# Fiscal and monetary policy rules in Brazil: empirical evidence of monetary and fiscal dominance

Tito Belchior S. Moreira, Mario Jorge Mendonça and Adolfo Sachsida

**Abstract**

Based on the hypothesis that the rules of monetary and fiscal policy in Brazil may have been subject to different regimes, the present study applies the Leeper model (1991 and 2005) to identify the chronology of policy regimes in terms of their active and passive character. The policy rules are estimated using the Markov-switching model, with a monthly database from November 2002 to December 2015, in which the regimes are endogenously determined. The results obtained indicate that fiscal dominance occurred in 2010 and between 2013 and 2014, while monetary dominance marked much of 2003 and the period 2005–2007. The model also seeks to explain why the inflation rate continued to rise during 2015 even though Central Bank of Brazil took an active monetary policy stance that year.

**Keywords**

Monetary policy, fiscal policy, inflation, gross domestic product, public debt, macroeconomics, econometric models, Brazil

**JEL classification**

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# I. Introduction

The government budget constraint means that the government's current debt must be compatible with the present value of its future income. The optimal monetary rule assumes that fiscal policy is not relevant to monetary policy and public debt is therefore assumed to be sustainable. In other words, the fiscal authority will always adjust taxes to ensure the payment of the debt. However, if the government uses seigniorage to balance the budget, the budget deficit will impact on the current or future rise in the money supply. It therefore needs to be determined whether the rise in debt may lead to an increase in the rate of inflation.

As remarked by Walsh (2003), if fiscal policy acts independently, the monetary authority is forced to create seigniorage revenue to balance the government accounts.[1] Leeper (1991) describes this situation —where fiscal policy is active and monetary policy is passive— as fiscal dominance. Sargent and Wallace (1981) show that one adverse effect of fiscal dominance is that if the primary balance falls, seigniorage revenue will have to be increased in order to accommodate the government budget constraint. In this context, attempts to control current inflation will lead to higher inflation in the future. The idea underlying this point is this: reducing seigniorage revenue will increase the deficit and, thus, total debt. Over time, the monetary authority will be forced to increase the money supply.

Leeper (1991) states that equilibrium policies can be classified in two ways, on the basis of a fiscal policy rule or a monetary policy rule. The first set are those in which the basic rate of interest responds to the rate of inflation (monetary rule) and taxes respond to fluctuations in public debt (fiscal rule). Here, monetary policy is active and fiscal policy is passive, fiscal shocks do not influence equilibrium prices, interest rates or real wages. This first case is a situation of monetary dominance. In the second set of rules, fiscal policy is active and monetary policy is passive. Fluctuations in public debt lead to money creation. In this case, the public deficit increase inflation, prices depend on government liabilities and the nominal interest rate depends on the relation between the amount of money and the government debt. A monetary contraction will push up inflation. This second situation is one of fiscal dominance, where monetary policy is a consequence of fiscal policy.[2]

Leeper (1991) studied the interaction between monetary and fiscal policy by analysing the equilibria produced by these monetary and fiscal parameters. In this model, monetary policy defines the nominal interest rate as a function of current inflation, while the fiscal authority choses a level of direct taxation in response to the rise in public debt. The parameters of fiscal policy rules determine the degree of independence of each source of revenue. The parameters associated with an active stance assume that fiscal policy does not respond to the conditions of constraint that must be applied in order to maintain equilibrium, i.e. the fiscal authority does not concern itself with public debt sustainability, but with increasing levels of economic activity, for example. Meanwhile, under the parameters of passive conduct by the fiscal authority, it would raise taxes when the deficit increases.

Conversely, the parameters of active monetary policy imply that the interest rates controlled by the central bank respond to the constraints that must be imposed to maintain equilibrium. The parameters of a passive stance by the monetary authorities would indicate no rise in the base rate when inflation rises; otherwise, the monetary stance is an active one, i.e. the monetary authority concerns itself mainly with maintaining price stability and not the level of activity or employment in the economy.

[1] Seigniorage revenue comes from two sources. The first is the increase in the real monetary base in relation to revenue. The second stems from the fact that to keep real cash reserves constant, the private sector needs to increase the volume of the nominal reserve to a rate roughly equal to the increase in the monetary base.

[2] In a seminal work, Martins (1980) established that the prices of securities are equivalent to the price level and that the nominal interest rate is determined by the ratio between the debt stock and currency reserves.

