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Public-debt management: the Brazilian experience

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This paper analyses public-debt management in Brazil, and considers the main recent theoretical models and the possible effect that the strategy adopted by the Treasury from 1999 onwards could have on the base interest rate. The findings show that the public-debt-management strategy adopted by Brazil was based on the recommendations of Calvo and Guidotti (1990). The average maturity of public debt, the proportion of shares linked to the Special System of Clearance and Custody (SELIC) and the public-debt-to-GDP ratio all play a significant role in determining the base interest rate. Government efforts to restructure public-debt maturities and reduce the negative effect on the interest rate are key in this regard.

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I
Introduction

In the 1980s, public debt in the United States soared, giving rise to a debate on fiscal sustainability. This did not affect the United States alone: in countries such as Belgium, Ireland, and Italy, for instance, the public-debt-to-GDP ratio reached 100% or more, with debt servicing representing a significant proportion of the public budget. Furthermore, the increase in real interest rates and the slowdown in economic growth looked likely to set the public-debt-to-GDP ratio on a dangerous course.

At the end of the 1980s, most countries had undertaken strict budgetary adjustment programmes. In 1989, for instance, Germany and the United States managed to stabilize the public-debt-to-GDP ratio. In the United Kingdom, a major programme was being rolled out on the basis of the privatization strategy. In some countries, however, the implementation of adjustment programs had been unsuccessful in promoting fiscal equilibrium.

According to Dornbusch and Draghi (1990), the macroeconomic environment in several countries during the 1980s raises several questions related to fiscal equilibrium:

(i) What is the microeconomic rationale behind a government having to choose between an increase in debt or fiscal equilibrium?

(ii) Are there macroeconomic implications (effects on economic activity, interest rate, etc.) stemming from the size of the public deficit, or the decision to finance the government through an increase in public debt?

(iii) How do countries deal with their deficits over time?

(iv) When public debt is high, is there a theoretical framework to offer guidance on appropriate maturities or indexation of public debt?

In terms of the final question, several theoretical models have been developed on the management of public debt. The five main models are: Calvo and Guidotti (1990); Giavazzi and Pagano (1990); Barro (2003); Missale, Giavazzi, and Benigno (2002); and Giavazzi and Missale (2004).

This debate currently deserves attention in developing countries. At the end of 1999, the Brazilian Treasury announced a strategy for extending the maturity of federal securities, based on models of public-debt management put forward by researchers such as Giavazzi and Pagano (1990) and Calvo and Guidotti (1990). Furthermore, in an attempt to improve the composition of government liabilities, efforts were made to increase the share of fixed-rate and price-indexed securities and to reduce the share of floating-rate and exchange rate-indexed debt. The main aim is to manage debt in a way that increases credibility.

Empirical analysis will be used to evaluate the public-debt-management strategy adopted by Brazil. The possible effect of the strategy on the base interest rate is also analysed. The article is organized into five sections. Following this introduction, section II details the main characteristics of contemporary models of public-debt management (based on relevant publications), section III describes Brazilian public-debt management during 2000-2005, section IV includes an empirical analysis, and section V presents the conclusions.

II
Contemporary models of public-debt management

The theoretical analysis of public-debt management received particular attention at the beginning of the 1990s, thanks to the analysis of Calvo and Guidotti (1990) and Giavazzi and Pagano (1990). Calvo and Guidotti (1990) analysed several frameworks for the indexation and maturity of public debt in order to

study their impact and optimal levels. The authors therefore analysed indexation in a framework of two periods (0 and 1), where period 0 sees the government fully commit the actions of the government in period 1 (full precommitment). The results indicate that the full indexation of public debt is desirable. However, full indexation may increase the tax burden as a source of public-sector financing. The optimal public-debt-management strategy therefore lies in longer debt maturities and a partial indexation of public debt.

Giavazzi and Pagano (1990) studied whether it is possible to reduce the risk of a crisis of confidence by correctly structuring public-debt maturities. The authors define a confidence crisis as an increased likelihood of change in the monetary regime, with the system in question taken to be a fixed exchange-rate regime. The researchers conclude that the central bank's capacity to resist a confidence crisis depends largely on how successful the Treasury is in refinancing public debt. The risk of monetary-regime change is therefore reduced (and the fixed exchange rate maintained) if the average public-debt maturity is increased or if interest or amortization payments are smoothed out.

Recently, the debate on the best framework for managing public debt was galvanized by the works of Missale, Giavazzi, and Benigno (2002), Barro (2003), and Giavazzi and Missale (2004). Missale, Giavazzi, and Benigno (2002) carried out an empirical analysis of how governments choose the maturity term when a fiscal stabilization programme is launched. In this context, it is assumed that the government aim is to achieve a fiscal surplus capable of stabilizing the public-debt-to-GDP ratio. For this purpose, 72 cases of fiscal stabilization are considered in countries of the Organisation for Economic Co-operation and Development (OECD) between 1975 and 1998. In each case, the governments' bond-issuance strategies two years after the launch of the stabilization plan were analysed. The analysis looked at two governments with different capacities for cutting expenditure. As a result, there are differing expectations as to what the interest rate will be at the end of the stabilization plan.

The analysis by Missale, Giavazzi, and Benigno (2002) suggests that governments are more likely to increase the maturity of public debt in the face of asymmetric information. This is a way of reducing the risk of refinancing and thus increasing the expectation that the fiscal effort will be successful. According to the authors, a government can issue bonds with mainly short-term payments in cases where investors are not aware of the government's for implementing the announced policies (presence of asymmetric information). The main idea is that this procedure must be adopted if the long-term cost is too high in terms of future interest-rate expectations.

Barro (2003) observed that the smoothing of the tax burden encourages the government to issue bonds whose payment is contingent on expenditure. When expenditure is equal in every period, public debt must be structured in consolidated annuities (consols). This isolates budget constraints from unexpected variations in the market prices of indexed bonds with different maturities.

The model put forward by Giavazzi and Missale (2004) assumes that the main objective of public-debt management in Brazil is to stabilize the public-debt-to-GDP ratio and thus reduce the probability of a crisis. In order to stabilize the public-debt-to-GDP ratio, the government must find sources of financing that offer low costs and limited variability of returns. Therefore, the choice of the public-debt instruments involves a trade-off between risk and the expected cost of debt servicing. From this point of view, the optimal framework of indexed public debt depends on a cost and risk assessment. Risk is minimized if an instrument offers protection against variations in the primary surplus and in the public-debt-to-GDP ratio, and if the variation in returns is relatively low.

It should be pointed out that the models of Missale, Giavazzi and Benigno (2002) and Giavazzi and Missale (2004) assume that the government's objective is to stabilize the public-debt-to-GDP ratio. Moreover, both models analyse the optimal framework for public debt, taking into consideration the trade-off between the cost of debt servicing and the risk of refinancing. Nevertheless, while the first model evaluates an optimal maturity framework for public debt, the second model analyses the optimal indexation framework for public debt. On the other hand, models such as those put forward by Giavazzi and Pagano (1990); Missale, Giavazzi and Benigno (2002); and Barro (2003) suggest that the optimal strategy is to increase the average maturity of public debt. In a different way, Calvo and Guidotti (1990) take both viewpoints into consideration.

