



REVISTA
CADERNOS DE
FINANÇAS PÚBLICAS
01 | 2022



FISCAL RULE AND MONETARY POLICY EFFECTIVENESS: ESTIMATES FOR THE BRAZILIAN CASE

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Abstract

A central bank needs to assess the effects of fiscal policy on the economy if it wants to be more precise on the impact of its decisions on the output growth and on the price level: inconsistent fiscal policy can render monetary policy ineffective. This paper tried to understand the effects of fiscal policy on the Brazilian monetary policy conduction. To do so, using monthly data between Jan/2003 and Jan/2020, a fiscal rule was estimated; from this fiscal rule, using the Kalman filter, a time series was extracted, containing the response of the primary surplus-to-GDP ratio to fluctuations in public debt-to-GDP ratio. Thus, a fiscal reaction index was tested on a monetary policy rule; the results pointed out that a greater fiscal response to changes in debt results in less real interest rate variability. The result can be interpreted as a greater monetary policy effectiveness induced by greater responsiveness to indebtedness.

Keywords: Monetary Policy, Fiscal Policy, Fiscal Rules

Classificação JEL: E31; H30; H63

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1. INTRODUCTION

A Central Bank aiming at considering all the impacts of its decisions on output and inflation seriously should use models to also analyze the potential impacts of fiscal policy on the price level, as Christopher Sims (2011) rightly points out.

Understanding macroeconomic dynamics is fundamental for a better perception by economic agents of the policies in progress and the results, whether positive or not, that these policies may have. Usually, discussions about macroeconomic dynamics always include the monetary and fiscal policies of the country in question, policies that determine the behavior of aggregates throughout the economic cycle and the development of society in subsequent years.

Starting in the 1980s, after the publication of the classic articles by Kydland and Prescott (1982) and Prescott (1986), the Real Business Cycle Theory (RBC) began to be used as a basis for macroeconomic analysis. The contributions of RBC at the time were based on three points: cyclical fluctuations would not be a sign of inefficient allocation of resources (in contrast to the previous interpretation originating in Keynes); technology would have a primary role in generating cyclical fluctuations; and monetary factors would have a limited role in explaining economic fluctuations. The new theory had little impact on monetary policy makers, but served as a foundation for what would come to be called the New-Keynesian theory.

Until the early 1990s, the models used to evaluate monetary policies combined, under the assumption of price rigidity, monetary availability (quantity of money) and aggregate demand. The evolution of the theoretical field led to the creation of new dynamic models based on the optimizing behavior of agents. The central point of these models, according to Walsh (2010), was the possibility of the monetary authority intervening in the economy to determine aggregate demand in the short run.

The New-Keynesian theory made use of the structure of RBC models along with assumptions that departed from classical monetary models, synthesizing dynamic stochastic general balance (DSGE) models. The concepts of monopolistic competition, nominal rigidities of prices and the non-neutrality of monetary policy in the short run were introduced. Thus, prices and wages are determined by agents to maximize their objectives, firms have costs to adjust their prices (as well as wages), and in the short run, due to price rigidity, changes in the monetary policy instrument result in changes in the real interest rate, output and unemployment rate. The New-Keynesian models, however, initially followed the long tradition of abstracting away fiscal policy when trying to estimate the behavior of inflation in the economy, giving primacy to monetary policy.

Developments from New-Keynesian models, especially after the Subprime crisis and the European public debt crisis, have adopted the fiscal variable as a determinant of monetary conduct. Authors such as Cochrane (1999), Woodford (2001), Sims (2011), and Leeper (1991; 2016) have highlighted the role of fiscal policy in aiding inflationary control, showing that this is often the macroeconomic sphere responsible for explosive inflation trajectories.

Leeper and Leith (2016) highlighted some post-Subprime crisis developments made possible by thinking together the effects of monetary and fiscal policies: most countries reacted to the crisis by coordinating monetary and fiscal policies; the adoption of fiscal austerity measures starting in 2010 created challenges for Central Banks that were already operating at the zero lower bounds of nominal interest rates; the European public debt crisis showed: (i) the need to observe fiscal limits; (ii) that deteriorated fiscal expectations make monetary policy action difficult or impossible; (iii) the long-term fiscal stress created by population aging may result in conflicts with the long-term objectives of monetary policy.

The first point of interest when discussing the relationship between macrodynamic and economic policy is monetary policy. Qualitative aspects of monetary policy makers influence agents both in the present and in the expectational field, as shown by Taylor (1993), Walsh (1995), Svensson (1997), Clarida, Galí and Gertler (1999), Balbino, Cola and Telles (2011), Barbosa, Camêlo and João (2016), among others. From the perspective of the monetary authority, issues such as credibility and reputation began interfering in the conduct of economic policy.

In Brazil, the Central Bank conducts monetary policy through the Selic rate, the basic nominal interest rate: The Central Bank of Brazil (BCB) sets a target for the market interest rate at which financial institutions lend money to each other. So that in this market the price is fixed - in other words, so that the level of the nominal interest rate chosen by the authority is actually practiced by the market - the BCB commits itself to buy all the quantity of liquidity that agents are willing to sell at the given price. For example, if financial institutions have an excess of Selic-rated funds, the BCB sells Selic-indexed debt, repurchasing the excess liquidity. Thus, the monetary authority controls the basic interest rate, which in turn influences the behavior of the economy's price levels.

However, one must consider whether a Central Bank committed to price stability is a sufficient condition to ensure inflationary control and social welfare. New theoretical developments show that it is not.

The second important point of the analysis is the fiscal issue, treated here as central to economic stability. Mishkin (2007) showed basic principles for policymakers acting under inflation targeting, among which is that fiscal policy should be conducted in a coordinated manner with monetary policy, given the various interactions between the two policies. Blanchard and Cottarelli (2010), in their "10 commandments for fiscal adjustment" stated that monetary and fiscal policies should be appropriately coordinated; it is necessary to have a credible medium-term fiscal target, and one should seek in the long run the decline of the public debt/GDP ratio. Montes and Tiberto (2015) showed that a better fiscal reputation reduces country risk and favors economic stability scenarios; therefore, failure to meet fiscal targets would raise the cost of public debt (considering the movement of interest rates implicit in government bonds) and the country's fiscal situation would deteriorate, along with the macroeconomic stability environment.

The two points of interest presented become interdependent when the interaction between them is analyzed. In the traditional theoretical literature, there are two combinations of monetary and fiscal conduct: in the first, shocks to the debt are fully covered by adjustments in the fiscal policy instrument, i.e., the primary surplus of the public sector; and in the second, real fluctuations in the debt generate changes in the price level. In the terms of Sargent and Wallace (1981), one can speak of monetary dominance and fiscal dominance.

There is, however, a third possible form of interaction, stemming from more recent developments in New-Keynesian monetary theory. In the works of Cochrane (1999; 2001) and Sims (1994) we find the Fiscal Theory of the Price Level (FTPL): even in the face of an independent and/or autonomous monetary authority that fulfills its mandate of inflation control, the price level of the economy could assume explosive behavior due to the influence of fiscal policy. The price level becomes the corrector of the mismatch between fiscal liabilities and public savings, that is, in the limit, the discrepancy needs to be corrected by increasing the price level - so that the entire economy is negatively impacted by the persistence of the fiscal imbalance.

If economic policy must view monetary and fiscal policy with equal importance, it must now have two objectives, e.g., stabilization of prices and public debt. If one of the objectives is not achieved, economic welfare may decline. For fiscal policy, the terms solvency, credibility and reputation come into discussion. Solvency of public debt is the characteristic of a given public debt to be sustainable, or not “explode”, in the long run; fiscal reputation is a backward-looking variable related to fiscal authority, that is, its consolidation depends on a recurrent compliance with fiscal targets; fiscal credibility is a forward-looking variable related to announcements and future objectives of fiscal policy itself, whose consolidation depends on the confidence of agents in the fulfillment of the former.

If fiscal policy is not aligned with debt stabilization through necessary adjustments for primary surplus purposes, the public debt/GDP ratio may grow to an extreme point where it is impossible for the government to honor all its obligations. The government would no longer be able to borrow and therefore fiscal policy itself would become incapable of conducting counter-cyclical policies or creating automatic stabilizers. The drawn scenario ends with a loss of credibility and fiscal reputation, inefficiency of economic policy, and a reduction in the country’s welfare, since the growing public debt tends to create an environment of greater volatility in asset markets and pessimism as to the solvency conditions of the public sector, reverberating in processes of hyper-devaluation of the national currency (WOODFORD, 2001; BLANCHARD, 2005).

In Brazil, even in the face of anti-inflationary actions by the monetary authority, for much of the past few years fiscal policy has not been guided by the stabilization of public debt; the general picture of works for monetary economics shows a Central Bank that pursues inflation control - even if it is not so strict in its actions. On the other hand, Blanchard (2005), Moreira and Carvalho Junior (2013), Moreira (2017), and Campos and Cysne (2019) found evidence of pro-cyclical fiscal policy, i.e., unsustainable fiscal conduct in the country.

The central motivation of this paper is to evaluate at what level fiscal policy, in terms of the search for stability in public debt, allows the Central Bank of Brazil to be more effective in the use of its monetary instrument - the Selic rate target. More specifically, to analyze the relationship between the response of fiscal policy to public debt and the effectiveness of the monetary policy instrument (Selic), starting from the testable hypothesis that a scenario of greater fiscal stability facilitates the Central Bank's role in controlling inflation.

For this, the first step was to estimate a fiscal rule for Brazil: together with an initial estimation by the Ordinary Least Squares (OLS) method, the cointegration method was used, following Campbell and Perron (1991) and Johansen (1991). The second step of the estimation involved the Kalman filter, presented in Kalman (1960) and Kalman and Bucy (1961): according to Grewal and Andrews (2008), the Kalman filter is a recursive and efficient estimation procedure in which, from observable variables, it is possible to estimate state variables (unobservable) and past, present and predicted states for a given model.

Using the Kalman filter it was possible to obtain a time series for the response of the primary surplus to public debt (%GDP) (that is, for the degree of cyclicity of Brazilian fiscal policy) from the fiscal rule estimated previously. Finally, by creating a fiscal response index, we tested its effect on a reaction rule for the Central Bank. The hypothesis tested was: an improvement in the fiscal response component increases the effectiveness of monetary policy.

The dissertation is organized as follows: section 2 presents the theoretical scope of the work; section 3 exposes a review of the related empirical literature; section 4 presents the methodology and results of the dissertation. Section 5 brings the conclusions of the paper, followed by references and exhibits.

2 THEORETICAL SCOPE

2.1 FISCAL POLICY AND THE INTERACTION WITH MONETARY POLICY

The proliferation of central banks operating under inflation targeting regime (ITR) has potentiated discussions about the independence of monetary authorities. With the achievement of the announced target being the main, or at least the simplest, way to evaluate the efficiency of monetary policy, the most common understanding in the literature was that the choice of monetary policy for a given inflation target should be a problem separate from other aspects of government policy. According to Woodford (2001), there were two central arguments: fiscal policy would matter little with respect to determining inflation; and monetary policy would have little effect on the government budget. But this idea was inconsistent, to say the least, since it did not consider the effects of monetary policy on the real value of the remaining public debt and on the necessity required to pay off this debt.

Mishkin (2007) stated that in economies with central banks operating under ITR, fiscal policy should be conducted in a coordinated manner with monetary policy. Despite this, inflation targeting

alone cannot guarantee fiscal discipline. Governments can adopt irresponsible fiscal policies even under an ITR, and the result can have a high cost to society.

One can classify a monetary or fiscal policy as either active or passive. According to Leeper (1991) an active policy is concerned with the expected behavior of some variables in future periods, so as not to remain restricted to current or past conditions, as the passive policy. The passive policy, on the other hand, is restricted by agents' optimization decisions and by the actions of the active authority.

In the theoretical literature there are two different combinations of monetary and fiscal conduct: in the first, shocks to public debt are entirely covered by adjustments in the fiscal policy instrument, the primary surplus of the public sector; and in the second, real fluctuations in the debt cause money creation or changes in the price level. For Sargent and Wallace (1981) one can speak of monetary dominance and fiscal dominance. In terms of the rule specification used by Leeper (1991), for the traditional literature, in the first combination monetary policy is active and fiscal policy passive; while in the second combination monetary policy is passive and fiscal policy active.

In the first combination, monetary policy pursues an inflation target, adjusting the real interest rate to meet the target, while fiscal policy adjusts primary surpluses to cover changes in public debt. In the second combination, fiscal policy does not cover debt shocks with public savings, setting fiscal balances according to exogenous objectives (i.e., political interests), while the monetary authority weakly adjusts the nominal interest rate to avoid impacts of increases in fiscal expenditures with interest payments on public debt. The first combination is called a Ricardian regime, and the second a non-Ricardian regime. In Ricardian regimes monetary policy plays the role of nominal anchor, while in non-Ricardian regimes this is an assignment of fiscal policy.

A government needs to deal with its intertemporal budget constraint so that the flow of financial payments is covered with primary surpluses. This is the basic idea of Ricardian Equivalence. Based on Woodford (1995) and Canzoneri, Cumby and Diba (2001) it is possible to express a relatively simple model to understand fiscal dynamics. A government's budget constraint can be written in nominal terms as

$$B_t = (T_t - G_t) + (M_{t+1} - M_t) + B_{t+1}/(1 + i_t), \quad (1)$$

where B_t represents the public debt, M_t the monetary base, T_t taxes, and G_t government spending, so that $(T_t - G_t)$ corresponds to public savings and can be summarized as s_t ; i_t is the interest rate for the period t . Equation (1) shows that the existing debt needs to be fully repaid, monetized or refinanced. For the sake of greater realism of the constraint, factors such as expansion of credit to the private sector and accumulation of foreign exchange reserves can also increase the monetary base, so

it is necessary to exclude net claims of the central bank with the private sector and abroad to continue using the same expression.

