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THE RELATIVE SOPHISTICATION OF FINANCIAL MARKETS in Brazil sets it apart from other developing economies. In the last twenty years, Brazil has proved fertile ground for financial innovations in response to high rates of inflation, reserve requirements, and low or zero nominal interest rate ceilings on conventional bank accounts. These innovations include the rapid growth of relatively unregulated finance companies, the emergence of a fledgling equities market, reductions in bank transacting costs through computerization, and the use of bank repurchase agreements as substitutes for conventional deposits (Gelb et al. 1980).

Primary and secondary markets for government securities, which also provide the basis for bank repurchase agreements, emerged in the early 1970s as well. These securities provided a convenient source of funds for the government in the face of shrinking money demand as they permitted agents to maintain relatively high yields and liquidity without resort to nonfinancial or foreign assets. Though the availability of treasury bills and indexed bonds contributed to the falling demand for money, the minimum denomination and transaction costs associated with holding and trading these instruments ensured that some agents would retain funds in zero or low-interest accounts. At the same time, those who might have transferred funds out of the domestic financial system, and beyond the reach of the government, were offered relatively attractive alternatives. Thus one can view the creation of these

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securities as a discriminatory financial taxation policy in which the most inelastic asset demands receive the highest taxation rates.

The peculiar features of Brazil's financial system have been recognized as a stumbling block to estimating the demand for money and for isolating the role of money in the inflation process (Gelb et al. 1980). Below we present evidence that the availability of alternative assets as a source of finance for the government and a store of value for agents has had important quantifiable effects on the demand for money and the relationships among government deficits, money growth, and inflation. Taking account of alternative assets allows one to explain much of the observed rise in monetary velocity (see Figure 1) and the puzzling fact that Brazil, unlike other high-deficit developing economies experiencing high inflation, shows money growth innovations *following* rather than preceding those in inflation (Hanson 1980).

We first develop a steady-state model of money-market equilibrium, which stresses the long-term connections between government financial policy, inflation, and real asset supplies and demands. This equilibrium model is nested within a short-term dynamic model allowing deviations from equilibrium in section 2. In estimating and testing the model we pay particular attention to problems of model specification commonly encountered in the estimation of money demand equations. We find that—contrary to the results of previous studies—Brazilian money demand appears responsive and stable. Section 3 turns to the issue of the connection between government deficits and inflation. There we argue that the peculiar pattern of intertemporal "cause and effect" between money and prices in Brazil is consistent with the predictions of section 1. Specifically, innovations in deficits can be seen as the "forcing process" to which other nominal variables respond.

1. ESTIMATING MONEY DEMAND

The estimation of money demand provides a short-term indicator of economic activity and a long-term guide to inflation targeting. In Brazil, selective government intervention in asset markets (e.g., interest rate ceilings, time-varying inflation indexation rules and treasury bill supply policy) along with high and changing rates of inflation make interest rates unappealing short-term indicators. Data on GNP is generally considered poor and is subject to extensive revisions. From the long-term perspective, the persistence of high and varying rates of inflation and the government's reliance on the inflation tax further motivate an interest in money demand, in order to connect long-term government policy with the time path of inflation.

Money demand estimation in the Brazilian context entails a unique set of potential advantages and pitfalls. The potential problems include an active and expanding market for repurchase agreements backed by treasury securities, the computerization of banking in the 1970s, and the existence of a black market for dollars. The latter provides a potential alternative to cruzeiro holdings, while the former two imply a change in transaction cost due to improvements in transaction technology and the available range of accessible alternative assets. Dornbusch et al. (1983) find that the dollar black market in Brazil appears to be unrelated to currency substitution. Below we report evidence consistent with this view.

