academicJournals

Vol. 5(9), pp. 343-356, December, 2013
DOI: 10.5897/JEIF2013.0532
ISSN 2141-6672 © 2013 Academic Journals
http://www.academicjournals.org/JEIF

Journal of Economics and International Finance

Full Length Research Paper

Public debt, capital stock and economic growth: An analysis of fiscal sustainability in Brazil

Tito Moreira

Catholic University of Brasilia, Brazil.

Accepted 08 November, 2013

This article analyzes the fiscal sustainability of the Brazilian economy in recent decades. It evaluates the solvency of public debt in Brazil through the cointegration tests that showed a long-term relationship between public revenue and expenditure in the period of 1975 (I) to 2010 (II). The results show a solvency ratio between the Revenue / GDP ratio and expense / GDP ratio. That is, for each $ 1.00 spent per unit of product, one gets a return of $ 1, 0078 of revenue collected per unit of product. On the other hand, the total revenue and total expenditure (deflated by the IGP-DI) do not pass through the solvency test if revenue from seigniorage is not included, that is, for each $ 1.00 spent deflated by the IGP-DI, one gets a return of $ 0, 9922 of revenue collected deflated by the IGP-DI, a value less than $ 1.00. Furthermore, fiscal sustainability tests for the period 1964 to 2008 reveal two important results: i) an increase in debt/capital stock ratio negatively affects the growth rate of capital stock and also negatively affects the growth rate of the product; ii) fiscal policy is weakly sustainable which could lead to a possible problem of insolvency.

Key words: Fiscal solvency, fiscal sustainability, debt/capital stock ratio.

INTRODUCTION

The recent international financial crisis, known as the *subprime* crisis, which began with the mortgage crisis in the U.S. housing sector had impact the world affecting emerging and developed countries. In an attempt to alleviate the sharp drop in the level of economic activities, countries used countercyclical policies, including expansionary fiscal policies. Such policies resulted in high budget deficits and strong public sector debts increments. Part of the countries of the Euro zone has very delicate fiscal situation with Greece, Ireland, Spain and Portugal. This new fiscal situation of derangement of the European countries can compromise the socio-economic, political and institutional design of the European common market. In this context, the discussion on the fiscal fundamentals of economies is again back in vogue.

Brazil was strongly affected, especially in the last quarter of 2008 and 2009. At the time, the Brazilian Government adopted series of measures to minimize this effect. Taxes were reduced in the production of automobiles, white line goods, among others, and there was an increase of government spending, which resulted in a deficit and increase of the national debt and a reduction of the primary surplus. Expansionary monetary and credit policies lead to a strong reduction in interest rates and strong expansion of credit. This made Brazil to leave the crisis more quickly. However, such policies had costs to the economy. After a brief drop in the Selic in recent period, the trajectory of the expected interest rate is that of high interest rate, due to inflationary pressures. As Brazil practices one of the highest interest rates in the world and has been incurring in successive and persistent nominal deficits, the expected result is an increase of the stock of public debt. Moreira and Soares (2010) make a more detailed analysis for counter-

E-mail: titoeco@yahoo.com.br.

cyclical measures implemented by Brazil and the effectiveness of such policies.

In this context, this paper analyzes the solvability and sustainability of Brazilian public debt in two different periods. In the period 1975:1 to 2010:2, we analyze the inter-temporal Brazilian debt solvency through the analysis of cointegration between sets of financial execution of total government revenue and expenditure (quarterly data). We use the same methodological approach of Hamilton and Flavin (1986). In the period 1964-2008, we analyze whether the fiscal policy is sustainable in the long term on the basis of the evolution of the public debt (annual data). In this case we use the methodological approach of Buiter and Patel (1992).

With respect to the period, 1975:1 to 2010:2 exposed in the preceding paragraph, it is intended to examine whether the federal public debt is solvent based on changes in revenue and expenditure totals. If in the long run, the Government can raise at least $ 1.00 of revenue for each $ 1.00 spent, then it is said that the debt is solvent. The advantage of this methodology is that it does not use the stock of debt in the analysis. In this way, the problem of choice of the series of public debt between the various existing debts is avoided.

With respect to the period 1964-2008, it is intended to test whether the fiscal policy is sustainable in the long term on the basis of the evolution of the stock of public debt and also test if this stock contributes to the reduction in the rate of output growth. In this sense one can assess the impact of debt on the sustainable growth of the country. In addition, on the basis of the results achieved, it is intended to suggest a fiscal indicator that is related to the primary function of the State, which is to carry out public policies (where there are market failures) that contribute to improving the well-being of the population or to a sustainable development.

The size of the public debt depends on the Government's inter-temporal budget constraint, implying that the discounted present value of their primary spending (excluding, therefore, the financial burden) must not be greater than the initial value of its net wealth (discounted any initial debt) plus the discounted present value of future budgetary revenues. This is also a condition of debt solvency.

The concept of liquidity must also be considered. In this respect, an entity is said to be liquid if its assets and funding made available by the market are sufficient to honor the payment and/or scrolling and to amortize its loans (Days and Oreiro, 2008).

The sustainability of fiscal policy and, therefore, of public debt, in turn, is a concept that involves the notions of solvency and liquidity. Thus, the sustainability of a country's debt is given by its ability to pay its debt service, that is, the present value of the budget constraints without the necessity in the future to incur deep adjustments in the balance between its revenues and expenses. In this sense, the notion of sustainability, along the lines defined by IMF, admits that a particular country uses future settings so long as it is done in a gentle manner without abrupt changes in economic policy, that is, excludes situations of need for debt restructuring or debt accumulation beyond the ability to generate resources for the services of the same (Dias and Oreiro, 2008).

Ellery Lustosa da Costa (2009) notes that the concept of sustainability is associated with the long-term behavior of fiscal policy. He argues that many of the Governments ' solvency crises are characterized by short-term liquidity constraints. In this context, it must be considered that the analysis of the fiscal policy situation of a Government must understand both dimensions of the question; that is, short-and long-term issues.

The exhibition of this work occurs as follows: after this brief introduction, section 2 presents the results of the tests of solvency of public debt. Section 3 analyses fiscal performance indicators and the results of the tests of public debt sustainability and finally the conclusions.

