Fiscal policy and economic growth in Brazil: a SVAR approach

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Abstract

This paper analyses the relation between fiscal policy and economic growth in Brazil from 2002 to 2016. It is shown that the country's macro regime was inspired on the "New Neoclassical Synthesis" theory, where fiscal policy has no role on stimulating economic activity, while there is a major focus on price stability through monetary policy. In Brazil, economic performance has deteriorated since 2011, when growth rates have gradually slowdown, until a major recession has taken place in 2015 and 2016. In order to understand the government capacity of stimulating growth through fiscal policy, a Structural Vector Auto-Regressive (SVAR) model is applied to the Brazilian economy in order to analyze the impact of different government expenditures, taxation and also the public debt, on economic growth.

Keywords: Fiscal policy, Growth, Fiscal multipliers, Inflation-Targeting, SVAR;

Resumo

Este trabalho analisa a relação entre política fiscal e crescimento econômico no Brasil entre 2002 e 2016. Procura-se demonstrar que no regime macroeconômico brasileiro, inspirado no modelo da Nova Síntese Neoclássica, a política fiscal não tem papel ativo no estímulo à demanda agregada, enquanto o controle de preços via política monetária é o principal instrumento macroconômico. No Brasil, após a continúa desaceleração do crescimento econômico a partir de 2011, observou-se dois anos recessivos consecutivos, em 2015 e 2016. A fim de compreendera capacidade do governo em estimular o crescimento econômico, neste trabalho estima-se um modelo de Vector Autoregressivo Estrutural (SVAR), onde analisa-se o impacto dos gastos, da tributação e da dívida pública na dinâmica do PIB.

Palavras-Chave: Política fiscal, Crescimento, Multiplicadores fiscais, Metas de inflação, SVAR.

1 Introduction

According to Kuhn, a scientific school of thought, or paradigm, can be identified by its assumptions. Departing from these assumptions, a research agenda, theories and specific methods are applied in order to solve the most important paradigm problems (McCombie and Pike, 2010). A paradigm consolidation, thus, depends on its capacity to answer the questions asked by the scientific community, in order to overcome other research programs. On macroeconomics new paradigm has emerged during the late 1990's and became an important reference on macroeconomic policy guiding: the so called New Neoclassical Synthesis (NNS), which can be seen on the works of Goodfriend and King (1997); Blinder (1997); Taylor (2000), among others. Conciliating different theoretical frameworks, specially if one considers the mainstream macroeconomic theory, that model has emerged, according to its supporters, as a "new consensus"on macroeconomic theory agenda. With a special attention on price stability, inflation targeting regimes based on monetary policy rules, became the basis of macroeconomic policy guideline.

After its 1999 balance of payments crisis, Brazil's government adopted an inflation targeting regime, as well as an annual primary public surplus target and a flexible exchange rate regime, introducing what is known as the macroeconomic tripod. This new macroeconomic policy framework was, thus, clearly based on the NNS recommendations and followed the example of other monetary authorities around the world. Although its main objective, stable inflation, was relatively accomplished, some important drawbacks could be noticed since then. This paper argues that the constraints imposed by the macro regime has added significant limits to fiscal policy, and, thus, the public sector capacity on stimulating growth.

In this sense, this paper analyses the relation between fiscal policy and economic growth from 2002 until 2016, in order to show how significant and at which degree this constraint has limited Brazil's GDP growth during this period. For that purpose, besides this introduction, this paper is organized in three other sections. The next section will present the New Neoclassical Synthesis model and its main hypotheses, in order to explain the theoretical background of Brazil's macro regime and the (no) role of fiscal policy in it. The third section will introduce the Structural

Vector Auto-Regressive (SVAR) approach to estimate fiscal policy impacts, followed by the identification approach to the model. The fourth section will present the results of the estimated model applications. After that, concluding remarks will summarize the main achievements of this paper.

2 Reviewing the New Neoclassical Synthesis model

After a severe balance of payments crisis, in 1999, Brazil has adopted a flexible exchange rate regime, not only necessary to overcome the foreign currency scarcity but also as part of the IMF funding help conditions (De Carvalho, 2000, see). At the same year, a inflation targeting regime was introduced in order to stabilize inflation and became the new price anchor, substituting thus, the fixed exchange rate regime. In the next year, a public primary balance surplus target was also set, with the objective of reducing debt to GDP relation. Although part of the IMF program, in this paper we support the idea that this new policy framework was also aligned with the new macroeconomic consensus, changing, thus, the relation between fiscal policy and economic activity in Brazil.

The research program known as New Neoclassical Synthesis has combined both the Real Business Cycle theory and the New Keynesian economics in order to give place to a "set of key principles - a core - of macroeconomics about which there is wide agreement"(Taylor, 1997). Among its main features and its corresponding theoretical influence one may highlight the below:

1. *Neutrality of money*, as consolidated by monetarists in the vertical long-run Phillips curve;
2. *Rational expectations*, as proposed by Lucas (1972);
3. *Short-term price stickiness*, derived from the New Keynesian theory (Arestis and Sawyer, 2002);
4. *Dynamic Stochastic General Equilibrium* (DSGE) models, introduced by the Real Business Cycle framework (Prescott, 1986, see);

Although the NNS can be represented in different ways, depending on the scope of the analysis and degree of complexity, in this paper we will follow Arestis (2009c), making the necessary changes to represent a closed economy. Having that considered, the NNS model is funded in three equations. First, describing the supply and demand equilibrium, the IS curve:

$$Y_t^g = a_0 + a_1 Y_{t-1}^g + a_2 E_t(Y_{t+1}^g) + a_3[r_t - E_t(p_{t+1})] + s_1 \tag{1}$$

Where Y_t^g describes the output-gap, with the subscripts denoting the period of each variable, a_0 represents a constant scalar, $E_t(Y_{t+1}^g)$ represents the expected output-gap, r_t denotes the nominal interest rate, $E_t(p_{t+1})$ represents the expected inflation and s_1 represents exogenous shocks. From this equation two fundamental hypotheses can be emphasized: first, there is a potential GDP, which represents the aggregate output when production capacity is at its desired level, and labour is full employed, or at its "NAIRU"level. Secondly, price expectations can influence GDP, at least in the short-run.

The first hypothesis derives from a supply-side determination of potential output. Thus, production factors growth and productivity evolution determine the long-run growth path, which is considered exogenous (Summa and Lucas, 2010), that is, not dependent on current GDP. As it can be seen, in the long-run, no demand-side effects can alter the potential GDP, as price flexibility rules for longer periods of time and, under rational expectations hypothesis, demand converges to its equilibrium level (when GDP gap is null). Under this assumption, the agents prediction is exactly the same as the mathematical conditional expectations of the model Taylor (2000). Another important feature of the model is that interest rates are directly related to income, under the hypothesis that not only investment depends on rates of return, but also consumption is affected by higher costs of credit (Romer, 2000, see).

On the other hand, cycle fluctuations derive from excess demand over supply, due to price stickiness in the short-run. Price variations on the NNS model can be seen through the second fundamental equation, or its Phillips-curve:

$$p_t = b_1 Y_t^g + b_2 p_{t-1} + b_3 E_t(p_{t+1}) + s_2 \tag{2}$$

It can be seen that current price changes, p_t, are positively correlated with output-gaps, denoted as Y_t^g. It is also possible to see that price level inertia, which impact is measured by the coefficient b_2, and also price expectations, $E_t(p_{t+1})$, influence the current price level, p_t. Price shocks, s_2 are also predicted to affect inflation, although not necessarily in a positive way, as exogenous shocks can be either positive or negative.