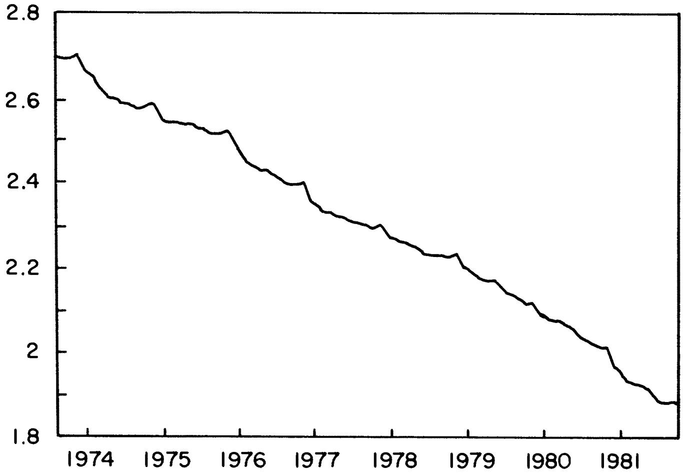

FIG. 1. Real Money Balances Measures the Log of the Ratio of Nominal Money to the Consumer Price Index (Sources are given in the Data Appendix.)

On the positive side, high and varying rates of inflation magnify incentives for active short-term portfolio adjustment, allowing identification of such adjustments on an empirical level. Moreover, Brazilian asset markets enjoy just the right degree of regulation, variety, and sophistication for the purposes of money demand estimation; moneyholders may choose to hold any of several alternative assets with observable rates of return which vary independently of one another mainly because of regulation.

The existing literature on money demand in Brazil bypasses some of these unique opportunities. Indeed, many studies ignore the existence of interest-bearing domestic assets in Brazil, and focus instead on the expected rate of inflation. Moreover, existing models have not emphasized the role of the treasury bill market in influencing money demand.[1]

Domestic assets in Brazil for the period 1972–1981 may be classified usefully by the determinants of their rates of return: cash and demand deposits that earn zero nominal interest, assets with pre-fixed interest whose principal receives a government-determined rate of indexation[2] (retirement accounts, government bonds, and passbook savings accounts), government treasury bills which also serve as backing for repurchase agreements, "bills of exchange" issued by finance companies which earn a market-determined rate of return,[3] and bank time deposits which earn pre-fixed, regulated rates of return.

[1]See Calomiris and Domowitz (1987) for a literature review.

[2]During our period almost all indexed assets received "monetary correction," while a few received the more generous "exchange correction." The indexation formulae are related to past inflation, but subject to frequent and drastic change. For example, a ceiling of 50 percent was placed on monetary correction for 1980, when the inflation rate was nearly twice that.

[3]Rates of return on bills of exchange were limited by regulation before 1975. We use the consumer credit rate in Rio de Janeiro as our measure of the return on bills of exchange. This allows us to capture nonpecuniary "convenience" services or other means by which competing financeiras transferred excess profits which came from interest rate ceilings.

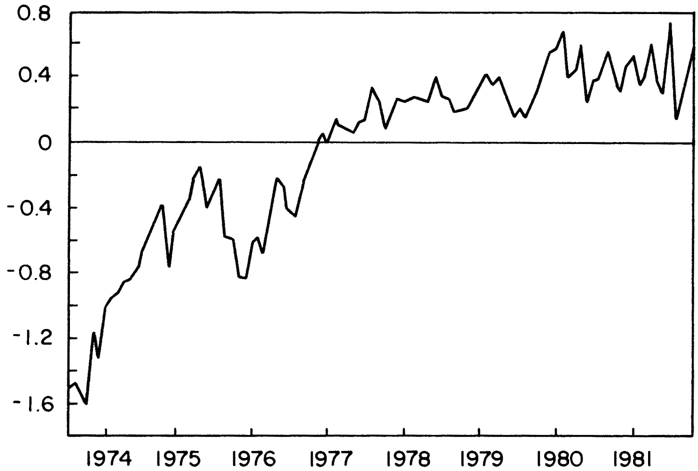

FIG. 2. T-bill Velocity Measures the Log of the Ratio of Total Transaction in the Secondary Market for T-bills to the Public's Holdings Stock of T-bills (Sources are given in the Data Appendix.)