In short, within the literature there are three main visions concerning the management of public debt. The first, represented by the models of Calvo and Guidotti (1990) and Giavazzi and Pagano (1990), emphasizes the dynamic inconsistency of fiscal policy. The second vision (Barro, 2003) considers the smoothing of the tax burden in a context of exogenous government expenditure, in order to identify the optimal framework for public debt. The third, as advocated by Giavazzi,

Missale and Benigno (2002) and Giavazzi and Missale (2004), focuses on the aim of stabilizing the public-debt-to-GDP ratio. Generally speaking, all these visions concur that an increased average maturity of public debt and a partial indexation of the debt both constitute optimal strategies.

III

Public-debt management in Brazil

This section presents a brief description of public-debt management in Brazil between the change of the exchange-rate regime in January 1999 and December 2005,[1] with special emphasis on three points: the public-debt-to-GDP ratio, the structure of public debt and the average maturity.

Between January 1999 and December 2005, the average public-debt-to-GDP ratio was 53.13%. However, between 1999 and 2000 this ratio fluctuated around 49.95% (see figure 1). Subsequently, debt increased substantially and reached 63.62% in September 2002. The acceleration of the rise in public debt during the second half of 2002 was due to "market fears" about a possible victory for Luis Inácio Lula da Silva in the presidential elections. A speech in which the candidate expressed unorthodox ideas increased the risk perceived by investors and triggered a process of rising interest rates and currency devaluation. However, the victory of this candidate and the establishment of the new government in 2003 did not change the course of economic policy. As a result, fiscal efforts were stepped up to reduce the public-debt-to-GDP ratio, which fell to almost 50% at the end of 2005.

The change to a floating exchange-rate system and the adoption of inflation targeting in 1999 are largely responsible for the trajectory of public debt indexed to the interest rate and to the exchange rate. Generally speaking, currency devaluation meant that it was no longer attractive to use the exchange rate as one of the main indexing factors. The use of the interest rate, on the other hand, remained a viable option. The principal reason is that, with inflation targeting, the main instrument available to the central bank is the base interest rate. Hence, the strategy adopted by the central bank to promote a disinflationary process increased the demand for bonds indexed to the interest rate.

In December 1999 the share of fixed-rate securities was 9%, which increased to 15% by the end of 2000. This was the result of the Treasury's strategy to gradually reduce the risk of short-term fluctuations in economic variables. However, due to the volatility in the domestic financial market in 2001, the proportion of fixed-rate securities in the public debt fell (to stand at 1.91% in April 2003). In that period, the Treasury needed to choose between increasing the level of fixed-rate securities at the cost of increasing the risk of refinancing, or accepting the reduction of such securities in the public-debt composition and extending debt maturities (i.e. lengthening the debt profile). The Treasury decided to reduce the volume of short-term fixed-rate securities.

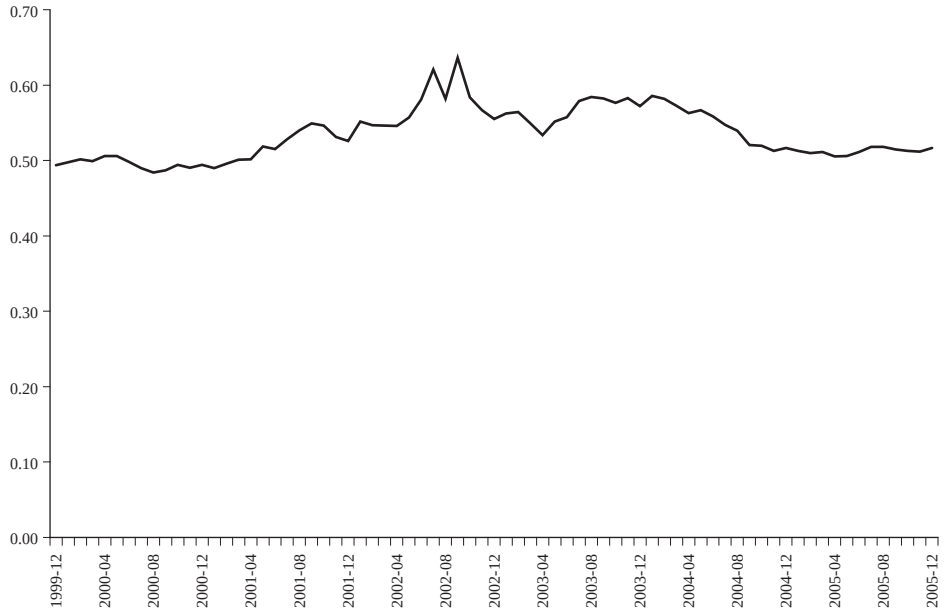
In 2002, with the aim of improving the debt composition, the Treasury adopted a strategy based on Assets and Liabilities Management (ALM) that emphasized the need to replace bonds indexed by the interest rate (over/SELIC) and the exchange rate with price-indexed papers. However, the proportion of interest-rate indexed bonds in the public debt composition increased to 60.8% in December 2002. On the other hand, the proportion of exchange-rate indexed bonds decreased and that of price-indexed bonds increased (see figure 2). The main reason for this pattern was currency devaluation and the fact that index-price performance exceeded the expectations of economic agents.

In 2003, 2004 and 2005 public-debt management was based on the strategy announced in 2002. In other words, the aim was to gradually reduce the proportion of exchange-rate indexed bonds and interest-rate indexed bonds, and to increase the share of public debt made up by fixed-rate and price-indexed bonds. The strategy was partially successful: it considerably increased the proportion of fixed-rate securities and price-indexed bonds, and reduced the share of exchange-rate indexed bonds to a negligible level. Nevertheless, the proportion of interest-rate indexed bonds stabilized at a high level

[1] This analysis is based on several reports of the Brazilian National Treasury. For an analysis concerning government debt management in the Euro Area, see Wolswijk and de Haan (2005).

FIGURE 1

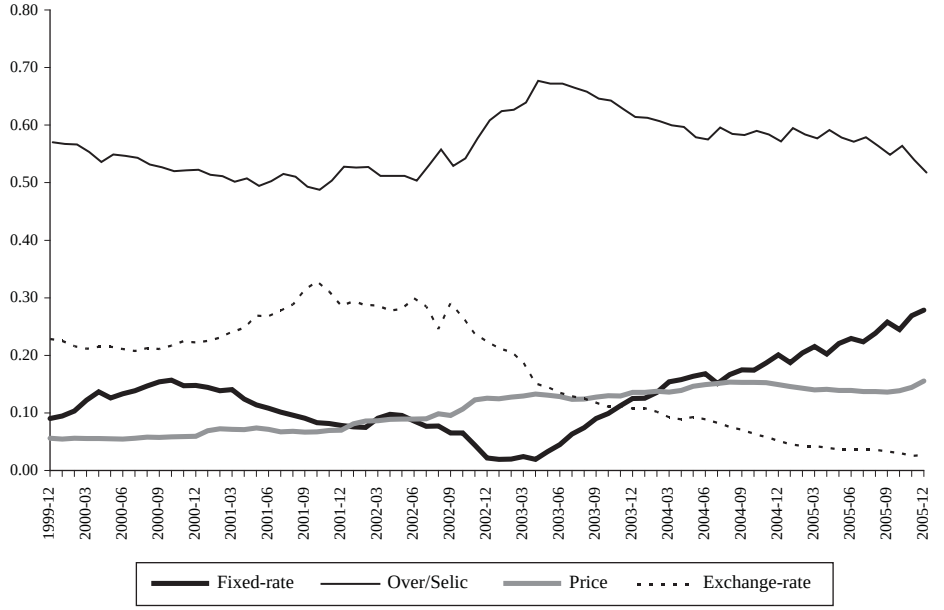
Public-debt-to-GDP ratio (%)



Source: The Treasury, Brazil.

