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ROGÉRIO DE MAICY BEZERRA

TIME VARYING TAX-SPEND NEXUS: EVIDENCE FROM BRAZIL

FORTALEZA
2020

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Dissertação submetida à Coordenação do Programa de Economia Profissional – PEP, da Universidade Federal do Ceará - UFC, como requisito parcial para a obtenção do grau de Mestre em Economia. Área de Concentração: Economia do Setor Público.

Orientador: Prof. Dr. Fabrício Carneiro Linhares

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RESUMO

O principal objetivo deste artigo é examinar a relação causal entre receita e despesa do governo no Brasil no período de janeiro de 1995 a maio de 2019. Diferentemente dos estudos anteriores, que assumem relação constante ao longo dos anos, este trabalho tenta usar o teste de causalidade de Granger para endogenamente capturar quebras estruturais no modelo e determinar a direção do relacionamento causal para cada subperíodo. Essa suposição é de grande importância para testar o nexo de despesas e receitas em países como o Brasil, que experimentaram vários eventos que mudaram significativamente a política fiscal em um horizonte de longo prazo e que a causalidade provavelmente mudará ao longo do tempo. Essa avaliação empírica tem relevância teórica e prática e pode ajudar a resolver adequadamente os desequilíbrios fiscais. Neste estudo, empregamos duas estatísticas de testes de Wald recentemente propostas por Shin *et al.* (2018), o teste Wald de janela rolante recursivo e o teste Wald de janela rolante de Swanson (1998). Os resultados refletem os paradigmas predominantes em diferentes períodos e dão suporte a hipótese de Sincronização Fiscal para o período até 2008. Para o período 2008 - 2011, marcado pela crise do *subprime*, prevaleceu a hipótese de Separação Institucional. Os resultados também oferecem suporte para hipótese Arrecadar-e-Gastar durante o período de 2011-2013 e Separação Institucional para os períodos de 2008-2011 e 2013-2015. Finalmente, a partir de 2015, quando o governo se esforçou ao máximo para reduzir gastos e encontrar novas fontes de receita, a hipótese de Gastar-e-Arrecadar prevaleceu. O novo quadro fiscal sugere que o Brasil está no caminho certo para controlar seu desequilíbrio fiscal.

Palavras-Chave: Receita. Despesa. Pública. Sustentabilidade do orçamento fiscal. Causalidade. Granger. Brasil.

ABSTRACT

The main purpose of this paper is to examine the causal relationship between government revenue and expenditure in Brazil over the period January 1995 to May 2019. Unlike previous studies, which assume constant relationship through the years, this work attempts to use Granger causality test to endogenously capture structural breaks in the model and to determine the direction of causal relationship for each subperiod. Such assumption is of great importance for testing revenue-expenditure nexus in countries like Brazil, which experienced several events that have significantly changed fiscal policy over a long-time horizon and the causality is likely to change over time. This empirical assessment has both theoretical and practical relevance and it can help properly address fiscal imbalances. In this study we employ two Wald test statistics recently proposed by Shin *et al.* (2018), the recursive rolling window Wald test and the rolling window Wald test of Swanson (1998). The results reflect the prevailing paradigms in different periods and provide support for Fiscal Synchronization hypothesis for the period up to 2008. For the period 2008-2011, marked by the subprime crisis, the Fiscal Synchronization hypothesis has prevailed. The results also offer support for Tax-Spend hypothesis for the period 2011-2013 and Institutional Separation for the periods 2008-2011 and 2013-2015. Finally, from 2015 onwards, when the government made utmost efforts to cut expenditures and to find new sources of revenue, the Spend-Tax hypothesis has prevailed. The new fiscal framework suggests that Brazil is in the right path to control its fiscal imbalance.

Keywords: Revenue. Expenditure. Public. Budget. Sustainability. Granger. Causality. Brazil.

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1 INTRODUCTION

Since the 1990s, Brazil has undergone several changes within its fiscal framework, but among other issues, the country was determined to bring a long period of super inflation to an end. After a history of failed stabilization plans, in July 1994 the Government launched the Real Plan. In this respect, the plan was quite successful and the inflation was curbed, however, country's public debt continued to grow. At this point, the country was engaged in the globalized world and the debate on the role of fiscal policy gained prominence in the conduct of macroeconomic policy and debt sustainability became the basic indicator of government fiscal health.

In late 2008, during Lula's second term, the country faces US mortgage crisis. In response to the financial crisis the government adopted counter-cyclical fiscal policies to regulate aggregate demand and boost economic recovery. Actually, most economies worldwide adopted the same strategy which entailed running large budget deficits. In October 2008, the government announced the reduction of the primary surplus target. During this period, both government spending was increased and taxes were reduced, however, the fiscal situation was under control.

In 2014, approximately two years prior to Dilma Rousseff's impeachment, the primary surplus target was further reduced and the country underwent substantial changes in its fiscal framework, thereby subsequent fiscal deficits led to a significant increase in the public debt. In December 2016, during Temer's administration, the government enacted the Constitutional Amendment 95, which established a spending ceiling for the federal budget. The new regulation imposes mandatory containment of the government expenditure until 2036. Despite the government's fiscal austerity, the country ended the year 2017 with a stunning debt of 80% of GDP.

With such remarkable events, we can argue that fiscal sustainability is the most suitable approach to achieving macroeconomic stability and, as such, it's very important to investigate the nature and the dynamic relationship between government expenditure and revenue. Notably, the revenue-expenditure nexus has been extensively addressed in recent years and the previous studies have been carried out along two different strands. The first strand employs Granger-causality techniques that assume a constant relationship, built on either linear or nonlinear cointegrating relationship between government revenues and expenditures. The main implication of this approach is that the revenue-expenditure nexus doesn't change over time

which is somehow a very strong assumption for data spanning long periods or during periods with events that have significantly changed fiscal policy, such as taxation policy or financing the social programs, pensions, healthcare, education, and so forth. Most of nonlinear model focus on changing relationship based on the debt or deficit level using a threshold model or whether the deficit are positive or negative. While the equilibrium relationship is allowed to change with the level of the threshold variable, the causality is considered fixed along these regimes. This approach has been addressed in the empirical studies of Enders & Granger (1998) and Enders & Siklos (2001), using TAR and M-TAR models, carried out a threshold cointegration test that allows for asymmetries in the adjustment process towards the long-run equilibrium, which involves testing the presence of threshold cointegration and, if confirmed, it proceeds to test whether the adjustment is asymmetric. Many others have also applied this method such as Narayan and Narayan (2006), Ndahiriwe and Gupta (2010), Ghartey (2010), Jibao *et al.* (2012) and Baharumshah *et al.* (2016), among others.

The second strand assumes that causal relationships between government revenue and expenditure are susceptible to change over the time series, therefore causality assessments based on the entire sample inevitably overlooks valuable information concerning the impact of changes in fiscal policy. Thus, it's crucial to determine structural breaks in the whole sample and the direction of causal relationships for each subperiod. The major difference in this approach is that the changes in causal relationships should not rely solely on the threshold level, but mostly on significant change on VAR parameters instead. In this study we follow the second strand by employing two Wald test statistics proposed by Shin *et al.* (2018), the recursive rolling window test and the rolling window test of Swanson (1998)

Our main objective is to examine this issue of causality between government revenue and expenditure in Brazil over the period January 1995 to May 2019. In particular we attempt to use Granger causality test to endogenously capture structural breaks or regime shifts in the model based on the assumption that causality is likely to change over time in countries like Brazil which have undergone several changes in fiscal policy over a long period of time. The findings of this study may contribute to the existing literature and the final empirical assessments may provide useful insights to properly understand and address fiscal imbalances.