We allow relative rates of return as well as income and transacting cost to enter the demand for zero-interest money:

$$(M/P)^d = \mu(i_1, i_2, i_3, \pi^e, Y, F) , \tag{1}$$

$$\mu_1, \mu_2, \mu_3, \mu_4 < 0, \mu_5, \mu_6 > 0 ,$$

where M denotes public holdings of cash and demand deposits, P the price level, i_1 the rate of indexation ("monetary correction"), i_2 the yield on bills of exchange, i_3 the yield on T-bills, π^e the expected rate of inflation, Y real income, and F the cost of transacting in financial markets.

Bank repurchase agreements act as a money substitute. The growth of transactions in the secondary market for treasury bills, and the rising transactions "velocity" of treasury bills (i.e., the ratio of secondary market transactions to existing T-bill stock) are evidence for the increasing use of T-bill repurchase agreements as a substitute for cash. Figure 2 shows that T-bill velocity increased tenfold from 1972 to 1981. Though repurchase agreements are not separable from other T-bill transactions, the increase in T-bill velocity at least in part reflects the increasing attractiveness of repurchase agreements. We employ T-bill velocity (V) as a proxy for the (negative of the) cost of transacting in these instruments. We write (1) as:

$$(M/P)^d = \tilde{\mu}(i_1, i_2, i_3, \pi^e, Y, V), \tilde{\mu}_6 < 0 . \tag{2}$$

Brazilian financial institutions allow some a priori identification of exogeneity and endogeneity of variables which enter money demand. The rate of indexation i_1 is pre-fixed, while the other variables are simultaneously determined with the supplies of money and other securities. The nominal supplies of money, treasury bills and bills of exchange, and the price level are not predetermined with respect to money demand but depend crucially on deficit policy and asset demands. The budget constraint of the government requires that nominal taxes (X) net of transfers (R) and expenditures (G) be financed by the net creation of government liabilities (D), which consist of nonmonetary liabilities of the monetary authority (NM), outside money (C), treasury bills (T), and indexed bonds (IB):

$$R + G - X = \Delta D = \Delta C + \Delta T + \Delta IB + \Delta NM\,. \tag{3}$$

The government divides exogenous real debt creation among treasury bills, treasury bonds, and liabilities of the monetary authority. Often liabilities of the monetary authority correspond directly to government loan items or pass-throughs (subsidies to commercial banks for particular loans). Some direct loans and pass-throughs are backed by bona fide loans, while others have been made with little expectation of repayment. Thus it is difficult to measure the implicit transfer accomplished through central bank programs. When the monetary authority creates liabilities through direct loans or loan pass-throughs to commercial banks, this does not determine the *composition* of monetary authority liabilities. The extent to which monetary authority liabilities take the form of outside money is determined by the relative demands for various types of depository and nondepository accounts by the public. The key exogenous variables set by the government, therefore, are the increase in total real debt and its composition among treasury bills, bonds, and other liabilities, *not* the supply of outside money. Total money demand, along with the money multiplier, determines the level of outside money.

Finally, expected inflation is determined simultaneously with equilibrium real balances and real government debt. In the steady state, given exogenous real debt creation, $\frac{\Delta D}{P} \equiv Z$, and the condition $\frac{\Delta D}{D} = \frac{\Delta P}{P}$, we have $\frac{D}{P} = \frac{Z}{\pi^e}$.

2. MODEL ESTIMATION AND TESTING

Based on the discussion in the previous section, we posit a long-term relationship for desired real money balances of the form

$$m^* = k + a_0 p + a_1 y + a_2 \pi^e + a_3 i_1 + a_4 i_2 + a_5 i_3 + a_6 v\,, \tag{4}$$

where all lowercase letters denote logarithms of variables; m^* is desired real balances; p is the price level; y is income; π^e is expected inflation; v is the logarithm of T-bill velocity, and i_1, i_2, i_3, are the logarithms of the interest rates described in the preceding section. The price level is included in order to test the zero-homogeneity assumption ($a_0 = 0$).