It is possible to express the budget constraint as a function of total government liabilities. Assuming y_t as the GDP it is possible to represent the components of the constraint in relation to the economy's output:

$$\frac{M_t + B_t}{P_t y_t} = \left[\frac{T_t - G_t}{P_t y_t} + \left(\frac{M_t}{P_t y_t} \right) \left(\frac{i_t}{1 + i_t} \right) \right] + \left(\frac{y_{t+1}/y_t}{(1 + i_t)(P_t/P_{t+1})} \right) \left(\frac{M_{t+1} - B_{t+1}}{P_{t+1} y_{t+1}} \right). \quad (2)$$

In Equation (2) the total government debt to GDP ratio should be equal to the public savings surplus to GDP plus the discounted value of the liabilities to GDP ratio of the period. $t+1$. In Equation (2) the ratio between output growth and the interest rate becomes the discount factor. One can simplify the previous equation in the form of Equation (3)

$$w_t = s_t + \mu_t w_{t+1} + 1, \quad (3)$$

where w_t represents total government liabilities and s_t the public savings surplus, both terms as a ratio of output, and μ_t is the discount factor. The constraint can be expressed with infinite iterations, in present value, as follows

$$w_t = s_t + E_t \sum_{j=t+1}^{\infty} \left(\prod_{k=t}^{j-1} \mu_k \right) s_j. \quad (4)$$

The way this constraint will be satisfied defines whether fiscal policy integrates a Ricardian or a non-Ricardian regime, whether the sequence s_j is being arbitrarily defined or if it helps to satisfy Equation (4) independently of the discount factors. If the primary surpluses automatically adjust to satisfy the constraint at any level, we have a Ricardian regime, in which prices will be determined in the conventional way, by monetary supply and demand.

Based on the life cycle theory, in which agents wish to maintain a stable pattern of consumption throughout life, when government deficits occur, agents would seek to save to finance the future increase in expenditure with taxes, canceling out a wealth effect. Changes in government debt would have no real effects on output, and there would be no lasting impact on economic growth. The government could then go into debt without impacting the price level.

In other words, it is characteristic in Ricardian regimes that higher interest rates increase the government's budget constraints, raising public sector spending on its debt. Possible increases in the price level will have their wealth effects cancelled out by the expected increase in taxes - or reduction in government spending, if we want to stick to more concrete scenarios today.

In theory, fiscal policy is considered to have flexibility to respond to debt shocks; however, in practice this dynamic is more complex. Fiscal policy goes through the executive and legislative branches of a democracy, and suffers from bureaucratic obstacles and constitutional deadlines that usually prevent full flexibility.

In the basic scheme suggested by Sargent and Wallace (1981), upon the announcement of a monetary target - what today would be an inflation target - the fiscal authority faces a constraint imposed by the demand for government securities and needs to adjust its budget accordingly. The monetary authority then autonomously seeks to control inflation.

Although the policy mix is generally presented in a simple way, coordination between the two is not trivial. When a central bank conducts contractionary monetary policy to contain inflationary shocks, the interest paid by the government also rises; subsequently, in the face of a lower price level, the real value of bonds also increases. Leeper (2016) treats this as a contradiction. From an accounting point of view, a passive fiscal policy would raise taxes to cover the increase in interest spending. From an economic point of view, the monetary authority's action will increase the wealth held by debt holders if a tax increase is not expected. As explained earlier, it is the expectation that the higher value of bonds will be taxed in the future that eliminates the wealth effect on output. Thus, the adjustment of the monetary policy instrument reduces inflation.

Non-Ricardian regimes are those in which the government does not fiscally adjust to the budget constraint over time, influencing monetary policy. Leeper (2001, 2016) shows that in these regimes fiscal policy chooses taxing and spending levels to stimulate the economy, relegating efforts to stabilize debt to the background. Therefore, shocks to government debt will result in a higher level of inflation: prices depend on government liabilities (money and bonds) and nominal interest rates depend on the ratio of money to debt. There is fiscal dependence, or rather the dominance of fiscal policy over monetary policy.

Under fiscal dominance the monetary authority makes debt growth possible by not fighting inflation in real terms, creating a wealth effect, but it also increases the value of government bonds - in terms of market value - when it goes to the open market to buy bonds. This action by the Central Bank reduces the government's financial expenses, which in turn will have less interest to pay.

Returning to Leeper's (2016) explanation of policy coordination, in a non-Ricardian regime with fiscal dominance there will in fact be no tax increase - or spending reduction - to remedy a budget constraint. By not using the monetary policy instrument to control the general price level, the monetary authority accepts to be led by the fiscal authority.

It would be possible to observe, especially in countries where the debt/GDP ratio is comfortable, a public debt bubble. Besides inflation via the expectational channel, the real appreciation of public debt would occur via a speculative component, since agents would expect higher returns in the absence of insolvency risk (Woodford, 2001), with the participation of the central bank accommodating this process.

There is, however, another scenario of coordination between monetary and fiscal policy. As seen, the commitment of a central bank to an anti-inflationary monetary policy rule, such as a Taylor rule, does not by itself guarantee price stability (WOODFORD 2001). Commitment alone would not prevent the occurrence of problems related to inconsistency between monetary and fiscal policies.

The problem is not always so simple to solve. Whenever faced with inconsistencies among policies, it would be enough for a monetary authority with sufficient credibility to insist on its announced target to correct the distortions. But Woodford (2001) reminds us that the issue may be more subtle: it is possible that policies are not actually inconsistent (in the sense that there is a balance in which fiscal and monetary commitments are maintained), but that the only possible balance involves an inflationary or deflationary adjustment.

This is the basis for what is called in the literature the Fiscal Theory of the Price Level (FTPL), in which even if the monetary authority is autonomous and exercises its mandate, fiscal policy could influence the price level of the economy.

The traditional approach assumes that the government must change its surplus to cover debt shocks, along the lines of a budget constraint. In the FTPL view it is possible to infer that the basis of the thinking is not that of a constraint, but a balance condition. The price level becomes the corrector of the mismatch between fiscal liabilities and public savings, which is not sustainable in the long run, and, in the limit, needs to be remedied by raising the price level - so that the whole economy pays for the perpetuation of the fiscal imbalance.

If the government surplus is inconsistent with balance at the price level, then, assuming stability at that price level, households view the increase in government debt as an increase in their wealth. Since the agent is non-Ricardian, the future path of primary surpluses in the consumer's intertemporal optimization is not well evaluated and it is not perceived that the increase in wealth is temporary. With increased demand for goods, there is an increase in the price level. Faced with this increase, consumption decisions will be reassessed, matching demand and supply of goods. The correction of the imbalance is due to a wealth effect.

One of the theoretical explanations for the phenomenon is the fact that the government is the only agent that pays a liability (non-monetary) with another liability (monetary or otherwise); in other words, it is a debtor with privileges and advantages over the private sector. For Woodford (2001) the government should not be conceived as a Ricardian agent. Governments with public debt problems can be lenient with increasing inflation, to generate inflationary revenue, reducing the real value of the debt.

As Leeper and Leith (2016) show, the FTPL is not a replacement for conventional theories of interaction between monetary and fiscal policies, but a complement. Its contribution would be to fill some spaces on the fiscal side of the model while expanding the universe of rules followed by monetary and fiscal authorities. The theory reveals a richer set of equilibria that can emerge when one considers that monetary and fiscal policies are intrinsically intertwined.

It is historical for macroeconomists to debate monetary policy or fiscal policy as primary causes of inflationary deviations, but Leeper and Leith (2016) insist that both Ricardian or non-Ricardian regime theories and FTPL are part of a more general theory of price determination, in which monetary and fiscal policies always interact with the private sector of the economy to produce an aggregate-level price balance.

2.2 SOLVENCY, REPUTATION AND CREDIBILITY IN FISCAL POLICY

Much of the macroeconomic discussion worldwide in the 1990s was related to the conduct of monetary policy. Authors such as Finn Kydland, Edward Prescott, Robert Barro, and David Gordon published in the previous two decades works that paved the way for the argument about credibility and reputation of monetary policy and monetary authority. The advancement of the discussion gave rise to the rules versus discretion debate, which in turn led to the movement to reduce central bank discretion.

The scope of the New-Keynesian theory, then in formation, raised the importance of the debate in question. Assuming, among other premises, information asymmetry implies having to live with uncertainties and with choices of agents, with information that would guide the conduct and effectiveness of monetary and fiscal policies. Less discretion would be relevant in this scenario. One of the results of the debate and of new technologies was the inflation targeting regime.

Adopted by several countries in the 1990s, the implementation of the inflation targeting regime (IMR) initiated a series of publications on the credibility and success of the new regime. One of the variables to be considered when assessing the efficiency of the monetary authority is the condition of the public accounts. Terms such as public debt sustainability and fiscal solvency have come to play a prominent role in macroeconomic analysis, along with fiscal credibility and reputation, as well as their monetary policy equivalents. The central idea is the inability of the monetary authority to control inflation in the face of unbalanced public accounts.

The absence of control over the growth of the public debt gives rise to problems in several areas of a country's economy, leading to probable social losses. These problems involve high short- and long-term interest rates; reduced private investment and lower long-term growth; and sudden changes in production and price levels (including the exchange rate).

Macroeconomic policies need to fulfill two fundamental tasks: determine the price level, through the inflation rate, and stabilize government debt (LEEPER, 2016). Like many central banks

around the world, the Central Bank of Brazil has in its mandate the stabilization of inflation, however, given the process of determining the price level in an economy, the fiscal sphere - here seen as an aggregate of the terms of solvency, reputation, and credibility - comes to the fore.

If fiscal policy is not configured in a way that stabilizes the debt, the debt could grow to an extreme point where it is impossible for the government to honor its obligations. The government would no longer be able to borrow, and therefore the fiscal authority itself would become unable to conduct countercyclical policies or to create and operate automatic stabilizers. The scenario in question would end with reductions in the country's welfare, amidst inefficiencies in macroeconomic policies. It is possible, then, to visualize the social and economic effects caused by pessimism regarding the public sector's ability to pay its debt, that is, its solvency.

Debt solvency, in intertemporal terms, can be defined as the characteristic that a certain public debt is sustainable, or does not "explode" in the long run. Debt solvency is a necessary condition for macroeconomic stability, especially for developing countries.

As highlighted by Mendoza and Ostry (2008), while industrial countries - in the sense of developed countries - face concerns about rising public debt due to demographic transitions, emerging countries also have difficulties in accessing capital markets, making it more difficult to solve the problem, and they tend to suffer more in the event of global crises. These are two examples of incentives to maintain long-term debt solvency and facilitate macroeconomic stability.

That said, how can one certify that a given fiscal policy will guarantee the sustainability of public debt? Part of the literature adopted ad hoc sustainability, in which the debt was sustainable when the expected present value of the primary balance, discounted by the interest rate on the debt, was equal to the initial debt. Generally, this hypothesis was investigated by testing for unit root and cointegration of the residuals of the fiscal data. Bohn (1998; 2005) suggested a model-based sustainability (MBS) fiscal rule that determines whether increases in public debt cause increases in the government's primary balance - that is, higher surpluses.

Bohn's (1998; 2005) basic idea is to find a systematic relation between the debt-to-GDP ratio and the primary balances in the form of Equation (5), in which s_t is the primary surplus in terms of GDP, ρ is a positive constant d_t is the debt-to-GDP ratio, Z_t is the vector with the variables that explain the primary surplus besides debt and ϵ_t e μ_t are the error terms.

$$s_t = \rho d_t + \alpha Z_t + \epsilon_t = \rho d_t + \mu_t \quad (5)$$

$$\mu_t = \alpha Z_t + \epsilon_t \quad (6)$$

In tests such as Bohn's, a positive response of the primary surplus/GDP ratio to increases in the debt/GDP ratio is expected, meaning that the fiscal authority reacts to positive shocks to public debt by invariably increasing the primary surplus. For Mendoza and Ostry (2008) this analysis requires that fiscal policies be consistent with the balance conditions that link the public and private sectors. Thus, ad hoc sustainability would be mistaken, since the interest rate on public debt is an incorrect discount factor to assess the expected present value of primary balances.

Solvency, or public debt sustainability, is necessarily accompanied by two other inseparable concepts, reputation and credibility. Better said, the credibility of fiscal policy and the reputation of the fiscal authority are determinants for the maintenance and effectiveness of long-term sustainability.

Reputation is a backward-looking variable related to fiscal authority, that is, it is determined according to past results, in the case relevant to this paper, according to the achievement of fiscal targets. Since reputation is a basic premise for the emergence of credibility, it is necessary that the public believes that the announced goal will be successfully achieved. Credibility, then, is a forward-looking variable related to fiscal policy itself, representing the confidence of agents in meeting the target in the future.

It is not complex or erroneous to infer that the policies announced by monetary and fiscal authorities should be fully executed and successful in achieving their previously announced targets. This would create an expectation that the authority complies with announcements, anchoring expectations and facilitating the control of instrumental variables of fiscal and monetary policy. Drawing a parallel with the extensive theoretical scope of monetary policy and conduct, the announcement of fiscal targets enhances the transparency and communication of the fiscal authority, allowing for greater monitoring of fiscal conduct, which encourages the authority's commitment to society; meeting the announced target ultimately enhances the authority's reputation and the credibility of fiscal policy.

Debates about reputation and credibility form the basis of discussions about inflation targeting regimes. In fact, an ITR will only achieve its primary objective in the presence of reputation and credibility. Works such as Kydland and Prescott (1977) and Barro and Gordon (1983a; 1983b) have shown the relevance of these two concepts in relation to the problem of time inconsistency, while Walsh (1995) and Svensson (1997) have pointed out that the reputation of the authority is a fundamental piece in the creation of credibility. All these studies focus on monetary policy, but their results certainly expand into the realm of fiscal policy. The behavior of the monetary policy instrument in the ITR depends not only on the conduct of policy itself, but also on expectations about future monetary policy (CLARIDA, GALÍ, and GERTLER, 1999), and this thinking extends to fiscal policy as well (MONTES AND TIBERTO, 2015).

Indeed, the proliferation of ITRs around the world has shed light on the fiscal conduct of several countries, as different studies have been conducted seeking to relate macroeconomic stability not only to the efficiency of monetary policy, but also to the ability to provide an orderly and stable fiscal

environment. The conduct of fiscal and monetary policy defines the reputation of the authorities that execute them and builds credibility.

According to Pires (2006), fiscal credibility is built on the expectation formed by agents about the sustainability of the public debt, so that the credibility analysis is compatible with the solvency of the public debt. Fiscal policy can only be credible if agents expect it to be sustainable. Thus, the study of credibility in the conduct of fiscal policy consists in answering whether the public debt is sustainable.

