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FEDERAL DOMESTIC DEBT IN BRAZIL: 1981-1996

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CENTRO DE DESENVOLVIMENTO E PLANEJAMENTO REGIONAL

FEDERAL DOMESTIC DEBT IN BRAZIL: 1981-1996

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SUMÁRIO

ABSTRACT

This paper investigates how the Brazilian federal domestic debt responded to innovations in fiscal and financial components of the government's budget constraint. Using monthly data from 1981:01 to 1996:12, a parsimonious model is selected to describe the federal domestic debt and a vector autoreregression system (VAR) is estimated to investigate the relationship between the debt and the other variables in the budget constraint. The results indicate that the financial components of the budget (real interest rate and inflation) are relatively more important than the fiscal ones (government expenditures and tax revenues) in contributing to the federal domestic debt dynamics.

JEL classification:
Keywords: Domestic debt; Fiscal consolidation; Brazil

1. INTRODUCTION

This paper investigates how the Brazilian federal domestic debt responded to innovations in the fiscal and financial components of the government budget constraint, particularly the real interest rate and inflation, and government expenditures and tax revenue.

The Brazilian federal debt as a ratio to GDP assumed an unprecedented upward trend after 1981, as borrowing from the international financial markets became increasingly more difficult and the government was unable to control its finances. The central government's borrowing requirements increased from 4.8% of GDP in 1983 to 12.5% in 1985, 26.6% in 1988, and 49.3% in 1989. Inflation rates also soared during this period with the annual rate ranging from 110% in 1981 to 2740% in 1990.

The pattern of budget deficits raised the issue of whether the federal domestic debt was heading to an unsustainable path (Uctum and Wickens, 1996). A debt is considered sustainable if its appropriately discounted value is backed by primary surpluses of equal present-value (Hamilton and Flavin, 1986; Bohn, 1991; Trehan and Walsh, 1991).

Tests of the intertemporal balance of the federal fiscal policy have indicated that the federal domestic debt assumed an unsustainable path after 1981 (Tanner, 1995; Luporini, 1997).

In order to devise a policy designated to bring the federal domestic debt to a path of growth consistent with price stabilization, it is important to know how the debt responded to innovations in the other variables in the government's budget constraint. In section II, I present the government budget constraint and discuss its intertemporal balance. The dynamic responses of the federal domestic debt are analyzed in sections III and IV. Section III uses time series analysis to investigate the importance of an innovation to the debt and its persistence. Finally, section IV defines a vector autoregression representation (VAR) of the variables in the government budget constraint, and analyses the dynamic responses of the debt to innovations in fiscal and financial variables. The results indicate that the response of the federal domestic debt to the fiscal components of the government budget constraint (government expenditures and tax revenues) was rather weak while the response to financial components (real interest rate and inflation) was strong.

2. THE GOVERNMENT BUDGET CONSTRAINT

The budget constraint for the government expressed in nominal terms can be written as:

$$B_t - B_{t-1} + M_t - M_{t-1} = G_t - T_t + i_{t-1}B_{t-1} \qquad (1)$$

where B is the par value of the stock of domestic government debt held by the public; M is the money stock; i is the *ex post* nominal interest rate, interpreted as the holding-period return on the stock of debt outstanding; G and T are government expenditures and revenues respectively.

The government has two ways of financing its deficit. It may borrow from the public by issuing bonds or it may use its monopoly over the country's currency and issue money. Although concerns about price stability leads to a general resistance to financing expenditures through money creation, countries which do not have an independent central bank have exercised it at various degrees. Particularly at times of high deficits and increasing debt accumulation, the government has an incentive to make use of seignorage, not only to improve its revenue collection, but also to induce a reduction of the real value of its debt[(1)]. Seignorage equals the inflation tax proceeds plus the change in the economy's real money holdings. It represents real revenue, which the government acquires by using newly issued money to buy goods and nonmoney assets.

The government budget constraint in constant dollars and in ratios to GDP can be expressed as:

$$b_t - b_{t-1} + m_t - m_{t-1} = -s_t + (r_{t-1} - g_{t-1})b_{t-1} - (\pi_{t-1} + g_{t-1})m_{t-1} \quad (2)$$

where $\pi \equiv \frac{dP}{P}$ denotes the inflation rate, $r \equiv i - \pi$ denotes the real rate of interest, and η denotes the rate of income growth.