The rest of the paper is structured as follows. Section 2 provides theoretical aspects on the revenues-expenditure nexus. Section 3 provides an overview of the fiscal system in Brazil. Section 4 articulates the empirical models used in the study. Section 5 presents the empirical results of the study. Section 6 provides a conclusion of this study.

2 THEORETICAL ASPECTS ON THE REVENUES-EXPENDITURE NEXUS

The empirical and theoretical literature divides the study of the causal relationship between revenues and government expenditure into four hypotheses. The first hypothesis of causality is the tax-spend hypothesis which was proposed by Friedman (1978) and Buchanan and Wagner (1978). According to this hypothesis, tax is the cause of government expenditure but these economists have different views about the direction of the causality. Friedman argues for a positive relationship and suggests that a decrease in taxes will reduce expenditure and eventually lower the fiscal deficit while an increase in tax is always followed by increases in expenditure which ultimately results in fiscal imbalances. On the other hand, Buchanan and Wagner (1978), contend for a negative relationship in which cuts in taxes would create a fiscal illusion and the costs of government may be consistently misinterpreted by the citizenry. This misinterpretation eventually would lead the public to demand for more public spending and, as result, increased expenditure and ultimately higher budget deficits. In terms of policy implications, the appropriate solution would be an increase in taxes as a way of financing such expenditures.

Some studies support tax-spend hypothesis such as the empirical works of Kollias and Makrydakis (2000) on Spain; Narayan (2005) on Indonesia, Singapore, Sri-Lanka and Nepal; Narayan and Narayan (2006) on Mauritius, El Salvador, Chile and Venezuela; Kollias and Paleologou (2006) on Italy and Spain; Afonso and Rault (2009) on Germany, Belgium, Austria, Finland and the UK, and on several EU New Member States; Ghartey (2009) on Kenya; Wolde-Rufael (2008) on Ethiopia, Ghana, Kenya, Nigeria, Mali and Zambia; Elyasi and Rahimi (2012) on Iran; Apergis, Payne and Saunoris (2012) on Greece; Mutascu (2016) on the Czech Republic, Hungary, and Slovenia.

The second hypothesis is the spend-tax hypothesis. Proposed by Peacock and Wiseman (1979) this theory argues that the level of spending is first determined by the government and then tax policy and revenue are increased to accommodate the desired level of spending. So, during periods of economic crisis, governments increase public spending to stimulate economic activity and eventually the temporary increases would lead to permanent increases in taxes. The policy implication in this situation is to reduce expenditures which would reduce taxes thereby lower the fiscal deficit. Barro (1979) also argues that budget deficit reduction can only be achieved

through reductions in expenditures. The spend-tax hypothesis is found in the empirical studies of Narayan and Narayan (2006) on Haiti; Kollias and Paleologou (2006) on Finland, France and the UK; Wolde-Rufael (2008) on Burkina-Faso; Afonso and Rault (2009) on Italy, France, Spain, Greece, and Portugal; SAYSOMBATH and KYOPHILAVONG (2013) on Lao PDR and MUTASCU (2016) on Bulgaria.

The third hypothesis of causality is the fiscal synchronization hypothesis which was proposed by Meltzer and Richard (1981). According to this hypothesis, expenditures and taxes are adjusted simultaneously and the causality is bidirectional and the policy implication in this situation is the government must take simultaneous decisions on revenues and expenditures in order to lower the fiscal deficit. The fiscal synchronization hypothesis is found in the studies of Kollias and Paleologou (2006) on Denmark, Greece, Ireland, the Netherlands, Portugal and Sweden; Wolde-Rufael (2008) on Mauritius, Swaziland and Zimbabwe; GHARTEY (2009) on South Africa and Nigeria; AREGBEYEN and INSAH (2013) on Nigeria and Ghana and MUTASCU (2016) on the Slovak Republic, support this hypothesis.

Finally, the fourth hypothesis is the institutional separation hypothesis proposed by Baghestani and McNOWN (1994). This theory argues that there is no causal relationship between revenues and government spending and the decisions concerning government revenue and expenditure are taken independently. This scenario reflects the institutional separation between the executive and legislative branches and thus decisions concerning government revenue and expenditure are taken independently.

The institutional separation hypothesis has been supported by the empirical findings of Kollias and Makridakis (2000) on Portugal; Kollias and Paleologou (2006) on Austria, Belgium and Germany; Narayan and Narayan (2006) on Peru, South Africa, Guatemala, Uruguay and Ecuador; Wolde-Rufael, (2008) on Botswana, Burundi and Rwanda; DADA (2013) on Nigeria and Mutascu (2016) on Estonia, Latvia, Lithuania, Poland, and Romania.

A tour of the empirical literature suggests that there are mixed findings on the relationship between government revenue and government expenditure. Several studies have investigated the revenue-expenditure nexus and the commonly used testing procedures generally fall into two categories: VAR (vector autoregression) and VEC (vector error correction) modelling. The first wave (80s and 90s) of VAR

models focused mainly in developed countries and the second wave mostly VAR and VEC for developing countries.

Fasano and Wang (2002) employed VAR and VEC models to investigate revenue-expenditure nexus for oil-dependent GCC countries and the results support evidence for tax-and-spend hypothesis in Bahrain, the United Arab Emirates and Oman while they found bidirectional causality for Kuwait, Qatar and Saudi Arabia. Kollias and Makrydakis (2000) examined this relationship in Greece, Portugal, Spain, Ireland and Chang *et al.* (2002) examine the same study in industrialized countries such as Taiwan, South Korea and Thailand. Narayan and Narayan (2006) found tax-and-spend hypothesis for Chile, Paraguay, Mauritius, El Salvador and Venezuela. For Haiti, fiscal synchronization hypothesis was discovered. Craigwell *et al.* (1994) examined government revenue and expenditure causality in Barbados. In another study, Li (2001) by applying VAR and VEC models for China found support for fiscal synchronization hypothesis.

3 AN OVERVIEW OF BRAZIL'S FISCAL SYSTEM

The 1980s, deemed the "lost decade", was a very troubled period for the Brazilian economy and was marked by a steady deterioration of purchasing power due to economic crisis, low growth and high inflation. During this period, the government implemented the "development pact", which was based on the growth of industrial production and infrastructure. The developmentalist state, in turn, required large investments and caused subsequent fiscal deficits. Thus, by 1989 the public debt had risen ten percentage points of GDP, which prompted the government to implement a reform, reduce its intervention in the economy and seek help from the IMF to increase domestic savings in the public sector.

Brazil in the 1990s dealt with multiple fiscal policies, but the monetary stabilization prevailed over the others. The country was engaged in the globalized world and the debate on the role of fiscal policy gained prominence in the conduct of macroeconomic policy.

Debt sustainability has become the basic indicator of government fiscal health. The opening up of trade and the withdrawal of federal government as growth driver demanded a prompt adaptation of the fiscal regime to the new world economic order, mainly due to the fiscal crisis that had dragged on since the 1980s.