FIGURE 2

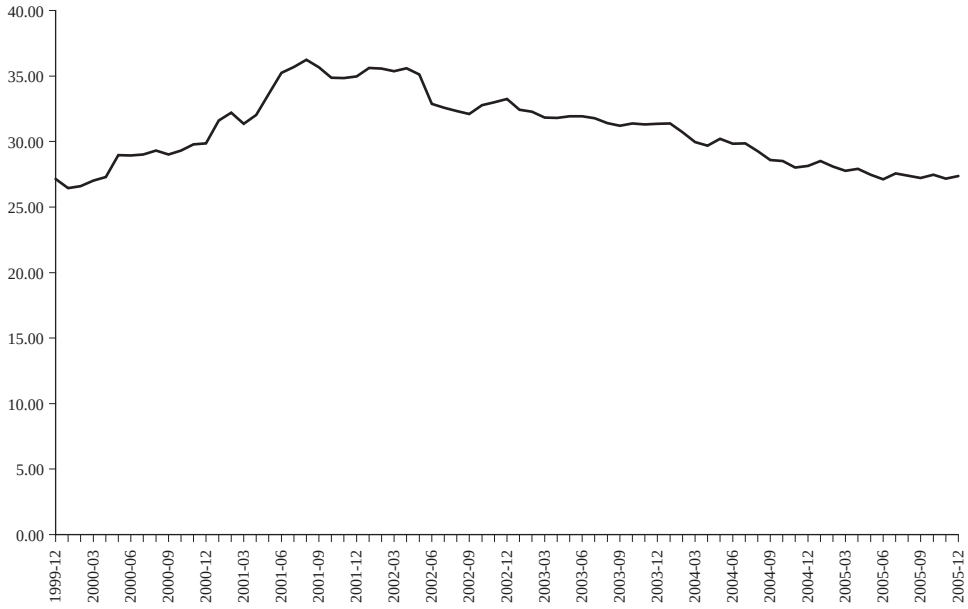
Public Debt – Composition by Indexing Factor



Source: The Treasury, Brazil.

FIGURE 3

Public Debt – Average Maturity



Source: The Treasury, Brazil.

(51.77% in December 2005), and remains the main form of indexation for public debt. This highlights the fact that the market has still not completely eliminated the risk of refinancing crises.

The Treasury did attempt to smooth the maturity structure of public debt. The average maturity of public debt increased from 27.13 months to 36.23 months between January 1999 and August 2001, and remained relatively stable until May 2002 (see figure 3). Subsequently, the average maturity trended downwards due to a lack of confidence on the domestic market. The maturity of the public debt in January 2006 (28.76 months) was lower than the average in 1999-2006 (30.78 months) and was close to the level observed in 1999. In short, the strategy adopted by the Treasury fell short of guaranteeing a sustainable increase in the average maturity of public debt.

Thus, the profile of Brazilian public debt gradually improved during the period under analysis. However, the public-debt-to-GDP ratio is still too high (51.65% in December 2005), which makes it difficult to control inflation and significantly reduce the base interest rate (over/SELIC).[2] The problem is particularly serious for the Brazilian economy because it has experienced a low economic growth rate in the period under analysis.

[2] The SELIC rate is the weighted average of the rates traded in overnight repurchase agreements (repos) backed by government bonds registered in the Special System of Clearance and Custody (SELIC). The terms SELIC, over/SELIC and base interest rate will be used interchangeably from hereon in.

IV
Empirical analysis

This section presents empirical evidence using the application of Ordinary Least Squares (OLS) and the vector autoregressive model (VAR) to analyse the relationship between the public-debt-to-GDP ratio and the main variables that explain the profile of Brazilian public debt. The main objective is to use the models described in section 2 to identify the theoretical basis for the strategy adopted in Brazil between December 1999 and December 2005.

The data used in this analysis are monthly and consist of the following variables:

(i) *Public-debt-to-GDP ratio (DEBGDP)*: variations in this variable are crucial for the analysis because they reflect any action taken to manage the public debt. As pointed out by Givazzi and Missale (2004), this is the most important variable for countries where fiscal vulnerability makes debt stabilization the main goal of debt management.

(ii) *Public-debt composition*: this variable is very important for public-debt management because any increase in the public-debt-to-GDP ratio is positively related to the indexing factor of public debt. In the case of Brazil, the main indexing factors are: the over/SELIC rate - which is the base interest rate of the economy (SELINDEX), the exchange rate (EXCINDEX) and the price index (PRICINDEX). Furthermore, based on the proportion of each indexing factor in the composition of public debt, a regressor entitled INDEX was created to represent the proportion of public debt associated with a given indexing factor. Fixed-rate securities (FRS) are also considered in the analysis.

(iii) *Average maturity of public debt* (AMPD):[3] this variable is expected to correlate strongly with public debt. For instance, according to Giavazzi and Pagano (1990), increasing public-debt maturity makes it possible to reduce the number of bonds that need to be refinanced during a crisis.

(iv) *Securities held by the public to mature in 12 months* (SHP): this variable is a proxy for the concentration of maturities of public debt. According to Giavazzi and Pagano (1990), the concentration of maturities is a major factor in the central bank's ability to resist a confidence crisis.

(v) *Primary surplus*: this variable represents the government effort to balance public finances. In this sense, increases in the primary surplus must reduce the level of public debt.

A first step in the empirical analysis is to examine the stochastic process in the series over time, i.e. to verify the integration order of the series. This procedure eliminates spurious results from the estimation of models. Therefore, unit-root tests were carried out (Augmented Dickey-Fuller –ADF– and Phillips-Perron –PP). The results, in both tests, show that the all the series under analysis are I(1) (see tables A1 and A2).[4]

The above-mentioned results suggest that it would be appropriate to use the first difference of series in the regression. However, this procedure can imply a loss of relation among series in the long run. It is therefore necessary to assess whether a linear combination among series is stationary, even if individually series are non-stationary. In other words, it is vital to check if series are cointegrated because, in that case, the regression of original series would imply reliable statistics.

1. Estimation of models

(a) *Model 1*

The first model captures the idea of Calvo and Guidotti's (1990) model of public-debt management. Their model suggests that lengthening the maturity terms, together with an adequate level of public-debt indexation, constitutes a good strategy for ensuring the credibility of economic policy and thus stabilizing the public-debt-to-GDP ratio. The theoretical model therefore considers a regressor related to public-debt indexation and another related to the average maturity of public debt. The model to be tested is expressed as:

$$DEBGDP = f(SELICINDEX, EXCINDEX, PRICINDEX, AMPD) \quad (1)$$

[3] The Treasury began this series in February 2000.