Rearrange (2) to obtain:

$$b_t - b_{t-1} + m_t - m_{t-1} = -s_t + (r_{t-1} - g_{t-1})b_{t-1} - (\pi_{t-1} + g_{t-1})m_{t-1} \quad (3)$$

Let $-\bar{s}_t = -s_t - (m_t - m_{t-1}) - (\pi_{t-1} - g_{t-1})m_{t-1}$ be the negative of the budget surplus inclusive of seignorage collection and define $\alpha_t \equiv (r_t - g_t)$ to rewrite equation (3) and obtain:

$$b_t = -\bar{s}_t + (1 + \alpha_{t-1})b_{t-1} \quad (4)$$

Define $Q_t = \prod_{j=0}^{N-1}(1 + \alpha_j)^{-1}$; $Q_0 = 1$. Multiplying equation (4) through by Q_t gives[(2)]:

$$Q_t b_t = Q_{t-1} b_{t-1} - Q_t \bar{s}_t \quad (5)$$

Rewrite (5) and obtain the market value of the domestic debt held by the public discounted back to period zero:

$$B_t = B_{t-1} - \bar{S}_t \quad (6)$$

where $B_t \equiv Q_t b_t$ and $\bar{S}_t \equiv Q_t \bar{s}_t$.

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1 For a discussion of the credibility issue and debt repudiation, open or through inflation, see Calvo (1988).

2 Wilcox (1989) first used the discount factor.

Applying recursive forward substitution, taking expectation as of time t, and applying the limit as N goes to infinite yields equation (7):

$$B_t = \lim_{t\to\infty} E_t B_{t+N} + E_t \sum_{j=1}^{N} \overline{S}_{t+j} \qquad (7)$$

The government's budget is balanced in expected present-value terms when its debt can be offset by the sum of expected future discounted primary surpluses. According to equation (7), this is the case when $\lim_{N\to\infty} B_{t+n} = 0$. If $\lim_{N\to\infty} B_{t+n} < 0$, the expected discounted future primary surpluses exceed the present value of the government's debt by an amount that does not converge to zero[(3)]. The government is accumulating revenues that could be translated into higher disposable income for households and, therefore, increased consumption level at all periods[(4)]. In the opposite case, $\lim_{N\to\infty} B_{t+n} > 0$, the present-value of the government's debt exceeds expected primary surpluses. This implies that the government is continually borrowing to meet interest payments on its debt, which will grow, *ceteris paribus*, at the rate of interest. But such a Ponzi scheme violates one of the household's optimality condition, since it amounts to providing the government with "free" resources. When $\lim_{N\to\infty} B_{t+n} = 0$ the government is asymptotically using the resources allowed by its budget constraint, no more and no less.

3. ECONOMETRIC ANALYSIS OF THE PERSISTENCE OF BRAZILIAN FEDERAL DOMESTIC DEBT

The federal domestic debt assumed an unsustainable path in 1981 in the sense that it has not been backed by expected primary surpluses of equal present-value (Tanner, 1995; Luporini, 1997). Therefore, the government has been rolling it over by issuing new securities to meet interest payments on previous borrowings and in this case, an unsustainable fiscal policy can be interpreted through the persistence of the debt.

From an econometric point of view, sustainability is translated into whether or not the series has a unit root. Since the federal domestic debt has assumed an unsustainable path after 1981, a positive shock to the debt has a permanent effect on its level, and the effect of the shock *h* months later is the sum of all previous changes. The presence of a unit root, however, can be consistent with high and low shock persistence. This section uses time series analysis to investigate the importance of an innovation to the debt and its persistence.

[3] In the case of equation (7), the government budget surplus includes seignorage revenue.

[4] Alternatively, the government could improve social welfare by increasing spending in public goods.

3.1. Data Set

The data set was obtained from the Brazilian Central Bank and consists of monthly observations over the period 1981:01 to 1996:12. Monthly observations can provide a more accurate description of the short-run dynamics of the federal domestic debt. Government debt at par value is the series 'Federal Domestic Debt held by the Public' (*Dívida mobiliária interna federal fora do Banco Central)*. The interest rate is the *overnight* rate, which is a weighted average based on the interest rates accorded between buyers and sellers (the Central Bank as the Treasury's agent) during a trading day. The daily average rate weighted by the volume of each day's operation is then used to calculate monthly rates.

Revenue is the series 'Total Treasury Revenue' (*Receita total do Tesouro Nacional*) and Expenditures is the series 'Total Treasury Expenditures' (*Despesa total do Tesouro Nacional*), which includes interest payments on the government debt. Data for government expenditures net of interest payments is, unfortunately, only available after January 1986 and not all the values obtained from the Central Bank are in accordance with the 'Treasury Secretariat' (*Secretaria do Tesouro Nacional*).