So, under these assumption, inflation is a demand-side phenomena. Thus, if one does not consider exogenous shocks, current output is higher than its potential when the basic interest rate, controlled by the central bank, is below its equilibrium level. Consequently, if monetary authority can correctly estimate the equilibrium policy rate, demand tends to its equilibrium level, determined by potential GDP, and so, inflation converge to its target. Another important assumption of the NNS Phillips curve is that all past and expected inflation is transmitted to current price variations, implying in a vertical long-run Phillips-curve (Arestis, 2009c). So that $b_2 + b_3 = 1$ and, thus, the Phillips curve is of the "accelerationist"type.

According to Goodfriend and King (1997) the importance of price variations is transmitted through changes in relative prices. That is, if prices do not correctly transmit production factors relative scarceness, firm's decisions will be harmed and, so, the firms "mark-up". The conclusion that can be taken from here is that price stability brings a correct allocation of resources in the economy, which will tend to its potential whenever b_3 is low or $E(p_{t+1})$ is close to zero.

This brings another important feature of the model, that is, the importance of managing agents price expectations. As agents learn with past errors, monetary authority cannot induce economic activity through successive changes on monetary policy. Consequently, one cannot expect the same responses for private consumption and investment decisions, to the same systematic policies, as agents are "rational".[1]

The alternative, then, is to set specific and public rules for economic policy as a way to manage expectations and make current GDP converge to its potential. In terms of monetary policy, the interest rate management should succeed according to the third fundamental equation of the model, its Taylor rule, as described below:

$$r_t = (1 - c_3)[r^* + E_t(p_{t+1}) + c_1 Y^g_{t-1} + c_2(p_t - p^t)] + c_3 r_{t-1} + s_3 \tag{3}$$

Where r_t is the current policy rate, r* represents the equilibrium interest rate, $E_t(p_{t+1})$ represents the expected price level for the next period, Y^g_{t-1} is the past output-gap, $(p_t - p^t)$ represents the deviation of current price from its target, and r_{t-1} is the past interest rate. Again, s_3 measures an exogenous shock on interest rates, with zero mean in the long-run.

One of the most fundamental innovations in the NNS model is that, instead of a policy based on the monetary base control[2], the primary interest rate was set to manage aggregate demand. In this sense, this monetary tool assumed a protagonist roll on macroeconomic policy management. So, while price control is the main objective of the model, as it represents the convergence of demand to its "natural"level, the interest rate is regarded as the best instrument

[1] This assumption is an important issue on macroeconomic theory and should be understood as not only a theoretical answer to "Lucas critique", but also as macroeconometric approach for structural changes (Goutsmedt et al., 2015).

[2] As proposed by the monetarist view, summarized on Fisher's equation: MV = PY

to achieve the macro-regime goal.

The importance of price stability justifies, along with rational agents, the importance of an independent central bank[3] practicing non-discretionary policies, in order to make its policy behaviour predictable, and, thus, anchoring private expectations of future inflation. As a result, central banking credibility becomes a policy instrument itself, along with transparent policy objectives and the public announcement of the means to achieve it (Teixeira et al., 2010).

One of the conclusions that can be taken from this model, is that only monetary policy errors are believed to continuously shift current GDP from its potential, and thus, inflation from its target. This is partially due to the fact that shocks, (s_3), are the only exogenous variable in the model, and, according to the reversibility condition, is expected to be zero in the long run (Setterfield, 1995 apud (Lavoie, 2002). Moreover, if central bank can correctly conduct its policy rate to the equilibrium level, the output gap will converge to zero, so that $r_t = r^*$.

Another important feature of this model that worth highlighting at this point, is that fiscal policy has no significant role on it. Many arguments have been developed in order to support fiscal policy ineffectiveness. The so-called crowding-out of private investment, the Ricardian Equivalence, introduced by Barro (1974), Fiscal Dominance, as proposed by Sargent and Wallace (1981), and also "institutional aspects", as emphasized by Hemming et al. (2002), represent strong theoretical arguments against discretionary fiscal policy, which, although not directly stated by the NNS, are aligned with the main assumptions of the model. In spite of not being in the scope of this work, some examples will be shown in order to understand fiscal policy downgrade on the current macroeconomic policy paradigm.

As Arestis (2009a) observes, the rational expectations assumptions reinforce the Ricardian equivalence theorem. The argument presented to sustain this hypothesis is that any deficit-based fiscal expansion will be offset by reductions on private agents expenditures, with no overall effect on long-run GDP. Moreover, fiscal policy is not only believed to negatively affect GDP's demand-side but also through its supply-side. For example, if government decides to increase its lump-sum taxes in order to outweigh a expenditure expansion, disposable income and, thus, labor supply, would reduce, negatively affecting the output level, in a general equilibrium model.

The last example that should be emphasized is the "institutional aspect"of fiscal policy, which at the same time mines fiscal policy effectiveness and upgrades monetary policy as the best alternative. As put by Blinder et al. (2004), the average time taken from the recognition of fiscal stimulus needs ("inside lags") to its observed effects ("outside-lags") is large enough

[3](Bernanke and Gertler, 2000, see) to a further approach into central banking independence.

to condemn fiscal policy efficiency. This is due to both the required time to observe a policy space, e.g.,weak demand, and the political processes required to conduct and implement a law, as is normally the case of fiscal policy. Monetary policy, on the contrary, specially if based on an independent central bank, have enough flexibility to influence aggregate demand through basic interest rate management, assuming, thus, a better position on the macroeconomic policy hierarchy. In this sense, fiscal policy should, at most, operate through automatic stabilizers, in order to keep demand on its trend and facilitate private agents anticipation. As stated by Allsopp and Vines (2005) fiscal policy goal is to bring "control and sustainability of the public finances as well as on the resource allocation and distributional effects on budgetary policy"(Tcherneva, 2008).

As macroeconomic policy is set to stabilize price dynamics, what if unemployment persists for long periods, even if inflation is at its target? In order to answer this question one must, first, answer how fiscal policy can induce economic activity. Having this in mind, in this work we argue that stabilizing inflation is not sufficient to make the level of economic activity reach its potential, so that public policy should shift towards fiscal expansion to expand demand, even in longer periods, if current GDP is persistently below its potential level. For that purpose, in the next two sessions we will estimate the impact of fiscal policy on growth in Brazil, in order to provide evidence in favour of our hypothesis.

3 Methodology

The concept of fiscal multipliers, although retracing to the beginnings of Keynesian theory, back in the 30's (Snowdon and Vane, 2005), is still a fundamental tool in economic policy analysis. Despite the main idea of fiscal multipliers being old-fashioned, its concept has evolved along the history of economic thinking, and more importantly, the statistical methods of measuring it. One of the simplest definition of fiscal multiplier is the ratio of change in output,Y_t due to a discretionary change in government spending, G_t (Batini et al., 2014). Mathematically,

$$\Delta Y_t / \Delta G_t \tag{4}$$

The main problem with this estimation is the separation between discretionary and endogenous government spending. Considering that a great deal of government revenues depends on output, and that government spending relies on government revenues, then it is easy to see that, G_t has a double causation relation with Y_t. At the same time, as government spending is, by definition, part of aggregate demand, and thus, its dynamics directly affects GDP, it is clear that separating cause and correlation between these two variables becomes of great importance. This difficulty is named the identification problem and can be addressed in different ways. In this paper the SVAR methodology will be implemented in order to overcome this issue, as we shall see. A SVAR model consists in a particular way to identify the reduced form model imposing restrictions on its structural representation. Thus, SVAR models require information about the process being estimated (in our case, a particular economic model) in order to set restrictions on the primitive system (Sims, 1980).

