# INTERTEMPORAL SOLVENCY AND PUBLIC DEBT: EVIDENCE FROM BRAZIL–1995-2004

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This article investigates the long-run solvency of the Brazilian public debt and the short run dynamics of government revenues and expenditures for monthly data from Jan/1995 to July/2004. Seignorage is not considered as a source of revenue. The conclusion is that the public debt is not solvent. Revenues are strongly exogenous for expenditures and the short run dynamics indicates that for each additional Real collected, the Brazilian government spends R$1,31 (±0.20 ).

## 1 INTRODUCTION

The objective of this work is the econometric study of the evolution of Brazilian government revenues and expenditures during the period from January, 1995 to July, 2004. The joint statistical analysis of these two time series is important for an evaluation of the solvency of the public debt of Brazil.

The economic literature is prolific in articles dealing with the sustainability of the Brazilian public debt.

Pastore (1995) analyzes the sustainability of the Brazilian debt growth with emphasis on the first half of the decade of 90's using quarterly data. Like the later works of Rocha (1997) and Issler and Lima (2000), he concludes that solvency is obtained only if one includes seignorage in the revenue flow.

Tanner (1995), working with monthly data, examines the relationship between tax revenues and government expenditures. The long-run budget balance requires short-run adjustment of these variables. However, the author points out a third variable–financial indexation or monetary correction, as an important element of the Brazilian government's budget balancing strategy over the period 1986-1991. Tanner's results suggest that reductions in the rate of indexation played a role in limiting the growth of the real government debt.

Rocha (1997) analyzes the Brazilian government's solvency in the period 1980-1993 using monthly data. He uses the methodologies proposed by Trehan and Walsh (1991) and Hakkio and Rush (1991) and bases his discussion on present

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values. He concludes that the budget deficit is balanced and that the intertemporal budget is solvent if seignorage is included as a revenue.

Cavalcanti (1999) shows that the Brazilian debt is sustainable during the period Jan./1989-Dec./1998. The same result is reached by Issler and Lima (2000) working with annual data from 1947 to 1992. The former does not include seignorage as a revenue source and the latter does.

Luporini (2000) analyzes the sustainability of the fiscal policy in Brazil using annual data from 1966 to 1996. The sustainability is tested through the mean-zero stationarity of the discounted debt/GDP ratio. She concludes that although the overall results indicate unsustainability, tests on subsamples show that the fiscal policy was sustainable prior to 1980. It assumed an unsustainable path during the 80's and early 90's. Using annual data from 1966 to 2000, Luporini (2002) also analyzes the sustainability of the Brazilian federal fiscal policy examining the responses of the government budget surplus to variations in the debt/GDP ratio and in the debt/income level ratio, using the approach proposed by Bohn (1998). Her results indicate that the government surplus has not systematically responded to changes in the ratio debt/income level, showing evidence that the fiscal policy can not be considered sustainable during the period analyzed.

Souza (2002) also analyzes debt and does not consider seignorage as a source of revenue during the period from Jan./1995 to Dec./2002. He mimics the works of Cavalcanti (1999) and Issler and Lima (2000) and shows that there exits a long-run equilibrium between revenues and expenditures and that revenues cause expenditures in the sense of Granger. He finds no evidence of weak exogeneity for revenues or expenditures.

For an analysis of the historical roots of the Brazilian public debt, we suggest Pastore (1995), Tanner (1994; 1995), and Rocha (1997). For a detailed analysis of the evolution of the debt after the Real Plan, see Bevilaqua and Garcia (2002).

The literature seems to point to seignorage as the fundamental element in the government's fiscal adjustment in periods where the Brazilian economy experienced high inflation rates. Seignorage represents real revenue which the government acquires by using newly issued money to buy goods and nonmoney assets.

With the advent of the Plano Real in 1994, and the drastic reduction in inflation rates, seignorage ceased to be an important source of government revenue. This is the main motivation that led us to analyze the solvency of the Brazilian government's debt during the period Jan./1995–Dec./2004, extending and updating the works of Cavalcanti (1999) and Souza (2002).

Our study of the solvability of the debt follows along the lines of Hamilton and Flavin (1986), Hakkio and Rush (1991) and Tanner and Liu (1994). The same setting has been used by Cavalcanti (1999), Issler and Lima (2000) and Souza (2002).