Monthly values for the GDP are not available, so economic activity was proxied by the 'Industrial Production Index' (1981=100), published by *Conjuntura Econômica*. Seignorage was calculated from high powered money data published by the Central Bank.

Finally, nominal variables (except interest and inflation rates) were converted into Millions of Cruzeiros Reais and divided by the *General Price Index* (IGP), internal supply, scaled so that 1989:12 price index equals 100. The real interest rate was calculated as $r = \frac{(1+i)}{(1+\pi)} - 1$, which is equivalent to the standard $r = i - \pi$ when the inflation rate is low. In a high inflation economy, however, the standard calculation causes distortions in the real rate of interest. Given the high inflation rates experienced by the country during the period analyzed here, I opted for the former definition.

3.2. Debt Persistence

The first step to analyze the persistence of the federal domestic debt is to find the order of integration (or the degree of differencing) of the debt series, so that it can be modeled as a stationary ARMA process. The Augmented Dickey-Fuller tests for the presence of a unit root on the first and second differences of the debt were performed. The log of the series is used in this section to facilitate the interpretation of the response function values. The results in Tables 1-3 show that first differencing the *log*(debt) yields a stationary series.

Having determined the order of integration, the number of autoregressive (*p*) and moving average polynomials (*q*) must be specified for the ARMA(*p,q*) estimation. The Box-Jenkins approach consists of matching the patterns of the sample autocorrelations and partial autocorrelations with the theoretical patterns of known models.

The senoid wave pattern of the sample autocorrelation (not reported) suggests an AR(*2*) representation; the partial autocorrelation can be viewed as dying out after one lag, consistent with an MA(*1*) representation. Hence, an initial guess for a parsimonious model might be that the debt, after appropriate differencing, is an ARMA(2*,1*).

Several models are estimated and the coefficients are reported in Table 4. Although the estimated ARMA(1,1) model has significant coefficients, overall, the ARMA(2,1) seems to perform better, both in terms of the Akaike criterion (-4.20 against –4.22) and in terms of the Q-statistic at the 12 lag (6.38 against 7.53).

Given the estimated coefficients, it is possible to show the impact of an innovation to the debt *h* months after the shock through impulse response functions. Table 5 shows the results.

The impulse response functions assume values above one for the models ARMA(1,1), ARMA(1,2) and ARMA(1,3) and are not reported in Table 5.(5) Assuming that the estimated ARMA(2,1) model best fits the data, the results in Table 5 indicate that, after 12 months, one can expect the change in the debt to increase an average of 6 percent following a 1% increase in its original level. This result illustrates the degree of innovation persistence and suggests the presence of a considerable inertial component in the debt dynamics.

Given the unsustainable path assumed by the federal domestic debt since 1981, the presence of the inertial component further limits the monetary authority's ability to implement a tight monetary policy and control inflation.

4. DYNAMIC RESPONSES OF THE GOVERNMENT BUDGET CONSTRAINT

In order to devise a policy designated to bring the federal domestic debt to a path of growth consistent with price stabilization, it is important to know how the debt responded to innovations in the other variables in the government's budget constraint.

By defining a vector autoregression representation (VAR) of the variables in the government budget constraint, this section analysis the dynamic responses of the debt and relate them to other variables. The vector autoregression representation allows us to describe a system of equations where all the variables are interdependent, making the approach appropriate for the analysis of the government budget constraint.

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[5] The response functions for models ARMA(3,2) and ARMA(3,3) oscillate in sign ($-1 < \phi_1 < 0$) and do not stabilize after 30 months.

4.1. Preliminary Stationarity Tests

The use of a vector autoregression system (VAR) requires that the variables involved be covariance-stationary (or weakly stationary) so that the parameters can be consistently estimated.(6) The Augmented Dickey-Fuller test (ADF) and the test developed by Phillips and Perron (1988), both for levels and first differences of the variables, were performed for different truncation lags. The Phillips-Perron (PP) test corrects the statistics for serially correlated and possibly heteroskedastic error terms.

Although graphical analysis of the series indicate that most of them seem to vary around a fixed mean, and therefore the stationarity tests should not include a trend term, unit root tests were performed with and without the inclusion of a trend and intercept terms, beginning with the least restrictive model, i.e., with an intercept and trend terms. Tables 1-3 report the results.