Analysis of the results of the tests of solvency of debt

This section is dedicated to the study of inter-temporal Brazilian debt solvency through the analysis of Co integration between sets of financial execution of total government revenue and expenditure in the period 1975 quarterly: 1 to 2010: 2. The annual data from 1964 until 2008 was used to highlight the initial intention of this article . However, mainly due to restriction of information as to available database of government revenue and expenditure between the years of 1964 and 1974 and also due to methodological incompatibility issues between sets in two periods, we chose to work with quarterly data from 1975. Table A1 in annex I describes the variables and their respective sources. Government spending (National Treasury Expenditure Total) includes the expenditures for interest and debt charges and Government revenue (Total National Treasury Revenue) does not include the revenue from seigniorage. Governments can earn revenue as a result of its monopoly on the issuance of currency. In this sense, seigniorage is defined as a result of monetary expansion by the real monetary balances. This is the purchasing power of monetary expansion made by the Central Bank. This source of revenue, known as seigniorage, is the ability that the Government has to increase revenue through its right to create currency. The main motivation of the study is to verify if the public debt can be considered solvent in the long run, even after the seigniorage revenue decline occurred from 1994.

The Cointegration tests is to verify if there is a long-term relationship of 1 to 1 between total revenue received and the total expenses carried out. In this context, the public debt will be solvent if for each $ 1.00 expenses made, a return equal to or greater than R $ 1.00 of revenue collected. For the examination of Co integration, here are the approaches of Hamilton and Flavin (1986), Hakkio and Hush (1991) and Tanner and Liu (1994). These authors conducted several tests of unit root for the American economy, assuming a fixed interest rate. Tanner (1995) applies this approach to the case of Brazil in the period between 1976 and 1991. The author notes that reductions in real economic indexing, usually associated with anti-inflationary plans were followed by increase in government spending, leading to the perception that such reductions were used as implicit defaults; concluding then that the Brazilian fiscal policy in the period was non-sustainable in the long term.

Pastore (1995) identifies the increase in weight of seigniorage as an additional source of revenue to prevent the growth of public debt to become unsustainable in the first half of the decades of the 90s. In the same vein, Issler and Lima (2000) show that the sustainability of public debt in Brazil from 1947 to 1992 was achieved mainly due to the use of the seigniorage revenue. From the result of these works one can have an idea of the importance that the seigniorage revenue had from the first half of the 1990s to provide the equilibrium of the balance of public accounts.

Souza et al. (2007) investigate the Brazilian debt solvency in the long run and analyze the short-term dynamics of governmental revenue and expenditure since monthly data from January 1995 to July 2004. They conclude that the public debt is not solvent disregarding the seigniorage revenue.

Ellery Lustosa da Costa (2009) presents a good discussion on fiscal sustainability of public debt. The author shows several methodological aspects on the thematic such as the presence of uncertainty in the analysis.

After the monetary stabilization plan in 1994, the seigniorage as a source of revenue lost its importance, in contrast to the period prior to 1994, as the economy started to operate with low rates of inflation. Thus, if the fiscal authority cares about debt sustainability, it must propose increasing taxes (or cutting of expenses) to generate high primary surpluses. Currently, as the tax burden as a share of GDP already reaches very high rates (approximately 35% of GDP) the generation of such surpluses depend on pretty much the reduction/optimization of costs. Thus the expenditure control becomes the main instrument feasible to provide the continuity of primary surpluses in the magnitude necessary for continued falling debt/GDP ratio.

The following is on the solvency tests of the public debt in Brazil through the long-term relationship between public revenue and expenditure in the period, 1975 to 2010. Literature tests the relationship between expenditure and revenue in two ways: the first relates revenue and expenditure as a proportion of GDP and the second relates revenue and expense deflated by a price index. If in any of the two cases or in both cases the solvency hypothesis is validated, then it is added to the budget recipe of the *seigniorage revenue*. This is the procedure that is used in the following section.

Debt solvency tests based on test of co-integration of Johansen

Table A1 in the appendix shows the variables used in the co-integration models and their respective sources. Table A2 in the annex shows that the total revenue and expenditure as a proportion of GDP and deflated by the IGP-DI are not stationary according to ADF unit root test. These results are corroborated by the KPSS test. The ADF and KPSS tests are used to verify if the studied series are stationary. In case they are not, the Co-integration tests can be used; tests that permit the validation of the results of the regressions. Based on Johansen Co-integration tests, the long-term relationship between revenue and expenditure can be assed. We will test the two equations presented below:

$$Log(\mathrm{Re}\,c/PIB)_t = \beta_0 * Log(Desp/PIB)_t + u_t \quad (2.1)$$

$$Log(\mathrm{Re}\,c/IGP)_t = \beta_0 * Log(Desp/IGP)_t + u_t \quad (2.2)$$

The Johansen Cointegration tests presented in the annex show that each equation tested, (2.1) and (2.2), represented by the estimated equations (2.3) and (2.4) respectively, presents an equation of Co-integration tests to a significant level of 5%, as tables in annex (A3, A4, A5 and A6). We tested a good number of *lags* (lags of the variables) and the results show that they were selected for the equation (2.3) four *lags* by FPE (*Final prediction error*), AIC (*Akaike information criterion*), SC (*Schwarz information criterion*) and HQ (*Hannan-Quinn information criterion*).

The estimated long-term equation (2.3) shows the estimated value of $\hat{\beta}_0 = 1{,}0078$ with a standard deviation of 0.0012 and a t-statistic of 86.4699, which is highly significant. This result indicates that the public debt is solvent, because there is a long-term relationship of 1 to 1. That is, for each $ 1.00 spent per unit of the product, one gets a return of $ 1, 0078 (+/-0.0012) revenue collected per unit of product.

$$Log(\mathrm{Re}\,c/PIB)_t = 1{,}0078 * Log(Desp/PIB)_t \quad (2.3)$$

For the estimated equation (2.4), the results show that two lags were selected on the basis of SC (*Schwarz information criterion*). The estimated long-term equation

(2.4) shows the estimated value of $\hat{\beta}_0 = 0,9922$ with a standard deviation of 0.0048 and a t-statistic of 208.027, which is also highly significant. This result indicates that the public debt is not solvent, because there is no relationship in the long term of 1 to 1. That is, for each $ 1.00 spent deflated by the IGP-DI there is a counterpart of R $ 0, 9922 (+/-0.0048) revenue collected deflated by the IGP-DI, less than the R $ 1, 00. We will test this same model including seigniorage revenues, according to equation (2.5).

$$Log(\mathrm{Re}c / IGP)_t = 0,9922 * Log(Desp / IGP)_t \quad (2.4)$$

In the same way of equation (2.4), the results show that the estimated equation (2.5), which includes total revenue from seigniorage, Rec *, also had two *lags* selected based on the criterion of SC (*Schwarz information criterion*). The estimated long-term equation (2.5) shows the estimated value of $\hat{\beta}_0 = 1,0170$ with a standard deviation of 0.0077 and a t-statistic of 132.718, which is also highly significant. This result indicates that the public debt is solvent when included in the recipe of the revenue from seigniorage, by presenting a $\hat{\beta}_0 = 1,0170$ (+/-0.0077) more than a unit.

$$Log(\mathrm{Re}c * / IGP)_t = 1,017 * Log(Desp / IGP)_t \quad (2.5)$$

The seigniorage is calculated by the difference of the monetary base deflated by the IGP-DI. Against the above, the results show empirical evidence that the debt is solvent. However, when one examines the relationship between the values of the spending and revenue deflated by the IGP-DI, the debt becomes solvent with the condition that it incorporates the seigniorage revenue. The fact is that in a fiduciary system, where Governments can earn revenue as a result of its monopoly on issuing currency, the debt will always be solvent. But if it is necessary to issue currency to make the debt solvent, the economy will have to bear more inflation. In other words, on a possible problem of short-term liquidity, for example, the Government can always use the seigniorage in Exchange for more inflation. The elevation of price levels of the economy is one of the costs that the society has to pay for none responsible fiscal policies.