Thinking about fiscal policy influencing monetary policy, the widespread understanding is: the growing public debt tends to create an environment of volatility and pessimism about the solvency conditions of the public sector (WOODFORD, 2001). Pessimism within expectations of government solvency may contaminate inflation forecasts, leading the monetary authority to adjust its monetary policy instrument. This is why Leeper (1991) worked on the balance between monetary policy, which takes an active role, and fiscal policy, which takes a passive role in the economy, as a stabilizing factor.

If a balanced debt trajectory and equally balanced fiscal indicators allow monetary policy to establish an economically favorable environment more easily in terms of price control, it is expected that from this same environment advances regarding the social development of a country will emerge, under the premise of economic development.

Assuming the maintenance of fiscal solvency as the compliance with fiscal targets, it follows that, over the years, there is a gain in reputation, which allows the fiscal authority to announce targets with greater credibility. The greater credibility, that is, the confidence of agents in the solvency of the debt, results in increased demand for government bonds, which in turn leads to lower implicit interest rates. Finally, the cost of public indebtedness decreases, making it easier to restart the cycle described to meet the announced fiscal targets.

The theoretical literature demonstrates strategies to manage the concepts of solvency, reputation and credibility to ensure macroeconomic stability. Missale, Giavazzi, and Benigno (2002) theorize that the risks of fiscal insolvency can be minimized by increasing the maturity of public debt. This would decrease the risks of refinancing the debt, raising the expectations of agents in the effectiveness of fiscal policy, implying the dilution of debt costs over time.

The theme had already been the focus of the works of Giavazzi and Pagano (1990) and Calvo and Guidotti (1990). In the former, the maintenance of debt sustainability would be capable of increasing the country's resistance to speculative attacks, while for the latter, a longer public debt maturity term would be a way of ensuring fiscal policy credibility, since future governments would be - to a certain extent - conditioned to comply with certain long-term targets. Another strategy also suggested by the literature is the increase in the portion of fixed-rate debt - to offer protection against variations and greater predictability to the government and the decrease in the indexation of the debt to interest and exchange rates.

The general idea presented in the literature on fiscal policy is to maintain a certain level of reputation of the fiscal authority and credibility of fiscal policy, guaranteeing the solvency of the public debt. Aspects such as the very profile of the public debt and its maturity term can help control the fiscal dynamics of a country and reduce macroeconomic uncertainty.

3 EMPIRICAL LITERATURE REVIEW AND EVIDENCE FOR BRAZIL

The bibliography cited in this section was chosen because (i) it uses econometric methods to test the proposed hypotheses, or because (ii) it uses similar macroeconomic time series in its estimations as explanatory or dependent variables, showing proximity to the present work. Here, evidence is presented for the topics discussed in the theoretical scope, both for the international case and the Brazilian case.

3.1 INTERNATIONAL EVIDENCE

Controlling the growth of public debt has become one of the major economic policy challenges faced by many major industrialized countries in recent years. Woodford (1996) noted the resurgence of this concern in the 1990s, when countries in the European Union needed to adjust their fiscal policies to meet the requirements of the Maastricht Treaty and enter the European monetary union. This showed that the way governments controlled their deficits was essential to the success of a monetary union. Bergin (2000) stated that even with little seigniorage revenue the inflation rate in nominal bonds could be higher if the member countries of a monetary union had large debts.

For the United States, there is a consensus among economists: from 1984 on there was a dominance of monetary policy over fiscal policy, that is, active monetary policy and passive fiscal policy. In the post-1984 period, US monetary policy would have been active, with a coefficient for inflation greater than one in the Taylor rule - as guided by Taylor (1999) and Clarida, Galí and Gertler (1999), for example. There is divergence, however, when looking at data prior to Paul Volcker's tenure as chairman of the Federal Reserve, the U.S. central bank. Clarida, Galí and Gertler (2000) showed that monetary policy did not raise the interest rate to real levels, accommodating inflation; Bhattarai, Lee and Park (2012) obtained results of passive monetary and fiscal policy in the pre-Volcker era; Davig and Leeper (2006; 2011) found evidence of active fiscal policy in some periods of the pre-Volcker era. The results for this period are generally not consensual.

Woodford (2001) argued that from World War II until the Treasury-Fed Accord of 1951 US monetary policy consisted of explicitly maintaining the market value of government debt, characteristic of a fiscal dominance. Earlier, Cochrane (1999) had already analyzed postwar US fiscal data with the FTPL, showing that the theory could accommodate the stylized fact that deficits and inflation are negatively correlated. Traum and Yang (2011), meanwhile, found no evidence supporting the existence of fiscal dominance in the United States at any post-World War II point in time. The authors

estimated scenarios in which fiscal policy was active and monetary policy passive, the existing data, however, did not satisfy the proposition of fiscal dominance.

An important point regarding investment dynamics and macroeconomic stabilization is the notion of risk. Arora and Cerisola (2001) studied the relationship between monetary policy and sovereign spreads in the United States, as well as the interaction with country risk. Their work showed that improving the country's macroeconomic fundamentals-such as adopting responsible fiscal policies-can help reduce country risk.

The response to the 2007-2009 recession was an example of coordination between monetary and fiscal policies. The response of governments to this crisis was generally aggressive, especially in the United States: The Federal Reserve cut interest rates on federal bonds by 500 basis points, reaching its lower limit in December 2008; on the fiscal side, the Economic Stimulus Act and the American Recovery and Reinvestment Act were passed, with amounts of \$125 billion and \$787 billion, respectively. According to Davig and Leeper (2011) and Chen, Leeper and Leith (2015) coordinated action in the country, however, is not recurrent. Chen, Leeper, and Leith (op. cit.) suggested that the elimination of conflicts between monetary and fiscal policies would result in a higher level of economic welfare, avoiding inflationary levels such as those recorded in the 1970s.

Still analyzing the U.S. economy, Leeper, Traum, and Walker (2017) estimated models with a higher level of fiscal detail, including data such as government consumption that can be complementary to or substitute for private consumption, different maturity structures of government debt, and rules for fiscal instruments. With data between 1955 and 2014, the results suggested that the full sample can fit both a monetary and a fiscal regime.

In Latin America, a region where rising public debt is traditionally synonymous with economic vulnerability and financial fragility, public debt as a ratio to GDP in Brazil, Colombia, and Mexico was on average 12 percentage points higher in the period 1996-2005 compared to the period 1990-1995. Mendoza and Oviedo (2008) found evidence that these countries - along with Costa Rica - were already approaching their natural debt limits. The authors explained that this limit is the one that must be respected to preserve credibility and their ability to repay debt.

Studies for groups of countries from different regions are also recurrent. Mendoza and Ostry (2008) conducted a study on fiscal solvency for 34 developing countries and 22 industrial countries based on stochastic and dynamic general balance conditions. The authors found stronger responses of the primary balance to changes in public debt in emerging countries; although not necessarily indicating fiscal discipline, the result indicates that due to the higher fiscal and financial risk of these countries, more forceful responses to changes in public debt must be observed if fiscal solvency is to be maintained in the long run. Additionally, the authors suggested that the public debt/GDP ratio should not exceed the 50% to 60% range, as values above this range are associated with a lower capacity to maintain fiscal solvency.

Ghosh et al. (2013) conducted a comprehensive study of 23 developed countries between 1970 and 2007. The authors sought to test a concept of “fiscal space,” the difference between the level of current debt and the threshold where fiscal solvency ceases. The results were mixed: the debt limit found for the countries ranged from 150% to 250% of GDP, but while countries such as Greece, Iceland, Portugal, and Japan showed signs of fiscal fatigue, others such as Australia, South Korea, and the Nordic countries had ample room to reach the limit of fiscal solvency. The results of the study could be used to ensure that public debt trajectories in certain countries do not assume an explosive profile, damaging expectations and the macroeconomic environment.

3.2 EVIDENCE FOR THE BRAZILIAN ECONOMY

The ITR has proven, both in Brazil and elsewhere, to be efficient in controlling inflation. As it is an expectations-dependent monetary regime, the importance of credibility and reputation in the context of monetary policy has been emphasized in solving problems of time inconsistency. Since fiscal policy influences monetary conduct and macroeconomic stabilization in the country, several papers have been produced trying to measure the credibility and reputation of fiscal policy and the fiscal authority, respectively.

The adoption of the ITR, with Decree no. 3,088 of June 21, 1999, was accompanied by a strategy to improve the public debt profile. Based on theoretical models of public debt management, the National Treasury began to lengthen the maturity of the Brazilian debt and established the announcement of targets for the primary surplus. The objective of this strategy was, besides increasing the country’s fiscal responsibility, to help the monetary authority to fulfill its inflation stabilization mandate. After the shocks caused by domestic and international uncertainties, in 2002 the Treasury initiated a process to alter the composition of the indexation of the public debt: by reducing the share of securities indexed to the basic interest rate and exchange rate and substituting them with inflation-indexed and fixed-rate securities, the public debt would have its profile lengthened, reducing the pressure on the behavior of interest rates. Clearly the monetary and fiscal policies were being thought of together, attesting to the interdependence between them.

But this form of coordination was not a regular feature of Brazilian economic policy. Loyo (1999) showed how the fiscal consequences of monetary policy in the 1970s and 1980s led to explosive inflation. The combination of active fiscal policy and monetary policy that sought to combat inflation by aggressively raising interest rates produced the following dynamic: higher interest rates increased interest revenues for bondholders that, in the absence of higher taxes, raised aggregate demand; higher demand further increased inflation, generating a response from the monetary authority via the interest rate, restarting the explosive inflation cycle.

Analyzing how the government reacts to variations in its debt level, De Mello (2008) estimated a fiscal reaction function with monthly data for the period between 1995 and 2004. For all the definitions used, the author found a positive response of the primary surplus to the increase in public debt.

The responsiveness of the central government and subnational entities to debt increased after 1998. The author found a weak positive correlation between output and the surplus, suggesting, slightly, a counter-cyclical fiscal reaction in the Brazilian economy.

The behavior of the fiscal reaction function for Brazil was also the subject of study by Luporini (2015) and Campos and Cysne (2019). The work of Luporini (op. cit.) estimated a fiscal reaction function for the country and investigated whether this function changed over time. The results suggested that the government's fiscal policy would have been sustainable over the period analyzed (1991 to 2011), a 1% increase in the debt-to-GDP ratio resulted in an average increase of 0.096% in the surplus relative to GDP. The author also showed that fiscal policy has been more stable since 2000, but less responsive to the debt level. Monetary policy responses have assumed a downward trend after 2006. Campos and Cysne (op. cit.) found results suggesting a sustainable fiscal reaction until 2013, but when limiting the sample to 2014-2016 all statistical methods pointed to an unsustainable fiscal reaction. The authors also showed that the response of the primary deficit to changes in the debt/GDP ratio decreased over the sample period.

Several studies have sought to understand the effects of attributes such as reputation and credibility of economic policy on Brazil's economy after the change of monetary regime. De Mendonça and de Guimarães e Souza (2009) analyzed several credibility and reputation indexes and their respective degrees of effectiveness to predict interest rate variations starting in 2000. The work showed that higher credibility requires smaller variations in interest rates to control inflation, as well as drives the interest rate to lower levels. This means that an increase in credibility translates into a greater likelihood of smoothing the expectations of economic agents. But it is necessary to understand the role of fiscal policy in facilitating the anchoring of expectations and the control of inflation by the monetary authority.

The influence of fiscal and monetary policies on business expectations in Brazil was the subject of study by Montes and Bastos (2013). Analyzing the period between the first quarter of 2000 and the second quarter of 2010, the authors found results that indicate a more stable macroeconomic environment when fiscal and monetary credibility increase. The favorable environment, in turn, contributes to increased business confidence, which may be enough to affect economic activity.

Other authors have thought about the role of fiscal policy in facilitating the conduct of monetary policy. Pires (2006) studied the credibility of fiscal policy using data on primary surplus expectations and public sector net debt expectations. De Mendonça and Da Silva (2008) showed that public debt management is directly related to greater economic credibility, suggesting that a lower indexation of the debt to the Selic rate promotes greater freedom for the monetary authority to pursue price stability. Moreira and Rocha (2011) analyzed 18 emerging economies, including Brazil, in the period between 1996 and 2008. The results suggested that it is not possible to reject the hypothesis that fiscal austerity lowers the domestic interest rate.

The work of De Mendonça and Da Silva (2008) concluded that, since the basic interest rate is the main instrument of monetary policy and since part of the public debt is indexed to this rate, there is reciprocity between monetary conduct and debt management. When monetary policy initiated a disinflation process, an effect on the fiscal balance was identified. The authors observed that increased levels of fiscal credibility contributed to reduce public debt and control inflation, although this increase was associated with a higher temporary cost of primary surplus. A public debt structure that is less indexed to the interest rate can diminish the effects of the search for price stability on the growth of public debt: the easier it is for the monetary authority to meet inflation targets means greater monetary credibility, lower inflation rates and a lower debt/GDP ratio.

Montes and Assumpção (2014) analyzed the influence of the credibility and reputation of the monetary and fiscal authorities on the behavior of the monetary policy instrument - the interest rate. The study found evidence that both the credibility and reputation of the monetary and fiscal authorities are negatively related to the behavior of the interest rate, and that a worse administration of the indexation structure of the public debt is also negatively related to the interest rate.

Montes and Tiberto (2015) studied the correlation between Brazilian public debt management and country risk, showing that better reputation reduced risk and increased economic stability. Thus, the opposite also tends to be true: under low reputation, failure to meet fiscal targets raises the cost of public debt (considering the movement of interest implicit in government bonds) and the country's fiscal situation deteriorates, along with the macroeconomic stability environment.

The authors cited above also found results that show an increase in fiscal reputation and a decrease in country risk when there is a change in the profile of the public debt and its lengthening. The consensus presented in the article recommends lengthening the average debt maturity, increasing the fixed rate portion and decreasing the participation of interest rate indexed securities to increase the reputation of the fiscal authority. Countries that start from a low reputation may incur high interest rates to increase the attractiveness of the bonds and sometimes it is better to first gain reputation to subsequently lengthen the debt without a very high social and economic cost.