During Fernando Henrique Cardoso's first term (1995-1998), fiscal policy efforts were directed towards the approval of constitutional amendments and legislation aimed at reducing the social security deficit and to control the fiscal expansion of subnational governments. However, there was less concern about direct control of revenues and expenses at the primary level. This situation of fiscal instability led the government to introduce the Fiscal Stability Plan aimed at limiting public spending and making it mandatory to define in the the Law of Budgetary Guidelines (Lei de Diretrizes Orçamentárias - LDO) the primary surplus target for next year and the indication for the two next years. The fiscal policy goal was to generate a primary surplus sufficient to produce the stabilization of the public debt/Gross Domestic Product (GDP) ratio. In Fernando Henrique Cardoso's second term (1998-2003), the government's fiscal austerity began to pay off as the government's accounts started having a primary surplus. From mid-2001 on, the total public sector deficit started to decrease. The Fiscal Stability Program was based mainly on the increase in the tax burden, as expenses continued to grow, given the

political difficulty in approving the law aimed at cutting back on expenditures. Despite this, structural reform efforts continued to be pursued in the second term, culminating in the approval of the Social Security Factor, part of the Administrative Reform and the Fiscal Responsibility Law (Lei de Responsabilidade Fiscal - LRF), which established limits on spending by the Union, states and municipalities, prohibiting the debt rollover to the successor.

In 2003, Luiz Inácio Lula da Silva takes over power. Lula's fiscal policy was carried out in different manners in both terms. In the first term, fiscal policy remained extremely restrictive and orthodox. The government sought to keep public debt on a short leash and consolidate sustained growth over time. New fiscal targets were announced in an attempt to increase investor confidence, and as a result the public sector started to register increasing primary surpluses year after year. In 2005, the federal government anticipated payments to the International Monetary Fund, adopting a strategy of exchanging external debt for domestic debt, relied on the issuance of government bonds. Free from the impositions of the IMF and with greater autonomy, the government allowed the expansion of public spending. During this period, the government reduced the primary surplus target and adopted an expansionary fiscal policy, through a policy of income redistribution (Bolsa Família Program), expansion of unemployment insurance and public investments. In 2007, the government launched the Growth Acceleration Program (Programa de Aceleração do Crescimento - PAC), a program that aimed to accelerate the country's growth and that provided for infrastructure investments in areas such as sanitation, energy, transport, housing and water resources.

In 2008 the country faces the US mortgage crisis, what was later dubbed as the "subprime crisis". Triggered by the collapse of a housing bubble, the subprime crisis began in US but spilled over to the international financial system and Brazil was no exception. Despite the crisis, the government maintained an expansionary fiscal stance as an inducer of growth and an instrument for regulating aggregate demand, especially in the period when private investment was reduced. In October 2008, the federal government announced the reduction of the primary surplus target. During this period, both government spending was increased and taxes were reduced. In 2010, government spending reached 16% of GDP, which corresponded to approximately 19% of GDP.

In 2010, President Dilma Rousseff takes the helm. In Dilma's government, fiscal policy was characterized by maintaining the social developmental policy of her predecessor. With regard to government spending, some areas suffered budget cutbacks, mainly those related to public investment and subsidized programs such as the housing program "Minha Casa Minha Vida". The primary surplus target was further reduced, however, investments and income transfers were not able to raise the level of aggregate demand nor did it provide the country's economic growth. Between 2013 and 2015, the subsequent fiscal deficits meant that the country was unable to pay the debt interest and the public debt experienced a significant increase. In 2015, after years of expansionary fiscal policy, in an attempt to balance public accounts, the country made a fiscal adjustment based on a reduction in public spending and an increase in the tax burden. From 2011 onwards, Brazil's GDP begins to show a declining trajectory, reaching the last quarter of 2015 with a drop in GDP of almost 6%. This year was also marked by the inversion of the political environment and Dilma Rousseff suffers a terrible blow and Brazil's senate voted to oust Dilma from the presidency and confirmed Michel Temer as the new country's leader.

Temer begins its term with the commitment to balance the federal budget by reducing the ceiling on public expenditure and approving pension reform legislation. Nevertheless, the government's response was an expansionary fiscal policy and public spending continued to grow. In December 2016 the government took a major step geared towards reducing fiscal imbalance and enacted the Constitutional Amendment 95, which created the New Fiscal Regime. Among other measures, the new legislation established a spending ceiling for the federal budget. Also known as "golden rule", the new regulation imposes mandatory containment of the Federal Government's expenditure until 2036. Under the new fiscal regime, government primary spending cannot increase more than the previous year's inflation rate, which is measured by consumer price index. Despite the government's fiscal austerity program, according to the Central Bank of Brazil, in October 2017, the country's gross public debt was close to 80% of GDP.

All in all, in recent years, the rampant fiscal deficit created uncertainties regarding the intertemporal sustainability of public debt. One of the key themes in the debate concerns understanding the time series dynamics between government

revenues and expenditures to better assess the fiscal policy aimed at fiscal deficit reduction.

4 EMPIRICAL APPROACH

In Brazil, during the 1997-2019 period, a number of events may have potentially changed the causal relationship between revenue and spending: the election of a president from a left-wing party in 2002, the financial crisis of 2007/2008, the sharp worsening of government budget balance in 2014, the impeachment of Dilma Rousseff in 2016, which also ended approximately 14 years of left-wing central government, and the recent economic crisis starting in 2017.

In a period with such remarkable events, the common approach to Granger causality testing would be the use of Wald test statistic computed for pre-determined sub-samples of the data. Although, this could provide some useful information, we could not test whether the change in the causal relationship truly occurred (despite the event, things could remain the same or change briefly) and we may lose change points that could be endogenously identified in the sample data. In the presence of structural breaks, one of the approaches that can be found in the theoretical literature is regime switching model such as the Markov switching model introduced by Hamilton (1988) and threshold autoregression models (GRANGER; TER SVIRTA, 1994; TER SVIRTA, 1998). Regime switching models can be used for a Granger causality analysis; however, they do not allow multiple structural breaks with possible shifts in parameters in each time period.

For time-varying Granger causality tests a good alternative is the rolling window estimation approach of Balcilar *et al.* (2010) and Swanson (1998), the recursive rolling estimation approach of Hurn *et al.* (2016) and Shi *et al.* (2018). Each of these has its advantages and potential shortcomings. To explain the time-varying causality tests conducted for the causality in the Tax-Spend nexus, consider the following bivariate P-th order vector autoregression:

$$r_t = \varphi_{10} + \sum_{i=1}^p \varphi_{11(i)} \cdot r_{t-i} + \sum_{i=1}^p \varphi_{12(i)} \cdot s_{t-i} + \epsilon_{r,t-i}$$

$$s_t = \varphi_{20} + \sum_{i=1}^p \varphi_{21(i)} \cdot s_{t-i} + \sum_{i=1}^p \varphi_{22(i)} \cdot r_{t-i} + \epsilon_{s,t-i}$$

where r_t and s_t are total government revenue and spending, respectively, p is the lag order, $er,t-i$ and $es,t-i$ are white noise error terms, and $t=1, 2, \dots, T$. When spending is important in predicting future values of revenue, then spending is said to cause revenue in Granger's sense, and vice versa. In this system of equations, the null hypotheses of interest are:

$$\begin{aligned} H_0 : s_t &\not\rightarrow r_t & \varphi_{12,1} = \varphi_{12,2} = \varphi_{12,3} = \dots = \varphi_{12,J} &= 0 \\ H_0 : r_t &\not\rightarrow s_t & \varphi_{21,1} = \varphi_{21,2} = \varphi_{21,3} = \dots = \varphi_{21,J} &= 0 \end{aligned}$$

where $(y \text{ DNGC } x)$ means y_t does not Granger cause x_t . Rejection of $H_{rs,0}$ ($H_{sr,0}$) is evidence of the Tax-and-Spend (Spend-and-Tax) hypothesis. Rejection of both $H_{rs,0}$ and $H_{sr,0}$ implies fiscal synchronization and failing to reject both null hypotheses means institutional separation.