[4] All tables and figures marked A are included in the appendix.

While it is not possible to identify the expected signs for the relations with public debt indexation ex-ante, the expected sign for average maturity is $\partial f/\partial \text{AMPD}<0$.

The cointegration test proposed by Johansen (1991), based on the significance of estimated eigenvalues, indicates that the trace statistic rejects the no-cointegration hypothesis at a significance level of 5%, but does not reject the hypothesis that there is more than one cointegration relation (see table A3). Given that series are cointegrated and that there is therefore a relation of long-run equilibrium among them, the equation (1) can be estimated with the original series without the problem of spurious results.

The results of equation 2 indicate that financing public debt using bonds indexed by price, the interest rate or the exchange rate results in an increase in public debt. Contrary to theoretical expectations, lengthening the maturity terms also increases the public-debt-to-GDP ratio.[5]

DEBGDP = (2)

0.0251 + 0.2971SELINDEX(-6) + 0.1344PRICINDEX(-6) + 0.0747EXCINDEX(-6) + 0.0102AMPD(-6)
(0.5813) (5.1122) (0.9372) (0.0747) (6.9825)

$R^2 = 0.7740$ DW = 1.080979 n = 67

Serial Correlation Test

F-statistic	9.548393	Prob. F(2,60)	0.000251
Obs*R-squared	16.17619	Prob. Chi-Square(2)	0.000307

Heteroskedasticity Test

F-statistic	1.255561	Prob. F(14,52)	0.266603
Obs*R-squared	16.92660	Prob. Chi-Square(14)	0.260110

Note: t-statistics between parentheses.

Since the number of degrees of freedom is higher than 20 and the level of significance is 0.05, the null hypothesis must be rejected if the t-statistics are higher than 2 in modules. In this case, only SELINDEX and AMPD are statistically significant. The R^2 reveals that 77% of the variation of the public debt can be explained by the variables present in the model. Furthermore, the F-statistic indicates rejection of the null hypothesis that all slope coefficients are equal to zero at the 5% level. With a view to testing the serial correlation in the residuals, the Durbin-Watson statistic (1.08) was used to show the presence of positive autocorrelation. The presence of serial correlation was confirmed by the Breusch-Godfrey test. In order to check the heteroskedasticity of residuals, a White test was carried out and the presence of heteroskedasticity was detected.

Due to the presence of autocorrelation and heteroskedasticity in the regression, the model was re-estimated by applying the Newey-West matrix. The new regression (equation 3) shows that the coefficients of SELINDEX and AMPD are once again statistically significant at the 0.05 level. Therefore, it is observed that the empirical evidence does not concur with the theoretical analysis of Calvo and Guidotti (1990).

DEBGDP = (3)

0.0251 + 0.2971SELINDEX(-6) + 0.1344PRICINDEX(-6) + 0.0747EXCINDEX(-6) + 0.0102AMPD(-6)
(0.5806) (5.1589) (0.6905) (0.8189) (4.6120)

$R^2 = 0.7740$ DW = 1.080979 n = 67

[5] It should be pointed out that the number of lags in the equation was based on the Schwarz criterion.

(b) *Model 2*

The second model considers the analysis of Giavazzi and Pagano (1990). Therefore, the variables used in the regression are: AMDP, SHP and the primary surplus (PS). The justification for using the primary surplus variable its that it is capable of reducing the public-debt-to-GDP ratio. Since the Johansen test shows that the hypothesis of the non-cointegration of series is accepted at the 0.05 level of significance (see table A3), the empirical model is:

$$D(DEBGDP) = f(D(AMPD),D(SHP),D(PS)) \quad (4)$$

with the following expected signs for the relations expressed through partial derivatives: $\partial f/\partial D(AMPD)<0$, $\partial f/D(SHP)>0$, $\partial f/\partial D(PS)<0$.

The result indicates that lengthening the maturity terms of public debt, generating a primary surplus and increasing the concentration of public-debt maturities increases the public-debt-to-GDP ratio. However, even though the results reveal that any coefficient has statistical significance, the F-statistic is not significant, and the Durbin-Watson statistic (2.5735) indicates the presence of negative autocorrelation (equation 5). The Breusch-Godfrey test confirms the presence of autocorrelation at 0.05 level of confidence. Furthermore, the White test reveals the problem of heteroskedasticity in the regression.

$$\underset{}{D(DEBGDP) = \underset{(0.2685)}{0.0005} + \underset{(1.2018)}{0.1530}D(SHP) + \underset{(0.6063)}{0.0024}D(PS) + \underset{(0.7448)}{0.0080}D(AMPD)} \quad (5)$$

$R^2 = 0.0271$ DW = 2.5735 n = 72

Serial Correlation Test			
F-statistic	5.784035	Prob. F(2,66)	0.004846
Obs*R-squared	10.73768	Prob. Chi-Square(2)	0.004660
Heteroskedasticity Test			
F-statistic	1.753743	Prob. F(9,62)	0.095738
Obs*R-squared	14.61008	Prob. Chi-Square(9)	0.102219

Note: t-statistics between parentheses.

Based on the above-mentioned results related to model 2, it was again necessary to correct the estimation using Newey-West matrix. The result is:

$$\underset{}{D(DEBGDP) = \underset{(0.2685)}{0.0005} + \underset{(1.2018)}{0.1530}D(SHP) + \underset{(0.7448)}{0.0024}D(PS) + \underset{(0.6063)}{0.0080}D(AMPD)} \quad (6)$$

$R^2 = 0.0271$ DW = 2.5735 n = 72

The results do not have statistical significance. Therefore, they cannot be used to interpret the implications of this model for the management of Brazilian public debt.

(c) *Model 3*

This model incorporates the idea from models of Giavazzi, Missale and Benigno (2002) and Barro (2003). Although the motivations in these models are different, the result is the same, namely that lengthening the maturity terms of public debt is an effective strategy for public-debt management. In this context, the regression considers the public-debt-to-GDP ratio as a dependent variable and AMPD as a regressor. The Johansen test indicates that the series are not cointegrated (see table A3). Therefore, the first difference of the series was considered in the regression:

$$D(DEBGDP) = f(D(AMPD)),\ \partial f/\partial D(AMPD)< 0 \quad (7)$$

The expected result is a negative relation between the lengthening of maturity terms of the public debt

and the public-debt-to-GDP ratio. Although the result indicates the presence of the expected negative relation, neither the t-statistic nor the F-statistic is significant. Furthermore, the Durbin-Watson statistic, the Breusch-Godfrey test and the White test indicate the presence of heteroskedasticity and serial autocorrelation.

$$D(DEBGDP) = \underset{(0.2260)}{0.0004} - \underset{(-0.1907)}{0.0005}D(AMPD) \quad (8)$$

$R^2 = 0.0005$ DW = 2.6476 n = 72

Serial Correlation Test			
F-statistic	5.642419	Prob. F(2,68)	0.005406
Obs*R-squared	10.24797	Prob. Chi-Square(2)	0.005952
Heteroskedasticity Test			
F-statistic	0.017126	rob. F(2,69)	0.983024
Obs*R-squared	0.035724	Prob. Chi-Square(2)	0.982296

Note: t-statistics between parentheses.