Still thinking about the interaction between monetary and fiscal policies, but focusing on policy coordination, Blanchard (2005), Marques Junior (2010), Moreira and Carvalho Junior (2013), and Moreira (2017) found evidence of active fiscal policy (i.e., an insolvent fiscal policy in the long run) in Brazil. Analyzing the country between 2002 and 2003, Blanchard (2005) showed that interest rate hikes could hinder the country's fiscal situation, decreasing the attractiveness of government bonds and scaring away investors. As for the context of fiscal dominance, Marques Junior (2010) found results that confirmed this situation, originally described by Blanchard (2005), relating public debt, default risk, and exchange rate. However, Marques Junior (op. cit.) identified fiscal dominance at a much lower level than that outlined by Blanchard (op. cit.). In turn, Moreira and Carvalho Junior (2013) found evidence of active fiscal policy in Brazil starting in 1999, via a reduction in the primary surplus.

This event would have resulted in increased public debt and weak interaction between monetary and fiscal policies, leading to inconsistency of announced targets.

3.3 SUMMARY TABLES

Table 1. Summary of the literature with international evidence

Authors	Time Sample	Estimation Method	Main results
Clarida, Galí and Gertler (2000)	Quarterly: 1960 to 1996	GMM	Pre-Volcker monetary policy in the US did not raise interest rates to real levels, accommodating inflation
Arora and Cerisola (2001)	Monthly: 1994 to 1999	ARCH Models	Despite the U.S. monetary influence, developing countries can control the behavior of country risk and growth; improving the country's macroeconomic fundamentals - such as adopting responsible fiscal policies - can help reduce country risk and interest rates.
Mendoza and Ostry (2008)	Annual: 1990 to 2005	Univariate regressions and the Hodrick-Prescott filter	The authors found stronger responses of the primary balance to public debt changes in emerging countries; public debt/GDP above the 50%-60% range is associated with less ability to maintain fiscal solvency.
Mendoza and Oviedo (2008)	Annual: 1991 to 2005	It uses a methodology that models uncertainty in the form of discrete Markov processes.	The public debt to GDP ratio of Brazil, Colombia, and Mexico was on average 12 percentage points higher in the period 1996-2005 compared to the period 1990-1995. These countries and Costa Rica were already approaching their limits for preserving credibility and solvency.
Traum and Yang (2011)	Quarterly: 1955 a 2007	Metropolis-Hastings Algorithm	The authors found no evidence to support the existence of fiscal dominance in the United States at any time post-World War II; the volatility of hours worked and inflation expected for regimes of fiscal dominance was much higher than that observed in the data for the period.
Bhattarai, Lee, and Park (2012)	Annual: 1960 to 2008	Bayesian Methods and Kalman Filtering	The results for the US suggest existence of passive monetary and fiscal policy in the pre-Volcker era.
Ghosh et at. (2013)	Annual: 1970 to 2007		The debt limit found for the countries ranged from 150% to 250% of GDP; the results of the study could be used to ensure that public debt trajectories do not assume an explosive profile, damaging expectations and the macroeconomic environment.
Chen, Leeper, and Leith (2015)	Quarterly: 1955 a 2008	Bayesian estimation, Metropolis-Hastings algorithm and marginal likelihood function.	U.S. monetary and fiscal policy are often in conflict; it is relatively rare to observe the combination of conservative monetary policy and debt-stabilizing fiscal policy; elimination of conflicts would result in greater economic welfare.
Leeper, Traum, and Walker (2017)	Quarterly: 1955 a 2014	Bayesian method, Kalman filter and Metropolis-Hastings algorithm	The relationship between monetary and fiscal policy is more relevant for regime determination than the detail of fiscal data; the full sample can fit both a monetary and a fiscal regime.

Source: Prepared by the author based on the literature presented.

Notes: Generalized Method of Moments (GMM), Auto-Regressive Conditional Heteroskedasticity Models (ARCH models).

Table 2. Summary of the literature with evidence for the Brazilian economy

Authors	Time Sample	Estimation Method	Main results
Blanchard (2005)	Monthly: 1995 to 2004	OLS and IR	Interest rate hikes could make the country's fiscal situation more difficult, decreasing the attractiveness of government bonds and scaring away investors; existence of fiscal dominance (in a modern sense).
Pires (2006)	Monthly: 2001 to 2005	VAR	The current fiscal regime has created expectations of consistency in the management of the public debt, which implies gains in credibility
From Mendonça and da Silva (2008)	Monthly: 2001 to 2006	VAR	Monetary policy has had an effect that cannot be neglected on the fiscal balance; increased fiscal credibility contributes to a reduction in public debt and to inflation control.
De Mendonça and de Guimarães e Souza (2009)	Monthly: 2000 to 2007	VAR	Higher credibility requires smaller variations in interest rates to control inflation, as well as driving the interest rate to lower levels.
Marques Junior (2010)	Monthly: 1994 to 2008	OLS and VAR	The results suggest a positive relationship between public debt, in default risk and exchange rate depreciation.
Moreira and Rocha (2011)	Monthly: 1996 to 2008	Regression with fixed effects	The hypothesis that a policy of fiscal austerity lowers the domestic interest rate cannot be rejected; the result illustrates the importance of fiscal policy in determining interest rates in emerging countries.
Montes and Bastos (2011)	Monthly: 2000 to 2009	OLS, GMM and VAR	The evidence suggests that credibility gains have promoted the reduction of the spread and the smoothing of the yield curve.
Luporini (2013)	Monthly: 1991 to 2011	OLS, VAR and VEC	The results suggest that fiscal policy has been sustainable over the period analyzed; fiscal policy has been more stable since 2000, but less responsive to the debt level; monetary policy responses have assumed a downward trend after 2006.
Montes and Bastos (2013)	Quarterly: 2000 to 2010	OLS, GMM and VAR	The results indicate that an increase in credibility creates a more stable environment, raising business confidence in the economy and, as a result, being able to affect economic activity.
Moreira and Carvalho Junior (2013)	Monthly: 1999 to 2011	OLS and GMM	There is empirical evidence that active fiscal policy existed from 1999 onwards - incompatible with the inflation targeting system; results suggest weak coordination among monetary, fiscal and exchange rate policies.

Montes and Assumpção (2014)	Monthly: 2003 to 2012	OLS and GMM	Both credibility and monetary and fiscal reputation have a negative relationship with the behavior of the basic interest rate.
Montes and Tiberto (2015)	Monthly: 2002 to 2011	OLS and GMM	The results suggest that the reputations of the fiscal and monetary authorities play an important role in reducing Brazil's country risk
Moreira (2017)	Monthly: 2005 to 2015	VAR and VEC	The country's fiscal responses have not been consistent with a sustainable fiscal rule (in terms of debt as a proportion of GDP); a more efficient and flexible fiscal rule could facilitate convergence of monetary and fiscal targets.
Campos and Cysne (2019).	Monthly: 2003 to 2016	Filter Kalman smoothing, penalized spline smoothing and time-varying cointegration	The paper finds a sustainable fiscal reaction function between 2003 and 2013, but an unsustainable one between 2014 and 2016; the results suggest that the primary surplus has decreased its response to debt/GDP variations over the analyzed period.

Source: Prepared by the author based on the literature presented.

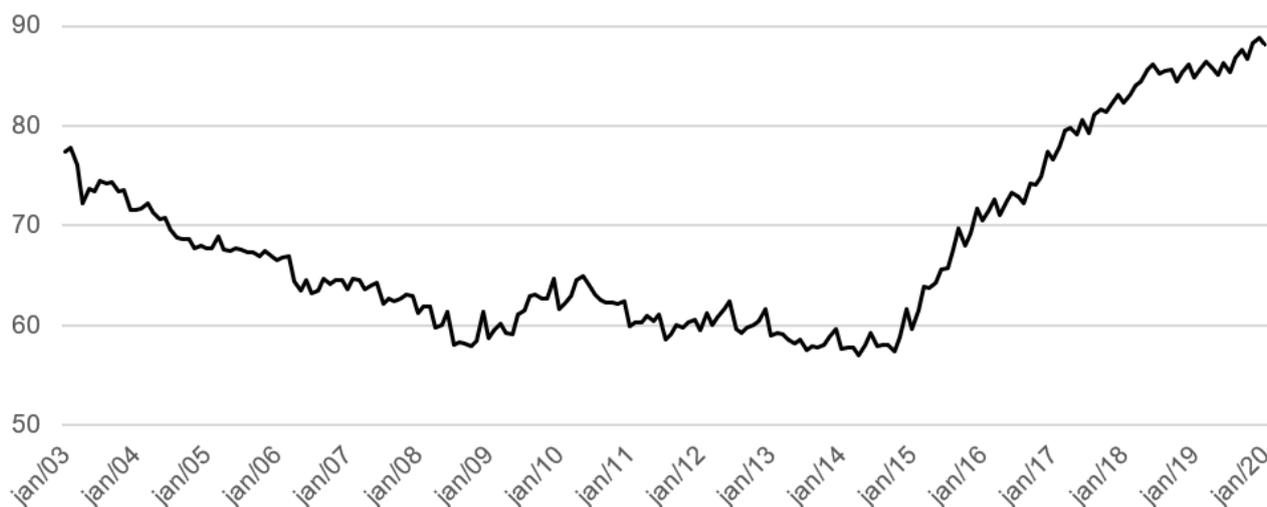
Note: Ordinary Least Squares (OLS), Generalized Method of Moments (GMM), Autoregressive Vectors (VAR), Instrumental Variables (IV), Vector Error Correction (VEC).

4 EMPIRICAL ANALYSIS FOR BRAZIL

This chapter presents the research data, the methodology used, the econometric results, and the discussion.

4.1 BRIEF EXPOSITION OF FISCAL VARIABLES AND INFLATION

Having revisited the results of the empirical literature on monetary and fiscal policies in the Brazilian economy, one can analyze the behavior of key variables for the paper for contextualization purposes. Public debt is a good starting point. Using the general government gross debt (GGDB), Chart 1 shows that it has shown an expressive downward trajectory in relation to the GDP until the year 2008. At the beginning of the series, the country was going through a tense electoral period, and the uncertainties generated by the so-called Lula risk led to an exchange rate overshooting, resulting, due to the indexation of a relevant part of the debt to the exchange rate, in a high debt/GDP ratio at the beginning of the sample period.

Chart 1. Evolution of general government gross debt in % of GDP between 2003 and 2020

Source: Prepared by the author. Data obtained from the BCB's Time Series Management System

Note: The BCB's operations with government securities are included, which allows a better follow-up of the debt situation in relation to the net debt concept; debts of state-owned companies are not accounted for.

The subsequent reduction in the debt/GDP ratio until 2008 was due to (i) the increase in the Brazilian GDP in the period and (ii) recurring primary surpluses. The year 2008 was marked by the first effects of the subprime crisis in the country, so that the model of economic policy persistently used to mitigate the effects of the crisis may have been responsible for the increase in gross debt as a proportion of the GDP. The result was positive in the short term, the Brazilian economy grew 7.5% in 2010, against -0.13% in 2009 and 5.1% in 2008 (IBGE). The election of a new government in 2010 (Rousseff administration), with less appreciation for the already established macroeconomic tripod, began a period of declining primary surpluses; the crisis of confidence related to the growing risks of insolvency of the Brazilian government explains the significant increase in debt/GDP from mid-2014 on. In turn, the Temer administration, which began in 2016, resumed the bases of the tripod, starting a period of fiscal adjustments and attempts to reestablish a favorable macroeconomic environment. In this period, one can highlight the creation of a growth ceiling for nominal government spending (Constitutional Amendment No. 95 of 2016), considered a basic condition for the resumption of economic stabilization¹. In January 2020, according to the DBGG methodology used here, the gross debt reached 88.18% of the Brazilian GDP.

Chart 2 shows the evolution of the public sector borrowing requirement (NFSP) in the primary concept, that is, excluding from the account the government's revenues and expenses with interest. Here it is possible to observe the achievement of primary surpluses above 3% of GDP until 2009.

¹ In Nov. 2019, EC 103/2019 was enacted, referring to a pension reform, deemed necessary given the spending cap. The EC was not highlighted in the paper due to its major effects expected only in the medium and long term and because its enactment took place two months before the last set of observations used (Jan/2020).

In this year, the government surplus reached one of its lowest values of the Lula era, largely due to the anti-cyclical policies in place. The significant reduction in the primary surplus after 2011 illustrates the lack of control of public accounts under the Rousseff administration, a lack of control that intensified after the 2014 presidential election with the recurrent occurrence of primary deficits. Chart 2 does not indicate stability in the government's primary result series.

Chart 2. NFSP as % GDP between 2003 and 2020



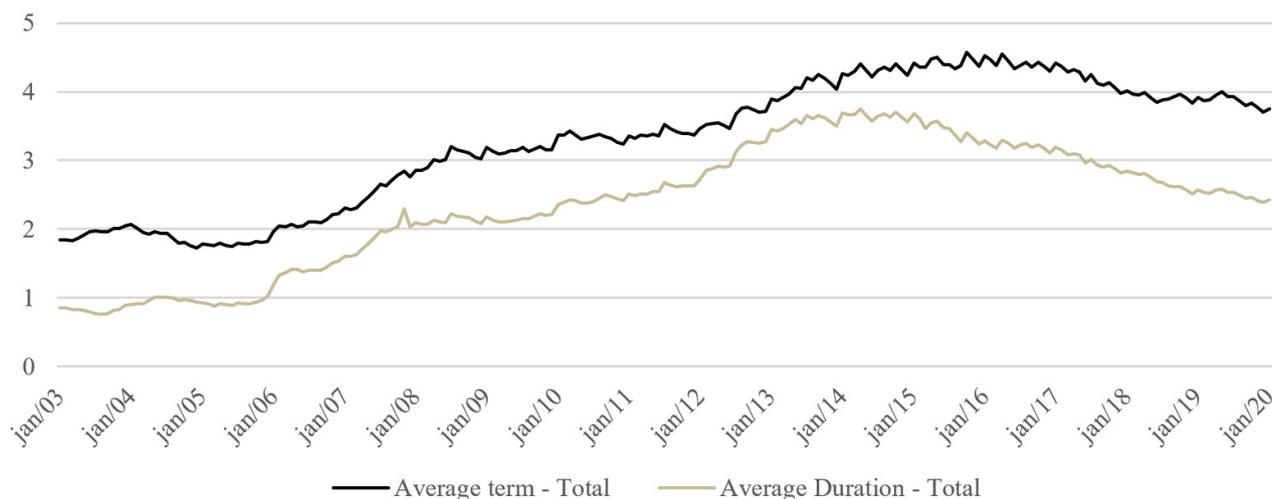
Source: Prepared by the author. Data obtained from the BCB's Time Series Generator System

Note: 12-month cumulative flow, primary result without exchange devaluation, total consolidated public sector

The process of fiscal deterioration presented in Charts 1 and 2 also refers to the movement of total government spending (as a proportion of GDP). Since the 1990s there has been a sustained growth in total expenditures, not always matched by the growth in total revenues (APPENDIX A). To a large extent the growth in expenditures was due to increases in social security benefits and mandatory expenditures not subject to financial programming; in this period discretionary expenditures did not grow in the same way.