In general terms, the traditional Wald test statistic has been employed to assess the null hypothesis $H_{rs,0}$, or $H_{sr,0}$ in most of the previous literature, generally under the assumption that the Granger causality does not change over the sample period. This is somehow a very strong assumption for data spanning long periods or during periods with events that have significantly changed fiscal policy. In this study, we employ two Wald test statistics recently proposed by Shin *et al.* (2018), the recursive rolling window Wald test and the rolling window Wald test of Swanson (1998), to determine and date changes in Granger causal direction that may have occurred within the full sample.

These tests involve calculations of the relevant test statistics for a sequence of subsamples of the data and their main difference is how this sequence is determined. Both tests are preferred also due to their strengths in terms of false and true causality detection rates. Suppose λ is some fractional observation of interest and the w_0 is the minimum window size, as a percentage of the whole sample, set to estimate the VAR model (1, 2). The first observation of interest is, therefore, $w_0.T$. The rolling window test compute the full sequence of Wald test statistics of $H_{rs,0}$ ($H_{sr,0}$) for each observation from $w_0.T$ to T , keeping the regression window size equal to w_0 . If a non-interrupted set of this Wald statistic sequence of $H_{rs,0}$ ($H_{sr,0}$) exceeds their corresponding critical values, beginning at the point $\lambda_{o,1}.T$ and ending at the point $\lambda_{e,1}.T$, $\lambda_{e,1} > \lambda_{o,1}$, the rejection of $H_{rs,0}$ ($H_{sr,0}$) is

detected for the period $[\lambda_0, 1.T, \lambda_e, 1.T]$. The calculations continue on the remaining of the sample so that one can have multiple periods of causality changes.

The recursive rolling window test is based on the supremum of a series of recursively calculated Wald statistics. For each λ , a set of Wald statistics of $Hrs,0$ (or $Hsr,0$) is computed for all subsamples extending backwards from $[(\lambda-w_0).T, \lambda.T]$ to $[0, \lambda.T]$. The Wald test statistics of $Hrs,0$ (or $Hsr,0$) for the observation $\lambda.T$ is therefore the supremum taken over all the test statistics in this set. As the observation of interest moves from $w_0.T$ to T , the set of subsamples in which the supremum Wald statistics are calculated increases with λ . And, in the same fashion as explained above, a significant change in causality is detected during $[\lambda_0, 1.T, \lambda_e, 1.T]$ when a set of this supremum Wald statistic sequence of $Hrs,0$ ($Hsr,0$) exceeds their corresponding critical values in this period. Shin *et al.* (2018) investigated the performance of these tests, together with the forward expanding Wald test (Thomas, 1994), in a bivariate VAR for different sample sizes, window sizes, causality strength, forms of heteroscedasticity, and one and two changes in causal relationship. Based on their simulations, for a sample size close to this study's, Shin *et al.* (2018) suggested the forward expanding testing approach performs the worst of the three methods. The performance of the recursive rolling approach is the most balanced, with false detection proportions and successful detection rates generally between the other tests.

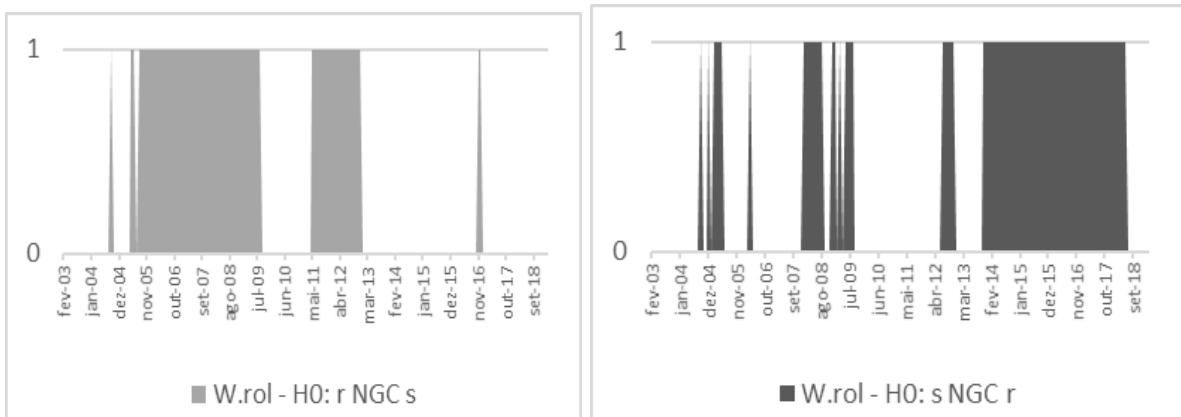
The rolling window approach has the highest successful detection rate, followed by the recursive rolling procedure, and provides a much more accurate estimator for the switch-off date. Following Shin *et al.* (2018) recommendations, we set the window size equal to 0.26, which corresponds to approximately 6 years. As the false detection proportions and successful detection rates may significantly change with the window size under some circumstance, we perform the robustness check by comparing the results with those with window sizes equal to 0.185 (4 years) and 0.37 (8 years). However, it is interesting to point out that while the successful detection rates generally improves when the minimum window size decreases but, as a smaller window size allows to detect more episodes in the data, it gets worse in the presence of multiple episodes. This problem is somehow reduced when the distance between the episodes is sufficiently large. The VAR lag order for each subsample used in the Wald statistic calculations is allowed to change and is selected by the Akaike Information Criterion. We use the heteroskedastic consistent versions of

these tests, covering cases where the error term may present conditional heteroskedasticity of unknown form or a general form of non-stochastic time-varying unconditional heteroscedasticity. We also use the residual based bootstrap critical values (estimated from 1,000 replications). Although the bootstrap critical values is greater standard asymptotic critical values of the Wald statistic, Shin *et al.* (2018) suggest using the when the sample size (T) is less than 400.

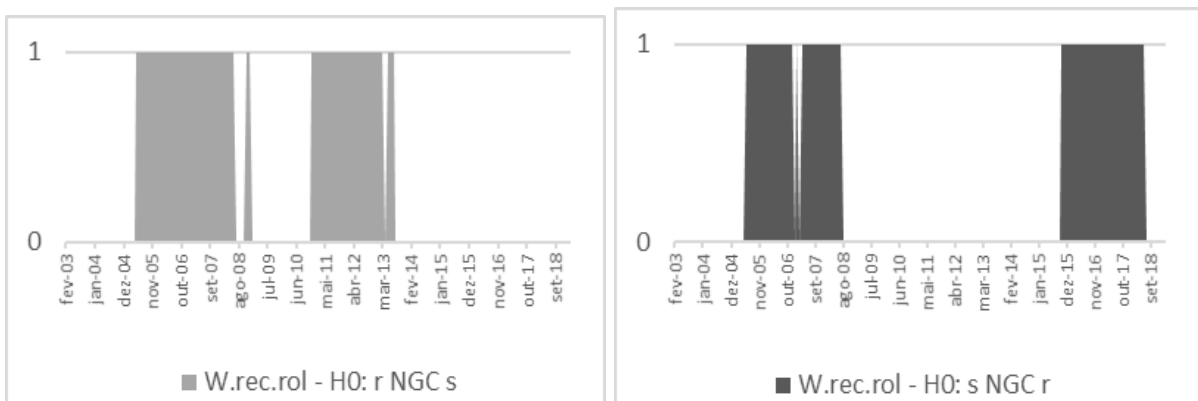
5 DATA AND RESULTS

The data comprises of monthly time series for the total government revenues (rt) and spending (St), both of them as a share of GDP, spanning from January 1997 to May 2019. The choice of variables measured in relation to GDP is based on the understanding that causality inferences for the Tax-Spend nexus may be distorted if we do adjust the government budget components to long run growth or business cycles of economy. All data are from Brazil National Treasury and were seasonally adjusted using the Census X-12 (multiplicative) method. After performing the tests on both rolling and recursive rolling we obtained the following results:

Rolling Test:



Recursive Rolling Test:

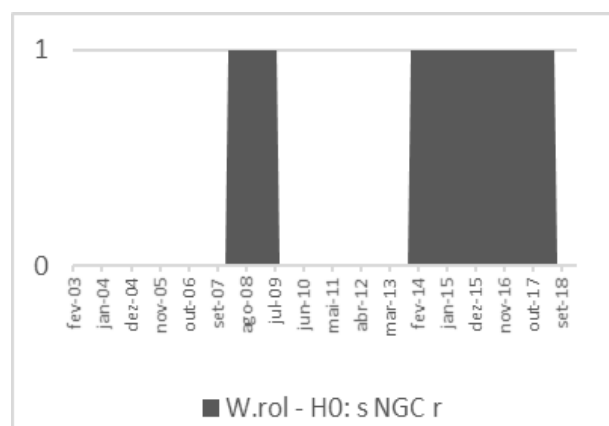
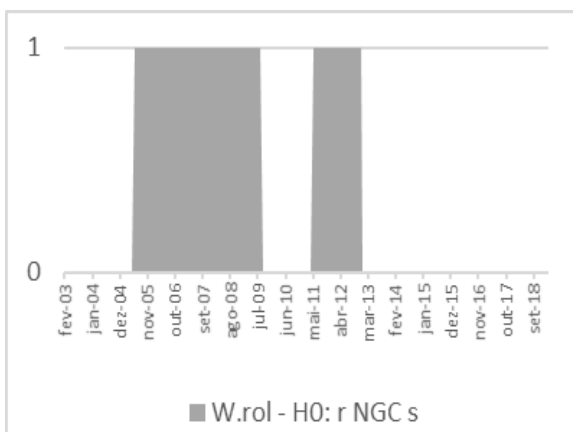


The augmented Dickey–Fuller (ADF) test statistics for the series were - 3.62 and -5.65 , respectively, considering the intercept plus linear trend model and selecting the number of lags using the Bayesian information criterion (BIC). For the 5% critical level ($- 3.24$), the unit root null hypothesis was rejected for both series. Results from the Phillips-Perron test also suggest the series are trend stationary.

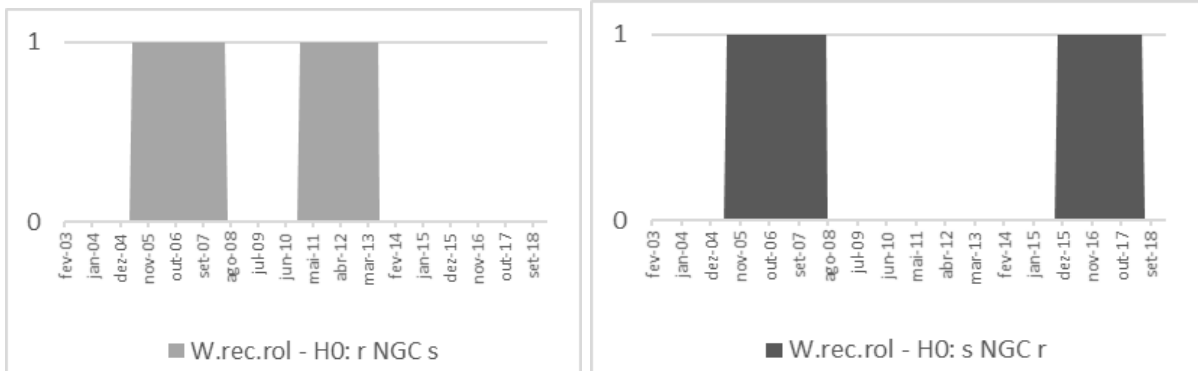
The appropriate order of the autoregression, P , is determined by AIC (Akaike Information Criterion). In our case, the maximum number of lags is 12. The test was carried out based on a window of approximately 6 years ($w_0 = 0.28$). That is, the smallest sample considered in the VAR estimation is 72 months (observations). Decreasing w_0 too much relative to the sample size (smaller w_0) could result problems of “non rejection of the false null” thereby causing major size-distortions.

In order to facilitate the result analysis, we performed some adjustments to the original tests by padding the graph’s gaps. Afterwards, we employed a more conservative approach and only considered long periods of time when H_0 was rejected and we discarded very short periods in which an H_0 was refused. Finally, we also merged the short periods to the long ones when the distance between them was short. The adjustments are shown in the figures below.

Rolling Test:



Recursive Rolling Test:



Basically, the test statistics provide two outcomes, value of “1” indicating rejection of the null hypothesis and value of “0” indicating non rejection of the null hypothesis. The first graph represents the rolling test by which we test the null hypothesis, $H_0: r \text{ NGC } s$, which reads “revenue does not Granger-cause expenditure”.

The second graph represents the testing of the null hypothesis, $H_0: s \text{ NGC } r$, which reads “expenditure does not Granger-cause revenue”. In the same manner, we carried out the recursive rolling test and the results are shown in graphs 3 and 4.

To confirm the robustness of our method we performed further analysis on both rolling window and recursive rolling window tests, but changing the window size parameters, $w_0 = 0,185$, (4 years) and $w_0 = 0,365$ (8 years). We verify that the additional tests using different window size parameters are rather consistent with the initial test, $w_0 = 0,365$ (6 years). The graphs for the additional tests are provided in Figures 1-4. The results are also contrasted with (1) the dynamics of the series of revenue/GDP and expenditure/GDP and with (2) the dynamics of the series of net debt/GDP and gross debt/GDP. For a practical standpoint, broken trend lines were estimated by the Bai and Perron's (1998) method which may be inconsistent in the case of series with a trend. Therefore, these trend lines are only for visual aid and its statistical validity should be considered with caveat.

In order to draw the final conclusion on which hypothesis prevails in each period, the results of the tests above are overlapped and final analysis revealed some interesting results. Although the rolling and recursive rolling tests yielded minor differences, as a whole the empirical results show that over the sample period all four

hypotheses seem to hold for different periods and each one of them will be discussed now.

Firstly, the results show that fiscal synchronization hypothesis prevailed until 2008 and, as proclaimed by Musgrave (1966), Meltzer & Richard (1981), revenue and expenditure decisions are taken simultaneously, and short-term adjustments are required on both revenue and expenditure, before they occur. According to Blanchard *et al.* (1990), fiscal synchronization plays an important role with regard to intertemporal fiscal budget balance. In fact, under such fiscal regime the country managed to maintain fiscal stability and to reduce public debt, as you can see in figure 7.

It should be noted that only in the first two years of Lula's first term, the government adopted a more orthodox and conservative policy, which followed the same pattern of its predecessor, former president Fernando Henrique Cardoso (FHC). The fiscal policy of FHC's administration was characterized by being very restrictive, a reality that can be attributed to the advent of the Fiscal Responsibility Law (Lei de Responsabilidade Fiscal - LRF) in the year 2000. The LRF emerged from the need to impose limits on public managers, at various levels of the government, in order to generate smaller fiscal deficits and to hold them personally accountable if they fail to comply with such requirement.

It's important to point out that under Fiscal Synchronization hypothesis increases in government spending or increases in taxes would not likely lead to fiscal imbalances, as there is a bidirectional causality running between government expenditure and revenue. In 2005, the country's economy takes a new turn as the government decided to pay off its debt to the International Monetary Fund and the country was no longer dependent on external aid. With a greater autonomy, the government increased the public spending and reduced the primary surplus target.