Although SVAR models require few theoretical assumptions, which means a weak *a priori* causality relation between the variables being regressed, its capacity on prediction and estimation of multivariate dynamic models, specially on macroeconomic policy analysis, has been widely accepted (Zivot and Wang, 2007). A Vector Auto-Regressive model consists of an n equations and n variables system, where each variable is explained by itself and the other variables, at the current and also in lagged periods. Despite is simplicity, this method is able to capture, in a systematic manner, the fundamental dynamics of the time series process (Stock and Watson, 2001).

In the literature of fiscal multipliers, three different identification methods used in VAR models, should be stressed. First, the "narrative approach", which tries to connect fiscal events, such as announced budget policies or war expenditures, to changes on GDP[4]. Secondly, the sign restriction approach, such as developed by Mountford and Uhlig (2009), which simply imposes signs for the impulse-response function, based on the expected relation between the model's variables. In this paper we will follow the Blanchard-Perroti approach based on Blanchard and Perotti (1999), which is a third identification method, first applied to estimate fiscal multipliers within a SVAR framework. In this approach the restrictions made at the model are based on economic theory and institutional information about the fiscal policy process. But before explaining the restrictions made in the estimated model, one might ask why are restrictions needed at all ?

To answer this question it is necessary, first, to show how a VAR model is structured. Departing from the structural model, that is, the real time-series generating process for the system of equations of the VAR, we have the following equation:

$$B_0 X_t = B_1 X_{t-1} + ... + B_p X_{t-p} + \epsilon_t \tag{5}$$

Where B_i represents the coefficients matrix describing the relations between the model's

[4]See Romer and Romer (2010)

variables, X_t. It is important to notice that B_0 denotes the contemporaneous relations between the variables, which makes the system of equations described by Equation 5 overparametrized Enders (2004). The model's random disturbances, or white-noise processes, are represented by the vector ϵ_t. In order to estimate this system, though, the model is normally represented on its reduced linear form, such as described by Lütkepohl (2005):

$$X_t = A_1 X_{t-1} + ... + A_p X_{t-p} + U_t \tag{6}$$

where

$$A_i \equiv B_0^{-1} B_i$$

$i = 1...p$

and

$$U_t \equiv B_0^{-1} \epsilon_t \tag{7}$$

Equivalently the model can be written on its autoregressive form, such as:

$$A(L) X_t = U_t \tag{8}$$

Where A(L) denotes the autoregressive lag order polynomial. This system is of special interest because, as one can see, Equation 7 relates the structural shocks to its reduced form counter-part. The problem is that responses of the vector X_t to shocks generated by the reduced-form model, U_t, does not tell us the effects of the real process. In other words, we want to analyze the response of X_t to structural shocks, ϵ_t, while it is expected to U_t be correlated with each other. In order to accomplish that, we need to impose restrictions on B_0, or, the variance-covariance matrix of the structural shocks, $\sum \epsilon_t$, so we call build a identified model and remove contemporaneous correlations between variables. Now, the problem relies on how to impose such restrictions and that is precisely answered by the identification method.

The so called Blanchard-Perotti approach, as stated earlier, relies on economic theory and institutional aspects of fiscal policy process to answer this problem. In this sense, information about the necessary time to change tax policy or implementing shifts on expenditures are of great importance. In terms of the empirical model, data frequency becomes the key to implement the model's restrictions. In this sense, if one believes that the necessary time to implement a shift on, say, investment expenditures after the recognition of weak demand (downturn on GDP) is greater then a quarter, then, GDP does not affect public investment policies within the same period, and thus, the contemporaneous relation from GDP to investment is set as zero. In a similar manner, this approach is done for each of the model's variables, taking into account fiscal outside and inside lags [5].

To resume on this, a estimation of 6 would produce an endogeneity problem and, thus, violate OLS assumptions, as the system would suffer from simultaneous equations bias (Enders, 2004). Consequently we need to impose restrictions on the reduced form VAR. The method for imposing those restrictions will be based on theory and data frequency in order to observe fiscal policy lags.

4 Data

This paper used data produced by the works of Orair et al. (2016) which consists in a extensive task of cleaning and estimating Brazil's general government expenditures from January 2002 to July 2016, in a monthly basis. In this sense, both central government and regional government's fiscal information have been evaluated. While most of the series derive from the Treasury's National Secretary (STN) and from the SIAFI system, part of regional government's data derive from the "Relatórios resumidos de Execução Orçamentário"(RREOs). All data have been processed in order to remove omitted information, double counting, as well as to unify all different source of data that have been used to construct the series. The so called "creative accounting"also have been treated with the exclusion or incorporation of expenditures between public institutions. Changing public primary result, this process is a fundamental tool to make clearer the real dynamics of public expenditures and exclude policy actions implemented to cover up public sector primary results and do not evidence the real nature of fiscal policy dynamics.

Six different series were used to estimate the SVAR model and they have been adapted to the problem of this paper, and only the net government public debt (Debt) series was not taken from the work of Orair et al. (2016), but from Brazil's Central Bank. Above one can see the modifications proposed, where the right hand side represents the original data names:

1) Consumption (G_c) = "Pessoal"+ "Outras Despesas"+ "Benefícios Sociais";

2) Investment (G_i) = "Ativos fixos";

3) Subsidies(G_s) = "Subsídios";

4) Revenues (T) = "Receitas";

5) GDP (y) = "PIB";

6) Debt (div) = "Dívida líquida do setor público";

[5](Blinder et al., 2004, see) for a better comprehension of fiscal policy lags

The method of aggregation of public expenditures was based on the expected effect of these variables on GDP. Consumption is composed by public pensions ("Pessoal"), social benefits ("Benefícios sociais") and also Other expenditures ("Outras despesas"). While the first two are an important share of the labour income and tend to be expended on consumption goods and services, "Outras despesas" represents regular government consumption of goods and services. Thus, Consumption effect on GDP tends to be the increase on capacity utilization and represent a share of aggregate demand derived from the public sector expenditures.

On the other hand, public investment G_i, is characterized to be not just a share of aggregate demand, but also an important expenditure on the supply side. That is, public expenditure on infrastructure, for example, is responsible for improving private sector investment decisions and its productivity, not just on the business cycle but also in the long-run (Dutt, 2013; Aschauer, 1989; Barro, 1990).

Although not expected to have the same effect on GDP as public investment, government Subsidies represent expenditures intended to decrease private costs and stimulate economic activity. This account is mostly composed by interest rate payments on credit subventions, and, thus, cannot be considered as direct investment nor public consumption, although directed to supply-side improvements.

All series have been converted into natural logarithm and deseasonalized by Arima-X13 method, with the exception of "Debt" series, which is in logarithm scale, but was not desazonalised as it does not show the same patter observable in the fiscal series (most of the expenditures and "Revenues").