Fiscal performance indicators and fiscal sustainability

This section addresses the second issue of this audit with respect to the best indicator to assess the sustainability of public debt. The debt/GDP ratio is a usual indicator of fiscal situation and, more specifically, public debt solvency. This relationship provides a relative measure between the debt and the size of the economy, since the surpluses potentially have a direct relationship with the total of goods and services that the economy can produce. This argument justifies the use of this indicator and considering the easy availability of data on debt and the GDP, its wide use could be understood.

The idea of debt sustainability is linked to the condition that the present value of debt approaching a positive value on a time horizon long enough. In this way, debt is solvent if the present value of the primary surpluses is identical to the value of the current debt, or if the present value of the primary surpluses is higher than the current value of the debt. In the first case, it can be said that the debt is solvent and in the second, that there is a strong solvency condition. In other words, the solvency condition ensures that the present value of the primary surpluses is equal to or greater than the current value of the debt. In this context, it is important that the economic agents believe that the country is capable of making sacrifices necessary to generate primary surpluses to ensure debt solvency condition. The size of this sacrifice depends directly on the proportion of wealth that will be used to achieve this condition. However the wealth is stock, while GDP is stream.

In this item, a comparative analysis between the ratio of debt stock with the capital stock and the stock of debt and GDP ratio (flow) will be made. Considering that the product (GDP) of a country depends on the use of production factors (labor, capital, natural resources, technology and entrepreneurship) capital stock can be used as an approximation (*proxy*) of wealth of a country. The higher the capital stocks of an economy, the greater the ability of the economy to generate (potentially) goods and services and, therefore, the greater the ability of generating primary surpluses to ensure the sustainability of public debt condition. Besides extraordinary situations such as wars or countercyclical policies to minimize serious economic crises, public debt is justified only if it is to increase the level of investment in the economy and, therefore, of its capital stock.

Filho points out in the preface of the book entitled "the national debt – the Brazilian experience" published in 2009 by the National Treasury Secretariat-STN that public debt is an appropriate instrument to finance public investment in construction of high cost assets and of long duration, such as a power plant, a sea port or a high ways. These public investments added to private investments together generate the capital stock of a nation. In this case, public debt allows you to distribute equitably between the present and future taxpayers the costs and risks of building assets that will generate income and benefits supposedly superior to its cost over a long period to several generations of taxpayers. The problems of high interest rates and defaults occur mainly

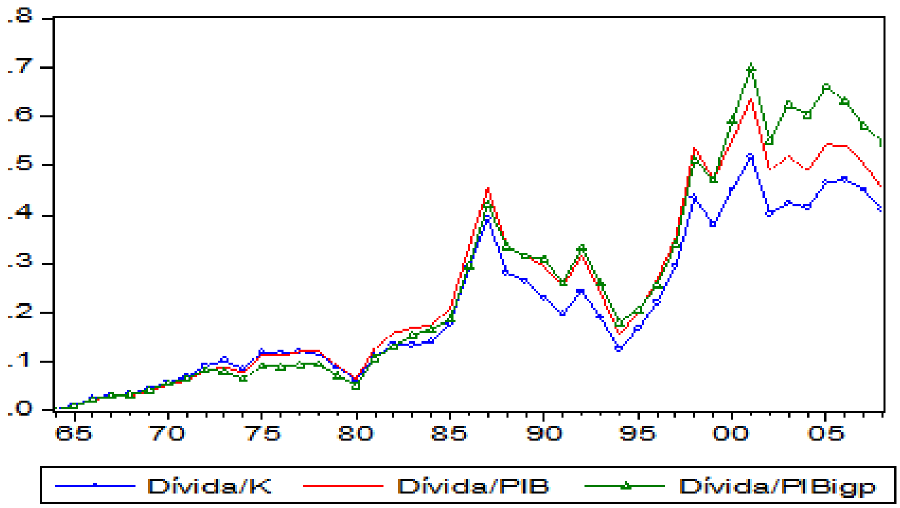

Figure 1. Evolution of public debt/capital stock and public /GDP ratio: (1964 – 2008). Note: K = Capital stock; PIBigp = GDP deflated by the IGP-DI. Data source: IPEA.

due to the continued misuse of public debt to finance the public deficit generated by expenditures on current expenditure. The payment of current expenses should normally be done with taxes rather than issuing public debt. To fund a large and growing proportion of public consumption with debt subject to interest payments means destroying the public wealth.

Against the above, one can infer that a higher debt-to-capital stock ratio suggests a bad use of the debt instrument. This may reflect a situation in which a country's public debt is being used mainly to pay interest or roll the debt at the expense of higher levels of public investment, which can compromise the ability of public debt.

The debt-to-capital stock ratio is used in the literature as important macroeconomic variable to determine the rate of growth of the economy, following the example of Araujo and Martins (1999). The authors show that the ratio between public debt and capital stock negatively affects the growth rate of the economy's capital stock, which is a *proxy* for the rate of growth of the product.

Figure 1 shows the evolution of the ratios- public debt/capital stock (Debt/K), public debt-to-GDP ratio (Debt/GDP) and public debt/GDP deflated by the IGP-DI (Debt/PIBigp). It is observed that the evolution of these three indicators is similar, that is, they increase and decrease at the same time, although in different proportions, as expected. This post, in addition to the qualitative differences (theoretical justifications) already presented, what distinguishes these series? The expected is that as the debt is stock and the capital also, this series should be less volatile or less dispersion than the series that compare public debt (stock) with product (flow). The information relating to the variables used in this section and their respective sources are provided in table A1 in annex. They are annual series for the period from 1964 to 2008. To relate debt with capital stock, it is more appropriate to use the total public sector debt. The capital stock of a country derives from public and private investment. In this way, public investment is not only the contribution of the Federal Government but also the States and the municipalities. However, the public sector debt is available only from 1981. Due to this data limitation, the federal public debt securities are used in this research.