The article is structured as follows. In section 2 we discuss some methodological issues involving the study of the debt sustainability. Section 3 is on data analysis. Finally, in section 4 we present conclusions and a short summary of the results obtained.

## 2 METHODOLOGICAL ISSUES

There are alternative econometric techniques available to test whether or not the debt is sustainable. The emphasis noted on empirical work has been on assessing the statistical properties of the debt through either, a univariate analysis involving the debt series itself (Hamilton; Flavin, 1986; Wilcox, 1989; Kremers, 1989; Uctum; Wickens, 1996), or on the cointegration properties of government revenues and expenditures (Trehan; Walsh, 1988, 1991; Hakkio; Rush, 1991; Haug, 1991; Bohn, 1991; Tanner; Liu, 1994; Ahmed; Rogers, 1995).

The univariate analysis, usually, is carried out verifying whether or not the debt/income time series is stable. The cointegration analysis typically verifies whether or not government revenues and expenditures are in long run equilibrium by checking if (1,1) is a cointegrating vector, in which case the deficit is a stationary process with mean zero. If that is the case, the debt/income ratio will tend to be stable.

We follow two approaches here. The univariate analysis is carried out via the classical Box and Jenkin's methods applied to the difference revenues-expenditures and cointegration via Johansen's technique. In the later case one is interested in knowing whether or not there exists a constant $\beta$ such that $y_t - \beta x_t$ is a zero mean stationary process, $y_t$ being government revenues and $x_t$ government expenditures, and testing if $\beta = 1$. Basic to both approaches is the assumption that the primary surplus and the real interest rate series define stationary processes.

## 3 DATA ANALYSIS

The data set we use was downloaded from the Central Bank of Brazil (BCB) and consists of real monthly observations, ranging from Jan./1995 to Jul./2004, on Government Expenditures (Despesa do Tesouro Nacional Total), which include interest payments on the government debt, Government Revenues (Receita do Tesouro Nacional Total), which do not include seignorage, the Primary Surplus (Resultado Primário do Governo Central) and the interest rate (Taxa Selic Mensal).

Figures 1 and 2 show the evolution through time of some of the financial flows of concern here. One notices in figure 1 that government revenues and expenditures evolve in a similar pattern. figure 2 displays the behavior of first order differences of these series. The impression one has is that government revenues and government expenditures are I(1) processes.

FIGURE 1
**Evolution of government revenue (Y) and expenditures (E)**

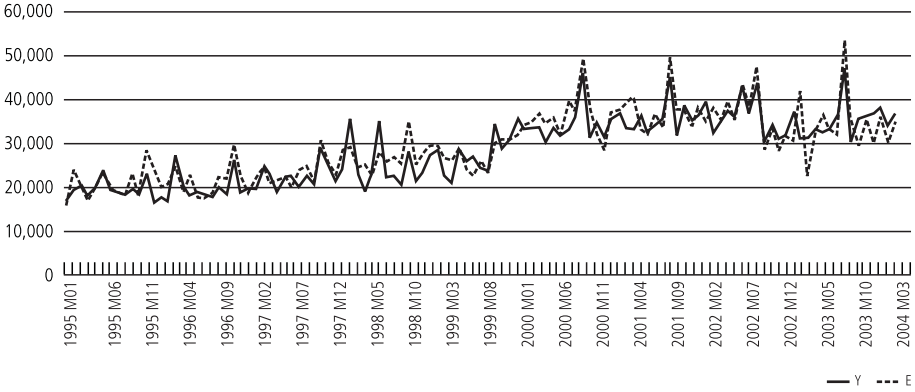
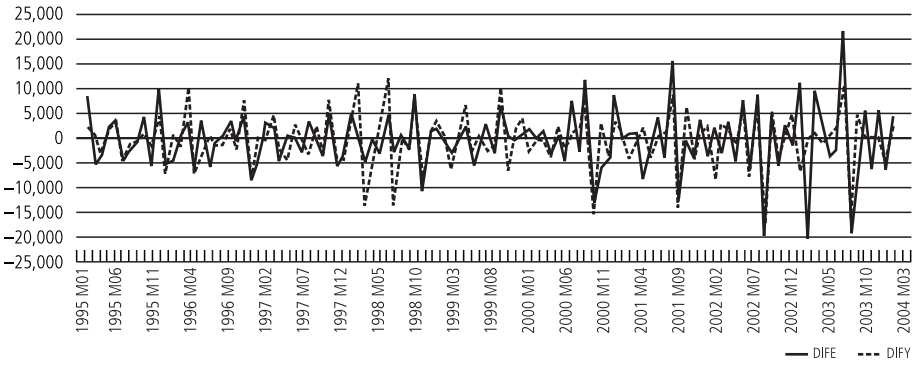