4.1 Model identification

As put by Peres and Ellery Junior (2009), data frequency is the key parameter to the model's identification scheme. This information is fundamental to impute the necessary time for the fiscal authority to recognize the need for discretionary policy and implement it. That is, it seems odd to think that discretionary fiscal policy can be implemented within a month, as data gathering (recognition) and fiscal policy decisions (implementation) normally takes longer periods. Having that in mind, the following system represents the model's identification method:

$$\epsilon_t^{G_c} = u_t^{G_c}$$
$$\epsilon_t^{G_s} = u_t^{G_s}$$

$$\epsilon_t^{G_i} = \beta_{G_i,G_c} u_t^{G_c} + \beta_{G_i,G_s} u_t^{G_s} + u_t^{G_i}$$
$$\epsilon_t^{T} = \beta_{t,Gc} u_t^{G_c} + \beta_{t,Gs} u_t^{G_s} + \beta_{t,G_i} u_t^{G_i} + u_t^{t}$$
$$\epsilon_t^{y} = \beta_{y,Gc} u^{G_c} + \beta_{y,G_s} u^{G_s} + \beta_{y,Gi} u^{G_i} + \beta_{y,t} u_t^{t} + \beta_{y,div} u_t^{div} + u_t^{y}$$
$$\epsilon_t^{div} = \beta_{div,G_i} u^{G_i} + \beta_{div,G_c} u^{G_c} + \beta_{div,G_s} u^{G_s} + \beta_{div,t} u_t^{t} + u_t^{div}$$

First, it can be noticed that in the model's identification system of equations, all restrictions were made on contemporaneous relations between structural shocks and reduced form residuals, the so called B matrix (Lütkepohl, 2005). That is, we have followed the same approach of Cavalcanti and Silva (2010), Samuel et al. (2016) and the interpretation of Blanchard and Perotti (1999) that there is no convincing way to identify the contemporaneous relation between structural shocks on revenues and expenditures. This means that structural shocks are not contemporaneously correlated, and so, the A matrix is a 6 x 6 identity matrix.

The first two equations states that structural changes in government's Consumption (G_c) and Subsidies (G_s), are not affected by unexpected movements of any other variable, but itself. This means that, in a month period, these expenditures do not respond to changes in public investment, GDP, Revenues nor Debt. Although not free of controversies, this hypothesis is sustained by the rigidity of this kind of expenditures, which are, mostly, obligatory and previously defined by the Annual Budget Law ("Lei Orçamentária Anual"). On the other hand, government investment, G_i, is not considered as an obligatory expenditure and, during a fiscal year, depends on the amount of the obligatory expenditures. So investment can be considered as a residual of Consume and Subsidies, and so $\beta_{Gi,Gs}$ and $\beta_{Gi,Gc}$ were not restricted.

Structural shocks on Revenues, are set to be influenced by all expenditures shocks, but not to GDP changes. So, while it is believed that Revenues can react to changes on public expenditures, as government needs to accomplish its primary balance target and effectively decides its expenditures policy, taxes do not respond to unexpected shocks on GDP. That is, within a month, government is not able to implement a discretionary tax policy to respond to changes in GDP, following the literature of fiscal multipliers for Brazil(Peres and Ellery Junior, 2009; Cavalcanti and Silva, 2010, see).

Structural shocks on GDP are set to respond to all fiscal variables. That is, changes in private consumption and investment, which corresponds to most part of GDP, do depend on government decisions on expenditures and taxation, even within a month period. While firms directly benefit from higher public expenditures, tax changes have shown evidence of impacting GDP in Brazil, even with quarterly data (Santos et al., 2008; Peres and Ellery Junior, 2009, see).

The last equation, which tries to estimate the structural impacts of fiscal variables and GDP on public debt (div), has remained unrestrained. That is, as all fiscal variables, by definition, affects public primary result, while GDP is affected by structural shocks on fiscal variables, then no restriction have been made on this variable. This approach was set in order to capture possible negative effects of public debt level on GDP performance. This variable was considered important as the New Neoclassical Synthesis considers that high public debt-GDP ratios crowds-out private investment, as it increases interest rates Arestis (2009b), may cause Ricardian Equivalence, or even generate a fiscal dominance phenomena (Sargent and Wallace, 1981, see).

Presented the methodology principles of this paper, next step is to estimate the model and analyze it's main applications: The impulse-response functions and a Variance Decomposition Analysis.

4.2 Model verification

The first condition to estimate a VAR(p) model without spurious correlation is that all variables are stationary. That is, the generating process of X_t, needs that all variables present constant mean and variance, and its covariance should only depend on the time interval between two different observations, and not on the period of observation itself (Lütkepohl, 2005). In order to check this condition, an Augmented Dickey-Fuller unit-root test (ADF) was implemented. First all variables were tested on their levels. Recognized that only for the Subsidies series the hypothesis of no unit-root could not be rejected, the test was repeated for the variables fist difference. Table 1 presents the ADF test results:

The test statistic, Z(t), developed by MacKinnon (1994) is an approximation of the t-statistic. The test results show no evidence of unit-root processes, as the null hypothesis of no-stationarity was rejected for all variables. Next step for the model estimation was to select the appropriate lag order. Four different information criteria methods were observed: Akaike (AIC), Schwartz (SIC), Hannan-Quinn (HQI) and Final Prediction Error (FPE). These methods are based on estimated residuals of different models, observing the number of observations of the model, the number of endogenous variables included, as well as the likelihood estimation of the residuals (Lütkepohl, 2005). Twelve lags were considered, taking into consideration the possible length of fiscal policy impacts on economic activity, normally considered to be an year. Figure 2 shows the lag selection criteria results:

Tabela 1: Augmented Dickey-Fuller test

Series	Test	Test Statistic Z(t)	Prob.
Investment	Drift and trend	-8,467	0.000
	Drift	-8,488	0.000
	No drift, no trend	-8,488	0.000
Consumption	Drift and trend	-11,442	0.000
	Drift	-11,462	0.000
	No drift, no trend	11,462	0.000
Subsidies	Drift and trend	-12,335	0.000
	Drift	-12,335	0.000
	No drift, no trend	-11,462	0.000
GDP	Drift and trend	-7,909	0.000
	Drift	-7,699	0.000
	No drift, no trend	-7,699	0.000
Revenues	Drift and trend	-12,105	0.000
	Drift	-11,942	0.000
	No drift, no trend	-11,492	0.000
Debt	Drift and trend	-6,187	0.000
	Drift	-6,215	0.000
	No drift, no trend	6,215	0.000

Source: Orair et al. (2016) and Central Bank of Brazil

Tabela 2: Lag Order Selection

Lags	FPE	AIC	HQIC	SBIC
0	9.4e-16	-17,57	-17,53	-17,457*
1	7,10e-16	-17,8582	-1,7529	-17,0476
2	5,2e-16*	-18.1683*	-17,557*	-16,6628
3	6,20E-16	-18,0017	-17,1082	-15,8014
4	7,10E-16	-17,8761	-16,7004	-14,9809
5	7,80E-16	-17,7949	-1,6337	-14,2049
6	9,00E-16	-17,6706	-15,9306	-13,3857
7	1,10E-15	-17,5283	-15,5061	-12,5486
8	1,30E-15	-17,3747	-15,0703	-11,7001
9	1,50E-15	-17,2551	-14,6685	-10,8856
10	1,50E-15	-17,3761	-14,5074	-10,3118
11	1,50E-15	-17,4268	-14,2759	-96,6768
12	1,80E-15	-17,3841	-1,3951	-89,3011