Moreira, Souza and Almeida (2007) apply the Leeper model to quarterly data from 1995 to 2006 and find evidence that, in this period, the Brazilian economy underwent a regime of fiscal dominance. Starting from the hypothesis that policy rules in Brazil may have been subject to different regimes, this study uses the Leeper model (1991 and 2005) to establish the chronology of the activeness or passiveness of monetary and fiscal policy rules. Moreira (2009 and 2011) tests empirically whether Brazilian fiscal policy was active or passive. The empirical results show that the channels of transmission of fiscal policy are seen through the effects of the public debt to GDP ratio on money demand, the primary surplus, the nominal interest rate, investment and the output gap. Lastly, estimates based on the Leeper model show that the Brazilian economy is characterized by fiscal dominance, which describes the fiscal theory of the price level.

In this context, the contribution of this work is to identify the interaction between fiscal and monetary policies, on the basis of endogenous Markov regime-switching. In other words, policy rules or response functions are estimated using the Markov-switching model. The sample comprises monthly data from 2002 to December 2015. The results obtained support the affirmation that fiscal dominance occurred in 2010 and between 2013 and 2014. Monetary dominance was present during much of 2003 and in the period 2005–2007. The model also explains why the inflation rate continued to rise in 2015, despite the central bank's adoption of an active monetary policy.

The present article is divided into seven sections, including this introduction. The second section presents the broad lines of the Leeper model (1991). The third describes the Markov-switching model, which is used in the fourth and fifth sections to estimate, respectively, the fiscal and monetary response functions. The sixth section analyses the activeness or passiveness of monetary and fiscal policy rules in Brazil; the seventh offers concluding remarks.

# II. The Leeper model (1991 and 2005)

The Leeper model (1991 and 2005) is based on a representative agent having a constant endowment $y$ to consume $c$ in each period. The government takes out $g < y$, generating no profit for the agent. The government also takes part $\tau$ of tax from $y$. The real reserve ratio $m$ is $\frac{M}{p}$, where $M$ is the stock of money and $p$ is the price level. Agents have a government security $B$ for a period obtaining a risk-free nominal yield $R$. Given an intertemporal discount rate $\beta \in (0,1)$, and taking $y_t$, $p_t$, $R_t$ and $\tau_t$ as exogenous variables for each $t$, the agent faces the following problem:

$$\max_{\{c_t, b_t, m_t\}} \sum_{t=0}^{\infty} \beta^t \left[ log(c_t) + log(m_t) \right]$$

$$\text{st. a } c_t + \frac{M_t}{p_t} + \frac{B_t}{p_t} + \tau_t = y_y + \frac{M_t}{p_t} + R_{t-1}\frac{B_{t-1}}{p_t} \tag{1}$$

Using first order conditions and the feasibility condition, $c_t = y_t - g_t$, it can be shown that the model is reduced to a defined system, respectively, by the Fisher and currency demand equations (2)-(3):

$$\frac{1}{R_t} = \beta E_t \left[ \frac{1}{\pi_{t+1}} \right] \tag{2}$$

$$m_t = c_t E_t \left[ \frac{R_t}{R_t - 1} \right]^{-1} \tag{3}$$

where $\pi_{t+1}$ is the inflation rate in $t + 1$ and $m_t = \frac{M_t}{p_t}$. Taking $b_t = \frac{B_t}{p_t}$, the government budget constraint obeys the following identity:

$$b_t + m_t + \tau_t = \frac{R_{t-1} b_{t-1} + m_t}{\pi_t} \quad (4)$$

Fiscal policy is defined by a rule that we denominate the fiscal response function, such that:

$$\tau_t = \gamma_0 + \gamma b_t + \psi_t \quad (5)$$

The monetary policy rule or response function followed by the central bank is identified as follows:

$$R_t = \alpha_0 + \alpha \pi_t + \mu_t \quad (6)$$

Leeper (1991) takes $\psi_t$ and $\mu_t$ as non-correlated first order autoregressions. A priori, the author does not propose any restrictions for $\alpha$ and $\gamma$.

Equations (2)-(4), (5) and (6) can be reduced to a recursive system in the variables $\pi_t$ and $b_t$ whose roots $\alpha\beta$ and $\beta^{-1} - \gamma$ determine the system's stability. Two situations of interest occur.