At this point, Lula's administration implements its expansionary fiscal policy through several social programs such as Bolsa Família, expansion of unemployment insurance and public investments. On the other hand, the government revenue experienced approximately the same rate of expenditure growth partly due to the rise in commodity prices, such as iron ore and oil. Thus, despite the increase in public spending the country managed to maintain fiscal sustainability.

The results also indicate institutional separation hypothesis for the period 2008-2011, as no causality is found between revenue and expenditure in this period.

Supported by Baghestani and McNown (1994), this theory argues that there is no causal relationship between revenues and government spending and the decisions concerning government revenue and expenditure are taken independently. The fiscal independence reflects institutional separation between the executive and legislative branches which seems to be a quite common phenomenon in periods of crisis.

The outbreak of the global financial crisis in 2008 led the country to further increase spending in order to boost aggregate demand and to prevent liquidity crisis. The federal government announced the reduction of the primary surplus target, increased spending and reduced taxes, however, these adjustments were not made in a coordinated manner, but rather, independently. Under this fiscal regime, the country's fiscal situation worsened, however, the country managed to reduce public debt levels, which can be accounted for the surplus position of the previous years.

The results also indicate tax-spend hypothesis for the period 2011-2013, which corresponds to the first years of Dilma Rousseff's first term. In Rousseff's administration, the government tried to maintain Lula's social policies, however, some subsidized social programs suffered budget cutbacks. The country experienced a severe fiscal adjustment with a sharp decrease in the government revenues and significant economic slowdown, when commodity prices fell and the government granted large tax exemptions and tax breaks. This pattern of taxation and spending resembles the version of tax-spend hypothesis proposed by Buchanan and Wagner (1978), which states that cuts in taxes would create a fiscal illusion and the cost of government is seen by the taxpayers as being less than it actually is. Thus, this misinterpretation would lead the public to demand for more public spending and ultimately higher budget deficits. Having said that, it's important to point out that the increase in the public expenditure was not triggered by the public demand itself, but rather, by the long-running government welfare programs and social security expenditures. Up to 2013, the government managed to maintain fiscal stability and to reduce public debt, as you can see in figure 7, however, fiscal situation continued to deteriorate over time and we could raise questions about the adequacy of the tax-spend regime concerning to the fiscal policy.

From 2013 to 2015, the results once again indicate institutional separation hypothesis. In this period the country was going through a deep political instability as the then president Dilma Rousseff was subjected to political trial as a result of administrative misconduct charges related to Fiscal Responsibility Law violation. It's

important to highlight that this scenario seems quite consistent with the idea that in periods of crisis the institutional separation hypothesis is likely to prevail and the lack of dependence between policy makers can result in fiscal imbalances. In such political turmoil the economy deteriorates even further and, in 2014, the country fell into recession and the public debt started to grow after a long time of steady recovery, as you can see in figure 7.

From 2015 onwards, the results indicate that the fiscal regime changes from institutional separation to spend-tax hypothesis. Supported by Peacock and Wiseman (1979) and Barro (1979), this theory argues that the level of spending is first determined by the government and then taxes are increased to accommodate the desired level of spending and, in such scenario, the policy implication is that budget deficit reduction can only be achieved through reductions in expenditures.

In this context, the spend-tax hypothesis converges with the historical analysis of this period. In the same year Rousseff was ousted from the presidency, the government made a fiscal adjustment based on a reduction in public spending and an increase in the tax burden. In December 2016, during Temer's administration, the government took another important step and enacted the Constitutional Amendment 95, which imposes mandatory containment of government expenditure until 2036. As of 2015, under the New Fiscal Regime, the country experiences a sharp increase in taxes and decrease in expenditures, as it can be seen in figure 7. The country still has daunting challenges ahead, however, the fiscal deficit already shows signs of falling over time and this fiscal framework seems to be the best approach for the country to get back to sustainable growth.

6 CONCLUSION

The objective of this article is to analyze the time-varying causal link between revenue and expenditure in Brazil over the period January 1995 to May 2019 using the rolling and recursive rolling estimation approaches. These approaches allow us to model time varying parameter so as to reflect changes in the Granger causality over the sample period.

For the period until 2008, the empirical findings lend support for the Fiscal Synchronization hypothesis. During periods of crisis of 2008-2011 and 2013-2014, the results provide support for the Institutional Separation hypothesis. For the period of 2011-2013 the Tax-Spend hypothesis has prevailed. Finally, for the period of 2015 onwards, the results provide support for the spend-and-tax hypothesis.

The current fiscal adjustments are quite consistent with the political implications of the tax-spend hypothesis contented by Peacock and Wiseman (1979) and Barro (1979). The recently implemented fiscal regime has proven effective in reducing fiscal imbalances and, although the fiscal budget is still in deficit, there is a substantial recovery from 2015 and the expenditure/GDP ratio shows a tendency of decrease from year to year and the revenue/GDP ratio indicates growth, as can be observed in the trend lines estimated by the method of Bai and Perron (1998). Thus, maintaining government expenditures at lower levels seems to be only way to ensure that Brazil is in the right path towards fiscal sustainability and economic growth, at the current juncture.

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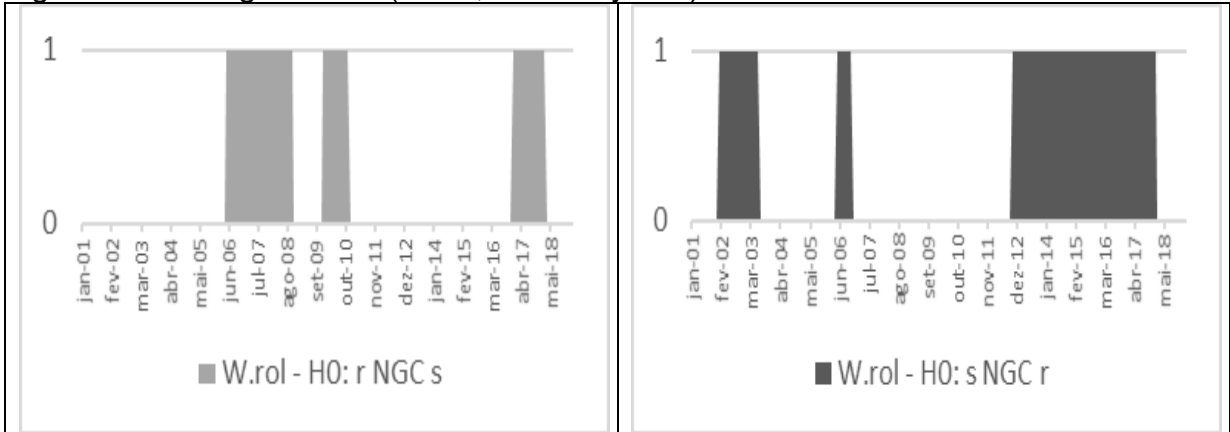
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APPENDIX