Based on (4), the error-correction rule for real balances is[4]

$$\Delta m_t = \beta_0 + \beta_1 \Delta p_t + \beta_2 \Delta \pi_t^e + \beta_3 \Delta i_{1,t} + \beta_4 \Delta i_{2,t} + \beta_5 \Delta i_{3,t} + \beta_6 \Delta v_t + \beta_7 (m - y)_{t-1} + \beta_8 \pi_{t-1}^e + \beta_9 i_{1,t-1} + \beta_{10} i_{2,t-1} + \beta_{11} i_{3,t-1} + \beta_{12} v_{t-1} + \epsilon_t \quad (5)$$

in which we have imposed long-term price homogeneity ($a_0 = 0$) and a long-term unit income elasticity ($a_1 = 1$). The validity of these restrictions is testable simply by adding the terms $\sigma_1 p_{t-1}$ and $\sigma_2 y_{t-1}$ to the right-hand side of (5) and testing the hypotheses $\sigma_1 = 0$ and $\sigma_2 = 0$.

Our data are monthly, extending from March 1972 to the end of 1981. A complete description of data sources is given in a Data Appendix, available from the authors. The choice of estimation period is dictated to some extent by our interest in the role of repurchase agreements in treasury bills. Prior to 1972 such repurchase agreements were not very common. In recent years the growth of repurchase agreements in government bonds as well as bills makes treasury bill velocity a less appealing proxy for repurchase agreements. It also is the case that measuring the rate of indexation has become more difficult due to the growth in the number of assets receiving "exchange" correction instead of "monetary" correction. We have been unable to gather the right kind of information to sort out the potential confusion over the types of corrections in the most recent time periods.

Estimates of the coefficients in the money-demand relation (5) are reported in Table 1. Instrumental variables estimation with respect to expected inflation is common to both sets of estimates reported.[5] Version II estimates, however, are corrected for the potential endogeneity of the yields on bills of exchange and T-bills and T-bill velocity, as suggested above.[6]

A series of diagnostic tests of model specification are given in Table 2. Tests of nonconstant residual variance are mixed. There is no evidence of dynamic ARCH effects (Engle 1982), but a White (1980) test for heteroskedasticity overwhelmingly rejects the null of constant variance. As a consequence, all standard errors in Table 1 are corrected for general forms of heteroskedasticity, in order to draw proper inferences. The heteroskedasticity-robust test of Domowitz and Hakkio (1985) fails to reject the null of no serial correlation in the regression errors, confirming the

[4]See Domowitz and Elbadawi (1987) and Domowitz and Hakkio (1986) for derivations based on single-period and expected multiperiod loss functions, respectively. The precise relationship between the long-term coefficients in (4) and the model coefficients in (5) is given in Calomiris and Domowitz (1987).

[5]All variables were subjected to twelfth-differencing prior to estimation in order to remove a strong stochastic seasonal. Seasonal dummies were not sufficient. The instrumental variables for expected inflation included lags of the inflation rate, of oil price inflation, of (black market) exchange rate depreciation, and of nominal T-bond growth, in addition to a quadratic time trend.

[6]These variables are instrumented using four lags each of i_2, i_3, and v, as well as four lags of the exchange rate depreciation and oil price inflation.

TABLE 1

MONEY DEMAND ESTIMATES

	I	II
constant	0.078 (0.048)	0.072 (0.050)
Δp	−0.159 (0.332)	−0.094 (0.368)
$\Delta \pi^e$	0.946 (0.374)	0.963 (0.426)
Δi_1	−0.034 (0.014)	−0.027 (0.017)
Δi_2	−0.067 (0.035)	−0.056 (0.087)
Δi_3	−0.048 (0.035)	0.039 (0.175)
ΔV	−0.012 (0.011)	0.016 (0.039)
$(m - y)_{-1}$	−0.130 (0.037)	−0.124 (0.037)
π^e_{-1}	−2.019 (0.597)	−2.116 (0.600)
$i_{1,-1}$	−0.007 (0.010)	−0.006 (0.009)
$i_{2,-1}$	−0.036 (0.033)	−0.028 (0.034)
$i_{3,-1}$	−0.034 (0.026)	−0.033 (0.027)
V_{-1}	−0.024 (0.012)	−0.018 (0.013)
R^2	0.463	0.391
SEE	0.026	0.027