In order to reduce the problem detected with heteroskedasticity and serial autocorrelation, the Newey-West matrix was applied to give the following result:

$$D(DEBGDP) = \underset{(0.2731)}{0.0004} - \underset{(-0.1634)}{0.0005}D(AMPD) \quad (9)$$

$R^2 = 0.0005$ DW = 2.6476 n = 72

The results indicate that lengthening maturity terms cannot be the only strategy considered when analysing public-debt management in Brazil.

(d) *Model 4*

This model is based on the theoretical analysis of Giavazzi and Missale (2004). In this approach, the composition of the public debt by indexing factor is essential to public-debt management. Therefore, the empirical model is:

$$DEBGDP = f(SELINDEX, EXCINDEX, PRICINDEX) \quad (10)$$

The Johansen test indicates rejection of the hypothesis of non-cointegration at the 0.05 level, which in turn implies that the estimation must be made without series differentiation. The result suggests that financing public debt using the indexing factors under consideration causes an increase in the public-debt-to-GDP ratio (equation 11). The t-statistics and the F-statistic are statistically significant at the 0.05 level.

$$DEBGDP = \underset{(6.1190)}{0.2281} + \underset{(3.0961)}{0.1976}(SELINDEX) + \underset{(8.8699)}{1.1189}(PRICINDEX) + \underset{(9.9757)}{0.4465}(EXCINDEX) \quad (11)$$

$R^2 = 0.6498$ DW = 0.6404 n = 73

Serial Correlation Test			
F-statistic	31.47047	Prob. F(2,67)	0.000000
Obs*R-squared	35.35982	Prob. Chi-Square(2)	0.000000
Heteroskedasticity Test			
F-statistic	2.226087	Prob. F(9,63)	0.031566
Obs*R-squared	17.61357	Prob. Chi-Square(9)	0.039931

Note: t-statistics between parentheses.

Nevertheless, both the Durbin-Watson statistic and the Breusch-Godfrey test reject the null hypothesis that there is no serial autocorrelation. The White test reveals no presence of heteroskedasticity in the residuals. Using the Newey-West matrix to correct the autocorrelation problem in the regression generates the following result:

$$\underset{}{DEBGDP} = \underset{(3.1203)}{0.2281} + \underset{(1.6719)}{0.1976}(SELINDEX) + \underset{(6.5161)}{1.1189}(PRICINDEX) + \underset{(5.8611)}{0.4465}(EXCINDEX) \quad (12)$$

$$R^2 = 0.6498 \qquad DW = 0.6404 \qquad n = 73$$

Based on the results of the above four models and considering R^2 as a criterion for selecting the adequate model, the best explanation for Brazilian public-debt management is found to be model 1.

2. Effect of public-debt management on the interest rate

The analysis included in the previous section shows that the model based on Calvo and Guidotti (1990) is the best match for the Brazilian case. It is therefore important to ascertain the effects of a strategy to manage public debt by extending the maturity of federal securities. Furthermore, it is also vital to consider the strategy announced at the end of 1999 to improve the composition of government liabilities by increasing the proportion of fixed-rate and price-indexed securities, and reducing the share of floating-rate and exchange-rate-indexed debt.

Besides the traditional argument of Sargent and Wallace (1981) that high debt and a large deficit could push up the interest rate, a concentration of redemptions is not appropriate due to the high cost it would entail in the event of a crisis of confidence. Even if there is sufficient demand for public bonds, the adverse environment may bring about an increase in the risk premium. Broadly speaking, an average maturity of public debt that is short (or long) may be associated with a high (or low) interest rate due to the high (low) default risk.

The base interest rate (over/SELIC) is fundamental to any analysis of Brazilian public debt. Between February 2000 and June 2005, an average 57% of federal public bonds were indexed by the over/SELIC rate. It is important to note that the Brazilian economy suffered several shocks in this period (stock-market instability and company losses in the United States, the crisis in Argentina and a speculative episode during the Brazilian presidential elections, etc.) that resulted in a failure to meet inflation targets in most cases (except in 2000 and 2004). As a result, the Treasury was forced to reduce the maturity of public debt and pay a risk premium in keeping with market demand. Therefore, the recent period has been marked by a certain rigidity in terms of reducing the short-term interest rate.

Although the literature on public-debt management suggests that it is appropriate to extend average debt maturity, this is known to come at the cost of a higher interest rate in economies lacking credibility. It is therefore necessary to establish whether the strategy adopted by the Brazilian government in November 1999 influenced patterns in the base interest rate. In order to assess the effects of the above-mentioned strategy, a vector autoregression (VAR) has been carried out using monthly data (February 2000-June 2005) on the average maturity of public debt (AMPD), base interest rate (SELIC), proportion of SELIC-indexed securities (DEBINDEX) and the net public-debt-to-GDP ratio (DEBGDP), as collected by the Treasury and the central bank.

Based on unit-root tests (Augmented Dickey-Fuller (ADF), Phillips-Perron (PP)) and the correlogram analysis of series, the series that were not stationary were differentiated as usual (see table A4 and figure A1). The VAR order was chosen on the basis of Schwarz and Hanna-Quinn criteria (see table A.5). The best model was found to be the one with two lags. According to the results of the Granger causality test (see table A6), the appropriate order of series in the VAR is given by DEBINDEX, DEBGDP, AMPD and SELIC.

As the data used are monthly, table 1 shows the variance decomposition during the first 12 months. The same period is used for impulse-response analysis (figure 4). According to table 1, the main variable that explains the variance of the DEBINDEX is the SELIC. Furthermore, the effect from DEBINDEX, DEBGDP and AMPD cannot be considered negligible. In relation to the impulse-response analysis, an increase in DEBGDP and

TABLE 1

Variance Decomposition

Months	DEBINDEX				DEBGDP			
	DEBINDEX	DEBGDP	AMDP	SELIC	DEBINDEX	DEBGDP	AMDP	SELIC
1	100.0000	0.000000	0.000000	0.000000	21.24768	78.75232	0.000000	0.000000
2	96.12370	0.548506	0.070362	3.257435	20.35500	77.37194	1.044210	1.228842
3	88.75164	1.938671	0.137191	9.172497	22.19732	74.39889	1.775024	1.628759
4	79.61383	3.934707	0.341600	16.109870	23.61782	71.97437	2.629931	1.777879
5	70.08112	6.494912	0.744171	22.679800	25.11833	69.89977	3.363887	1.618018
6	61.21069	9.376426	1.400784	28.012100	26.39971	68.09051	4.025889	1.483891
7	53.49525	12.405370	2.322360	31.777020	27.43824	66.29889	4.597992	1.664886
8	47.10612	15.407520	3.485837	34.000530	28.18081	64.38233	5.092001	2.344862
9	42.00308	18.246190	4.839272	34.911460	28.64143	62.30412	5.518081	3.536366
10	38.04516	20.817080	6.314428	34.823340	28.87721	60.13637	5.894771	5.091652
11	35.05080	23.053550	7.838196	34.057450	28.97471	58.00493	6.243172	6.777184
12	32.83436	24.925200	9.343047	32.897380	29.02146	56.03551	6.583174	8.359860
Months	AMPD				SELIC			
	DEBINDEX	DEBGDP	AMDP	SELIC	DEBINDEX	DEBGDP	AMDP	SELIC
1	0.045657	0.192932	99.76141	0.000000	3.801453	0.009787	0.790343	95.39842
2	0.778571	2.248934	96.67985	0.292648	2.178402	0.017220	0.469151	97.33523
3	2.060256	2.107929	95.28145	0.550367	1.268569	0.149315	0.241378	98.34074
4	2.682422	2.648740	93.80588	0.862955	0.769177	0.417978	0.157037	98.65581
5	3.267876	3.142126	92.55247	1.037530	0.567184	0.847052	0.259898	98.32587
6	3.628730	3.823221	91.44420	1.103845	0.641838	1.432912	0.583220	97.34203
7	3.855810	4.582652	90.47320	1.088343	0.991108	2.160451	1.146940	95.70150
8	3.965667	5.414534	89.57918	1.040623	1.603879	2.992243	1.948685	93.45519
9	3.996434	6.274359	88.73238	0.996830	2.443098	3.868523	2.952911	90.73547
10	3.975144	7.133281	87.91835	0.973226	3.436800	4.712257	4.086191	87.76475
11	3.924048	7.965808	87.14221	0.967930	4.483481	5.444579	5.245283	84.82666
12	3.858583	8.756080	86.41586	0.969480	5.472444	6.005445	6.319608	82.20250