APPENDIX A – FIGURES 1 AND 2

Rolling Test

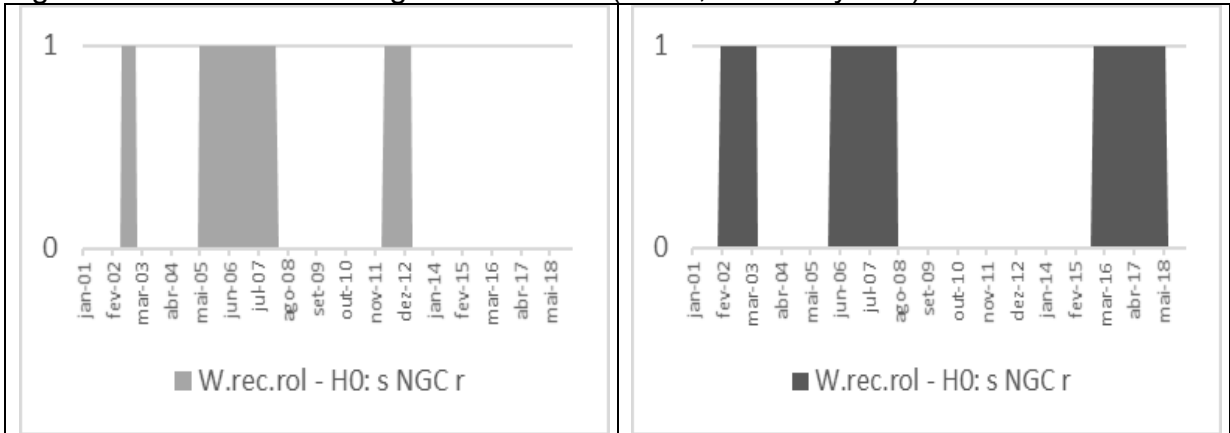
Figure 1 – Rolling Window ($w_0=0,185$ or 4 years)



Source: Author's elaboration

Recursive Rolling Test

Figure 2 – Recursive Rolling Window Test ($w_0=0,185$ or 4 years)

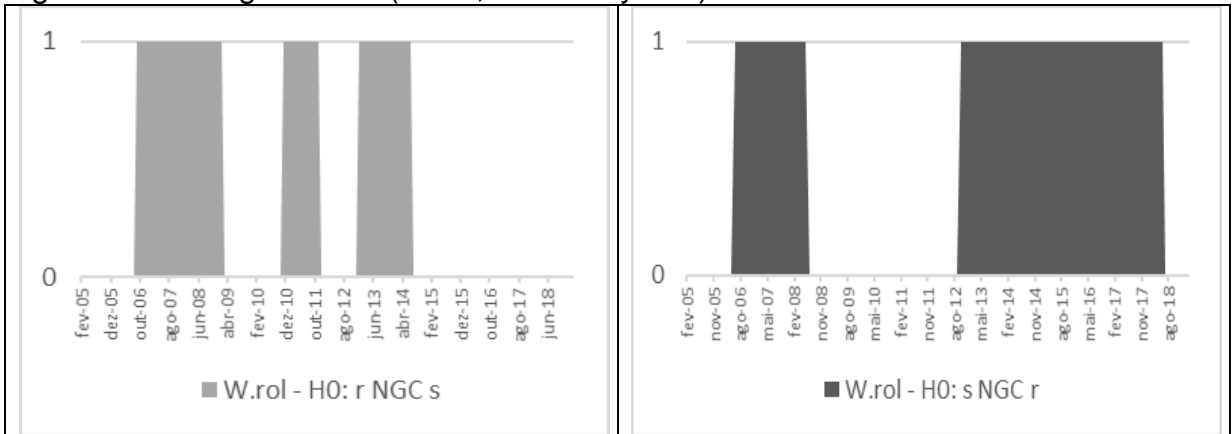


Source: Author's elaboration

APPENDIX B – FIGURES 3 AND 4

Rolling Test

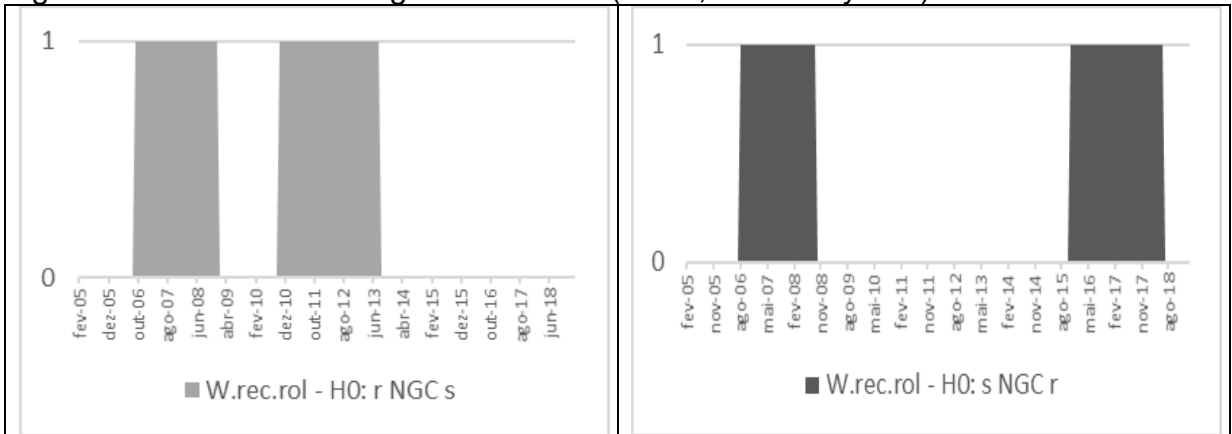
Figure 3 – Rolling Window ($w_0=0$, 365 or 8 years)



Source: Author's elaboration

Recursive Rolling Test

Figure 4 – Recursive Rolling Window Test ($w_0=0$, 365 or 8 years)