Unit root tests have low power to reject the null hypothesis of a unit root; thus, if the null is rejected under a model with an intercept (drift) and time trend, there is no need to proceed testing more restrictive models, and one can conclude that the series does not have a unit root. According to Table 1, the ADF tests in levels fail to accept the null hypothesis for expenditures (*G*), tax revenue (*R*), seignorage (*S*), and the real interest rate (*Int*), indicating that the series are in fact level stationary. The correlogram of *Expenditures, Revenue* and *Seignorage* (not reported) seems to indicate some degree of serial correlation in the residuals. Thus, the Phillips-Perron test was used to test for the presence of a unit root. The test statistics rise dramatically when corrected for serially correlated and possibly heteroskedastic error terms and the null of a unit root is strongly reject. Thus, levels of expenditures, tax revenue, seignorage and interest rate will enter the vector autoregression estimations.

The results presented in Table 1 indicate, moreover, that the null hypothesis of a unit root can not be rejected at the 1% confidence interval for either the debt (*B*) or the inflation (π) series in levels. Since the null was not rejected, it is necessary to test for the significance of the trend term under the presence of a unit root in order to determine whether too many deterministic terms were wrongly included in the first model. The *t* statistics for the trend coefficient of the debt and inflation series are 1.65 and 1.47, respectively. When compared to the Dickey-Fuller critical value of 3.53 (1% level), the *t* values indicate that the trend terms are not significantly different from zero and the unit root tests should be carried out without them.

The models were reestimated without the deterministic trend and the null of a unit root was tested again. The results are presented in Table 2. Once more the ADF and PP tests indicate the presence of a unit root in the level of the debt and inflation series. We should thus proceed to test whether, under the null, the presence of the intercept is appropriate in the model. The *t* statistics for the constant terms are 2.30 for the debt series and 2.08 for the inflation series. The Dickey-Fuller critical value for the case in hand (3.22 at the 1% level) indicate that the constant terms are not significant and the unit root tests should be applied to a model with no trend or intercept. Table 3 presents the results.

6 A process Y_t is said to is covariance-stationary if neither its mean nor the covariances depend on the date t.

The Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests show that the debt (*B*) and inflation (π) series contain a unit root at the 1% confidence interval for all truncation levels reported and are, therefore, nonstationary in levels. As the results indicate, both series become stationary after first difference.

4.2. Dynamic Responses

As determined by the stationarity tests, the VAR was estimated with the following variables: seignorage (level), inflation rate (first difference), real interest rate (level), tax revenue (level), government expenditures (level), and debt (first difference). A likelihood ratio test (LR) suggested by Sims (1980) was used to determine the VAR lag length. The LR statistic of 82.62 for a two-lag against a four-lag VAR was smaller than the critical value for a $\chi^2(4)$ variable (after small-sample bias is taken into account). The null hypothesis that a two-lag VAR can adequately capture the dynamics of the system can not be rejected at the 5% confidence interval.

Although Box-Jenkins approach recommends the use of seasonal autoregressive and moving average terms for monthly data, the variables used in the VAR do not exhibit any systematic seasonal movements and, therefore, seasonal autoregressive terms were not included in the estimations.

The estimated coefficients of the VAR are difficult to interpret and the results can be better summarized by the impulse response functions and variance decomposition of the error-covariance matrix.

The impulse response functions trace the responses of an endogenous variable to a change (one standard deviation) in one of the innovations in the variables of the VAR. Cholesky decomposition was used to orthogonalize the error terms so that the covariance matrix of the resulting innovations is diagonal and the impulse response functions can be interpreted. The ordering of the variables, however, can substantially alter the response functions and therefore should be decided with care. The ordering used here implies the following assumptions:

a) current values of inflation, real interest rate, revenue, expenditures and debt do not influence seignorage;

b) current values of seignorage, but not of real interest rate, revenue, expenditures or debt, influence the inflation rate;

c) current values of seignorage and inflation, but not revenue, expenditures or debt, influence the real interest rate;

d) current values of seignorage, inflation and interest rate, but not of expenditures or debt, influence revenues.

The first and third assumptions are the least palatable of the four: current levels of inflation will not affect seignorage and current levels of the debt will not affect the interest rate. One may think of changes in the inflation rate influencing the level of seignorage collection only with a lag, so that their current values should not be included in the regression. The same case can be argued for current levels of debt not affecting the real interest rate. Other orderings resulted in stronger, if not unusual, assumptions.

Table 6 indicates the dynamic responses of the debt to the other variables in the government budget constraint. The results illustrate the relative unimportance of shocks to government expenditures and tax revenue in explaining responses of the debt. Instead, a shock to the interest rate is the most important factor explaining the debt response, besides an innovation to the debt itself.

The debt immediate response to an interest rate shock is positive, declining in intensity and being absorbed in approximately six months. The debt response to its own innovation is also positive, and follows the same pattern of the response to the interest rate shock, although with a lag. This is an indication of the feeding mechanism through which changes in the interest rate affect debt issuing: a shock in the interest rate causes a shock in the debt, which induces a positive response in the debt itself.