NOTE: Dependent variable is the change in the log of real balances, with a standard deviation of 0.035. Estimates based on monthly data, from March 1972 through December 1981. Heteroskedasticity-robust standard errors are in parentheses. Version I estimates are obtained from ordinary least squares; Version II estimates are based on instrumental variables procedures.

TABLE 2

MODEL DIAGNOSTICS: MARGINAL SIGNIFICANCE LEVELS IN VERSIONS I AND II

	I	II
Heteroskedasticity (White)	0.003	0.001
Heteroskedasticity (ARCH)	0.84	0.80
Serial correlation	0.34	0.46
Hausman statistic	0.12	—
Chow statistic	0.45	0.56
Zero exchange rate effect	0.94	0.77
Price homogeneity	0.31	0.97
Unit income elasticity	0.22	0.96

appropriateness of the dynamic specification.[7] One cannot reject the stability of the model parameters at any reasonable level of statistical significance, based on a Chow (1960) test.

A Hausman (1978) statistic is used to examine the potential endogeneity of T-bill yield and velocity, as well as the yield on bills of exchange. The marginal significance level associated with a test of the equivalence of parameter estimates across versions I and II is 0.12, and we would fail to reject the exogeneity of these variables at the 10 percent significance level. A closer examination of the components of the statistic suggest that it is the exogeneity of the T-bill rate that may be questionable. T-bill velocity is clearly exogenous on statistical grounds.

The price homogeneity and long-term unit income elasticity restrictions cannot be rejected at reasonable levels of statistical significance. Point estimates of unconstrained income and price elasticities are 0.93 and 0.97, respectively, based on the version I results. Instrumental variables estimates are 0.90 and 0.95 for income and price effects. The point estimates suggest that any violation of the unit restrictions also is unimportant in economic, as well as statistical, terms. These results are quite similar to the income elasticities reported in Blejer (1978), Viñals and van Beek (1979), Cardoso (1983), and Khan (1979, 1980). Leiderman (1980) reports income elasticities twice as large.

We also impose a zero restriction with respect to the effect of exchange rates on the money demand function, as suggested by our analysis of target balances in section 1. Dornbusch et al. (1983) argue that foreign currency substitution is not an important element in money demand.[8] In order to test this hypothesis we add the rate of exchange rate depreciation as an opportunity cost to the set of interest rates in the model. As Table 2 shows, the hypothesis of zero explanatory contribution cannot be rejected. Point estimates of exchange rate effects are quite small in magnitude as well. Blejer (1978) found a large and significant effect of exchange rate depreciation in his study of Brazilian money demand. Blejer's use of annual data and his assumption of adaptive inflation expectations may explain the difference between his finding and ours. If currency depreciation predicts inflation (as our rational expectations forecasts of monthly inflation indicate it does), then by constraining annual expectations of inflation to depend only on the past rate of inflation, Blejer may have misinterpreted the indirect role of exchange rate depreciation (an inflation forecaster) as a direct currency-substitution effect.

The coefficients reported in Table 1 are not directly interpretable since they represent combinations of structural coefficients, including long-term elasticities and relative adjustment costs. We simply note that the estimated coefficients are of the expected sign, with the exception of those on the change in the T-bill rate and the change in T-bill velocity in version II, which are estimated with standard errors

[7]Standard Lagrange multiplier tests for serial correlation resulted in even higher marginal significance levels. All other statistics reported subsequently have been corrected for non-constant error variances.

[8]Empirical evidence on this point is given in Domowitz and Hakkio (1986) for industrialized countries and in Domowitz and Elbadawi (1987) for a country with relatively crude financial markets. These references all support the view that foreign currency substitution is not important for modeling domestic money demand.