FIGURE 2
**Evolution of first differences: government revenue (DIFY) and government expenditures (DIFE)**




The suggestion of random walks is confirmed by the ADF (Augmented Dickey-Fuller) tests shown in table 1. Philips-Perron tests lead to similar results.

TABLE 1
**Unit root tests, intercept and no time trend in regression**

| Series | Lags | ADF | p-values |
|---|---|---|---|
| Revenues | 3 | –1.253 | 0.649 |
| Δ Revenues | 2 | –12.611 | <0.001 |
| Expenditures | 5 | –1.450 | 0.555 |
| Δ Expenditures | 4 | –9.329 | <0.001 |

The primary surplus and the real interest rate, both, seem to evolve like stationary processes. The classical Box and Jenkin's approach indicates that the AR(12) $s_t = \delta + y s_{t-12} + u_t$ fits the primary surplus well, where

$\hat{\delta} = 2207.7\,(640.526)$ and $\hat{y} = 0.615(0.095)$. The real interest rate can be modeled using the AR(2) representation $r_t = \eta + \varphi r_{t-1} + k r_{t-2} + \zeta_t$ where $\hat{\eta} = -80.898(5.228)$, $\hat{\varphi} = 1.518(0.081)$ and $\hat{k} = -0.521(0.081)$. Therefore the conditions spelled out by Hamilton and Flavin (1986) and Hakkio and Rush (1991) are satisfied.

Figure 3 shows the evolution of the deficit measured by the difference between revenues (do not include seignorage) and expenditures (include interest payments on the government debt). The process is clearly stationary but the mean level seems to be negative. Indeed the process is well fit by the AR(12) process $deficit_t = \mu + \alpha\, deficit_{t-12} + \varepsilon_t$ where $\hat{\mu} = -878.628(438.419)$, $\hat{\alpha} = 0.304(0.099)$ and $\mu \neq 0$ at the 5% level. This is indication of lack of sustainability.

FIGURE 3
**Evolution of the deficit (revenues–expenditures)**

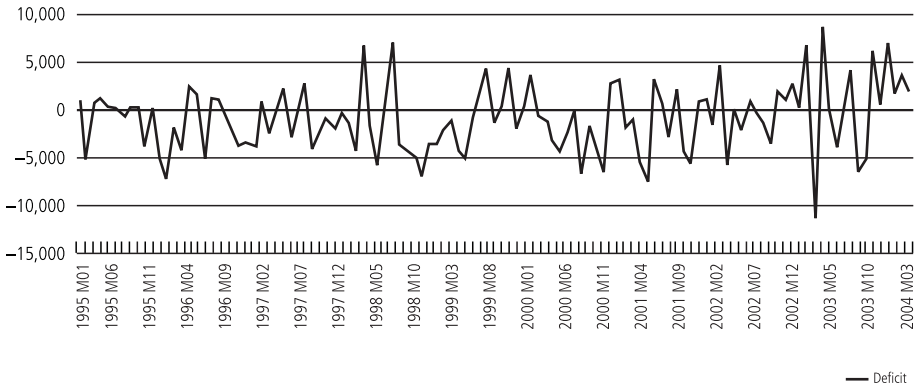
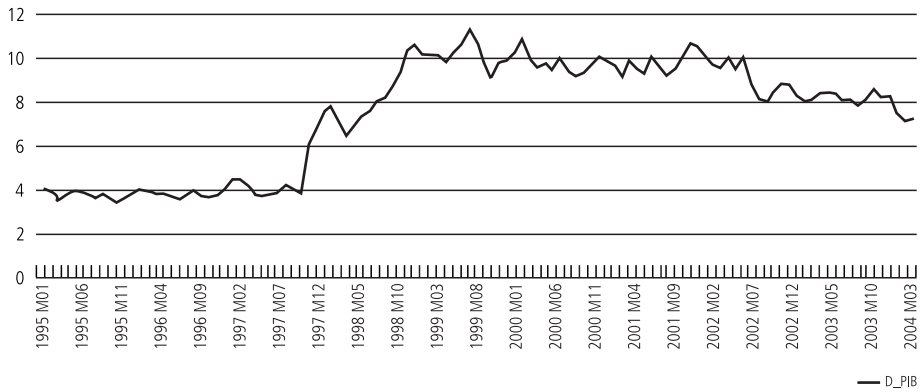