The fiscal deterioration can also be visualized by adding macroeconomic data of a financial nature to the analysis. In Chart 3, the average term and average duration of public securities issued by the National Treasury have been decreasing since 2015, in parallel with the growing evolution of gross debt; the explanation for such a process involves fears of unsustainability of the Brazilian public debt by economic agents. Basically, when faced with a given risk of default, agents demand higher interest rates for long-term securities, which forces the issuer (the National Treasury) to work with securities with shorter maturities.

Chart 3. Average term and average duration (in years) of public securities between 2003 and 2020

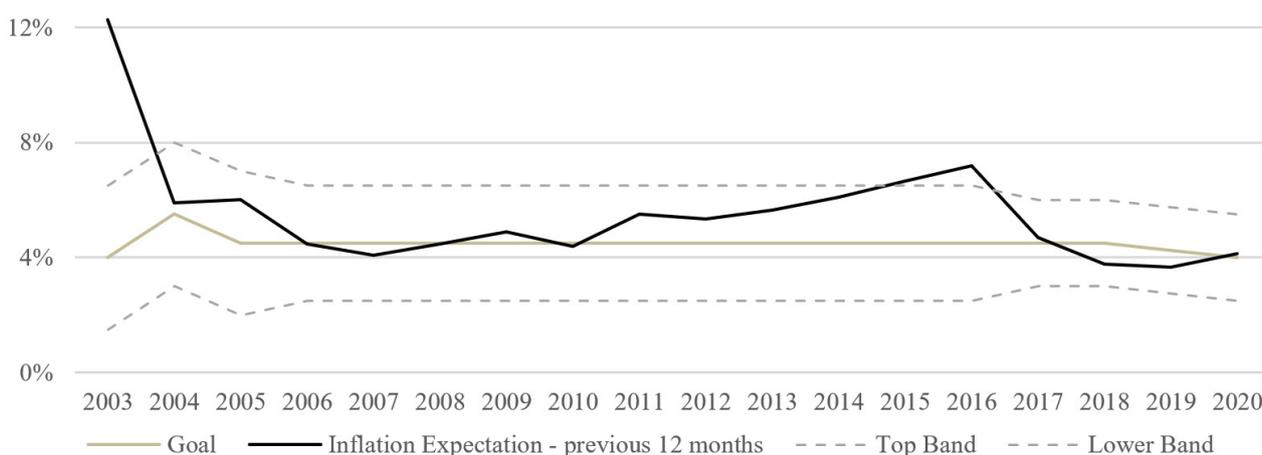


Source: Prepared by the author. Data obtained from the BCB’s Time Series Generator System

Note: Bonds with coupon indexed to Selic can have long term and shorter duration, since they are sensitive to the interest rate

The other key variable is the behavior of monetary policy. Brazilian monetary policy can be evaluated with a focus on credibility; to make the concept more tangible, one can use the level of convergence of inflation expectations to the announced target as a proxy - approximate - of monetary credibility. Put differently, understanding credibility as the convergence of inflation expectations to the announced target over time, a simple exercise to evaluate this macroeconomic aspect would be to analyze Chart 4, containing inflation expectations and announced inflation targets.

Chart 4. Inflation expectations and announced target between 2003 and 2020



Source: Prepared by the author. Data obtained from the BCB’s Time Series Generator System

Note: The central inflation target is accompanied by bands; according to the BCB’s Financial Education Program, the use of bands allows shocks to be accommodated and the target to be met without the need for very restrictive policies

Chart 4 shows that inflation expectations converged to the target between the years 2006 and 2010, but took off since then and grew until 2016; moreover, the downward movement of inflation until the year 2018 can be interpreted as an effect of the economic recession of the years 2015 and 2016, whose inertial effects, including in terms of higher unemployment rates, would be observed years ahead. The mild rise in inflationary expectations at the end of the series, in turn, may be related to a gradual and fragile economic recovery over the years 2017, 2018, and 2019.

The ITR allowed for the containment of inflation within the expected tolerance intervals between 2004 and 2014, but as of the mid-2010s the regime no longer seemed to be effective as an anchor of expectations. Returning to the initial discussion of the subsection, analyzing Charts 1, 2, and 3, the signs of deteriorating fiscal conditions in the country seem, as indicated by economic theory, to influence several issues regarding monetary policy, including its credibility and effectiveness.

4.2 DESCRIPTION OF VARIABLES

The period analyzed was from January 2003 to January 2020. The time series were made available by the Time Series Management System (SGS) of the Brazilian Central Bank, the Institute for Applied Economic Research (Ipea) and the Brazilian Institute of Geography and Statistics (IBGE). The variables used in different stages of this work were

SP_t = the government's primary surplus, i.e., excluding from the account the government's revenues and expenses with interests, represented by the NFSP series (Public Sector Borrowing Requirements); the accumulated value in 12 months of the total consolidated public sector was used;

DEB_t = the gross debt of the general government (Federal Government, state and municipal governments); for the DBGG historical series² as a percentage of the total GDP all the debts of the government spheres with the private sector, the public financial sector and the rest of the world are included, according to the Statistics Department of the Central Bank of Brazil; the gross debt series had its methodology changed in 2008, so the old methodology was used for the empirical exercise to cover the early 2000s;

$E[SP]_t$ = the primary surplus expectation as a percentage of GDP for the end of the following year, using the median of expectations at the close of each month;

$SELIC_REAL_t$ = the real interest rate, represented by the annualized historical series of the Selic Over, which is the average rate of return on government bonds in the interbank market at the end of each day, subtracted from the inflation expectation for 12 months ahead; the daily Selic rate at the end of each month was used to compose the monthly historical series; bearing in mind that the Selic target only represents an objective to be pursued by the monetary authority and the Selic Over fluctuates around the announced target, the use of the daily index does not tend to create discrepancies in

² Included in this concept are the Central Bank operations with public securities, which allows a better follow-up of the debt situation in relation to its net concept; debts of state-owned companies are not accounted for.

relation to the proposed model;

$IPCA_t$ = the monthly variation of inflation, using the seasonally adjusted Broad Consumer Price Index (IPCA);

$E[IPCA_t]$ = the accumulated inflation expectation for 12 months ahead, using the median of the IPCA expectations at the end of each month;

$IBCBR_t$ = the total product of the Brazilian economy, represented by the seasonally adjusted Central Bank's IBC-Br index; the use of the IBC-Br as a proxy for the GDP is necessary since the official product series is not monthly;

$CAMBIO_REAL_t$ = the real exchange rate for the US dollar at the end of the period, deflated by the IPA-DI, base month index June 1994.

Additionally, for robustness purposes, the seasonally adjusted series of the IBGE's Monthly Industrial Survey - Physical Production³ (PIM-PF) was used as a proxy for GDP replacing the IBC-Br. We also tested the significance of a dummy - $DUMMY_F_t$ - to identify a change in fiscal conduct as of the end of 2014.

Table 3 presents the descriptive statistics of the variables.

Table 3. Estatísticas descritivas das variáveis

VARIABLES	AVERAGE	MEDIAN	MAX	MINIMUM	DP
SP_t	1,469	2,180	4,080	-3,040	2,215
DEB_t	67,872	64,520	88,780	57,030	9,039
$E[SP]_t$	2,009	2,800	4,300	-2,210	2,189
$SELIC_REAL_t$	6,972	6,620	19,180	0,450	4,001
$IPCA_t$	0,469	0,430	2,200	-0,270	0,307
$E[IPCA]_t$	5,189	5,230	11,560	3,330	1,231
$IBCBR_t$	130,237	135,710	148,660	99,030	13,773
$CAMBIO_REAL_t$	72,222	71,790	122,830	48,910	15,208
$PIMPF_t$	92,811	91,300	105,000	77,500	7,223

Source: Prepared by the author.

Appendix B contains the graphs with the historical evolution of the variables. Expectations for primary surplus averaged 2.00% of Gross Domestic Product for the entire sample and peaked in two periods in the final months of 2004 and 2005; the real interest rate reached 19.18% in June 2006 and its lowest value in December 2019; the average and median of inflation expectations for 12 months

³ For the PIM-PF a basket of industrial products is selected and IBGE considers that the variation of this basket represents the short-term evolutions of the value added of the whole industry (IBGE, 2015).

ahead were, respectively, 5.18% and 5.23% for the entire period - variation above the 4.5% target in force during much of the period analyzed but below the upper band -; the highest value for the real exchange rate was observed in February 2003, due to the electoral fears discussed earlier. For the series representing the product, the highest value for the IBC-Br index was recorded in December 2012, for the PIM-PF index the highest value occurred in November 2011; the explanation for this lies in the different composition of the indices, the former tending to be closer to a more robust calculation of domestic production and the latter representing a basket of selected industrial products.

4.3 METHODOLOGICAL ISSUES

(i) Ordinary Least Squares Method (OLS)

For the initial analysis, the Ordinary Least Squares (OLS) method was used to estimate a tax reaction rule. Consider the regression model in the matrix form of Equation (7),

$$y = X\beta + e \quad (7)$$

where y is the vector of the dependent variable, X the matrix of explanatory variables, β the vector of parameters to be estimated and e the vector of random errors. According to Greene (2012) a regression by MQO estimates the coefficients in such a way that the sum of the squared error term of the model results in the smallest possible value. This means, in Equation (8) in matrix terms, a minimization of

$$\sum_{i=1}^n e_i^2 = e'e = (y - X\beta)'(y - X\beta) \quad (8)$$

for a given y and X .

(ii) Cointegration Method

Along with the initial estimation, the existence of a long-term relationship between the variables was analyzed using the cointegration method based on the definition of Campbell and Perron (1991). A group of time series can be said to be cointegrated if at least one linear combination of these variables is stationary. Campbell and Perron (op. Cit.) explained the basic concept of cointegration starting from a vector $n \times 1$ of variables y_t where each element is represented in the form

$$y_{it} = TD_{it} + Z_{it}; \quad A_i(L)Z_{it} = B_i(L)e_{it}; \quad (i = 1, \dots, n), \quad (9)$$

where TD_{it} is the deterministic component of the variable i , $A_i(L)$ e $B_i(L)$ are poly-

nomials in the lag operator L , Z_{it} is a noise function (or stochastic component of y_t) modeled as an ARMA process and $e_{it} \in N(0, \sigma_i^2)$.

The vector of variables in Equation (9) is cointegrated if there is at least one non-zero vector β_i vector that is different from zero so that $\beta_i' y_t$ is stationary. β_i is a cointegrating vector. If there are r independent vectors so that β_i ($i = 1, \dots, r$) we say that y_t is cointegrating with cointegrating rank r . Defining the matrix of cointegrating vectors $n \times r$ as β_i (β_1, \dots, β_r), the r elements of the vector $\beta_i' y_t$ are stationary and β is called the cointegration matrix.

The concept presented by Campbell and Perron (1991) corresponds to stochastic cointegration: here linear combinations that eliminate unit roots are allowed to have non-zero linear trend. In the stronger definition, deterministic cointegration, the deterministic trend of the data should also be eliminated. The salient point is: this concept of cointegration does not require all data series to be first-order integrated, some series can be $I(0)$. In practice, according to the authors, researchers are commonly faced with series vectors containing $I(0)$ and $I(1)$ variables.

(iii) Kalman Filter

The second step of the research involved obtaining a time series for the response of the primary result to public debt (% GDP) from a fiscal reaction rule using the Kalman filter. Rudolph Emil Kalman developed in the 1960s an efficient recursive estimation algorithm, according to Grewal and Andrews (2008), in which from an observation variable it is possible to estimate a state variable, which in turn is unobservable. Thus, it is possible to estimate past, present, and predicted states for a given model.

The filter incorporates all available information, regardless of its accuracy, to estimate the value of the desired variables, using (i) knowledge about the system and the dynamics of the measurement instruments; (ii) statistical description of errors and uncertainty measurement in dynamic models; and (iii) all information about the initial state of the desired variables (MAYBECK, 1979).

The Kalman filter can be used efficiently in state-space models, which, according to Eubank (2006), are stochastic systems involving discrete variables in time series. If dynamic models are those described by changes in the state of their components, in a state-space system the observable variables are represented by dynamic functions of unobservable variables. The state-space representation allows one to estimate the parameters of a linear model at every instant of time. As Harvey (2003)⁴, the state-space model can be represented by two equations, the first, the observation equation, given by

$$s_t = b_t' \alpha_t + \mu_t \quad t = 1, 2, \dots, T \tag{10}$$

where s_t a series over time, b_t a vector $m \times 1$, α_t is the state vector $m \times 1$ e ϵ_t is the white

4 Also based on Kalman (1960) and Kalman and Bucy (1961).

noise residual term with zero mean and variance σ_{μ}^2 . The second equation, called the transition equation, shows how the state variables are generated:

$$\alpha_t = \Gamma_t \alpha_{t-1} + \eta_t \quad (11)$$

where Γ_t is the transition matrix $m \times m$ e η_t is a vector of $m \times 1$ white noise with zero mean and covariance matrix Q_t . The residue terms ε_t e η_t satisfy $E(\varepsilon_t \eta_s) = 0_{m \times 1}$ for $t, s = 1, 2, \dots, T$. The initial state vector α_0 has mean a_0 and covariance matrix P_0 so that $E(\varepsilon_t \alpha_0) = 0_{m \times 1}$ e $E(\eta_t \alpha_0') = 0_{m \times m}$ for $t, s = 1, 2, \dots, T$.

In this paper, Equation (10) represents a fiscal reaction rule, being s_t is the primary surplus as a proportion of GDP. Using the fiscal reaction rule in a state-space model it was possible to extract the response series of the primary result in relation to public debt, the fiscal response.