Table 1 shows some descriptive statistics of the three series. As expected, the Debt/K ratio presents values for the mean and median lower than debt-to-GDP ratios and debt/PIBigp, because the amount of capital stock is usually higher than the GDP. In addition, the maximum and minimum value of the Debt/K ratio is less and higher respectively in respect of other indicators. This leads to a lower Debt/K ratio dispersion which can be attested by the small standard deviation and a small coefficient of variation. This result shows that the Debt/K indicator is more conservative in the sense of being less volatile. This means that when the ratio of debt and GDP increase or decrease debt/K ratio increases and decreases (respectively) in a more smoothly manner. In this way, one can intuit that the debt/K ratio better reflects a long-term situation. The GDP is more subject to cyclical fluctuations in the economy than the capital stock.

Table 2 shows a strong correlation between the three indicators under consideration. The values are greater than 98%.

A way to attest to greater softness of debt/K ratio compared to other indicators is to check the inclination of each series over the analysis period. In this way a tax

Table 1. Descriptive statistics.

	Debt/K	Debt/Gdp ratio	Debt/PIBigp
Average	21.34512	24.94770	26.05164
Median	16.75097	20.13716	18.68270
Maximum Value	51.69384	63.75717	69.89566
Minimum Value	0.153375	0.135499	0.132641
Standard Deviation	15.38227	18.83309	21.65977
Coefficient of variation	72.06%	75.49%	83.14%

Note: compiled by author.

Table 2. Correlation matrix.

	Debt/K	Debt-To-Gdp ratio	Debt/PIBigp
Debt/K	1.000	0.996	0.988
Debt/Gdp Ratio	0.996	1.000	0.989
Debt/PIBigp	0.988	0.989	1.000

Note: compiled by the author.

Table 3. Results of the Regressions for equation (3.1).

	Debt/K (3.2)	Debt/GDP (3.3)	Debt/PIBigp (3.4)
Constant	-0.0204 (0.0192)	-0.0385 (0.0228)	-0.0726 (0.0255)
Trend (*Trend*)	0.0106 (0.0007)	0.0131 (0.0009)	0.0151 (0.001)
R^2	82.36%	83.3%	84.28%

Source: compiled by the author. Note: values in parentheses = standard deviation.

indicator regression against time will reveal which series has the slightest inclination $\hat{\beta}_1$ as specified below:

$$(IndicadorFiscal)_t = \beta_0 + \beta_1 * Trend + u_t \quad (3.1)$$

The three regressions presented in Table 3 are stationary waste, indicating that the regressions are not spurious. For the three regressions, (3.2, 3.3 and 3.4), the estimated coefficients of the trend (*Trend*) $\hat{\beta}_1$, are statistically significant at 1% level. It could be observed that the estimated slope coefficient on the trend regression (3.2), whose dependent variable is Debt/K at the value of 0, 0106 worth less than the other estimated values of regressions (3.3) and (3.4) whose estimated values are respectively 0.0131 and 0.0151. These last two coefficients refer to the regressions which dependent variables are debt/GDP and debt/PIBigp respectively. The Wald test shows that the value of 0, 0106 is statistically different from 0.0131 at the significant level of 1%; that is 0. 0106 < 0.0131.

Against the above, it can be confirmed a smoother debt/K series in relation to other series of Debt/GDP ratio. This means that when the Debt/GDP ratio is increasing, the Debt/K ratio also increases, but in a smaller proportion. In this way the Debt/GDP ratio may be overestimating the improving fiscal situation. On the other hand, when the debt-to-GDP ratio is reducing, the debt ratio/K also decreases, but in a smaller proportion. In this way the debt-to-GDP ratio may be overestimating the improving fiscal situation. In the subsection below, tests for fiscal sustainability for the period 1964 to 2008 are developed

Fiscal sustainability tests

As already mentioned in the previous section, there are advantages of using Debt/Capital Stock indicator in relation to Debt/GDP indicator without disregarding the latter since it is much easier to get information of GDP than capital stock. In addition, there is a strong correlation between the Debt/GDP ratios and Debt/Capital Stock. That said, in this subsection the Debt/Capital Stock ratio will be used to assess solvency and fiscal sustainability issues. The stock of public sector fixed capital available in IPEA is a result from studies of researchers working with the theme, making it a necessity for the availability of information by the official organ. As IBGE is the entity responsible for national accounts, it is essential that it provides the fixed capital stock series of public sector and total fixed capital stock of the Brazilian economy, which includes the stock of fixed capital in the private sector. The ideal is to provide fixed capital stock data from the public sector and the private sector separately.

Literature shows that there are several ways to test the fiscal sustainability. A good review and analysis on fiscal sustainability tests are presented by Luporini (2006). We use specifically the approach of Buiter and Patel (1992), also described by Luporini (2006). Then we develop the approach of modeling Buiter and Patel (1992) and also show that of Araujo and Martins (1999). This model reveals that the public Debt/Capital Stock negatively affects the growth rate of capital stock. Similarly, you can also test if the proportion of debt to capital stock negatively affects the growth rate of the product.

Buiter and Patel (1992) propose, on the basis of article of Wilcox (1989), a strong solvency criterion that apart from debt stationary, it cannot have a positive trend, stochastic or deterministic. The test consists of estimating the equation shown below:

$$B_t = \alpha_0 + \alpha_1 trend + \sum_{i=1}^{\infty} \beta_i B_{t-i} + \varepsilon_t \qquad (3.2)$$

Where B is the public debt, trend ism tendency and ε the stochastic term. The insolvency can occur if at least one of the following conditions is met, according to Buiter and Patel (1992):

i) The roots of $1-\beta(L)$ not all outside of the unit circle, that is, the differential equation is not stable;
ii) There is a deterministic trend, such that $\alpha_1 \neq 0$, and the coefficient is possibly positive;
iii) The average expectation is non-null, that is, $\alpha_0 \neq 0$ such that the process that governs the debt can be stationary, but its expectation average is not null.

Still following Buiter and Patel (1992) equation 3.2 can be simplified as follows:

$$B_t = \alpha_0 + \alpha_1 trend + \beta_1 B_{t-1} + \varepsilon_t \qquad (3.3)$$

Where the null hypothesis of insolvency is given by $\beta_1 = 1$ and $\alpha_1 = 0$. In this context, we have that:

i) If the null hypothesis is not rejected, the discounted debt is not stationary, fiscal policy is unsustainable and will lead to insolvency proceedings if such a situation continues indefinitely;
ii) If the null hypothesis is rejected but there is a deterministic trend, fiscal policy is weakly sustainable because possibly the low insolvency problem will arise;
iii) If the null hypothesis is rejected and you cannot reject $\beta_1 < 1$ and $\alpha_1 = 0$ then if there is a positive average such that $\alpha_0 > 0$ Once again, such a situation will lead to an eventual insolvency.