The debt's initial response to an inflation shock is negative and its effect is completed after six months. As expected, inflation affects the debt by reducing the real value of government's outstanding liabilities. Most of Brazilian debt is price-indexed, however, and the real value of government's outstanding securities should not respond to an innovation in inflation. Although the shock was unexpected, during the period of higher inflation variance, the indexation factor applied to government securities was adjusted daily. The negative response of the debt to an inflation shock can be better explained by the inefficacy of the indexation factor in protecting the real value of the outstanding debt.[7]

The debt responses to a revenue and expenditure shock are equivalent in size, in opposite directions, but very small: the debt responds positively to a revenue shock and negatively to an expenditure shock. As expected, a shock to seignorage affects the debt negatively as an increase in seignorage reduces the government needs to borrow. But this response is also small. In fact, in spite of the high inflation rates experienced by the country, seignorage collection in Brazil is relatively small when compared to other high-inflation countries.[8] There are two main reasons for this result. First, the existence of the 'overnight' market guaranteed high degrees of liquidity for investors, who could switch between indexed securities (formally indexed or floating-rate) and cash, and therefore steer clear from the effects of inflation on their cash balances. The resulting increase in money velocity reduces the demand for real balances eroding the base for the inflation tax.

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[7] Tanner (1995) shows that the indexation factor was used by the Brazilian government as a fiscal policy instrument, with periods of increased government expenditures being followed by reductions in real indexation.

[8] The average seignorage collection in the 1980s was less than 4 percent of the Brazilian GDP, compared to 6.5 percent in Argentina and 10 percent in Chile (Thurston, 1997).

Second, banks were allowed to meet reserve requirements against deposits through the holdings of indexed government securities. As a result, this other source of seignorage was also unavailable for the Brazilian government.

In sum, the debt responses to innovations in other variables in the government's budget constraint have indicated that: (i) shocks to government revenue and expenditure are relatively unimportant; (ii) the debt's initial response to a change in inflation is negative; (iii) the debt's response to seignorage is also negative; and (iv) a shock to the interest rate is the most important factor affecting the response of the debt.

Table 7 indicates the responses of the other variables in the government constraint to an innovation in the debt.

Debt shocks induce a slight negative response of the interest rate that is fully completed after seven months.

Inflation responds positively to a debt shock. The response is powerful and takes about ten months to be fully absorbed. This effect might come as a surprise since one would expect that a shock to the debt should induce a negative response on inflation through its effect on the money supply. During the 1980s, the prices that government securities were able to command in the market were falling. Prices were falling and security yields were on the rise, and several times the Central Bank had to cancel auctions. The existence of the so-called *repurchase agreements* and the Central Bank's policy of keeping a stable demand for government securities by pegging the interest rate, however, implied that an unexpected increase in the debt was translated into increases in the money supply sooner or later.[9]

Debt shocks have a small but negative impact on government expenditures during the second quarter following the shock. The effects on revenue are also slightly negative, but negligible. Finally, a debt innovation does not seem to affect seignorage.

In sum, the responses of the other variables in the government constraint have indicated that: (i) debt shocks have a small but negative impact on government expenditures during the second quarter following the shock; the effect on revenue is also slightly negative, but negligible; (ii) debt shocks induce a slight negative response of the interest rate, completed after 7 months; (iii) debt shocks do not seem to affect seignorage; and (iv) the response of inflation is positive.

The variance decomposition of a VAR gives the relative contribution of an innovation to the mean-squared error of the forecasted variable *h* periods ahead.

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[9] The *repurchase agreements* were repurchase letters issued by the central bank along with Treasury's securities. In Brazil, the central bank is the agent responsible for placing the Treasury's securities in the primary market. The repurchase letters insured financial institutions holding Treasury's debt that the central bank was standing ready to reacquire the securities in the secondary market at the daily average interest rate. As a result, in periods of instability, the central bank would loose control over the money supply, which would then be determined by the demand for real balances.

Table 8 shows that after 24 months, 37.95% of the forecast error variance of debt is accounted for by its own innovations, 40.58% by innovations in the interest rate, 13.11% by innovations in the change of the inflation rate, and 7.40% by innovations in seignorage. Innovations in expenditures and revenue account for only 0.59% and 0.37% of the forecast error variance of the debt, respectively.

The importance of an innovation in the debt to the forecast error variance of seignorage is small and stable, ranging from 2.11% to 2.21% after the first quarter. But in addition to seignorage's own innovation, the debt is the most important variable, followed by the interest rate.

