 1990 to December 1993) yielded very similar results. The coefficient of the ECM term for the equation of bonds on wages was negatively signed and statistically significant (-0.14, $t = -2.217$), while the coefficient of the ECM term for the equation of wages on bonds was positively signed and this time highly significant (0.21, $t = 2.852$). As for the lags of the two variables, only the first lags

[6] As this necessarily implies estimating long-run parameters we applied the Johansen method only for the 14 years of the full sample, which we believe might represent a long-run given the context of enormous uncertainty involved in a persistent high-inflation country.

[7] This change of periodicity was first established informally by wage setters, because of the accelerating inflation observed since the early 1980s, and was later endorsed by the government with the shortening of the lapse of time between wage adjustments allowed for by the official wage policy.

[8] We have also included a variable which measures the annual change in the target real wage and the annual change in the tax wedge to account for some of the exogenous variables which might affect the relationship between the degrees of indexation, as suggested by Equations 1 and 2. The coefficient for changes in the target real wage was always significant, and positive in the first case and negative in the second. The coefficient for changes in the tax wedge was significant and negative in both cases.

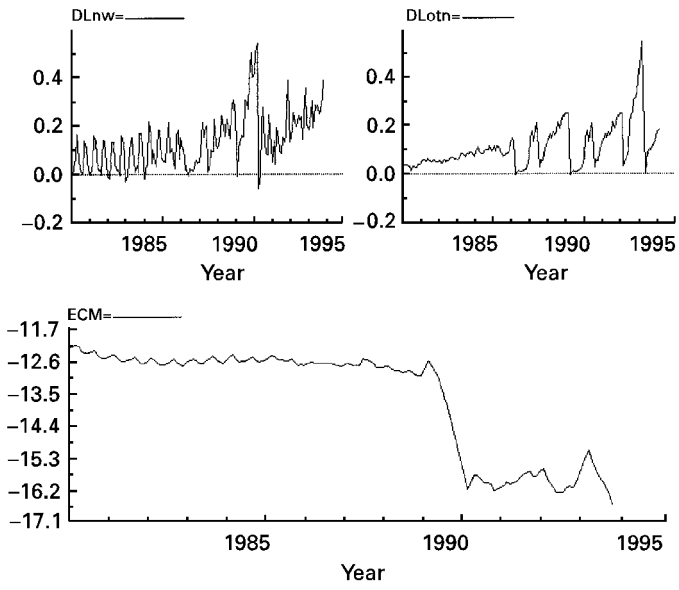

Fig. 1. *Changes in wages, bond prices and the error-correction term*

appeared statistically significant, reflecting again the change in the indexation rule. Therefore, there is rather more evidence now of the claimed two-way causality, or simultaneity, postulated earlier (see Table 2).

The negative coefficient of the error-correction term in the equation for changes in bond indexation implies that more than proportional increases on the part of wage setters will force the government to react by reducing the indexation of its bonds. On the other hand, the positive error-correction term in the equation for changes in wage indexation implies that more than proportional increases on the part of the government will force wage setters to react by pushing for an increase in the degree of wage indexation. Finally, the statistically significant error-correction terms implies that the one-period-lagged value of the indexation of either variable can be used to help forecast the current value of the other.

Some possible implications of the results

In what follows we speculate on some of the possible implications that can be drawn from these results. First, if one considers that the indexation of public bonds is a parameter for the indexation of other markets, then the simultaneity of the degrees of indexation suggests that wage setters are quite able to protect their salaries from inflation. Earlier work on wage determination corroborates this assertion. Amadeo (1993), for example, shows that in the most organized sectors of the Brazilian economy, relative wages tend to move together with relative prices. Carneiro and Henley (1994) and Carneiro (1995) provide econometric evidence on the ability of wage bargainers to protect their salaries from inflation.

Table 2. *Summary of results*

	Jan 80–Dec 88	Jan. 90–Dec 93
ECM bonds ⇒ Wages	− 0.138	− 0.144
Significant lags	5th, 6th	1st
ECM wages ⇒ Bonds	+ 0.042	+ 0.215
Significant lags	5th, 6th	1st
Causality implication	Bi-directional	Bi-directional

Second, the simultaneous degree of indexation is also suggestive of the stability of the demand for money in Brazil, in the period analysed. Assuming for example that the country has never experienced a process of currency substitution, even in the presence of persistent high-inflation, as opposed to other high-inflation countries (e.g., Argentina, Bolivia and Israel), the existence of widespread indexation and the ability of wage setters to keep pace with inflation does not endorse the abandonment of the domestic currency (Carneiro and Faria, 1997). Econometric evidence for the stability of the demand for money in Brazil is provided by Phylaktis and Taylor (1993), Rossi (1994) and de Mello and Carneiro (1995).

Finally, although not a direct implication of the results, one could speculate that widespread indexation reduces the variance of relative prices in the presence of inflation (e.g. Devereaux, 1989). If one considers that the price mechanism is important in signalling market disequilibria, such as excess supply and/or demand, the ability of an indexed economy to operate efficiently would be largely affected. The immediate consequence of this would be an inefficient allocation of resources in which relative prices are no longer a reliable parameter for rational economic decisions. Furthermore, the ability to avoid the real costs of inflation would protect a large number of 'bad businesses' which would certainly not operate in a stabilized economy.

IV. CONCLUSIONS

In this paper we have examined the dynamic relationship between the indexation of public bonds and wages in Brazil. We constructed a simple model in which the degrees of indexation of bonds and wages are determined simultaneously. We have applied the cointegration technique and estimated error correction representations to assess the temporal causality between the degrees of indexation. Our results present evidence of two-way causality between the indexation of wages and public bonds in Brazil in the period 1980–93. The basic assumption of the paper was that in equilibrium the expected rate of inflation, which both the government and wage setters care about, will coincide. This equilibrium inflation relates the degrees of indexation and operates as a transmission mechanism implying a bi-directional causality.

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