Buiter and Patel (1992) make an extension (generalization) of the statistical modeling of Wilcox (1989) using techniques developed by Phillips and Perron (1988). They show that $\alpha_0 < 0$ and $\alpha_0 = 0$ are conditions consistent with the strong solvency and the solvency situations respectively. Therefore, if $\alpha_0 > 0$ then the discounted debt value is positive. That way there are no conditions of the present value of the debt to be paid, whether via current and future primary surpluses, either by current and future seigniorage[1].

The equation (3.3) can be normalized by the outdated capital stock K_{t-1} such that,

$$b_t = \alpha_0 + \alpha_1 trend + \beta_1 b_{t-1} + \varepsilon_t \qquad (3.4)$$

Where: $b_t = B_t / K_{t-1}$. The equation (3.4) for being estimated eliminating the effects of economic cycles by adding the output gap h_t obtained via HP filter as follows:

$$b_t = \alpha_0 + \alpha_1 trend + \beta_1 b_{t-1} + \delta * h_t + \varepsilon_t \qquad (3.5)$$

That done, it is intended to relate Debt/Capital Stock ratio with the growth rate of this stock, $K_t - K_{t-1} / K_{t-1}$. Araujo and Martins (1999) demonstrate that it is possible to have a long-term sustainable growth in a sector model with overlapping generations. They assume a convex technology, without redistribution of income from the older generation to the younger, via income tax and no pure altruism a la Barro (1974). Working with a production function AK and assuming an hypothesis in which the agent's utility function incorporates an absolute inheritance reason, the authors derive a clear policy implication of the model: an increase in government debt negatively affects the growth rate of capital stock such that,

$$\frac{K_t - K_{t-1}}{K_{t-1}} = \frac{\delta\ A - 1}{1+\delta} - \frac{B_t / K_{t-1}}{(1+A)(1+\delta)} \qquad (3.6)$$

Where K_t is the capital stock at the beginning of period t,

[1] We follow the approach of Luporini (2006) on solvency criterion of Buiter and Patel (1992) up to this paragraph.

Table 4. Dependent variable: Public Debt (t)/Capital Stock (t-1) estimated (3.4) via GMM with Kernel: Bartlett, Bandwidth: Fixed (System 1A).

Variables	Coefficients	Standard deviation	T-statistic	Value prob.
Constant	-0.0007	0.0063	-0.1049	0.9167
Trend	0.0039	0.0007	5.6305	< 0.0001
Debt (t-1)/K (t-2)	0.6244	0.0663	9.4140	< 0.0001
R^2	0.8783		Adjusted R^2	0.8716

Note: instruments b (-2, -3, -4, -5), (-2, -3, -4, -5), constant. Source: drawn by author.

Table 5. Dependent variable: growth rate of capital stock estimated (3.7) via GMM Kernel: Bartlett, Bandwidth: Fixed (System 1A).

Variables	Coefficients	Standard deviation	T-statistic	Value prob.
Constant	0.0963	0.0113	8.5038	< 0.001
Debt (t)/K (t-1)	-0.1977	0.029	-6.8062	< 0.001
R^2	0.4108		Adjusted R^2	0.3949

Note: instruments *b*(-2, -3, -4, -5), (-2, -3, -4, -5), $\hat{k}$ (-2,-3,-4,-5) *Constant.* Source: Elaborated by author.

B_t is the stock of government debt at the beginning of period t. A represents the technology and the coefficient δ indicates the agents ' preferences. This equation shows that the growth rate of the stock of capital is endogenous. In this context, the flow of debt financing as a proportion of capital stock in the previous period negatively affects the rate of capital accumulation. This result is due to the dislocation effect of the reduction of productive investment as a result of the increase in public debt.

The equation (3.6) can be rewritten as follows:

$$\hat{k}_t = \gamma_0 - \gamma_1 * b_t + u_t \qquad (3.7)$$

Where, $\hat{k}_t = K_t - K_{t-1} / K_{t-1}$, $\gamma_0 = \frac{\delta\ A-1}{1+\delta}$, $\gamma_1 = \frac{1}{(1+A)(1+\delta)}$ and u_t is the stochastic term.

So we can estimate equations (3.4) and (3.7) in the form of system via GMM (Tables 4 and 5: System 1A) and then estimate equation system (3.5) and (3.7) via GMM (Tables 6 and 7: System 1B). A similar methodology is used by Moreira (2009, 2011).

Estimation of the systems of two equations via GMM: 1A and 1B

The results presented in Table 4 show that all variables are statistically significant at 1% level, except for the constant. It can be observed that the null hypothesis is rejected, where Ho: $\beta_1 = 1$ and $\alpha_1 = 0$ because $\hat{\beta}_1 = 0{,}6244\ (+/-0{,}0663) < 1$ and $\hat{\alpha}_1 = 0{,}0039\ (+/-0{,}0007) > 0$. In this context, as the null hypothesis is rejected, but there is a positive deterministic trend, $\hat{\alpha}_1 > 0$ the fiscal policy is weakly sustainable, because eventually the problem of insolvency will appear (case ii)

It can be observed that the dependent variable of Table 4, (Debt (t)/K (t-1), receives feedback from the dependent variable of Table 5, growth rate of Capital stock, $\hat{k}_t$. The variable Debt (t)/K (t-1) is also an independent variable in Table 5 that impacts $\hat{k}_t$ forming a system.

The GMM method applied jointly to the two equations in the form of the system leads to the statistics presented in Tables 4 and 5. The specification of the model is tested by J statistic associated with identified constraints. The value J of 0.212 statistics with a *p-value* of 0.925 does not indicate evidence to reject the model specification.

The results presented in Table 5 show that all the estimated coefficients are statistically significant at 1% level. It is noted that there is a negative relationship between the stock of debt/capital stock and the rate of growth of capital stock. The estimated coefficient equation (3.7) is $\hat{\gamma}_1 = -0{,}1977$. This result is consis-

Table 6. Dependent variable: public debt (t) /capital stock (t-1) estimated (3.5) via GMM with Kernel: Bartlett, Bandwidth: Fixed: (System 1B).