Source: Orair et al. (2016) and Central Bank of Brazil

It can be seen that while AIC, HQ and FPE criteria indicate the need for two lags, SIC criteria indicates only one lag to include. In order to a more precise model estimation, both lag orders were considered, and two models were estimated, a SVAR(0) and a SVAR(2). After that, both Portmanteau, as refined by Ljung and Box (1978) and a Lagrange multiplier (LM) test, as presented by Johansen (1995) were tested, concerning the inclusion of sufficient lags and correctly fit the model. In this approach a no-residual correlation at the respective lag order represent the null hypothesis. Below we can see the Portmanteau test results[6],

Tabela 3: Portmanteau residuals autocorrelation test

Lags	*Q-Stat.*	*Prob.*	*Adj Q-Stat.*	*Prob.*	*g.l*
1	10.36171	NA*	10.42339	NA*	NA*
2	21.24914	NA*	21.44120	NA*	NA*
3	64.57638	0.5613	65.55146	0.5272	67
4	98.76039	0.5998	100.5642	0.5495	103
5	142.8658	0.3937	146.0143	0.3250	139
6	179.6332	0.3893	184.1351	0.3031	175
7	210.6797	0.4933	216.5231	0.3825	211
8	245.6106	0.5130	253.1897	0.3798	247
9	284.9188	0.4568	294.7089	0.3038	283
10	325.7566	0.3851	338.1152	0.2211	319
11	367.1344	0.3173	382.3737	0.1522	355
12	403.4568	0.3211	421.4724	0.1387	391

Source: Orair et al. (2016) and Central Bank of Brazil

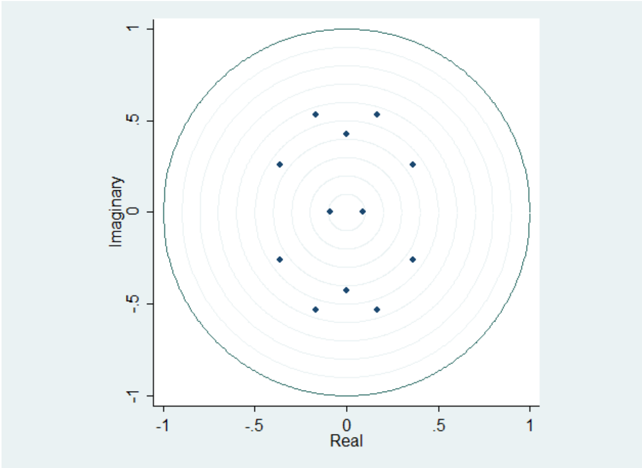
As Table 3 indicates, including two lags in the model reduces the probability of residuals autocorrelation. Thus, two lags were included in the SVAR model, as both lag information criteria and residuals autocorrelation tests suggested. Having considered the variable's stationarity condition and the model's appropriate lag order selection, the system could be estimated and, then, verified. The first verification made was the model's stability. Following Enders (2004), a VAR model general form can be represented by the following identity:

$$A(L)Y_t = A_0 + \epsilon_t \tag{9}$$

Where L represent the lag operator polynomial, X_t is a vector of endogenous variables and A_i are the system coefficients, where $i = 1...p$. The stability condition, thus, requires that A(L)=0, which means that the model converges to an equilibrium. Graphically representing the stability condition, one may analyze the A(L)'s roots. If their inverse remain inside the unit circle, then the system is considered stable, a necessary condition for the model's appropriate estimation. Below we can graphically see the eigenvalues of the estimates of the SVAR (2):

[6] Although both tests have shown similar results, that is, pointed for inclusion of two lags in the model, it was considered that only one of the tables was sufficient to illustrate the findings

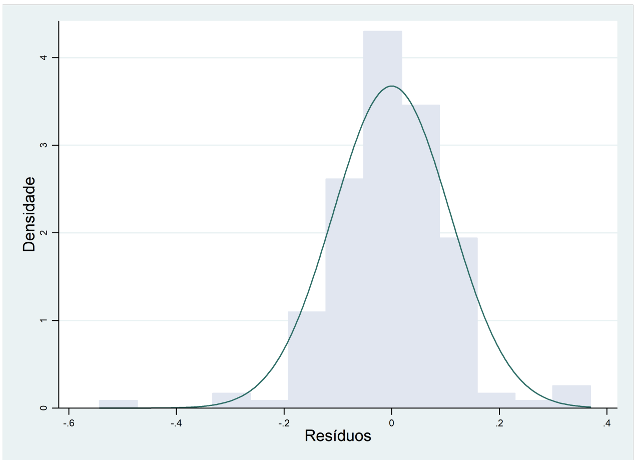
Figura 1: Roots of the companion matrix



Source: Orair et al. (2016) and Central Bank of Brazil

After checking the stability condition, the two last tests, before proceeding to the SVAR model applications are necessary: i) residuals distribution normality test and ii) residuals heteroskedasticity test. For that purpose, three different statistics were estimated for the model's residuals: a skewness statistic, a kurtosis statistic, and the Jarque–Bera statistic. The null hypothesis is that disturbances are normally distributed. The test suggests that for all three statistics tested, there is no evidence of normality distribution of the errors, for all variables regressed. Despite the evidence against a normal distribution, Figure 2, below, shows evidence of an normal distribution approximation:

Figura 2: Residuals histogram



Source: Orair et al. (2016) and Central Bank of Brazil

Lastly, residuals heterokedasticity were tested in order to analyze the model specification.

Although this assumption violation does not represent a coefficient estimation bias, it does reduces its efficiency. For that reason it is important to test the for the homokedasticity of the residuals variance. Therefore, an extension of White (1980) test has been applied. Again, three different statistics are calculated: a F for the mutual significance of cross products of square residuals of the system, a R^2 statistic, which represent the original White test statistic and a LM statistic, which is calculated by the sum of squared residuals divided by two standard deviations. Table 4 shows the tests results:

Tabela 4: Heterokedasticity test

Joint test:

Chi-sq	df	Prob.
841.7186	504	0.0000

Individual components:

Dependent	R-squared	F(24,144)	Prob.	Chi-sq(24)	Prob.
res1*res1	0.106691	0.716597	0.8285	18.03070	0.8015
res2*res2	0.560532	7.652868	0.0000	94.72989	0.0000
res3*res3	0.133891	0.927537	0.5650	22.62763	0.5419
res4*res4	0.318178	2.799952	0.0001	53.77209	0.0005
res5*res5	0.161909	1.159129	0.2897	27.36267	0.2878
res6*res6	0.356529	3.324431	0.0000	60.25342	0.0001
res2*res1	0.158143	1.127101	0.3220	26.72616	0.3174
res3*res1	0.163587	1.173492	0.2759	27.64625	0.2752
res3*res2	0.621751	9.862560	0.0000	105.0759	0.0000
res4*res1	0.229713	1.789302	0.0196	38.82146	0.0285
res4*res2	0.279793	2.330937	0.0011	47.28500	0.0031
res4*res3	0.283622	2.375461	0.0009	47.93204	0.0026
res5*res1	0.166818	1.201304	0.2505	28.19218	0.2520
res5*res2	0.185924	1.370322	0.1317	31.42120	0.1420
res5*res3	0.235214	1.845334	0.0148	39.75121	0.0227
res5*res4	0.334451	3.015112	0.0000	56.52220	0.0002
res6*res1	0.197225	1.474072	0.0852	33.33099	0.0973
res6*res2	0.548288	7.282807	0.0000	92.66072	0.0000
res6*res3	0.117630	0.799868	0.7323	19.87945	0.7036
res6*res4	0.325119	2.890462	0.0001	54.94519	0.0003
res6*res5	0.125223	0.858888	0.6564	21.16263	0.6291

Source: Orair et al. (2016) and Central Bank of Brazil

The null hypothesis here is that the model's residuals have no heterokedasticity. It can be seen that while the joint test reject this hypothesis, both individual statistics F and χ^2, show mixed evidence of homokedasticity. If this result is not conclusive about the residuals variance distribution, the violation of this hypothesis is believed to not change the SVAR(2) application's results, as the coefficient's estimators remain non-biased. Having considered the model's specification and verification, next step is to conduct typical SVAR applications.