The previous two equations describe a dynamic system in state-space form. From a state-space model like the one described one can then apply the Kalman filter for three stages: prediction, update and refinement. In the first step, based on information available at $t-1$ (so, $S_{t-1} = \{s_1, s_2, \dots, s_{t-1}\}$), the state vector is predicted α_t and its variance:

$$\begin{aligned} A_{t|t-1} &= E(\alpha_t | S_{t-1}) = \Gamma_t \alpha_{t-1|t-1} \\ P_{t|t-1} &= V(\alpha_t | S_{t-1}) = \Gamma_t P_{t-1|t-1} \Gamma_t' + Q_t' \end{aligned} \quad (12)$$

The update equations account for the advance of the state variable and the variance in time, obtaining a priori estimates for the next instant. In the second step α_t is updated based on the expected value and the variance of the state vector observed in the period t so that here $S_t = \{s_1, s_2, \dots, s_t\}$:

$$\begin{aligned} c_{t|t} &= E(\alpha_t | S_t) = \alpha_{t|t-1} + K_t (s_t - b_t c_{t|t-1}) \\ P_{t|t} &= V(\alpha_t | S_t) = P_{t|t-1} - K_t b_t' P_{t|t-1} \end{aligned} \quad (13)$$

where $K_t = P_{t|t-1} b_t' (b_t P_{t|t-1} b_t' - \sigma_{\mu}^2)^{-1}$ is called the gain of the Kalman filter.

In the first two steps the estimation uses all past and present information. The third stage, refinement, allows all information in the sample to be used. Therefore, $S_T = \{s_1, s_2, \dots, s_T\}$,

$$\begin{aligned} c_{t|T} &= E(\alpha_t | S_T) = \alpha_T + P_t \Gamma_t' P_{t+1|t}^{-1} (c_{t+1|T} - \Gamma_t c_t) \\ P_{t|T} &= V(\alpha_t | S_T) = P_t + P_t \Gamma_t' P_{t+1|t}^{-1} (P_{t+1|T} - P_t) [P_t \Gamma_t' P_{t+1|t}^{-1}]' \end{aligned} \quad (14)$$

The coefficients of Γ_t and the variances of the error terms are assumed constant over time and estimated by maximum likelihood. In practice the steps work together: from initial estimates the state and covariance are advanced in time (prediction) and then the Kalman gain is calculated to update the state and covariance, returning for a new advance in time (update and refinement).

(iv) Generalized Method of Moments (GMM)

Finally, the interference of the fiscal response in the monetary drive was analyzed using a Generalized Method of Moments (GMM) estimation. The GMM method is robust to avoid possible problems of heteroscedasticity, autocorrelation and endogeneity in the estimation (HANSEN, 1982). Given the hypothesis of exogeneity of the instruments (JOHNSTON, 1984), the set of instruments chosen was lagged to the period t-1 or earlier. An overidentification analysis of the instruments was performed with the J-statistic test to ensure the correct specification of the instrumental variables (HANSEN, 1982; CRAGG, 1983).

GMM is based on the method of moments (MM), developed as early as the 19th century, and instrumental variables estimations. GMM uses instrumental variables to eliminate endogeneity and requires a set of moments specified for the model, with these moments being functions of the model parameters and the data. The basic idea behind GMM can be explained based on Hall (2003). Given a model in which a vector of observable variables v_t and a vector $p \times 1$ of unknown parameters θ_0 satisfy the vector $p \times 1$ of population moment conditions

$$E[f(v_t, \theta_0)] = 0. \tag{15}$$

The MM estimator of θ_0 can be found by solving the sample moment condition. If this estimator is denoted by θ_T then it can be defined by

$$g_T(\hat{\theta}_T) = T^{-1} \sum_{t=1}^T f(v_t, \hat{\theta}_T) = 0 \tag{16}$$

where T represents the sample. Equation (16) represents a set of p equations in p unknown parameters, having a unique solution. Furthermore, the solution of this equation converges to the solution of Equation (15). However, if $f(\cdot)$ were a vector $q \times 1$ and $q > p$, there would exist a set q of equations for $p < q$ unknown parameters. This system can only have a solution using the generalized method: a value of θ that comes closest to satisfying Equation (16) is chosen as the estimator for θ_0 . Operationally it is measured how far $g_T(\theta)$ is from zero.

4.4 RESULTS AND DISCUSSION

(i) Fiscal reaction function and estimation of the fiscal response for the Brazilian economy

The first part of the empirical analysis involved estimating a fiscal rule for Brazil, the initial step in generating a fiscal response series. The variables were subjected to unit root tests⁵ - the Aug-

⁵ The lags for the ADF test were determined based on Akaike's information criterion (AIC); for the PP and KPSS tests the bandwidth selection used the Newey-West method (Bartlett kernel).

mented Dickey-Fuller (ADF) unit root test, the Phillips-Perron (PP) unit root test, and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) stationarity test. The results are presented in Tables 4 and 5.

Table 4. Unit root tests - variables at level

VARIABLES	ADF	PP	KPSS
SP_t	-2,059	-1,207	0,232***
DEB_t	0,795	0,826	0,415***
$E[SP]_t$	-2,864	-2,351	0,258***
$SELIC_REAL_t$	-3,896**	-1,678*	0,240***
$IPCA_t$	-8,701***	-8,644***	0,147**
$E[IPCA]_t$	-3,731***	-5,211***	0,212**
$IBCBR_t$	-2,082*	-2,311	0,412***
$CAMBIO_REAL_t$	-1,943	-2,971**	0,411***
$PIMPF_t$	-2,036	-2,115	0,381*

Source: Prepared by the author.

Note: For the ADF and PP tests: (***) rejects the null hypothesis of unit root at the 1% level, (**) rejects the null hypothesis at the 5% level, (*) rejects the null hypothesis at the 10% level; for the KPSS test: (***) rejects the null hypothesis of stationarity at the 1% level, (**) rejects the null hypothesis of stationarity at the 5% level, (*) rejects the null hypothesis of stationarity at the 10% level.

Table 5. Unit root tests - variables in first difference

VARIABLES	ADF	PP	KPSS
$D(SP_t)$	-3,574***	-13,012***	0,133
$D(DEB_t)$	-2,133**	-19,029***	0,064
$D(E[SP]_t)$	-2,944***	-11,716***	0,134
$D(IBCBR_t)$	-8,274***	-13,744***	0,072
$D(CAMBIO_REAL_t)$	-5,610***	-11,774***	0,070
$D(PIMPF_t)$	-16,385***	-16,353***	0,245

Source: Prepared by the author.

Note: For the ADF and PP tests: (***) rejects the null hypothesis of unit root at the 1% level, (**) rejects the null hypothesis at the 5% level, (*) rejects the null hypothesis at the 10% level; for the KPSS test: (***) rejects the null hypothesis of stationarity at the 1% level, (**) rejects the null hypothesis of stationarity at the 5% level, (*) rejects the null hypothesis of stationarity at the 10% level.

It was verified that the variable of interest for the estimation of a fiscal rule (the primary surplus) and four out of the six variables initially considered as explanatory (based on the literature on

fiscal rules) were integrated of first order - I(1). The cointegration test was used as a robustness analysis; moreover, since there is a long-term relationship it becomes possible to work with the variables at the level without the risk of incurring in spurious regressions.

Thus, the variables were used at the level in the estimation after the existence of a long-run relationship was confirmed. The fiscal rule for Brazil was estimated by MQO with Newey-West correction in different specifications, as shown in Table 6. In the same table the ADF test on the residuals can be understood as a first cointegration test (ENGLE AND GRANGER, 1987). However, other tests follow after the discussion about Table 6, performed only in the specification chosen to continue the work.

For the last three specifications we chose to use the $PIMPF_t$ series instead of the $IBCBR_t$ as a robustness analysis. A dummy variable was also tested to investigate a change in fiscal conduct as of the end of 2014 - as of this date the debt began an upward trajectory and recurrent primary deficits were observed; for periods prior to November 2014 the dummy assumes value 0 and for later periods, 1.

Table 6. Specifications of tax reaction rules

Explanatory variables	MQO estimation: SP_t					
	Model 1.1	Model 1.2	Model 1.3	Model 1.4	Model 1.5	Model 1.6
c	-1,538** (0,624) [-2,464]	-1,540** (0,622) [-2,475]	-0,738*** (0,448) [-1,645]	-2,750*** (0,598) [-4,594]	-2,724*** (0,589) [-4,622]	-1,792*** (0,470) [-3,814]
SP_{t-1}	0,909*** (0,040) [22,347]	0,908*** (0,039) [22,842]	0,963*** (0,027) [35,578]	0,878*** (0,037) [23,525]	0,877*** (0,037) [23,724]	0,969*** (0,021) [45,438]
DEB_{t-1}	0,015*** (0,004) [3,817]	0,015*** (0,004125) [3,817767]	0,010*** (0,003) [3,112]	0,021*** (0,003) [5,518]	0,020*** (0,003) [5,529]	0,015*** (0,003) [4,318]
$E[SP]_{t-1}$	0,076** (0,037) [2,056]	0,078** (0,034) [2,253]	-	0,100*** (0,029) [3,387]	0,102*** (0,028) [3,604]	-
$IBCBR_{t-1}$	0,004 (0,002) [1,602]	0,004* (0,002) [1,628]	0,001 (0,001) [0,574]	-	-	-
$IPCA_{t-1}$	0,011 (0,047) [0,242]	-	0,031 (0,046) [0,680]	0,025 (0,042) [0,611]	-	0,047 (0,043) [1,094]
$PIMPF_{t-1}$	-	-	-	0,014*** (0,003) [3,923]	0,014*** (0,003) [3,927]	0,009*** (0,002) [3,255]
$DUMMY_F$	-0,337*** (0,115) [-2,919]	-0,333*** (0,120) [-2,777]	-0,317** (0,125) [-2,536]	-0,304*** (0,108) [-2,806]	-0,296*** (0,111) [-2,661]	-0,284*** (0,121) [-2,340]

<i>Adjusted R²</i>	0,990	0,990	0,990	0,991	0,991	0,990
<i>AIC</i>	-0,222	-0,289	-0,207	-0,180	-0,302	-0,249
<i>ADF Test</i>	-4,942***	-4,969***	-5,200***	-4,762***	-4,813***	-4,848***
<i>LM test (prob)</i>	0,413	0,382	0,468	0,378	0,238	0,000

Source: Prepared by the author.

Note: () for standard errors and [] for t-statistics. ADF test on the residuals of the regressions. * significant at 10%, ** significant at 5%, *** significant at 1%;

All specifications indicate a countercyclical fiscal policy, that is, although relatively low in relation to their standard deviation, the statistically significant positive coefficients at 1% for debt suggest the existence of a countercyclical rule for fiscal policy in Brazil between 2003 and 2020. The relationship found is essential to ensure a sustainable trajectory for the public debt, which, in turn, collaborates with the active action of the monetary authority by not generating inflationary pressures.

The result for DEB_t is in line with the works of De Mello (2008), Luporini (2015) and Campos and Cysne (2019). However, for the last two, more recent works, two considerations are relevant: Luporini (op. Cit.) indicated that the fiscal response would have been weaker in the later years of the sample and Campos and Cysne (op. Cit.), only by restricting the sample between 2014 and 2016, found an unsustainable trajectory of the Brazilian public debt. As seen in Table 6, increases in the debt/GDP ratio result in increases in the primary surplus/GDP.

The coefficient for the lagged primary surplus was significant in all specifications, indicating the existence of a strong inertial component, ranging between 0.877 and 0.969. The result for this coefficient is related to the natural tightening observed in fiscal policy and potentiated in Brazil.

The positive coefficients for the expected primary surplus show that a higher expected surplus in $t-1$ translates into higher current surplus, with coefficients ranging from 0.076 to 0.078. The primary result of a government is a variable subject to political wills, and even if a given government is fiscally balanced, it is necessary to understand the natural constraint of the governmental budget decision process; it is not possible to think that this expectational variable has similar dynamics to inflation or interest rate expectations. The result here, for the expected value of the primary surplus, reflects good pricing regarding the future behavior of the primary result.

The results for the output were divergent in terms of the significance of the coefficients. While the $IBCBR_t$ was significant in only one specification, the robustness variable $PIMPF_t$ variable was significant in all specifications tested. The positive coefficients related to the variables $IBCBR_t$ e $PIMPF_t$ suggested that in the face of economic expansion a higher primary result is observed; since the data for the Brazilian economy did not indicate a decrease in government spending in the period analyzed, the higher surplus in this case is related to increased revenues.

In all specifications, the coefficient for inflation was not significant, a result in line with the literature on fiscal rules for the Brazilian economy after the 1994 stabilization with the Real Plan. When taking the result for the coefficients of public debt as indicative of a passive fiscal policy, the primary surplus would not be expected to react to variations in inflation - which can be extended to variations in output. Here we did not observe possible effects of inflation on taxes or on the real value of debt - which in theory could influence the behavior of the primary surplus.

The coefficients for $DUMMY_F_t$ were significant in all estimations. The six fiscal rule specifications showed that there was a change in fiscal conduct from the end of the year 2014. The result is similar to those found by Luporini (2015) and, in particular, Campos and Cysne (2019), who found an unsustainable trajectory of public debt after 2014. The year 2014 - electoral year - is taken as the initial milestone of the perception of Brazilian fiscal deterioration; although the problem was perceived before 2014, it was after this year that the trends of some fiscal indicators became clear, especially the Public Sector Borrowing Requirement (NFSP) and public debt.

Model 1.2 proved to be, among the three that used the $IBCBR_t$ the only specification with all significant regressors and with the lowest Akaike information criterion⁶ (AIC), and was then used to proceed with the research - the next step being to extract the fiscal reaction from the selected model. The tax reaction function then took the form

$$\widehat{SP}_t = -1,540 + (0,908) SP_{t-1} + (0,015) DEB_{t-1} + (0,078) E[SP]_{t-1} + (0,004) IBCBR_{t-1} + (-0,333) DUMMY_F_t. \quad (17)$$

In the following paragraphs, the use of the cointegration test as a robustness analysis for the MQO result and as validation of the use of the level variables in the previous estimation is reported.

The ADF test on the residuals of Model 1.2 showed the stationarity of the estimation residual, which can be understood as a cointegration test. Despite testifying to the existence of cointegration, this form of analysis has a limit: it does not detail cointegration. Thus, we proceeded to investigate the long-term relationship between the variables by means of the cointegration test based on Campbell and Perron (1991) and Johansen (1991). The former demonstrated that for a cointegrated relationship to exist it is not necessary that all variables in each model have the same order of integration, it is enough that at least two of them have the maximum order among the series. In Model 1.2 except for $IBCBR_{t-1}$ all variables are first order integrated. Since Equation (17) is a dummy variable, it was decided to include it as an exogenous variable in the cointegration test.