Source: Authors' estimates.

SELIC contributes to a durable increase in DEBINDEX. On the other hand, an increase in AMDP is capable of reducing debt indexation. This result suggests that the extension of debt maturity is the result of credibility considerations, with reduced public demand for a high proportion of public debt to be indexed to the interest rate.

Public debt plays a fundamental role in the performance of DEBGDP. Besides this, indexation is relevant to variance decomposition and is capable of promoting a decrease in debt. This result needs to be clarified. As pointed out by Calvo and Guidotti (1990), indexation is a useful strategy for reducing public debt. However, using interest rate as the main index factor is not a good choice because, when there is a lack of credibility, an increase in indexation implies a reduction in debt maturity. Furthermore, the positive effects are only short term, as the cost of public debt service continues over time.

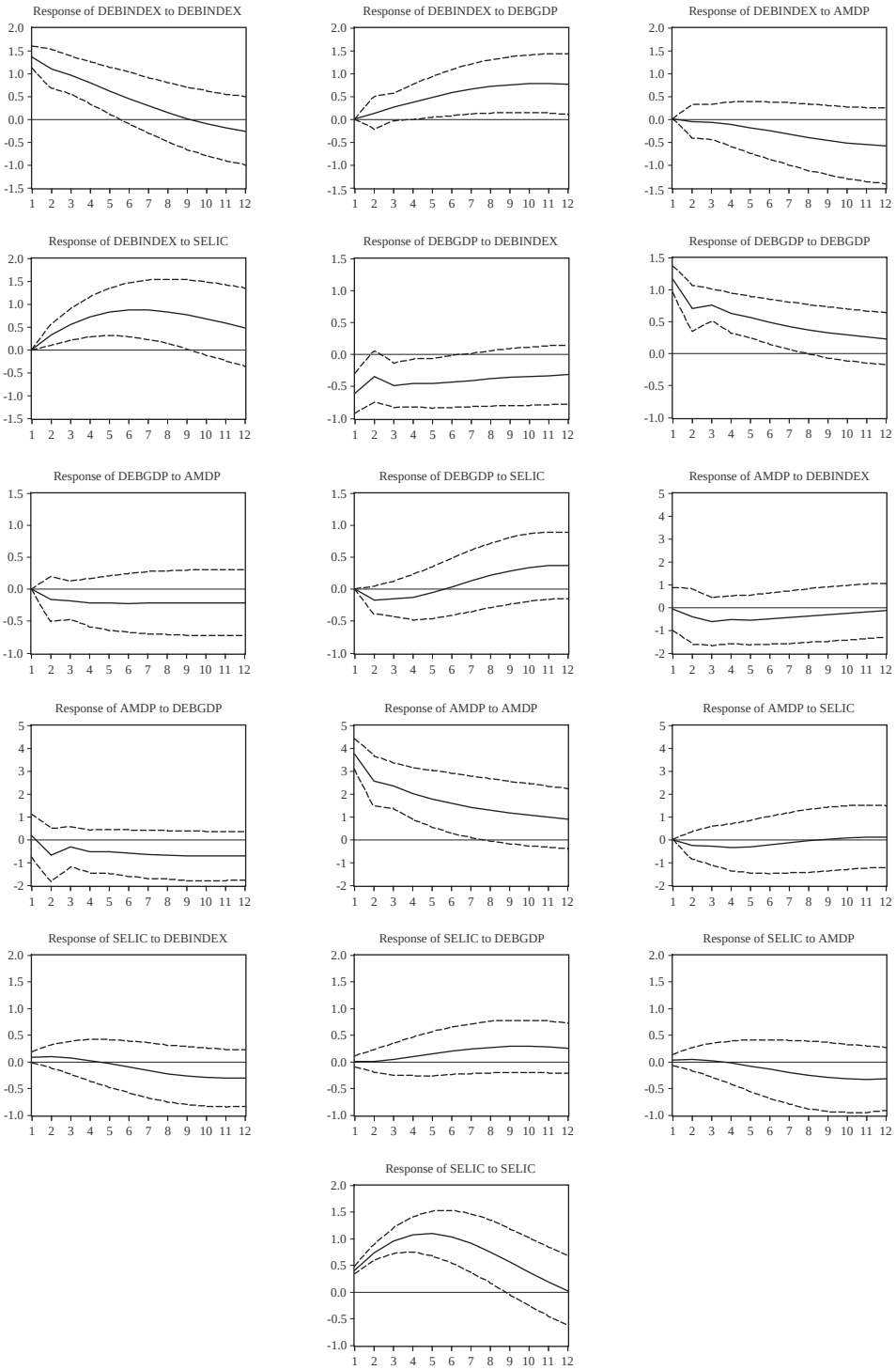
Although variance decomposition indicates that neither AMDP nor SELIC are relevant to debt variance, the data generated by impulse-response analysis should not be ignored. An increase in AMDP brings down public debt, while an increase in the interest rate raises debt after the sixth month. Therefore, the combined effect of a longer public debt maturity and lower interest rate may be to promote a fall in debt.

An analysis of AMDP reveals that average maturity is the main variable to explain variance and that an extension of debt maturity is not eliminated over time. Although DEBGDP has little significance in the variance of AMDP, as predicted by the theories, an increase in DEBGDP tends to reduce the maturity of public debt. The relative importance of DEBINDEX and SELIC in the

FIGURE 4

Impulse-response

Response to Cholesky One S.D. Innovations ± 2 S.E.



Source: Prepared by the authors.

variance of AMDP, as in the impulse-response analysis, shows that the external shocks to these variables do not have statistical significance.

In terms of SELIC variance, the main variable is the SELIC itself. The other variables together account for approximately 18%. The impulse-response analysis reveals that a shock transmitted by DEBINDEX brings down the interest rate after the fifth month. Similarly, a shock transmitted by AMDP, contributes to a permanent decrease in SELIC after the fourth month. These results indicate that public-debt management that seeks to decrease debt stock and extend average debt maturity helps to bring down the base interest rate. Shocks transmitted by SELIC to itself disappear after twelve months.