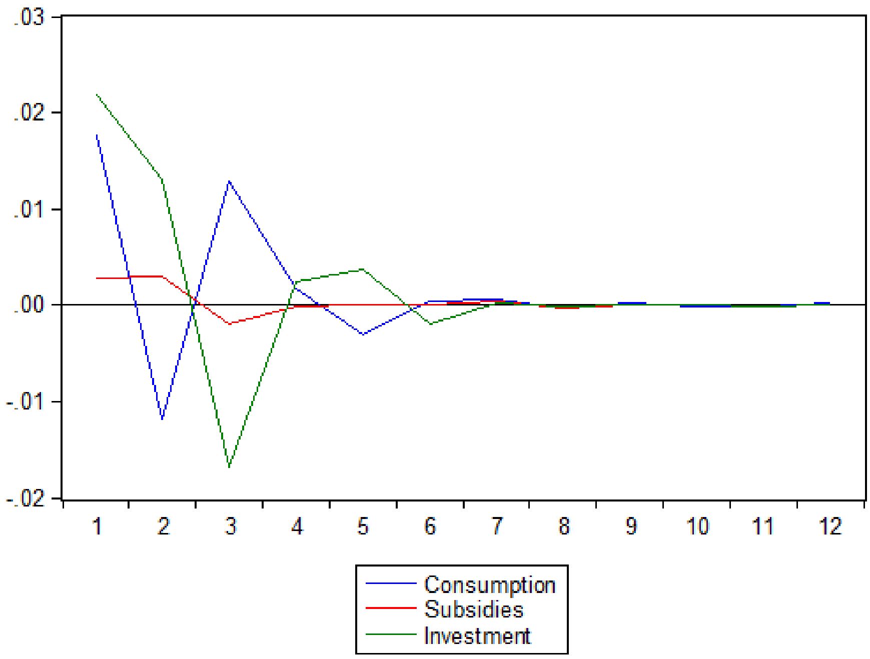
4.3 SVAR applications and Results

Impulse-Reponse functions (IRFs) are one of the most important applications of VAR/SVAR models. Considering a vector autoregression moving average, Enders (2004) shows the following example to illustrate IRFs meaning:

$$X_t = A_0 + \sum_{0}^{\infty} \phi_i \epsilon_{t-i} \tag{10}$$

Where, again X_t denotes the system endogenous variables, A_0 are constants, ϕ_i are impact multipliers, equivalent to $B_0^{-1}\epsilon_t$ on 7, which measures the impact of reduced form shocks on the endogenous variables. If one simulates the impact over time of a change on ϕ_i on the model's variables, then it is possible to see, graphically IRFs dynamics. After restricting the model as describe in Section 4.1, then one can understand the cross influence of all variables of the SVAR model. Below we can see the impact of all public expenditure variables on GDP:

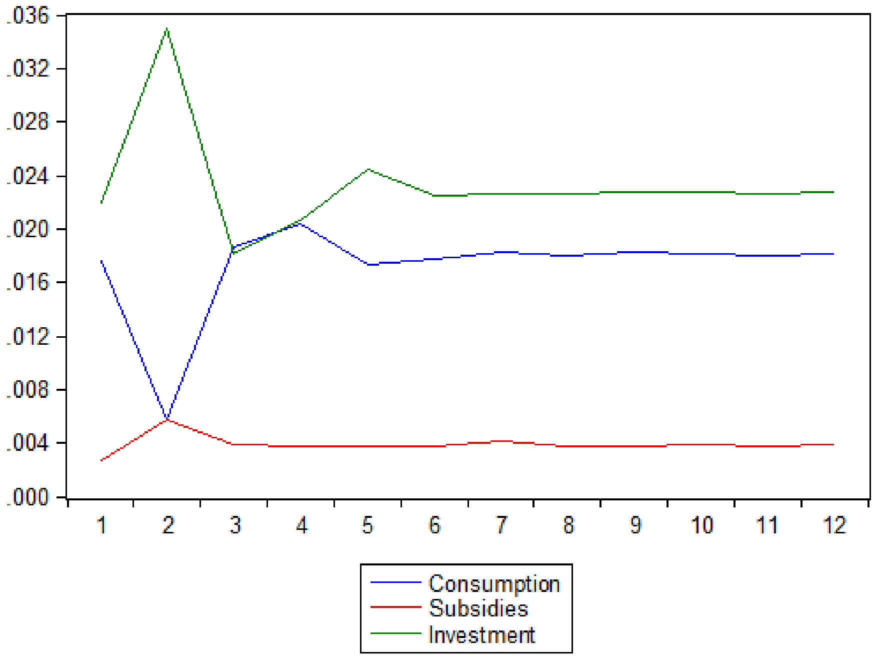
Figura 3: GDP response to Consumption, Subsidies and Investment structural shocks (one sd. deviation)



Source: Orair et al. (2016) and Central Bank of Brazil

The first thing to be noticed is that while Consumption and Investment show greater impact on GDP, subsidies evidence a weaker correlation with economic activity. Besides that, all series show not only positive,but also negative impacts on GDP, suggesting an unstable but positive relation after twelve months. Nevertheless, public investment shows a higher impact on GDP if compared to Consumption, while Subsidies show almost null impact on growth. Another way to analyze Impulse-Response functions is to analyze not one period shock on structural residuals, but a continuous shock over time, as seen in Figure 4:

Figura 4: Accumulated response of GDP to Consumption, Subsidies and Investment on GDP (one SD. deviation)