In identifying the optimal lag for estimating the unrestricted VAR (APPENDIX C) the Schwartz (SC) and Hannan-Quinn (HQ) information criteria indicated the use of a lag, however, given that the

⁶ A higher sum of squares of the error (SSE) results in a higher AIC, however, the criterion penalizes parameter input, since models with more variables tend to have lower SSE. Therefore a lower AIC indicates a better fitting model.

VEC model to be estimated later uses the variables in first difference, we sought to compensate for the loss of degrees of freedom by reducing a lag of the unrestricted VAR; thus, Table 7 contains the optimal specification of the Johansen cointegration test for the unrestricted VAR without lag. The Akaike (AIC) and Schwartz (SIC) information criteria suggested a linear trend model, with an intercept and linear trend in the cointegration vector.

Table 7. Optimal specification of the Johansen cointegration test (1 lag)

Data Trends Rank or No. of ECs	No	No	Linear	Linear	Quadratic
	No intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Akaike's information criterion by rank (rows) and model (columns)					
0	5,445	5,445	5,405	5,405	5,441
1	5,346	5,333	5,291	5,206	5,234
2	5,327	5,323	5,280	5,204*	5,223
3	5,354	5,336	5,331	5,243	5,252
4	5,431	5,408	5,408	5,324	5,324
Schwarz information criterion by rank (rows) and model (columns)					
0	5,445	5,445	5,470	5,470	5,571
1	5,476	5,479	5,486	5,417*	5,494
2	5,587	5,616	5,605	5,562	5,613
3	5,744	5,775	5,787	5,747	5,773
4	5,951	5,993	5,993	5,975	5,975

Source: Prepared by the author.

Note: * indicates the most parsimonious specification.

The tests of the Trace and Maximum Eigenvalue in Table 8 indicated the existence of a long-run relationship between the variables, confirming that using the variables at the level in the tax rule did not incur in spurious estimate.

Table 8. Tests of the Trace and Maximum Eigenvalue

Dash Test				
Trace Statistics	Critical value 0.05	Prob.**	Valor crítico 0,05	Prob.**
None *	0,249	88,382	63,876	0,000
Até 1	0,086	29,830	42,915	0,512
Até 2	0,048	11,450	25,872	0,848
Até 3	0,006	1,403	12,517	0,993
Maximum Eigenvalue Test				
No. of cointegrations	Eigenvalue	Stat. Max-Eigen	Critical value 0.05	Prob.**
None *	0,249	58,552	32,118	0,000
Até 1	0,086	18,376	25,823	0,349
Até 2	0,048	10,050	19,387	0,613
Até 3	0,006	1,403	12,517	0,993

Source: Prepared by the author.

Note: * indicates rejection of the hypothesis at 5%; ** MacKinnon-Haug-Michelis (1999) p-value.

The estimation of the normalized cointegrated equation (long-run balance relationship) in Table 9 confirmed a countercyclical fiscal policy in the long run. The economic interpretation for Table 9 assumes inversion of the signs found in the estimation. The coefficient found for DEB_t was positive, in line with the results of Table 6, showing a higher primary surplus resulting from positive changes in the public debt. The coefficient found for $IBCBR_t$ was also positive, indicating that a higher level of output in the Brazilian economy resulted, in the period analyzed, in a higher primary surplus.

Table 9. Estimation of the cointegrated equation (long-run balance relationship)

Cointegrated Equation	
$Spt (-1)$	1,000
$DEBt (-1)$	-0,578*** (0,077) [-7,487]
$EXPEC_SPt (-1)$	0,493 (0,468) [1,051]
$IBCBRt (-1)$	-0,502*** (0,096) [-5,207]
C	85,274

Source: Prepared by the author.

Note: * significant at 10%, ** significant at 5%, *** significant at 1%.

The error correction model (Table 10) showed the short-run relationships between the variables; put differently, in the face of a disturbance in the long-run balance between the variables, the error correction model informs how the return to balance will occur in the short run. The coefficients indicate the speed of adjustment of the variables considered in the model. One can observe that, in the face of a transitory imbalance, the surplus returns to long-term balance; the positive coefficient of the debt indicates that there is no return to balance.

Table 10. Estimation of the Error Correction model (short-term relationship)

Error Correction Template	D(SP)	D(DEB)	D(EXPEC_SP)	D(IBCBR)
Fit Coefficients short-term	-0,040*** (0,006) [-5,909]	0,157*** (0,035) [4,385]	-0,030*** (0,006) [-4,659]	-0,057 (0,035) [-1,584]

Source: Prepared by the author.

Note: * significant at 10%, ** significant at 5%, *** significant at 1%.

Once the long-run relationship was confirmed and the fiscal rule of Model 1.2 could be estimated at the level, the Kalman Filter - together with the parameters of Model 1.2 - was used to extract a time series for the fiscal response, the series RF.

Effect on the effectiveness of Monetary Policy

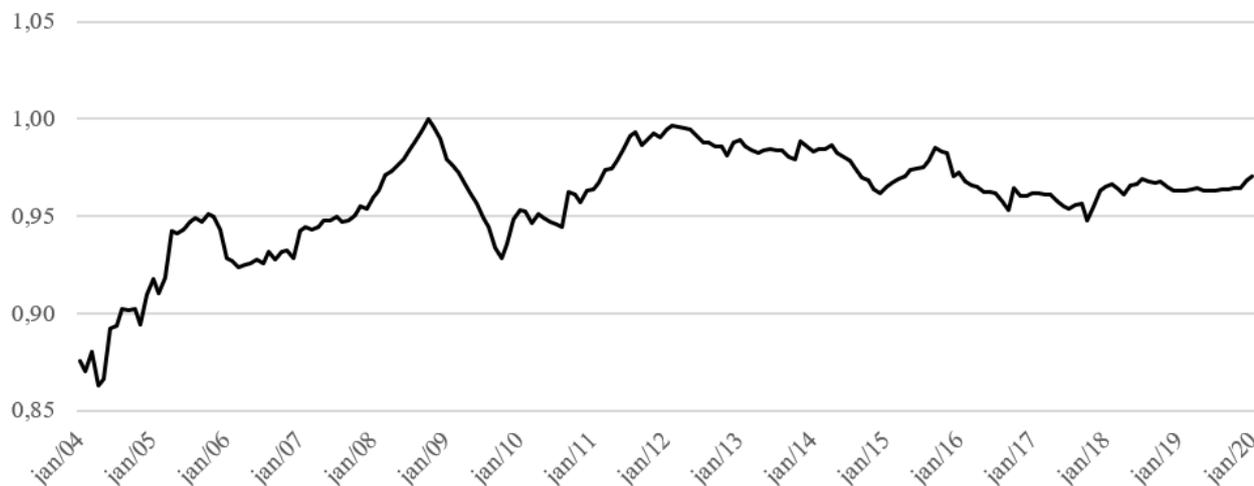
In the second part of the empirical analysis a fiscal response series was extracted, subsequently inserted in a Central Bank reaction estimation to evaluate the degree of interference of fiscal conduct in the behavior of the real interest rate. To generate a fiscal response series, the RFthe parameters of Equation (17) (referring to Model 1.2⁷ of the initial MQO estimation) were used in a state-space model to be estimated by the Kalman Filter. Defining DEB_{t-1} as a regressor with recursive coefficients, when extracting the unobservable state series, the result found was the relationship between the primary surplus and debt, or specifically the response of SP_t to the movements of DEB_{t-1} .

Given that the Kalman Filter is a recursive process, the first observations of the series RF were characterized by higher variance, so we chose to work with a reduced sample in the final stage of the work: January 2004 to January 2020. The series was linearized from the start date of the reduced sam-

7 As highlighted above, Model 1.2 was, among the specifications that used the $IBCBR_t$ the one with the smallest Akaike's information criterion (AIC).

ple, therefore, in practice, we worked with a tax response index with values between 0.862 and 0.999.⁸

Chart 5. Tax Response Index between 2004 and 2020



Source: Prepared by the author.

The more recent downward behavior of the fiscal response has been in line with the data presented earlier: smaller primary surpluses in the presence of explosive gross debt as a percentage of GDP.

To test the hypothesis of greater effectiveness of monetary policy in a better fiscal environment, a reaction rule was estimated for the Central Bank in the form

$$D(SELIC_REAL_t) = \beta_1 + \beta_2 D(SELIC_REAL_{t-1}) + \beta_3 RF_{t-1} + \beta_s N_{s t} + \varepsilon_t, \quad s = 4, \dots, m \tag{18}$$

where $N_{s t}$ is a set of $m - 4$ variables that also influence the behavior of the change in the real interest rate⁹.

Equation (18) is in practice a version of the Taylor Rule. John B. Taylor (1993; 2000) has identified a relationship between changes in U.S. interest rates and fluctuations in inflation and output. In general, a Central Bank has preferences regarding the sensitivity of the interest rate to the price level and the output, so that, for example, positive variations of the last two variables need to be responded by the monetary authority with also positive variations of the monetary policy instrument. Central

⁸ The linearization was made based on the observation of the highest value of the series: in Oct/2008 the observed value was 0.007429. The formula used for the linearization was $RF_t = \text{série extraída}/0,007429$.

⁹ As it is in first difference, by hypothesis it would not be expected trends in the dependent variable, since in the long term, in theory, there would be no variations in the real Selic, which would be at its natural level - which could be interpreted as the absence of an intercept in the equation. However, since we are working with a limited sample, specifications with a constant were used to capture possible biases in the real interest rate during the sample period.

banks use reaction rules based on the original Taylor design to keep inflation rates within the established targets¹⁰.

Despite being in real terms and modified by a fiscal component, for a better adherence of the empirical exercise to economic theory we opted to use the deviation of the Brazilian economy's total output from the potential output, i.e. the output gap, as the explanatory variable of the real interest rate; since there is no direct measure of the potential output, it was necessary to use a statistical filter - the Hodrick-Prescott (HP) filter¹¹ - to obtain a value for potential output and for the cycle.

The HP filter is widely used in output gap estimations in Brazil and in the international literature. The output gap, regarding its construction process via HP filter, has a stationary nature. The use of a reduced sample (January 2004 to January 2020) made it necessary to repeat the unit root tests for the variables. These tests can be found in Appendix D. The reaction rule was estimated by GMM (Table 11).

Table 11. Estimation of the effect of the fiscal response in a monetary reaction rule

Variables explanatory	GMM estimation: $D(SELIC_REAL)_t$			
	Model 2.1	Model 2.2	Model 2.3	Model 2.4
c	1,306* (0,731) [1,785]	1,167*** (0,628) [2,664]	1,847*** (0,757) [2,438]	1,277* (0,715) [1,784]
$D(SELIC_REAL)_{t-1}$	0,766*** (0,086) [8,855]	1,017*** (0,155) [6,529]	0,843*** (0,064) [13,035]	0,862*** (0,073) [11,788]
$D(E[IPCA]_{t-1})$	0,828*** (0,177) [4,671]	1,227*** (0,276) [4,437]	0,880*** (0,240) [3,652]	1,136*** (0,239) [4,742]
$IBCRR_GAP_{t-1}$	0,028** (0,001) [2,006]	-0,017 (0,019) [-0,931]	-	-
$D(CAMBIO_REAL)_{t-2}$	0,001 (0,002) [0,055]	-	0,031 (0,056) [1,175]	-
RF_{t-1}	-1,359*** (0,757) [-1,795]	-1,720*** (0,655) [-2,626]	-1,191*** (0,785) [-2,436]	-1,320* (0,746) [-1,768]
<i>Adjusted R²</i>	0,381	0,342	0,373	0,346
<i>J-statistic (prob.)</i>	0,339	0,405	0,404	0,261

10 In the New-Keynesian view a higher interest rate would reduce demand, thus reducing inflation; authors such as Cochrane (2011) and Leeper (2016) claim that this is "old-Keynesian" logic and that the Central Bank's move increases future inflation, generating a new equilibrium.

11 Hodrick and Prescott (1997) define that a time series is composed of a long-term trend component and a short-term cyclical component, the filter proposed by the authors allows us to obtain the trend component, which here represents the potential output.

Source: Prepared by the author.

Note: () for standard errors and [] for t-statistics. Instruments: constant, D(SELIC_REAL)(-3 to -6), D(E[IP-CA])(-2 to -6), IBCBR_GAP(-3 to -6), D(CAMBIO_REAL)(-3 to -7), RF (-2 to -6); * significant at 10%, ** significant at 5%, *** significant at 1%.

The coefficient for the lagged real interest rate was significant in all specifications tested, indicating the existence of an inertial component in the variation of the real interest rate. In other words, the estimation captured a considerable gradualist behavior of the Central Bank of Brazil with its monetary policy instrument, with coefficients between 0.76 and 1.01 at 1% statistical significance. The literature for monetary policy in inflation targeting regimes indicates the importance of gradualism in the functioning of the regime, either by anchoring expectations, by gradualism itself being a channel of inflation control, or to avoid errors in the intensity of monetary policy. High gradualism may indicate greater ease in anchoring expectations and, given the effect on consumption and savings decisions, smoothing the macroeconomic environment.

It is interesting to note the higher coefficient related to inflation expectations - significant at 1% in all specifications - compared to the output gap, suggesting greater sensitivity to variations in expected inflation in the actions of the monetary authority. This highlights the forward-looking behavior of the Central Bank in Brazil in the analyzed period and aligns with results found previously by works such as Minella et al. (2003) and Triches and Feijó (2017).

In all specifications the coefficient for the variable RF_t variable remained negative and significant at 1% (except for the last specification, with 10%), with results between -1.19 and -1.72, validating the central hypothesis of the paper: the increase in the fiscal response index, i.e. a greater response by the fiscal authority in terms of primary surpluses in relation to public debt/GDP, is related to smaller variations of the real short-term interest rate, suggesting a gain in the effectiveness of monetary policy.

The result shows the importance of fiscal rules in the Brazilian context, not only relative to spending (such as the public spending cap rule) but especially those that address debt or the fiscal result. The negative coefficient of the fiscal response in all specifications of the Central Bank reaction rule suggests smoothing of short-term real interest rate variations, which can be interpreted as greater effectiveness of monetary policy in a context of fiscal consolidation. On the contrary, a reduction in the fiscal response index is accompanied by greater variability of the real interest rate, denoting loss of effectiveness and increased monetary uncertainty in the country. This understanding is reinforced by two practical aspects of the Brazilian fiscal design: (i) the high plastering of public spending and (ii) the poor performance of revenues in recent years.