V
Concluding remarks

Empirical evidence suggests that Brazil adopted a public-debt-management strategy based on the recommendations of Calvo and Guidotti (1990). The average maturity and stock of public debt are relevant to the amount of SELIC-indexed securities. Furthermore, the results indicate that the average maturity of public debt, the proportion of SELIC-indexed securities and the net public-debt-to-GDP ratio play an important role in determining the Brazilian base interest rate.

Another relevant fact is that, although indexation reduces the debt-to-GDP ratio, this strategy is not appropriate for an economy with insufficient credibility, due to the high cost of public debt service. Therefore, the government should endeavour to extend the maturity of public debt and reduce any adverse effect on the interest rate. Furthermore, given the extremely high interest rate and the short maturity of public debt in Brazil, the strategy of generating primary surpluses has yet to yield positive results.

The strategy of extending the maturity of public debt announced by the Brazilian government at the end of 1999 is the right approach. However, according to Wolswijk and de Haan (2005, p. 19) "this new environment required an adaptation of strategies. Very practical considerations regarding cost and risks continue to dominate the objectives adopted, rather than tax or deficit stabilisation as suggested in the academic literature". As pointed out by Sargent and Wallace (1981), an economy that does not have sufficient credibility to neutralize shocks and that has a high debt-to-GDP ratio can generate a real interest rate that is higher than the economic growth rate. This concurs with Calvo and Guidotti (1990), who draw attention to the fact that a strategy of extending the maturity of public debt for economies with a debt-to-GDP ratio above 50% implies a high cost due to the increase in the interest rate.

It is important to stress that fixed-rate debt avoids large interest payments when the SELIC rate rises during a crisis or reacts to negative supply shocks (Giavazzi & Missale, 2004). However, in an economy such as Brazil's, where the maturity of fixed-rate bonds remains relatively short, the benefits of a fall in interest rates are negligible. This emphasizes the importance of reducing the proportion of public debt indexed to the interest rate and increasing inflation-indexed debt, for instance.

(Original: English)

APPENDIX

TABLE A1

Augmented Dickey-Fuller (ADF)

Series	Lag	Test	Critical values 1%	Critical values 5%
EXCINDEX	0	-1.5303	-2.5974	-1.9453
D(EXCINDEX)	0	-6.7300	-2.5979	-1.9454
SHP	1	-2.6615	-3.5256	-2.9029
D(SHP)	0	-5.2898	-2.5979	-1.9454
DEBGDP	1	0.1151	-2.5979	-1.9454
D(DEBGDP)	0	-11.8064	-2.5979	-1.9454
INDEX	3	-0.7176	-2.5989	-1.9455
D(INDEX)	2	-2.7292	-2.5989	-1.9455
PS	0	0.8879	-2.5974	-1.9453
D(PS)	0	-8.2902	-2.5979	-1.9454
AMPD	1	0.0480	-2.5979	-1.9454
D(AMPD)	0	-6.2564	-2.5979	-1.9454
PRICINDEX	0	1.9278	-2.5974	-1.9453
D(PRICINDEX)	0	-8.4058	-3.5256	-2.9029
SELINDEX	0	-0.4879	-2.5974	-1.9453
D(SELINDEX)	0	-7.6033	-2.5979	-1.9454
FRS	3	0.3476	-2.5989	-1.9455
D(FRS)	7	-4.0700	-4.1079	-3.4815

Source: Prepared by the authors.

Note: Augmented Dickey-Fuller test (ADF) – the final choice of lag was made based on the Schwarz criterion (SC). No-constant specification or time trend was used for series D(DEBGDP), DEBGDP, D(SHP), D(EXCINDEX), EXCINDEX, D(PS), PS, D(SELINDEX), SELINDEX, PRICINDEX, D(PRICINDEX), INDEX, D(INDEX), AMPD, D(AMPD) and FRS. Constant was used for the series SHP. Constant and time trend were used for the series D(FRS).

TABLE A2

Phillips-Perron (PP)

Series	Lag	Test	Critical values 1%	Critical values 5%
EXCINDEX	4	-1.3393	-2.5974	-1.9453
D(EXCINDEX)	3	-6.7357	-2.5979	-1.9454
SHP	4	-0.9566	-2.5974	-1.9453
D(SHP)	2	-5.2984	-2.5979	-1.9454
DEBGDP	1	-1.9423	-3.5242	-2.9023
D(DEBGDP)	0	-11.8064	-2.5979	-1.9454
INDEX	5	-1.3002	-2.5974	-1.9453
D(INDEX)	5	-8.5988	-2.5979	-1.9454
PS	2	0.9238	-2.5974	-1.9453
D(PS)	3	-8.2913	-2.5979	-1.9454
AMPD	0	-1.8567	-4.0906	-3.4734
D(AMPD)	3	-6.2913	-2.5979	-1.9454
FRS	6	1.2483	-2.5974	-1.9453
D(FRS)	6	-7.9343	-2.5979	-1.9454
PRICINDEX	2	2.0541	-2.5974	-1.9453
D(PRICINDEX)	2	-8.4084	-3.5256	-2.9029
SELINDEX	3	-0.4753	-2.5974	-1.9453
D(SELINDEX)	3	-7.5926	-2.5979	-1.9454

Source: Prepared by the authors.

Note: Phillips-Perron test – lag is the lag truncation chosen for the Bartlett kernel. No-constant specification or time trend was used for series D(DEBGDP), SHP, D(SHP), D(EXCINDEX), EXCINDEX, D(PS), PS, D(SELINDEX), SELINDEX, PRICINDEX, INDEX, D(INDEX), D(AMPD), FRS and D(FRS). Constant was used for the series DEBGDP and D(PRICINDEX). Constant and time trend were used for the series AMPD.

TABLE A3

Johansen Cointegration Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5% Critical Value	Prob.**
Model 1				
None *	0.431613	90.133850	69.818890	0.0005
At most 1 *	0.267025	49.457240	47.856130	0.0351
At most 2	0.215673	27.090880	29.797070	0.0994
At most 3	0.109833	9.600017	15.494710	0.3128
At most 4	0.016844	1.223073	3.841466	0.2688
Model 2				
None	0.289991	46.485160	47.856130	0.0669
At most 1	0.166373	21.826800	29.797070	0.3082
At most 2	0.111015	8.724999	15.494710	0.3914
At most 3	0.003500	0.252436	3.841466	0.6154
Model 3				
None	0.184701	16.462700	20.261840	0.1539
At most 1	0.024151	1.760242	9.164546	0.8248
Model 4				
None *	0.306547	56.785930	47.856130	0.0058
At most 1 *	0.231001	30.428710	29.797070	0.0422
At most 2	0.138665	11.516800	15.494710	0.1816
At most 3	0.010627	0.769249	3.841466	0.3804

Source: Estimates calculated by the authors using the Johansen cointegration test.

Note:
* denotes rejection of the hypothesis at the 0.05 level.
** MacKinnon-Haug-Michelis (1999) p-values.