Source: Orair et al. (2016) and Central Bank of Brazil

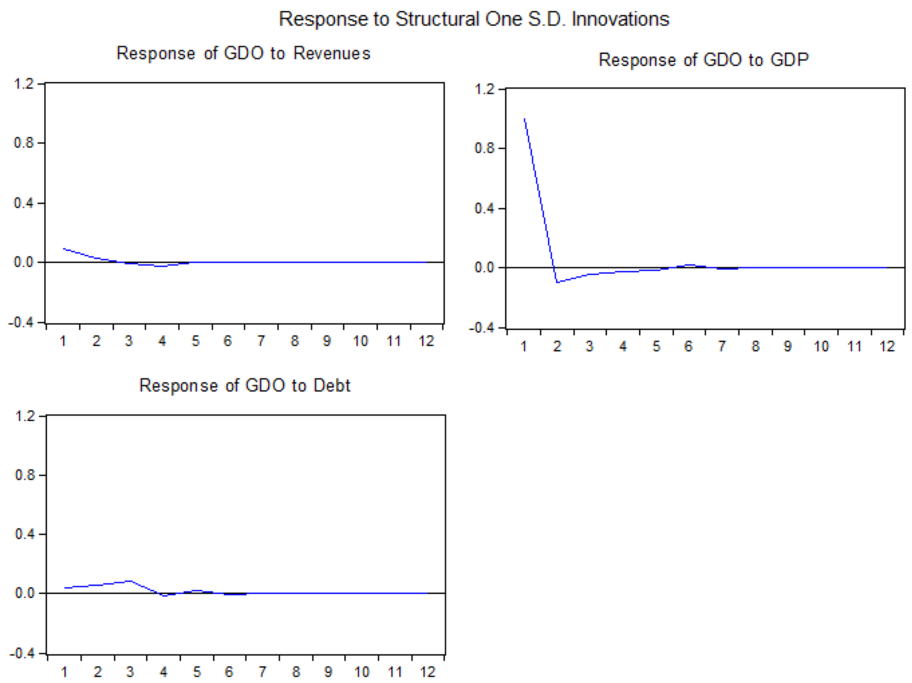
Figure 4 shows the same pattern as the one period shock of Figure 3, as expected. It is easier to see, though, the slight but noticeable difference between consumption and investment. It is also clear that Subsidies have very low impact on GDP dynamics, as its accumulated shocks remain close to zero at all twelve periods. This result is consistent with previous evidence, where the impacts of public investment show higher multiplier effects, as evidenced by long-run (Aschauer, 1989, see) and also short-run estimations (Auerbach and Gorodnichenko, 2012; ADB and Furceri, 2016), including also SVAR estimations for Brazil (Orair et al., 2016).

Although Figures 3 and 4 show that all public expenditures have a similar pattern in what concerns the length of the impact on GDP (they all converge after approximately six months), this result is narrowly related to data frequency and should not be of great concern[7].

Next, we will analyze GDP responses to Revenues, GDP itself and Debt structural shocks, as showed in Figure 5:

[7]Not only quarterly data show similar results, that is, converging impact after six periods (Peres and Ellery Junior, 2009; Blanchard and Perotti, 1999, see), but also, annual data impulse-response functions may show similar pattern Afonso and Costa (2013).

Figura 5: GDP response to Revenues, GDP and Debt structural shocks (one sd. deviation)

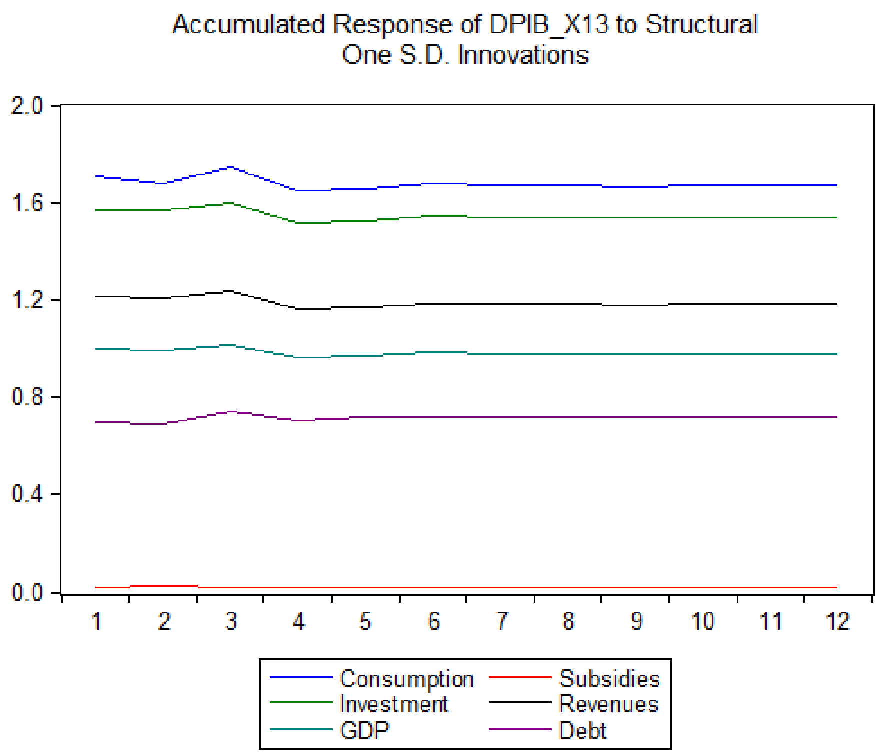


Source: Orair et al. (2016) and Central Bank of Brazil

It is clear that all series show a positive but shorter impact (close to two periods) on GDP, if compared to expenditures. It is also possible to notice that GDP is responsible for the highest impact on itself, which evidences its endogeneity. Revenues and Debt, the fiscal variables of interest in this analysis show, on the other hand, a smaller, though positive, correlation to GDP dynamics. Two different interpretations can be highlighted about the GDP response to Revenues shocks. First, the positive impact of Revenues shocks on GDP might only reveal an endogenous relation due to the restriction approach proposed. Secondly, this result can be evidence of a real positive relation between Revenues and economic activity. The rationality of this argument as sustained by Dutt (2013), is that the public sector has a higher propensity to consume (close to one) if compared to public sector. In fact, in the case of Brazil, all public income was spent, as during the period of analysis, public sector had only nominal deficits. Furthermore, as both expenditures and taxes increased as a proportion of GDP, this results can be evidence in favour of the Haavelmo theorem, which states that GDP growth is proportional to an equal increase of taxes and expenditures.

As it is usual on Impulse-Response analysis, different identification methods have been implemented in order to check the model's robustness. The first identification alternative was setting the $X_t = [T_t, G_t, Y_t]$ ordering, where T represents government taxes, G government expenditures and Y denotes GDP. Under this specification, ϵ_t^y, uncorrelated structural shocks on taxes, are affect by unexpected shocks on GDP, by structural shocks on G, and to structural shocks on taxes, T. The same approach applies to government expenditures, while GDP is affected by unexpected movements on expenditures, taxes and itself, not being mutually correlated to any structural shocks. In Figure 6 we can see the accumulated response of GDP to all fiscal variables:

Figura 6: Accumulated response of GDP (one SD deviation)