TABLE 3

LONG-TERM COEFFICIENTS IN REAL MONEY-DEMAND EQUATION, AND MEAN AND MEDIAN ADJUSTMENT LAGS

Version	Variable	Long-Term Coefficient	Mean Adj. Lag	Median Adj. Lag
I	Industrial Production Index (Y)	1[a]	8.5 months	2.8 months
II	Industrial Production Index	1[a]	8.8 months	2.7 months
I	Expected Monthly Inflation (π^e)	−0.155 (0.037)	7.1 months	2.7 months
II	Expected Monthly Inflation	−0.171 (0.040)	7.5 months	2.7 months
I	Monthly Rate of Indexation (i_1)	−0.054 (0.072)	1.9 months	1.4 months
II	Monthly Rate of Indexation	−0.048 (0.066)	2.2 months	1.5 months
I	Monthly Bill of Exchange Rate (i_2)	−0.277 (0.270)	4.8 months	2.3 months
II	Monthly Bill of Exchange Rate (Instrumented)	−0.226 (0.302)	5.1 months	2.3 months
I	Annual T-Bill Yield (i_3)	−0.262 (0.153)	5.3 months	2.4 months
II	Annual T-Bill Yield (Instrumented)	−0.266 (0.160)	8.2 months	2.8 months
I	T-Bill Velocity (v)	−0.185 (0.078)	7.2 months	2.7 months
II	T-Bill Velocity (Instrumented)	−0.145 (0.094)	8.0 months	2.8 months

NOTE: All variables are expressed in logarithms, except expected inflation.

[a] Coefficients are restricted to be unity. Unrestricted estimates were 0.93 and 0.90, insignificantly different from unity at the 10 percent significance level.

exceeding the coefficients. A detailed derivation of the long-term elasticities—the coefficients in equation (4)—and the mean and median adjustment lags for disturbances to each of the arguments in equation (4) is given in Calomiris and Domowitz (1987). These are reported in Table 3.

Our long-term elasticities with respect to expected inflation are smaller than many of those reported in other studies. For example, Blejer (1978) reports a long-term coefficient of −0.35, compared to our estimates of −0.16 and −0.17. This may be due to the inclusion of asset yields and the use of forecasted inflation rather than lagged or actual inflation.

With respect to the dynamics, previous studies' mean and median adjustment lags have been large relative to those reported in Table 3. This is because estimates of speeds of adjustment historically have been based on partial adjustment models (see Hendry 1980 for discussion). In contrast, mean lag estimates here are quite low, with adjustment lags ranging from 8.5 months for an income shock to 2 months for a shock to the rate of indexation. The lag distribution is skewed, however, and median lags are much shorter. Fifty percent of the adjustment to an income shock takes place within less than 3 months, for example.

3. EVIDENCE OF THE ENDOGENEITY OF NOMINAL VARIABLES TO DEFICITS

Previous studies of the relationship between money and inflation (e.g., Hanson 1980) document a unique feature of the Brazilian economy. Changes in money do not predict changes in the price level, but changes in the price level do predict changes in money. This finding and the large increases in the growth rate of prices relative to money (rising velocity) have led the Brazilian authorities to claim that "cost-push" influences (like the oil price rises of the 1970s) have been the source of high Brazilian inflation.

Our model is consistent with a lagging response of nominal balances to changes in prices, and the rising velocity of money, but our interpretation of the source of Brazilian inflation is very different from the cost-push view. Nominal money in Brazil is endogenous to real asset demands and nominal government deficits. Real money demand has been stable and responsive. Rising deficits are mainly to blame for secular rises in money, interest rates, prices, and exchange rates; thus money should not predict or cause changes in other nominal variables, as it would if the money stock were supply-determined.

In Table 4 we report the results of a VAR (Vector Autoregressive) model for Brazil, which includes money, prices, the bill-of-exchange rate, the industrial production index, and public holdings of T-bills and indexed bonds. Innovations in nominal government debt aggregates serve as proxies for innovations in government deficits.