Variables	Coefficients	Standard deviation	T-statistic	Value prob.
Constant	-0.0133	0.0202	-0.6588	0.5122
Trend	0.0061	0.0019	3.2688	0.0017
Debt (t-1)/K (t-2)	0.4536	0.1344	3.3754	0.0012
Output Gap	5, 76E-07	2, 62E-07	2.1964	0.0313
R^2	0.8244		Adjusted R^2	0.8093

Note: instruments *b*(-2, -3, -4, -5), (-2, -3, -4, -5), $\hat{k}$ (-2,-3,-4,-5), *Constant.* Source: Elaborated by the author.

Table 7. Dependent variable: growth rate of capital stock estimated (3.7) via GMM Kernel: Bartlett, Bandwidth: Fixed: (System 1B).

Variables	Coefficients	Standard deviation	T-statistic	Value prob.
Constant	0.0913	0.0106	8.5747	< 0.001
Debt (t)/K (t-1)	-0.1852	0.0279	-6.6461	< 0.001
R^2	0.4252		Adjusted R^2	0.4097

Note: instruments *b*(-2, -3, -4, -5), $\hat{k}$ (-2, -3, -4, -5), *Constant.* Source: elaborated by the author.

tent with the model prescribed by Araujo and Martins (1999), that is, debt as a proportion of capital stock in the previous period negatively affects the rate of capital accumulation. This is due to the displacement effect (crowding *out* effect) on the reduction of productive investment as a result of the increase in public debt. An increase in public debt implies a reduction in national savings, which is on a lower level of investment.

The estimates presented in Tables 6 and 7 are distinguished from the previous (Tables 4 and 5: by appending the output gap in the equation that tests the fiscal sustainability, as equations (3.5) and (3.7). By this way you can also test the robustness of the results, that is, check whether the results of estimates of the two systems are similar.

Based on the results presented in Table 6, it is noticed that all the variables are statistically significant at 5% level, except for the constant. The null hypothesis is rejected, H_o : $\beta_1 = 1$ and $\alpha_1 = 0$ because $\hat{\beta}_1 = 0{,}4536\,(+/-0{,}1344) < 1$ and $\hat{\alpha}_1 = 0{,}0061\,(+/-0{,}0019) > 0$. In this way we obtain a similar result to the previous one, where the null hypothesis is rejected, but there is a deterministic trend positive, $\hat{\alpha}_1 > 0$ which implies a weakly sustainable fiscal policy, since eventually the problem of insolvency (case ii) will appear.

The GMM method applied jointly to the two equations in the form of the system leads to the statistics presented in Tables 6 and 7. The specification of the model is tested by J statistic associated with identified constraints. The statistical value J of 0.201 with a *p-value* of 0.95 does not indicate evidence for rejecting the model specification.

The results presented in Table 7 show that all the estimated coefficients are statistically significant at 1% level. There is a negative relationship between the debt/capital stock ratio and the rate of growth of capital stock. The estimated coefficient equation (3.7) is $\hat{\gamma}_1 = -0{,}1852$. This result is consistent with the previous one, where debt as a proportion of capital stock in the previous period negatively affects the rate of capital accumulation.

The results presented in the two systems converge: i) the fiscal policy is weakly sustainable which could lead to a possible problem of insolvency proceedings; ii) debt as a proportion of capital stock in the previous period negatively affects the rate of capital accumulation.

Considering that $Y_t = AK_t$, equations (3.6) and (3.7) can be rewritten as follows:

$$\frac{Y_t - Y_{t-1}}{Y_{t-1}} = \frac{\delta\ A - 1}{1+\delta} - \frac{B_t / K_{t-1}}{(1+A)(1+\delta)} \qquad (3.8)$$

Where Y_t is the product at the beginning of period t. Equation (3.8) can be rewritten as follows:

Table 8. Dependent variable: Public Debt (t)/ Capital Stock (t-1) estimated (3.4) via GMM with Kernel: Bartlett, Bandwidth: Fixed: (System 2A).

Variables	Coefficients	Standard deviation	T-statistic	Value prob.
Constant	0.0064	0.0080	0.7961	0.4286
Trend	0.0025	0.0008	3.1998	0.0020
Debt (t-1)/K (t-2)	0.7371	0.0713	10.3381	< 0.0001
R^2	0.8779		Adjusted R^2	0.8712

Note: instruments *b*(-2, -3, -4, -5), $\hat{y}$ (-2, -3, -4, -5), Constant. Source: elaborated by the author.

Table 9. Dependent variable: Growth Rate of product estimated (3.9) via GMM Kernel: Bartlett, Bandwidth: Fixed: (System 2A).

Variables	Coefficients	Standard deviation	T-statistic	Value prob.
Constant	0.0681	0.0112	6.0890	< 0.001
Debt (t)/K (t-1)	-0.0998	0.0362	-2.7599	0.0073
R^2	0.1308		Adjusted R^2	0.1073

Note: instruments *b*(-2, -3, -4, -5), $\hat{k}$ (-2, -3, -4, -5), *Constant.* Source: elaborated by the author.

Table 10. Public Debt (t)/ CapitalStock (t-1) estimated (3.5) via GMM with Kernel: Bartlett, Bandwidth: Fixed: (System 2B).

Variables	Coefficients	Standard deviation	T-statistic	Value prob.
Constant	-0.0015	0.0170	-0.0888	0.9295
Trend	0.0039	0.0016	2.3733	0.0203
Debt (t-1)/K (t-2)	0.6099	0.1106	5.5139	< 0.001
Output Gap	3, 55E-07	1, 64E-07	2.1636	0.0338
R^2	0.8628		Adjusted R^2	0.8511

Note: instruments *b*(-2, -3, -4, -5), $\hat{y}$ (-2, -3, -4, -5), Constant. Source: elaborated by the author.

$$\hat{y}_t = \gamma_0 - \gamma_1 * b_t + u_t \qquad (3.9)$$

Where $\hat{y}_t = (Y_t - Y_{t-1})/Y_{t-1}$ the growth rate of the product $\gamma_0 = \frac{\delta\ A-1}{1+\delta}$, $\gamma_1 = \frac{1}{(1+A)(1+\delta)}$ and u_t is the stochastic term. So the previous procedure can be repeated and equations (3.4) and (3.9) can be estimated in a form of a system via GMM (Tables 8 and 9: System 2A) and then estimate the equation system (3.5) and (3.9) via GMM (Tables 10 and 11: System 2B). The difference in the two previously estimated systems in Tables 4 to 7 is that now the equation of Araujo and Martins (1999) has as its dependent variable the output growth rate instead of the rate of growth of capital stock. Once again the robustness of the results can be tested. Similar results can be expected since there is a strong association between the two variables, $\hat{k}_t$ and $\hat{y}_t$.