After 24 months, 9.02% of the forecast error variance of inflation is accounted for by innovations in the debt. Innovations in the real interest rate account for 55.13% of the forecast error variance in the change of the inflation rate, a percentage higher than that accounted for inflation's own innovation.

An innovation to the debt has a small feedback effect on the real rate of interest (0.75%), revenue (1.08%) or government expenditures (4.03%).

Although an innovation to the debt accounts very little to the forecast error variance of the real interest rate, an innovation to the real interest rate accounts for 40.58% of the debt's forecast error variance, a percentage higher than the debt's own innovation (37.95%). This high relative importance of innovations in the real interest rate combined with the low relative importance of innovations in expenditures and revenue corroborate the idea of a self-feeding mechanism whereby the government borrows, meets interest payments by borrowing more, and keeps rolling its debt over.

5. CONCLUDING REMARKS

This paper has provided evidence on the dynamic responses of the federal domestic debt to innovations in fiscal and financial variables of the government budget constraint. As shown in section II, after 12 months, one can expect the change in the debt to increase an average of 6 percent following a 1% increase in its original level, illustrating the degree of innovation persistence and suggesting the presence of a considerable inertial component in the debt dynamics.

The multivariate analysis carried out in section III showed the relative unimportance of shocks to government expenditures and tax revenue in explaining the responses of the debt. Instead, a shock to the interest rate is the most important factor explaining the debt's response, besides an innovation to the debt itself.

The findings of this paper pose questions about the government's real ability to use the interest rate as its main instrument for inflation targeting. The relative importance of interest rates movements to the debt dynamics along with its inertial component hamper the monetary authority's ability to implement a tight monetary policy and thus control inflation. Even though the stabilization plan implemented in 1994 has succeeded in reducing the inflation rate to historically low levels, the need to restructure Brazil's unsustainable domestic debt still remains and must be an essential part of any serious and consistent fiscal reform.

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TABLES

TABLE 1

Unit Root Tests: Intercept and trend

Variable	ADF(2)	ADF(4)	ADF(8)	PP(2)	PP(4)	PP(8)
G	-8.371	-4.932	-2.772	-19.058	-18.169	-17.905
ΔG	-16.368	-12.205	-7.476	-	-	-
R	-10.642	-6.862	-3.855	-27.468	-24.951	-23.881
ΔR	-16.940	-12.667	-8.309	-	-	-
Int	-8.566	-6.910	-4.952	-11.821	-11.667	-11.709
ΔInt	-12.892	-10.483	-7.978	-	-	-
S	-6.494	-5.188	-3.718	-14.448	-14.625	-14.747
ΔS	-14.251	-10.875	-6.066	-	-	-
B	-2.547	-2.274	-2.454	-2.698	-2.626	-2.769
ΔB	-8.093	-5.709	-4.386	-15.859	-15.872	-15.914
$\Delta(log\text{B})$	-6.839	-4.962	-3.485	-13.495	-13.639	-14.396
π	-3.803	-2.971	-2.707	-3.908	-3.348	-3.600
$\Delta\pi$	-9.699	-7.604	-5.861	-13.509	-14.538	-15.187

ADF(*d*): Augmented Dickey-Fuller Test, null of unit root, lag truncation *d*
PP(*d*): Phillips-Perron Test, null of unit root, lag truncation *d*
McKinnon critical values 1%, 5% and 10% confidence interval: -4.01, -3.43, -3.14 .

TABLE 2

Unit Root Tests: Intercept

Variable	ADF(2)	ADF(4)	ADF(8)	PP(2)	PP(4)	PP(8)
G	-8.381	-4.936	-2.818	-19.093	-18.201	-17.935
ΔG	-16.404	-12.210	-7.410	-	-	-
R	-10.405	-6.569	-3.488	-26.431	-23.951	-22.775
ΔR	-16.981	-12.683	-8.252	-	-	-
Int	-8.412	-6.173	-4.700	-11.716	-11.536	-11.533
ΔInt	-12.927	-10.512	-8.003	-	-	-
S	-6.375	-5.065	-3.562	-14.355	-14.593	-14.783
ΔS	-14.289	-10.902	-6.089	-	-	-
B	-2.209	-1.936	-2.095	-2.342	-2.253	-2.373
ΔB	-8.102	-5.709	-4.364	-15.888	-15.902	-15.939
$\Delta(log\text{B})$	-6.851	-4.969	-3.478	-13.527	-13.669	-14.424
π	-3.798	-3.017	-2.790	-3.895	-3.353	-3.589
$\Delta\pi$	-9.705	-7.593	-5.821	-13.536	-14.538	-15.100

ADF(*d*): Augmented Dickey-Fuller Test, null of unit root, lag truncation *d*
PP(*d*): Phillips-Perron Test, null of unit root, lag truncation *d*
McKinnon critical values 1%, 5% and 10% confidence interval: -3.47, -2.88, -2.57.