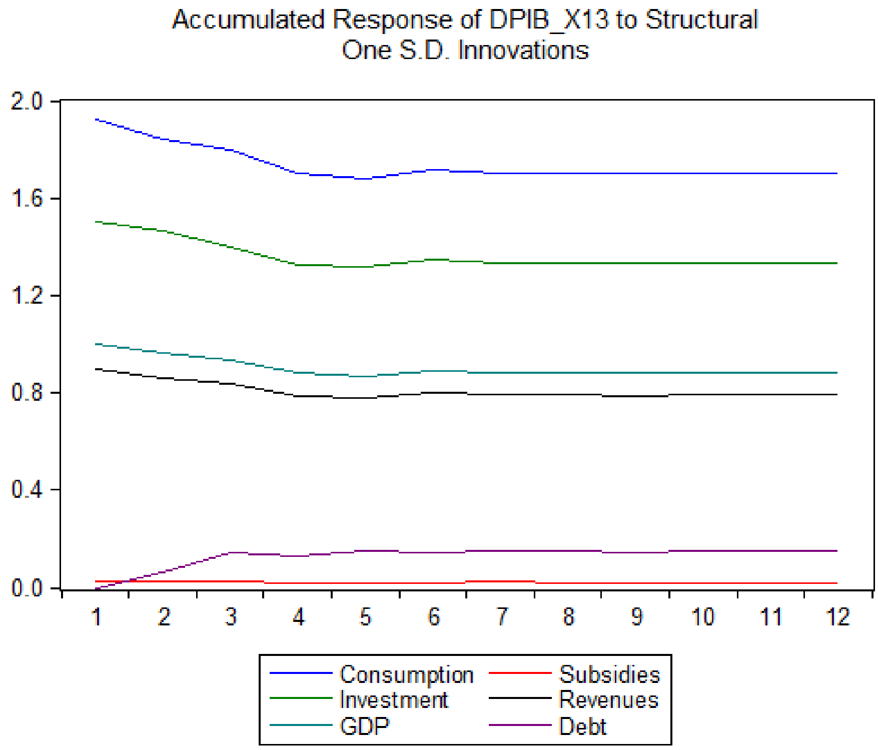


Source: Orair et al. (2016) and Central Bank of Brazil

From this evidence one can notice that public consumption and investment expenditures show a stronger impact on GDP than any other variable. Followed by Revenues, GDP, Debt and, at last, Subsidies. This result exhibits similarities with the previous model estimated, as Consumption and Investment show greater influence among the expenditures side. Revenues, in turn, if appears to have a weaker relation to GDP structural residuals, if compared to the previous model, presented the third highest impact on economic activity. Again, Subsidies show the weakest influence on GDP, adding further evidence against its effectiveness.

A third identification method has also been tested with the $X_t = [G_t, T_t, Y_t]$ ordering approach. Now, government expenditures are only affect by its own non expected shocks, while taxes are contemporaneously affected by structural expenditures shocks and by non expected GDP shocks, besides its own non expected shocks, u_t^T. GDP structural residuals, as commonly set, are affected by all fiscal variables: expenditures, Revenues and Debt, besides itself. Figure 7 resumes the impulse-response functions results for this specification:

Figura 7: Accumulated response of GDP (one SD deviation)



Source: Orair et al. (2016) and Central Bank of Brazil

Again, evidence supports the previous results, that is, strong and positive Consumption and Investment relation with GDP. Its interesting to notice that the difference between these two expenditures is greater then both previous models, supporting an stronger relation of public Consumption with growth.

The results suggests, again, a positive relation between Revenues and GDP, although weaker then Consumption and Investment. Finally, Subsidies and Debt, show weaker, but positive relation with private consumption and investment, the greatest share of GDP.

Another fundamental SVAR model application is the Variance Decomposition analysis. This method separates the variation of each endogenous variable into the component shocks of the model. Thus, this approach gives an estimation of the relative importance of each fiscal variable on GDP. Table 5 shows the results for GDP's variance:

Tabela 5: GDP variance decomposition (in %)

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6
1	1.000000	0.030505	0.000721	0.047594	0.820044	98.94332	0.157812
2	2.073557	0.043612	0.001619	0.063622	0.897868	98.50232	0.490963
3	2.861824	0.059219	0.001956	0.090487	0.894866	97.83809	1.115382
4	2.890865	0.059423	0.001956	0.090953	0.944899	97.76187	1.140901
5	3.011392	0.060265	0.001954	0.092245	0.944093	97.70662	1.194826
6	3.018857	0.060244	0.001952	0.092559	0.945277	97.69633	1.203641
7	3.019201	0.060270	0.001967	0.092554	0.945867	97.69297	1.206376
8	3.020599	0.060275	0.001981	0.092554	0.945912	97.69290	1.206376
9	3.020920	0.060277	0.001981	0.092555	0.945933	97.69242	1.206836
10	3.021808	0.060279	0.001983	0.092555	0.945936	97.69218	1.207066
11	3.021951	0.060279	0.001984	0.092556	0.945938	97.69218	1.207065
12	3.022091	0.060282	0.001984	0.092556	0.945946	97.69216	1.207075

Factorization: Structural

Source: Orair et al. (2016) and Central Bank of Brazil

It can be seen that while expenditures account for nearly one percent of GDP variance along twelve periods, Revenues impact varies between 8% and 9%, while GDP shocks respond to nearly 98% of its own variance changes over twelve months. Finally, Debt's share goes from nearly 0 to approximately 1,2%. This result, sheds light into two important issues. First, under the model's restrictions fiscal variables have low impact on GDP, as nearly 98% of its variance decomposition are not due to fiscal policy. Secondly, expenditures shocks have a relatively smaller impact on GDP if compared to Revenues and even Debt. Observing the impact of each one of the expenditures variables, one can see that Investment has greater impact on GDP then Consumption and Subsidies, which, in turn, shows the weakest relation with economic activity. Hence, the variance decomposition analysis is consistent with Impulse-Response functions, and evidence both the difference between each public expenditure on economic dynamics, and an considerable influence of Revenues on GDP.

Considering the overall results from the model's applications, this paper offers new evidence about the relation between fiscal policy and economic growth in Brazil. It has been shown that different expenditures have different impacts on GDP, while taxes (Revenues) also show a strong and positive relation with GDP. Looking at Consumption composition, it can be seen that public and private pensions and social benefits have an important role, among fiscal variables, on GDP dynamics. If one considers that almost 70% of social benefits of General Regime of Social Security ("RGPS") are below or equal to the minimum wage (Rangel et al., 2009), then it is easy to associate a high propensity to consume out of the public Consumption variable. The same interpretation can be made out of social benefits, which is mainly directed to the share of population on poverty conditions (Ipea, 2011).

Another important issue in the context of fiscal policy management in Brazil from 2002 to 2016, is the role of public investment. As noticed elsewhere (Dutt, 2013; Barro, 1990; Barro and Sala-i Martin, 1992; Aschauer, 1989, see), public investment can be fundamental on stimulating long-run economic growth. In Brazil, a similar relation has been observed elsewhere (Serrano and Summa, 2015), as it could be seen a significant growth on public investment, leaded by the Acceleration Growth Program (PAC) during the 2005-2010 period, when the country had particularly high rates of economic growth. On the contrary, during Brazilian slow growth performance, from 2011-2016, an expressive fiscal adjustment was made, with significant public investment cuts (Orair, 2015), while public subsidies expenditures gained special attention and grew approximately 27% from 2011 to 2014, in real (Gobetti and Orair, 2015).

5 Conclusion

This paper sheds light into how the country's macro regime restrictions on fiscal policy are related to an weaker growth pattern. For that purpose, this work associated conciliated two perspectives: a theoretical and a applied one. While the former is important to highlight the role of fiscal policy under the New neoclassical synthesis, which inspired Brazil's macroeconomic policy framework, the latter shows how fiscal policy may have positive and significant impact on GDP.

Under different assumptions, the SVAR model has shown how desegregating public expenditures have different impacts on GDP. It is clear how consumption and investment have a more robust impact on economic activity, while public subsidies show much smaller influence on growth. Revenues also show a positive relation between public Revenues and GDP, which poses different interpretations: first, it may reflect a higher propensity to consume of government if compared to the private sector, specially if one considers that during the whole period of analysis, public sector presented only nominal deficits. Secondly, it may only reflect this variable endogeneity to GDP. Public net debt, in turn, had shown a weak relation with GDP, revealing that aggregate private demand decisions are not likely to be influenced by this variable.

Collectively the results found on this work poses questions on the rationality of cutting private and public pensions and social benefits, which composes public Consumption variable, in order to stimulate economic activity. Alternatively, Subsidies expenditures increase do not seem appropriate as a fiscal stimulus policy, as this kind of incentive show the weakest impact on GDP, among all fiscal expenditures. Finally, we can associate Brazilian macroeconomic regime with a slow growth pattern, as fiscal policy faces strong restricitions.

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