The contribution of the fiscal field for a more effective monetary policy instrument necessarily involves the two points listed above. The high degree of fiscal constraint naturally reduces the capacity to respond to shocks in the debt, a capacity that deteriorates in the absence of an optimal level of revenues. To prevent an unsustainable debt trajectory seems inevitably to involve a reduction in the

compulsory expenditures of the Brazilian state. This situation is corroborated by an analysis by the Independent Fiscal Institution (IFI), linked to Brazil's Federal Senate: in a 2020 publication the body highlighted that there was a relationship between meeting primary result targets and the compression of discretionary spending¹².

Another important point in the Brazilian fiscal framework is the dynamics of spending. The growth in spending has been reflected over the years in a greater need for financing, and the way in which this financing has been designed - through the profile of the public debt - influences the Central Bank's actions. The current participation of securities indexed to the Selic rate in the public debt (41% in January of 2020, according to data from the BCB's Time Series Management System) allows that in a low interest rate environment it is possible to temporarily admit a high level of public debt, since financing is less costly. It is necessary to emphasize the term temporarily: fiscal shocks or even the perception of the unsustainability of the debt on the part of agents may initiate an explosive process of increase in interest rates implicit in longer public bonds and, consequently, an increase in the debt/GDP ratio - a situation like that presented by Blanchard (2005)¹³. In addition, by issuing short-term securities, the Central Bank could become a hostage to the rolling over of the debt over a short horizon. Therefore, the Central Bank would have greater difficulty in meeting inflationary targets, stimulating greater variability in the Selic rate in real terms.

Between 2014 and 2017, as shown in Chart 5, the fiscal response decreased, a period consistent with the increase in the country's gross debt. In scenarios of high debt/GDP, rising inflation expectations and low GDP growth, it is likely that lower fiscal responses, i.e., lower surpluses/GDP - when they exist - generate complications for the actions of the monetary authority (LUPORINI, 2015). The outlook is worrisome given that the country's last primary surplus was recorded in 2013, which, based on the estimated monetary reaction rules, would indicate deterioration in the effectiveness of the monetary authority in controlling its policy instrument over the past seven years. In practice, for the Brazilian case, the primary surplus target is no longer the beacon of expectations about the sustainability of the public debt, a function momentarily transferred to public spending rules.

Using a simple illustration to estimate the effect of the fiscal response: an expansionary fiscal authority would require a more conservative profile of the monetary authority to achieve macroeconomic stability; in the scenario described by the estimates, interest rates would need to be more volatile for inflation to converge to the pre-established target. Although some works cited in previous sections show monetary contributions to inflation above the target as of 2011, the result found in the estimation indicates that the poor performance of monetary policy was directly related to the fiscal

12 The average current expenditure between 2006-2010 was 1.23%; the average between 2015-2019 was at 1.16%.

13 Blanchard performed a study with data for the Brazilian economy between 1995 and 2004, when a relevant portion of the public debt was indexed to the exchange rate, a situation divergent from the current one. However, recent work proves a similar risk of fiscal dominance in the style suggested by Blanchard: a relationship between public debt, interest rates, and risk premium.

scenario in the last decade.

Even if one considers, for example, the existence of a countercyclical fiscal rule for the Brazilian economy - as found in the first stage of the empirical analysis - continued reductions in the fiscal response would still have the effect of greater variability of the monetary policy instrument. In other words, even if one does not consider the existence of fiscal dominance or the situation described in the FTPL, a worsening in the relation between the primary surplus/GDP and the public debt/GDP would still negatively impact the Central Bank's actions, restricting its flexibility to deal with shocks to the economy.

5 FINAL CONSIDERATIONS

This paper evaluated the following hypothesis: a monetary authority committed to price stability is not a sufficient condition to ensure inflationary control and economic welfare. Recent developments confirm this hypothesis, as do the empirical results found by this paper. A determinant for macroeconomic stability would then be fiscal policy. This paper has contributed to the literature related to the evaluation of fiscal policy by finding an inverse relationship between the cyclicity of primary surpluses and the dynamics of the real interest rate in Brazil.

Using monthly data between 2003 and 2020, the study found evidence that better response of the fiscal authority to shocks in the debt/GDP ratio results in less variability in the real interest rate in Brazil, which can be understood as greater effectiveness of monetary policy. The fiscal response notably retracted in the occurrence of the subprime crisis and decreased again with the economic recession that began in 2014 in Brazil. From this period on, it was possible to observe the relationship between the Brazilian government's fiscal deterioration and the failure to meet announced inflationary targets. A fiscal consolidation process could contribute to less variability in real interest rates, greater macroeconomic stability and inflation control.

The result found may indicate a more complex logic than the classical one presented in the Ricardian equivalence. The degree of response to the debt shock would generate disturbances in the macroeconomic environment over time: depending on the fiscal response (assuming that the authorities are aware of a future correction via public budget or inflation), the erosion of monetary policy could happen even in the presence of non-negative primary outcomes.

The paper suggests the need to reverse the process of falling fiscal reaction that began after 2014, aiming to reduce the cost of eventual future disinflation. As an advance for further studies, it would be recommended (i) to use in a similar analysis the risk premium for Brazilian government bonds - the use of the sovereign risk premium makes it possible to think in terms of fiscal fragility; (ii) to use different definitions of debt and nominal result and test sub-samples; and (iii) to specifically analyze the participation of fiscal consolidation events in the country's monetary dynamics, such as the LRF and the spending cap law.

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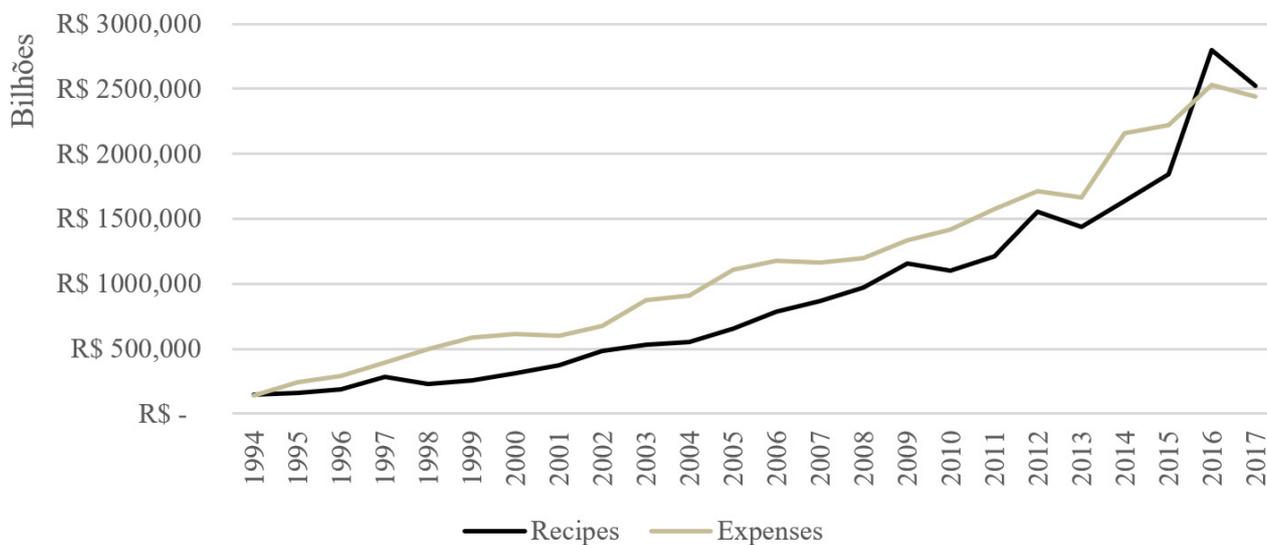
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APPENDIX A - FEDERAL BUDGET REVENUES AND EXPENDITURES

Evolution of Union budget revenues and expenditures between 1994 and 2017



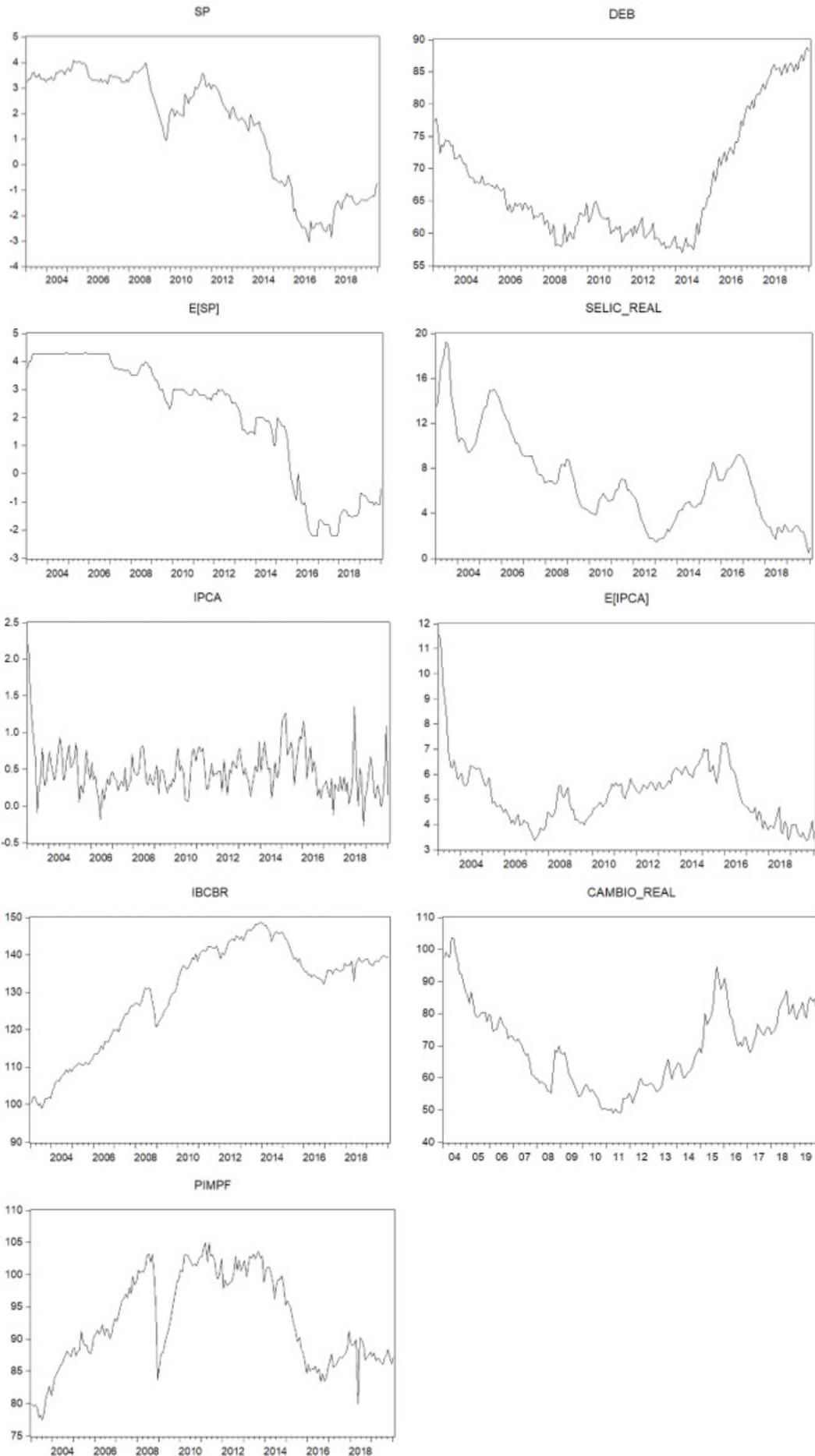
Source: Prepared by the author. Data obtained from the National Treasury Secretariat (STN).

Evolution of the Union's contingent expenditures between 2006 and 2018

Year	Total (% of GDP)
2006	1,72
2007	1,73
2008	1,84
2009	2,20
2010	2,43
2011	2,14
2012	2,25
2013	2,25
2014	2,45
2015	1,99
2016	2,24
2017	1,79

Source: Prepared by the author based on the Fiscal Policy Observatory of IBRE/FGV. Data obtained from SGS and SIGA Brasil.

APPENDIX B - EVOLUTION OF THE VARIABLES



APPENDIX C - IDENTIFICATION OF THE OPTIMAL LAG FOR UNRESTRICTED VAR

Lag	AIC	SIC	HQ
0	17,224	17,358	17,278
1	5,275	5,675*	5,437*
2	5,179	5,846	5,449
3	5,151*	6,085	5,529
4	5,242	6,442	5,728
5	5,322	6,788	5,915
6	5,213	6,946	5,914
7	5,171	7,171	5,981
8	5,242	7,509	6,160

Source: Prepared by the author.

Note: * indicates the optimal lag according to the information criteria

APPENDIX D - UNIT ROOT TESTS

Unit root tests, second step of the empirical analysis - variables at the level¹⁴

VARIABLES	ADF	PP	KPSS
$SELIC_REAL_t$	-2,596	-1,498	0,193**
$E[IPCA]_t$	-1,039	-0,984	0,206
$IBCBR_GAP_t$	-4,162***	-3,872***	0,035
$CAMBIO_REAL_t$	-2,290	-2,128	0,369*
RF_t	-3,348**	-3,217**	0,322***

Source: Prepared by the author.

Unit root tests, second step of the empirical analysis - variables in first difference

VARIABLES	ADF	PP	KPSS
$D(SELIC_REAL_t)$	-5,504***	-8,084***	0,058
$D(E[IPCA]_t)$	-11,283***	-12,263***	0,108
$D(CAMBIO_REAL_t)$	-5,322***	-11,294***	0,075

Source: Prepared by the author.

14 For the ADF and PP tests: (***) rejects the null hypothesis of unit root at the 1% level, (**) rejects the null hypothesis at the 5% level, (*) rejects the null hypothesis at the 10% level; for the KPSS test: (***) rejects the null hypothesis of stationarity at the 1% level, (**) rejects the null hypothesis of stationarity at the 5% level, (*) rejects the null hypothesis of stationarity at the 10% level.