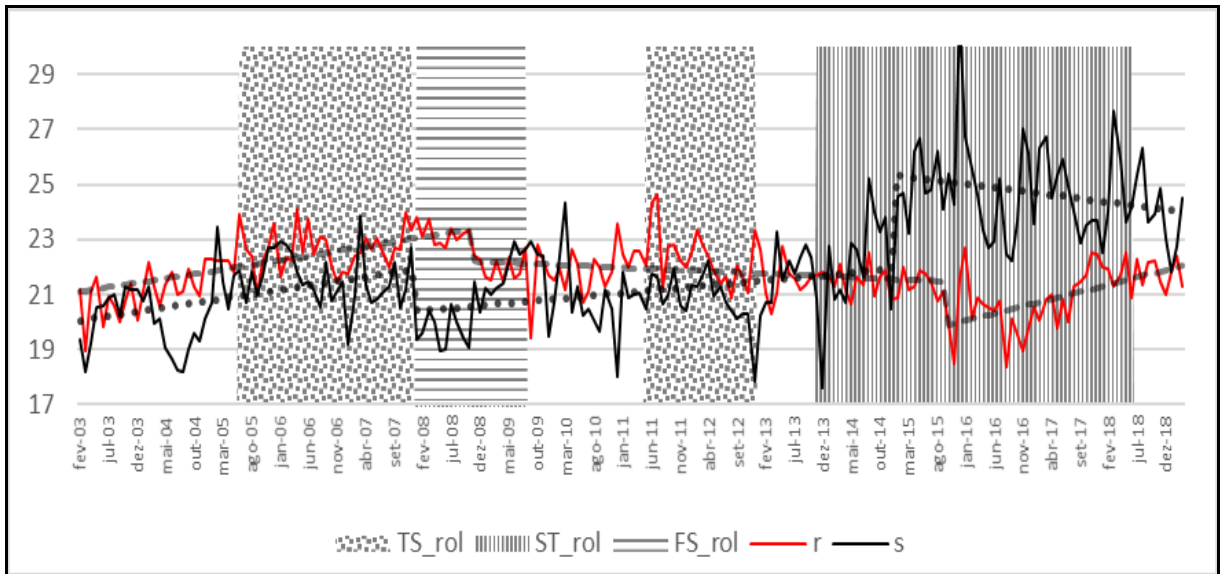
Source: Author's elaboration

APPENDIX C – FIGURES 5 AND 6

Case 1: Revenue and Expenditures

Rolling Test

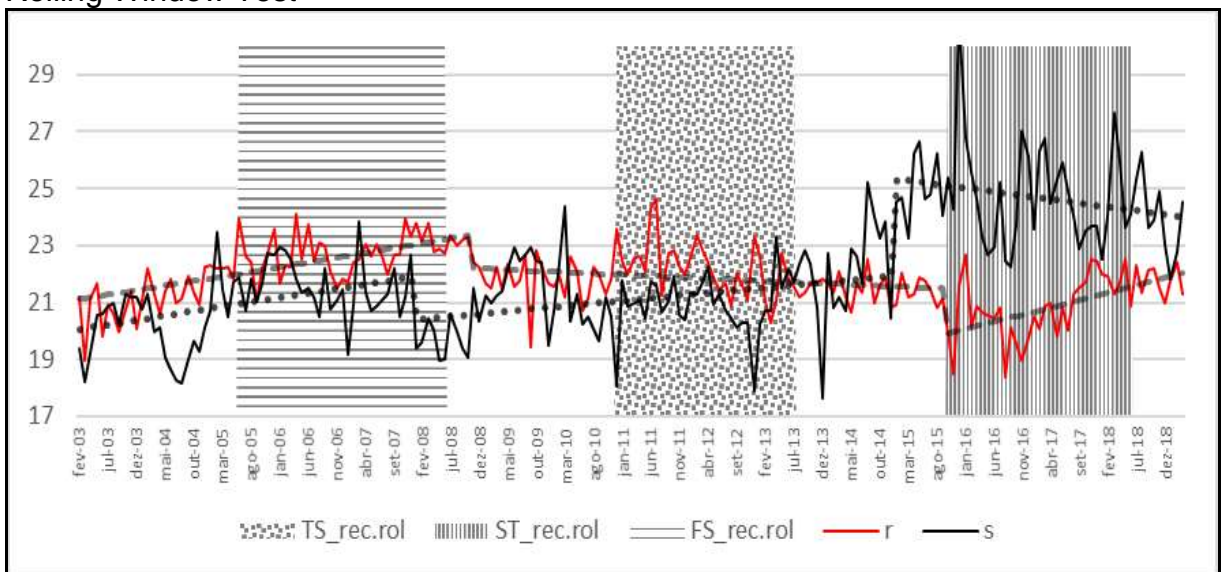
Figure 5 – Dynamics of the revenue/GDP and expenditure/GDP series - Rolling Window Test



Source: Author's elaboration

Recursive Rolling Test

Figure 6 – Dynamics of the revenue/GDP and expenditure/GDP series – Recursive Rolling Window Test



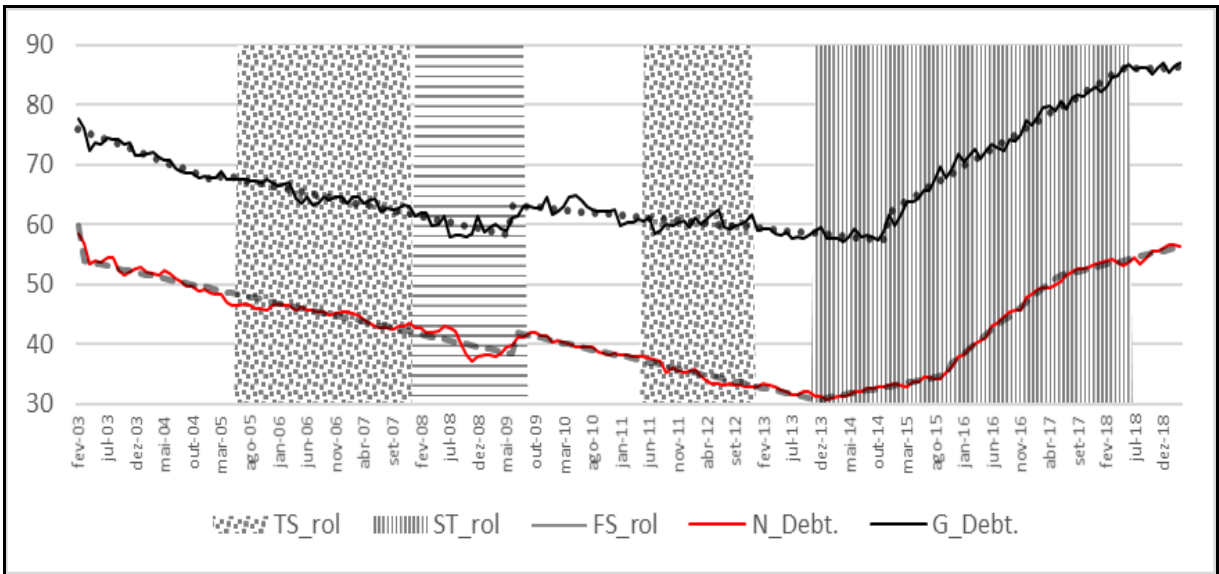
Source: Author's elaboration

APPENDIX D – FIGURES 7 AND 8

Case 2: Public Debt

Rolling Test

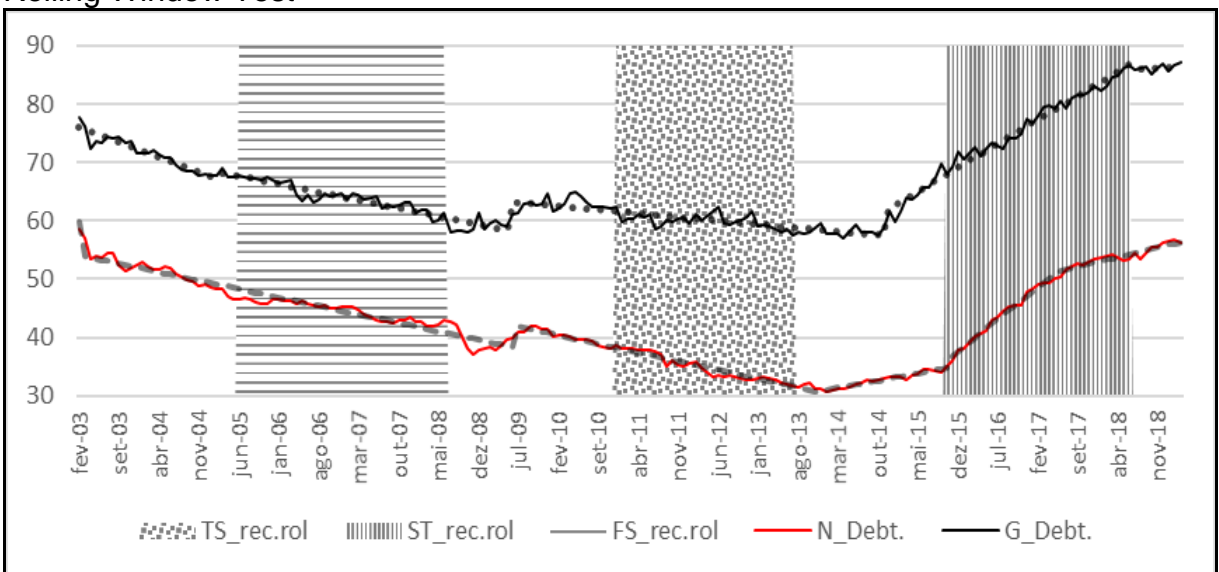
Figure 7 – Dynamics of the gross debt/GDP and net debt/GDP series - Rolling Window Test



Source: Author's elaboration

Recursive Rolling Test

Figure 8 – Dynamics of the gross debt/GDP and net debt/GDP series – Recursive Rolling Window Test



Source: Author's elaboration