Figure 4 shows the evolution of the debt as a proportion of GDP. It is evident the effort made by the authorities to control its relative size lately.

FIGURE 4
**Evolution of the debt as a proportion of GDP (D_PIB)**



Johansen's analysis provides further indication that the debt is not solvent. The series of government revenues and expenditures cointegrate for var especifications of orders 2, 3, and 4, without constant terms specified in the cointegrating equation and in the var representation. Table 2 shows some statistics related to this analysis. The cointegrating vectors for lags 2, 3 and 4 are (1, 0.971), (1, 0.974), and (1, 0.976) respectively. None of these representations lead to the acceptance of the hypothesis of sustainability at the 5% level. The best model according to Akaike's criterion uses 4 lags. The best model according to Schwarz's criterion uses 2 lags although the choice 4 also seems reasonable.

For further analysis we follow Issler and Lima (2000) and overfit using 4 lags in the var representation.

TABLE 2
**Statistics from the cointegration analysis**

| Lag | Long run elasticity $\beta$ | Std. error | p-value $\beta = 1$ vs $\beta < 1$ | AIC | BIC |
|---|---|---|---|---|---|
| 2 | 0.971 | 0.011 | 0.003 | 38.95 | 39.14 |
| 3 | 0.974 | 0.013 | 0.025 | 38.90 | 39.20 |
| 4 | 0.976 | 0.013 | 0.033 | 38.78 | 39.17 |

Our results do not agree with Cavalcanti (1999) and Souza (2002) since we point to a direction of unsustainability.

In the context of the Johansen's approach we now proceed with the inspection of weak exogeneity of the variables under analysis. Table 3 presents the results of this statistical exercise with 4 lags. Government revenues are weakly exogenous for government expenditures. The conclusion is similar for 2 lags with a smaller p-values, 0.091 for revenues and less than 0.001 for expenditures.

TABLE 3
**Tests of weak exogeneity**

| Variable | Chi-square | DF | p-value |
|---|---|---|---|
| Revenues | 0.52 | 1 | 0.473 |
| Expenditures | 6.32 | 1 | 0.012 |

Finally, in table 4 we show Granger causality tests. The direction of causality detected is from government revenues to government expenditures. The results are robust relative to the choice of lags.

It follows from our statistical exercise that government revenue is strongly exogenous. This means that the equation of expenditure as function of revenue

can be used for forecasting purposes. Following this normalization in the classical Engle-Granger approach to cointegration (GUJARATI, 2003), one is led to conclude that for each additional real collected the government spends R$ 1,31 (± 0.20) in the short run.

TABLE 4
**Tests of Granger causality**

| Null hypothesis | Observations | F Statistic | p-value |
|---|---|---|---|
| The revenue does not (Granger) cause expenditures | 110 (4 lags) | 3.31 | 0.014 |
| The expenditures do not (Granger) cause revenues | | 0.881 | 0.478 |

Bohn (1992) shows that the exogeneity of expenditures is a necessary condition for Ricardian equivalence. We are led to conclude that the behavior of a rational Brazilian consumer is not consistent with Ricardian equivalence.

## 4 SUMMARY AND CONCLUSIONS

Using techniques related to univariate Box and Jenkin's analysis and cointegration of time series we have shown that the government debt can not be considered sustainable in the long run using data ranging from Jan./1995 to July/2004. Government revenue is weakly exogenous for government expenditure and does not Granger cause it. It follows that government revenue is strongly exogenous for government expenditures. Exploring the normalization induced by this result and using the Engle-Granger representation one is led to conclude that for each additional Real collected the government spends R$ 1,31 on the average in the short run.

The article's results, compared with previous works dealing with similar data, notably Cavalcanti (1999) and Souza (2002), points to a deterioration of the government debt in terms of sustainability.

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