The exogenous variables are time, time squared, eleven monthly dummy variables, a constant term, and lagged oil prices. All others are lagged endogenous variables. Five-month lag structures were used in the estimations. Treasury bills,

TABLE 4
VAR RESULTS

	F-Tests for Inclusion of Lags Dependent Variables:						
Lagged Values of:	T	IB	E	i_2	Y	P	M
T	0.00	0.90	0.85	0.09	0.33	0.48	0.21
IB	0.24	0.00	0.01	0.35	0.29	0.05	0.00
E	0.96	0.89	0.01	0.54	0.76	0.10	0.01
i_2	0.52	0.21	0.25	0.01	0.99	0.71	0.00
Y	0.42	0.90	0.21	0.87	0.03	0.04	0.06
P	0.44	0.55	0.28	0.04	0.76	0.00	0.01
M	0.11	0.50	0.38	0.08	0.51	0.47	0.00
	Forecast Variance Decomposition (20-month horizon):						
Forecast Variance of:	T	IB	E	i_2	Y	P	M
T	36.4	10.5	17.6	12.4	3.8	7.2	12.1
IB	3.5	53.9	19.7	5.4	6.1	5.3	6.2
E	2.1	55.4	29.0	1.9	3.6	6.6	1.5
i_2	6.1	14.5	11.0	41.2	5.6	10.8	10.8
Y	12.4	10.4	16.3	6.1	44.0	5.0	5.9
P	2.0	35.2	10.4	9.7	7.5	27.1	8.0
M	17.5	18.5	6.3	25.3	16.1	3.1	13.3

NOTE: Variables are as defined in the text. All variables except i_2 are expressed in logarithms. Five monthly lags of each endogenous variables are included in the estimation equations, as well as five lags of oil prices, monthly dummies and a quadratic time trend.

which play an important role in repurchase agreements, are separated from treasury bonds. All variables except the bill-of-exchange rate are in log levels. Table 4 gives an account of the avenues of prediction in the model. We find that money does not predict prices, while bonds are one of the strongest predictors of prices. The bond supply is also a significant predictor of the money supply and the exchange rate. At the same time, no other variable is important in predicting bonds.

One way to measure the importance of the effects of each variable in the system on every other variable is the decomposition of forecast variance. This describes the percentage of a variable's forecast variance, over increasing time horizons, that can be attributed to innovations from each variable in the system. In order to run simulations of the system's responses to shocks and derive forecast-variance decompositions, it is necessary to order contemporaneous shocks when orthogonalizing the system. We order the variables from most "exogenous" to most "endogenous" as follows: T, IB, E, i_2, Y, P, M.[9] E is the black-market exchange rate.

Table 4 illustrates the importance of public debt for E, i_2, P, and M. Shocks to bonds produce positive responses to all nominal variables. Bond innovations account for 35 percent of the long-term (20 month) forecast variance of the price level and 55 percent of the exchange rate, while money innovations account for 1.5 percent and 8 percent of the respective forecast variances of the exchange rate and price level.

It is interesting to note that price innovations are neither statistically significant nor economically important in accounting for changes in bonds. This may seem surprising, given that bonds are indexed partially to inflation. This result reflects the fact that past levels of bonds incorporate previous indexation adjustments. The importance of exchange rate innovations for bonds and the price level reflects expectations of inflation, and consequently, indexation.

These results are consistent with our model in which government deficit policies and real asset demand functions together determine nominal money balances, which adjust with a lag to innovations in deficits, interest rates and inflation.

The central role of deficits in generating inflation may help explain the recent collapse of the "Cruzado Plan." In the absence of consistent reductions in the deficit "forcing process," price controls alone will not be successful for reducing inflation in the long term. Only if government spending is reduced and direct taxation is increased will Brazil be able to stem its inflationary tide.

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[9]The results are quite robust to variations in the ordering. In particular, when money was switched from last to first, the only important difference in the simulation results was the percentage of each other's forecast variance which M and i_2 impulses explain.

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