Estimation of the systems of two equations via GMM: 2A and 2B

Except the constant, the other coefficients are statistically significant at 1% level. Once again the null hypothesis is rejected, H_0: $\beta_1 = 1$ and because and $\alpha_1 = 0$, because

Table 11. Dependent variable: Growth Rate of the product estimated (3.9) via GMM Kernel: Bartlett, Bandwidth: Fixed: (System 2B).

Variables	Coefficients	Standard deviation	T-statistic	Value prob.
Constant	0.0644	0.0102	6.3353	< 0.001
Debt (t)/K (t-1)	-0.0877	0.0326	-2.6903	0.0089
R^2	0.1275		Adjusted R^2	0.1040

Note: instruments b(-2, -3, -4, -5), $\hat{y}$ (-2, -3, -4, -5), constant. Source: elaborated by the author.

$\hat{\beta}_1 = 0,7371\,(+/-0,0713) < 1$ and $\hat{\alpha}_1 = 0,0025\,(+/-0,0008) > 0$. So there is the case where fiscal policy is sustainable weakly, since eventually the problem of insolvency (case ii) will appear.

The GMM method applied jointly to the two equations in the form of system leads to the statistics presented in Tables 8 and 9. The specification of the model is tested by J statistic associated with identified constraints. The J value of 0.182 with statistics p-*value* of 0.90 does not indicate evidence for rejecting the model specification. The second system equation shows, based on Table 9, that all the estimated coefficients are statistically significant at the 1% level and that the debt/capital stock ratio lagged negatively affects the rate of output growth, with an estimated coefficient $\hat{\gamma}_1$ = -0.0998.

The introduction of output gap does not change the results, according to the results of Table 10. Note that all the estimated coefficients are statistically significant at 5% level, except the constant, and that $\hat{\beta}_1 = 0,6099\,(+/-0,1106) < 1$ and $\hat{\alpha}_1 = 0,0039\,(+/-0,0016) > 0$. It is obtained in this way that fiscal policy is sustainable weakly, since eventually the problem of insolvency (case ii) will appear.

The GMM method applied jointly to the two equations in the form of the system leads to the statistics presented in Tables 10 and 11. The specification of the model is tested by J statistic associated with identified constraints. The statistical value J of 0.159 with a *p-value* of 0.90 does not indicate evidence for rejecting the model specification.

And, finally, Table 11 shows that all the estimated coefficients are statistically significant at the 1% level and that the lagged debt/capital stock ratio negatively affects the growth rate of the product with an estimated coefficient $\hat{\gamma}_1$ = -0.0877.

The main results presented show that fiscal policy is sustainable weakly, because eventually the problem of insolvency will be appearing. It is noted also that there is a negative relationship between the stock of debt/capital stock and the rate of growth of capital stock. Similarly, it was confirmed a negative relationship between the proportion of debt stock/capital stock and output growth rate.

In the introduction of this article, it was shown a concern about the impact of the federal government public debt on the sustainable development of the country. In this context, we find empirical evidence that reinforces this concern, that is, the increase of debt/capital stock ratio contributes to the reduction of rates of output growth. These results show that increased debt reduces the ability to pay the debts in the long run, since it contributes to a reduction of growth rates of GDP and capital stock. Such empirical evidences are consistent with the result that the fiscal policy in the period under examination is weakly sustainable.

Conclusion

With regard to the solvency of public debt in Brazil the cointegration tests in the period that comprises the first quarter of 1975 to the second quarter of 2010 showed that the long-term relationship between Revenue/GDP ratio and expense/GDP ratio passed in the solvency test. In other words, for each $ 1.00 spent per unit of product one gets a return of $ 1, 0078 of revenue collected per unit of product. On the other hand, the long-term relationship between total revenue and total expenditure (deflated by the IGP-DI) does not pass the test of solvency, that is, for each $ 1.00 spent deflated by the IGP-DI one gets a return of $ 0, 9922 of revenue deflated by the IGP-DI, value less than $ 1.00. However, including revenue from seigniorage, the result shows an estimated revenue value deflated by the IGP-DI equivalent to $ 1, 0170. This result indicates that public debt is solvent by including in the recipe, the Government gain with the seigniorage. In this context, future research may use cointegration tests with structural breaks to compare with results of this article.

With respect to the public debt sustainability tests for the period 1964 to 2008 the results show that:

i) An increase in debt/capital stock ratio negatively affects the growth rate of capital stock and also nega-

tively affects the growth rate of the product;
ii) The fiscal policy is weakly sustainable which could lead to a possible problem of insolvency.

These results show that the fiscal expansion policy engendered by the Government to combat the subprime crisis must take into account a possible worsening of the fiscal situation. It should be remembered that an increase of the debt/GDP ratio or debt/capital stock leads to a fall in GDP growth rates and capital stock. In this way, it is more advisable to perform countercyclical fiscal policies rather than cyclical.
It is worth mentioning that the initial aim of this article was to use annual data from 1964 to 2008. However, mainly due to the restriction of information as well as the availability of database of government revenue and expenditure between the years of 1964 to 1974 and also due to methodological incompatibility issues between sets in two periods, we chose to work with quarterly data from 1975. In this way, the comparison of test results of Cointegration tests in the period that comprises the first quarter of 1975 until the second quarter of 2010 with fiscal sustainability tests based on annual data from 1964 until 2008 is not suitable.

ACKNOWLEDGEMENT

The authors would like to thank the CNPq (Conselho Nacional de Pesquisa – the National Research Council) for its financial support.