TABLE A4

Unit root tests (ADF and PP) - VAR

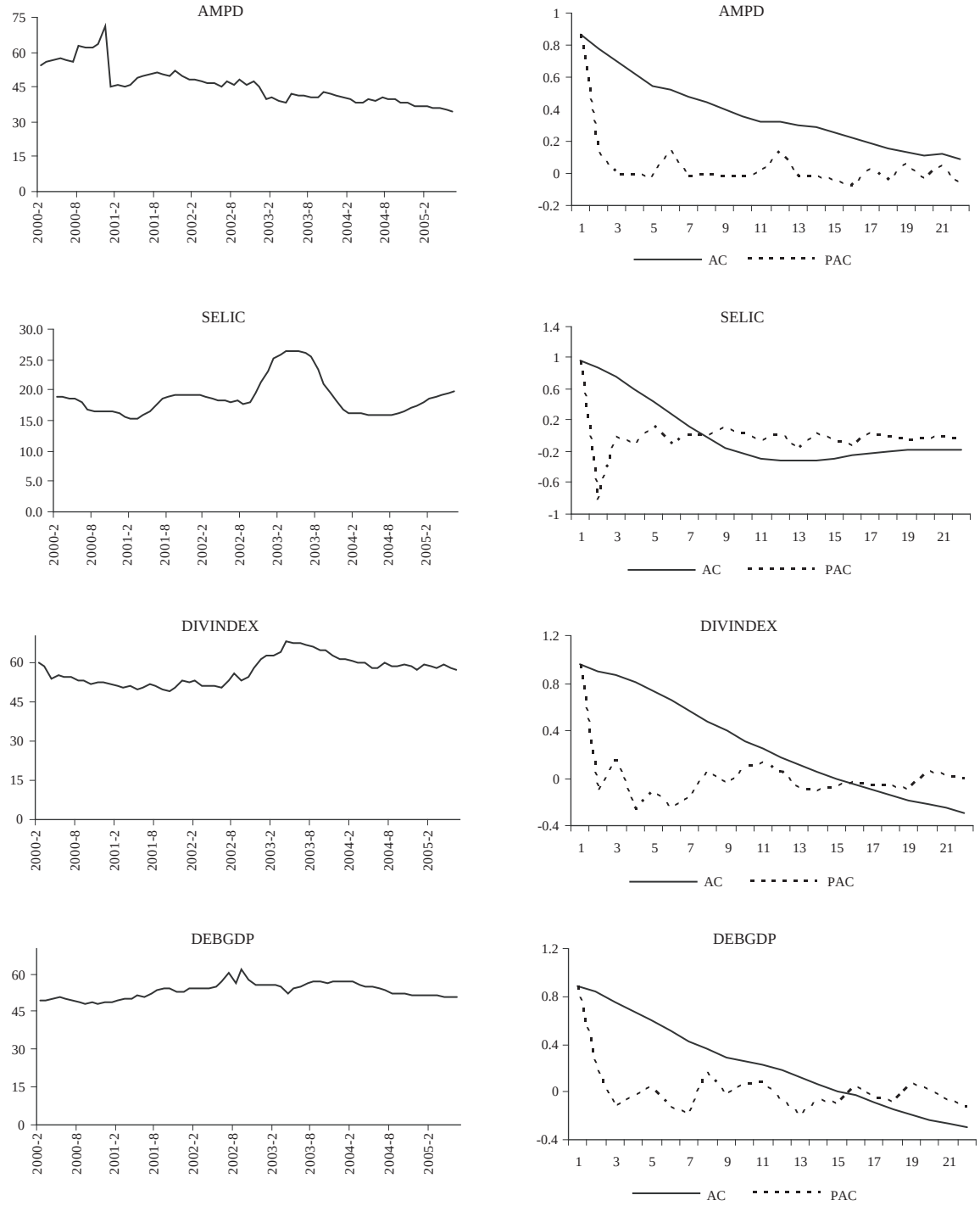
	ADF				PP			
Series	Lag	Test	Critical values 1%	Critical values 5%	Lag	Test	Critical values 1%	Critical values 5%
AMPD	0	-0.333129	-2.601596	-1.945987	1	-4.392240	-4.107947	-3.481595
D(AMPD)	0	-6.932854	-2.602185	-1.946072				
SELIC	1	-3.420096	-3.538362	-2.908420	5	-0.236942	-2.601596	-1.945987
D(SELIC)					3	-2.774981	-2.602185	-1.946072
DINVINDEX	0	-0.333129	-2.601596	-1.945987	3	-0.322813	-2.601596	-1.945987
D(DIVINDEX)	0	-6.932854	-2.602185	-1.946072	3	-6.904872	-2.602185	-1.946072
DEBGDP	1	0.075217	-2.602185	-1.946072	1	0.040130	-2.601596	-1.945987
D(DEBGDP)	0	-10.72096	-2.602185	-1.946072	2	-10.55005	-2.602185	-1.946072

Source: Prepared by the authors.

Note: Augmented Dickey-Fuller test (ADF) – the final choice of lag was made based on the Schwarz criterion (SC). No-constant specification or time trend was used for all series except SELIC whose constant was used. Phillips-Perron test – lag is the lag truncation chosen for the Bartlett kernel. No-constant specification or time trend was used for all series except AMPD whose constant and time trend were used.

FIGURE A1

Evolution and correlogram of the series[a]



Source: Treasury and central bank of Brazil.

[a] AC = autocorrelation, PAC = partial autocorrelation. The figures 1 to 21 indicate the number of lags. The ordinates record the autocorrelation and partial autocorrelation values.

TABLE A5

AIC, SIC and HQ criteria for VAR

VAR	with constant		no constant	
Order	SIC	HQ	SIC	HQ
0	22.43041	22.34540		
1	15.18016	14.75511	15.18027	14.84023
2	14.89359*	14.12851*	14.75558*	14.07551*
3	15.42656	14.32144	15.35733	14.33722
4	15.90623	14.46108	16.02932	14.66918
5	16.47140	14.68622	16.53693	14.83675

Source: Authors' estimates on the basis of the Schwarz (SIC) and Hannan-Quinn (HQ) criteria.

Note: (*) denotes lag order selected by the criterion.

TABLE A6

Granger causality test

VAR (2)

Null Hypothesis:	Obs	F-Statistic	Probability
DSELIC does not Granger Cause DAMPD	62	0.15207	0.85927
DAMPD does not Granger Cause DSELIC		0.40028	0.67200
DDIVINDEX does not Granger Cause DAMPD	62	0.55802	0.57544
DAMPD does not Granger Cause DDIVINDEX		0.03362	0.96696
DDEBGDP does not Granger Cause DAMPD	62	1.02862	0.36404
DAMPD does not Granger Cause DDEBGDP		0.16018	0.85237
DDIVINDEX does not Granger Cause DSELIC	62	0.74929	0.47730
DSELIC does not Granger Cause DDIVINDEX		7.63111	0.00116
DDEBGDP does not Granger Cause DSELIC	62	2.82503	0.06763
DSELIC does not Granger Cause DDEBGDP		1.20975	0.30581
DDEBGDP does not Granger Cause DDIVINDEX	62	0.86605	0.42607
DDIVINDEX does not Granger Cause DDEBGDP		2.41721	0.09826

Source: Authors' estimates.

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