TABLE 3

Unit Root Tests: No trend or intercept

Variable	ADF(2)	ADF(4)	ADF(8)	PP(2)	PP(4)	PP(8)
G	-3.435	-1.855	-1.112	-11.265	-13.087	-16.200
ΔG	-16.447	-12.240	-7.420	-	-	-
R	-3.961	-2.084	-1.145	-13.327	-15.079	-18.356
ΔR	-17.025	-12.713	-8.255	-	-	-
Int	-8.052	-6.250	-4.142	-11.524	-11.346	-11.468
ΔInt	-12.960	-10.541	-8.025	-	-	-
S	-3.893	-2.878	-1.858	-10.647	-12.346	-14.491
ΔS	-14.328	-10.932	-6.104	-	-	-
B	-0.125	0.035	-0.027	-0.149	-0.113	0.022
ΔB	-8.075	-5.675	-4.320	-15.877	-15.883	-15.901
$\Delta(log B)$	-6.820	-4.941	-3.462	-13.491	-13.652	-14.451
π	-2.489	-1.926	-1.660	-2.559	-2.053	-2.184
$\Delta\pi$	-9.731	-7.614	-5.837	-13.572	-14.594	-15.155

ADF(*d*): Augmented Dickey-Fuller Test, null of unit root, lag truncation *d*
PP(*d*): Phillips-Perron Test, null of unit root, lag truncation *d*
McKinnon critical values 1%, 5% and 10% confidence interval: -2.58, -1.94, –1.62.

TABLE 4

Model estimate parameters (1-L)log(Debt)

Model (p,q)	ϕ_1	ϕ_2	ϕ_3	θ_1	θ_2	θ_3
0.1	-	-	-	0.031	-	-
				(0.073)		
0.2	-	-	-	0.017	0.129	-
				(0.072)	(0.072)	
0.3	-	-	-	0.020	0.125	0.026
				(0.073)	(0.072)	(0.073)
1.0	0.029	-	-	-	-	-
	(0.073)					
1.1	0.850	-	-	-0.781	-	-
	(0.153)			(0.183)		
1.2	0.823	-	-	-0.824	0.092	-
	(0.147)			(0.159)	(0.078)	
1.3	0.830	-	-	-0.829	0.109	-0.025
	(0.171)			(0.184)	(0.094)	(0.083)
2.0	0.024	0.133	-	-	-	-
	(0.072)	(0.072)				
2.1	0.691	0.103	-	-0.692	-	-
	(0.219)	(0.082)		(0.212)		
2.2	0.559	0.218	-	-0.559	-0.106	-
	(0.658)	(0.611)		(0.668)	(0.591)	
2.3	0.629	0.162	-	-0.627	-0.046	-0.016
	(1.110)	(0.913)		(1.111)	(0.914)	(0.131)
3.0	0.014	0.130	0.048	-	-	-
	(0.073)	(0.073)	(0.073)			
3.1	0.719	0.114	-0.021	-0.718	-	-
	(0.315)	(0.091)	(0.103)	(0.305)		
3.2	-0.190	0.741	0.076	0.192	-0.630	-
	(0.449)	(0.284)	(0.108)	(0.445)	(0.314)	
3.3	-0.003	-0.192	0.804	0.061	0.305	-0.776
	(0.052)	(0.058)	(0.043)	(0.032)	(0.043)	(0.002)

Standard deviations in parenthesis.

TABLE 5

Univariate analysis: Debt impulse responses h months ahead

Model(*p*,*q*)	1	2	3	6	12	18	24
(1,0)	0.001	0.029	0.001	0.029	0.029	0.029	0.029
(2,0)	0.133	0.006	0.018	0.000	0.000	0.000	0.000
(2,1)	0.591	0.473	0.387	0.211	0.063	0.019	0.019
(2,2)	0.530	0.418	0.350	0.195	0.061	0.019	0.006
(2,3)	0.557	0.152	0.375	0.210	0.066	0.021	0.007
(3,0)	0.131	0.051	0.018	0.003	0.000	0.000	0.000
(3,1)	0.631	0.514	0.426	0.239	0.076	0.024	0.008
(3,2)	0.777	-0.213	0.601	-0.202	-0.144	-0.092	-0.055
(3,3)	-0.192	0.805	0.031	0.082	0.187	0.248	0.266