REFERENCES

ARAÚJO JT, e Marco A, Martins C (1999). "Economic Growth with Finite Lifetimes". *Econ. Letters*. 62:377-381,
BARRO RJ (1974). "Are government bonds net wealth?" *J. Political Econ.* 91:1095-1117.
CAPUTO SILVA A, Lena O, de Carvalho e Otavio L (2009). de Medeiros. Dívida Pública – A Experiência Brasileira, Ed. STN,
DIAS JAIME F, e José LOreiro (2008). Uma análise sobre a sustentabilidade de médio-prazo da dívida pública brasileira sob condições de risco (2008-2010), Disponível em Web-site: WWW.onkx.com/oreiro, acesso em 06/12/2010.
ELLERY LUSTODA DA COSTA, CARLOS E (2009). Sustentabilidade da dívida pública. In Dívida Pública – A experiência brasileira, Ed. STN 96.
HAKKIO CS, e M Rush (1991). Do I the budget deficit sound large?, *Econ. Inquiry* 24:429-445.
HAMILTON JD, e Flavin MA (1986). On the limitations of government borrowing: the framework goes empirical testing, *Am. Econ. Rev*. 76(4):808-816.
ISSLER JV, e LIMA LR (2000). Public debt sustainability and endogenous seignorage in Brazil: team serializes evidence from 1947-1992. *J. Deve. Econ.* 62:131-147.
MOREIRA TITO BS (2009). Mecanismos de Transmissão da Política Fiscal no Brasil: Uma Investigação Empírica. XIV Prêmio Tesouro Nacional 2009, Disponível em www.stn.fazenda.gov.br, acesso em 06/12/2010.
MOREIRA Tito BS (2001). Mecanismos de Transmissão da Política Fiscal no Brasil: Uma Investigação Empírica. *Revista de la Cepal*, forthcoming
MOREIRA TITO BS, e SOARES FERNANDO AR (2010). A Crise Financeira Internacional e as Políticas Anticíclicas no Brasil, XV Prêmio Tesouro Nacional 2010, Disponível em www.stn.fazenda.gov.br, acesso em 06/12/2010.
PASTORE Afonso C (1995). Public deficit and the sustainability of the growth of the national debt and it expresses, seignorage and inflation: an analysis of the Brazilian monetary regime, *Revista de Econometria*, 14:2
SOUZA GERALDO da S. e S, Tito BS, Moreira Joaquim R (2007). de Albuquerque. Intertemporal Solvency and Public Debt: Evidence from Brazil – 1995-2004. Planejamento e Políticas Públicas (IPEA) 2 (30): 7-14.
TANNER E, e P LIU (1994). Is the budget deficit "do I Sound Large?" It adds further evidence, *EcoN. Inquiry.* 7(23): 511-518.
TANNER E (1995). Intertemporal solvency and indexed debt: evidence from Brazil, 1976-1991, *J. Int. Money Financ.*14(4):549-573
WILCOX D (1989). The sustainability of government deficits: implications of the present-value borrowing constraint. *J. Money Credit Bank.* 21(3):291-306.
BUITER W, e R PATEL (1992). "Debt, deficits and inflation: an application to the public finances of India", *J. Public Econ.* 47 (1):171-205,
LUPORINI V (2006). Conceitos de Sustentabilidade Fiscal. Textos para Discussão, TD n° 189, UFF/Economia, Maio, Disponível em http:/www.uff.br/econ, acesso em 06/12/2010.
PERRON PHILLIPS PCB, e P (1988). "Testing for a Unit Roots in Time Series Regression", Biometrica 75 (2):335-46.
WILCOX D (2989). "The sustainability of government deficits: implications of the present-value borrowing constraint", *J. Money Credit Bank.* 21(8):291-306.

Annex

Table A1. Series Used and Source.

Variables	Source
Financial execution-recipes-total-$ (millions)	IPEA
Financial implementation-expenditure-total-$ (millions)	IPEA
GDP market prices-$ (millions)	IPEA
Monetary base M0-processing-order period-$ (millions)	IPEA
Deflator: Gpi-Ds	IPEA
Federal securities debt issued-national Treasury responsibility-order period-$ (millions)	IPEA
Basic prices GDP (deflator: GPI-DS)-$ (millions)	IPEA
GDP (2009 prices)-R $ (millions) 2009	IPEA
Fixed Capital stock liquid-total-$ 2000 (billions)	IPEA

Note 1: * code STN-2268; ** Code of STN-2276. Note 2: We use X-12-ARIMA, a method of seasonal adjustment, for removing the seasonal component of the times series.

Table A2. Unit root test: *augmented dickey-fuller* (ADF); null hypothesis: variable has unitary root.

Variable	5% critical value	T-statistic	Prob.
$Log(\mathrm{Re}\,c / IGP)^{c,trend}$	-3.443	-1.690	0.750
$Log(\mathrm{Re}\,c / IGP)^{c}$	-2.882	-0.125	0.943
$Log(Desp / IGP)^{c,trend}$	-3.444	-2.339	0.410
$Log(Desp / IGP)^{c}$	-2.883	-0.768	0.824
$Log(\mathrm{Re}\,c / PIB)^{c,trend}$	-3.443	-2.264	0.450
$Log(\mathrm{Re}\,c / PIB)^{c}$	-2.882	-0.516	0.883
$Log(Desp / PIB)^{c,trend}$	-3.444	-2.525	0.316
$Log(Desp / PIB)^{c}$	-2.883	-1.203	0.672
$Log(\mathrm{Re}\,c* / IGP)^{c,trend}$	-3.443	-1.123	0.921
$Log(\mathrm{Re}\,c* / IGP)^{c}$	-2.883	0.916	0.995

Notes: the variables were tested with constant (c) and with constant and trend (c, *trend*). If there is no call, means that the test was carried out without constant and without trend. *Rec* *= budget revenue + revenue from seigniorage.
Source: elaborated by the authors.

Table A3. Test of Cointegration tests of *Johansen* -series: Log (Rec/GDP); Log (Exp/Gdp).

Hypothesis: N° e. C (s)	Eigenvalue	Trace statistics	5% critical value	Value prob.
None *	0.0996	16.3847	12.3209	0.0099
At least 1	0.0145	2.0040	4.1299	0.1848

Note: Trace test indicates a Co integration tests equation (Ce) at the level of 5%. (*) = Indicates rejection of the null hypothesis (not cointegram series) to the level of 5%.

Table A4. Test of cointegration tests of *Johansen* -series: Log (Rec/GDP); Log (Exp/Gdp).

Hypothesis: N° e. C (s)	Eigenvalue	Statistics Max-Eigenvalue	5% critical value	Value prob.
None *	0.0996	14.3806	11.2248	0.013
Atleast 1	0.0145	2.0040	4.1299	0.1848

Note: Trace test indicates a test of Co integration tests equation (Ce) at the level of 5%. (*) = Indicates rejection of the null hypothesis (not cointegram series) to the level of 5%.

Table A5. Test of Cointegration tests of *Johansen* -series: Log (Rec/PGI); Log (Exp/IGP).

Hypothesis: N° E.C (s)	Eigen value	Trace statistics	5% critical value	Value prob.
None *	0.1513	25.6994	12.3209	0.0002
At least 1	0.0206	2.8901	4.1299	0.1054

Note: Trace test indicates a Test of Co integration tests equation (Ce) at the level of 5%. (*) = Indicates rejection of the null hypothesis (not cointegram series) to the level of 5%.

Table A6. Test of Cointegration tests of *Johansen* -series: Log (Rec/PGI); Log (Exp/IGP).

Hypothesis: N° e. C (s)	Eigen value	Statistics Max-Eigenvalue	5% critical value	Value prob.
No *	0.1513	22.8093	11.2248	0.0003
At least 1	0.0206	2.8901	4.1299	0.1054

Note: Trace test indicates a Test of Co integration tests equation (Ce) at the level of 5%. (*) = Indicates rejection of the null hypothesis (not cointegram series) to the level of 5%.