TABLE 6

Debt responses to one standard deviation innovation

Innovation in	Lag in months				
	1	2	3	4	5
Int	0.240	-0.072	-0.001	-0.048	0.004
	(0.022)	(0.027)	(0.026)	(0.023)	(0.015)
ΔB	0.246	-0.001	0.017	-0.010	0.009
	(0.013)	(0.027)	(0.027)	(0.014)	(0.010)
$\Delta\pi$	-0.111	-0.069	-0.061	-0.010	0.000
	(0.026)	(0.025)	(0.019)	(0.015)	(0.011)
R	0.023	0.001	-0.001	0.006	0.001
	(0.018)	(0.026)	(0.025)	(0.016)	(0.006)
G	-0.025	-0.011	-0.012	0.007	-0.000
	(0.018)	(0.022)	(0.023)	(0.012)	(0.001)
S	-0.086	-0.063	-0.015	-0.017	-0.007
	(0.023)	(0.028)	(0.028)	(0.015)	(0.001)

Standard deviations in parenthesis.

TABLE 7

Responses to one standard deviation Debt innovation

Lag in months	Response of				
	Int	$\Delta\ \pi$	R	G	S
1	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
2	-0.269	2.129	-0.005	0.017	0.000
	(0.255)	(0.312)	(0.025)	(0.022)	(0.000)
3	0.174	-0.117	-0.040	-0.031	0.000
	(0.261)	(0.500)	(0.028)	(0.023)	(0.000)
4	0.035	0.228	0.006	-0.066	0.000
	(0.140)	(0.422)	(0.014)	(0.014)	(0.000)
5	0.067	-0.266	-0.007	0.026	0.000
	(0.095)	(0.192)	(0.009)	(0.016)	(0.000)
10	0.002	-0.013	-0.000	-0.000	0.000
	(0.007)	(0.027)	(0.000)	(0.002)	(0.000)

Standard deviations in parenthesis.

TABLE 8

Variance Decomposition:
Proportion of forecast error h months ahead produced by each innovation (%)

Variance Decomposition of	Contribution of an innovation in						
	h	S	$\Delta \pi$	Int	R	G	ΔB
S	1	100.000	0.000	0.000	0.000	0.000	0.000
	2	98.703	0.536	0.024	0.371	0.092	0.273
	3	95.925	0.821	0.570	0.431	0.139	2.115
	6	94.928	0.913	1.368	0.431	0.147	2.213
	12	94.905	0.917	1.382	0.432	0.148	2.215
	24	94.905	0.917	1.382	0.432	0.148	2.215
$\Delta \pi$	1	7.710	92.290	0.000	0.000	0.000	0.000
	2	4.108	30.800	55.941	0.040	0.015	9.096
	3	4.139	30.992	55.625	0.044	0.130	9.059
	6	4.049	31.387	55.133	0.107	0.301	9.024
	12	4.054	31.378	55.131	0.108	0.307	9.023
	24	4.054	31.378	55.131	0.108	0.307	9.023
Int	1	1.056	7.067	91.878	0.000	0.000	0.000
	2	5.294	10.034	84.135	0.006	0.012	0.519
	3	5.468	11.549	81.973	0.041	0.253	0.716
	6	5.616	11.567	81.718	0.056	0.259	0.754
	12	5.617	11.571	81.744	0.056	0.259	0.754
	24	5.617	11.571	81.744	0.056	0.259	0.754
R	1	2.959	0.070	0.000	96.940	0.000	0.000
	2	2.531	0.058	0.039	96.885	0.478	0.014
	3	3.106	0.071	0.045	95.194	0.553	1.030
	6	3.135	0.129	0.117	94.574	0.976	1.070
	12	3.136	0.133	0.189	94.480	0.979	1.084
	24	3.136	0.129	0.189	94.480	0.979	1.084
G	1	4.618	1.772	0.053	1.021	92.536	0.000
	2	5.578	3.294	0.182	1.058	89.627	0.258
	3	6.006	12.512	0.223	0.939	79.344	0.978
	6	5.124	11.536	15.925	1.019	62.120	3.975
	12	5.113	11.485	16.273	1.030	62.069	4.030
	24	5.113	11.485	16.273	1.030	62.120	4.030
ΔB	1	5.294	8.921	41.475	0.374	0.464	43.472
	2	7.386	11.248	41.475	0.374	0.464	43.472
	3	7.328	13.299	39.900	0.350	0.565	38.561
	6	7.405	13.112	40.576	0.369	0.586	37.953
	12	7.404	13.114	40.576	0.369	0.587	37.950
	24	7.404	13.114	40.576	0.369	0.587	37.950