## 1. Monetary dominance: $|\alpha\beta| > 1$ and $|\beta^{-1} - \gamma| < 1$

This is the case of a single equilibrium. In this region, monetary shocks produce expected trajectories and fiscal shocks are irrelevant. In other words, in region I, monetary policy has no constraints and may actively pursue price stability, responding strongly to inflation. Fiscal policy obeys the constraints imposed by the behaviour of the private sector and by monetary policy, and adjusts passively to the collection of direct taxes to balance the budget. Ricardian equivalence obtains here. In this case, monetary policy is active and fiscal policy is passive. This means that monetary policy is effective at determining the price level and the monetary authority need not concern itself with the budget constraint, because the fiscal authority can choose a tax level to keep debt sustainable at any given time. Leeper (2005) shows that equilibrium inflation is an entirely monetary phenomenon and that fiscal shocks do not affect inflation or the nominal interest rate. This is the ideal region for policymakers to establish an inflation target by controlling the rate of interest. More specifically, there is no restraint of any kind on monetary policy and it can actively pursue price stability. Fiscal policy obeys the constraints imposed by monetary policy and the private sector and adjusts passively to achieve budget equilibrium.

## 2. Fiscal dominance: $|\alpha\beta| < 1$ and $|\beta^{-1} - \gamma| > 1$

In this region, monetary policy responds weakly to inflation ($|\alpha\beta|<1$) while fiscal policy does not respond strongly to debt ($|\beta^{-1} - \gamma|>1$). This regime also generates a single equilibrium. This is equivalent to the situation described by Sargent and Wallace (1981) when they coined the expression "unpleasant monetarist arithmetic". In this case, monetary policy is passive and fiscal policy active. Now, the monetary authority obeys the constraints imposed by fiscal policy.

There are two possible cases. The first arises when the two roots have modulus less than 1, i.e. each authority is acting passively. Without an additional constraint imposed by one of the authorities to take an active stance, there are many equilibrium-compatible money supply increase processes that lead to price level indeterminacy, an outcome remarked by Sargent and Wallace (1975). In the second case, the two roots have modulus greater than 1, so that both authorities are acting actively. Unless shocks $\psi_t$ and $\mu_t$ are supposed to be correlated, there is no process of increase in the money supply that ensures that agents will finance government securities.

In light of the foregoing, some brief remarks are warranted on coordination between monetary, fiscal and indeed exchange-rate policies, although the Leeper model (1991) does not address the

last of these. Bearing in mind the trade-off between inflation and unemployment and the fact that in 1999 Brazil adopted an inflation-targeting system that implicitly admitted the prevalence of a monetary dominance regime, a number of conjectures may be made.

If the central bank pursues lower inflation, even at the cost of higher unemployment, and the Ministry of Finance pursues long-term public debt sustainability, the central bank will respond by raising the Selic rate if inflation expectations rise. Similarly, fiscal policy will always seek to maintain a large enough primary surplus to maintain public debt sustainability. This is an indication of coordination between fiscal and monetary policymakers.

In other words, this is the policy that can ensure monetary dominance. Any other case must correspond to a lack of coordination or, worse, a conflict of interest between policies. For example, if the central bank tries to raise the base rate in order to keep inflation close to the target and fiscal policy prioritizes increasing employment (a smaller surplus to boost aggregate demand) even at the expense of inflation, the policy aims are contradictory. The opposite case, and cases in which both policies are active or both passive, speak to policy conflicts, suggesting a lack of coordination between policymakers.

It may also be said that a deliberate policy of excessive build-up of foreign reserves can generate adverse effects: on the one hand, it increases the monetization of the economy as a result of foreign-exchange buying by the central bank, which pushes up inflation. On the other hand, to maintain price stability, the central bank will be forced to issue repurchase agreements, which increases public debt. The pass-through effect must also be borne in mind, whereby part of the exchange-rate variation —whether rise or fall— is passed on to the rate of inflation.

# III. Response function modelling with regime-switching

The previous section presented the Leeper model (1991), which may be used to obtain the conditions to determine whether policy is active or passive. From a practical point of view, it is necessary to ascertain the fiscal and monetary policy rules, and on that basis to verify the stability of the model. On the basis of the Leeper model (1991), Moreira, Souza and Almeida (2007) found evidence that Brazil underwent a regime of fiscal dominance from 1995 to 2006.

The present study takes that literature further, taking as a basis the hypothesis that monetary and fiscal policies may have undergone different regimes during the sample period analysed. The existence of different regimes makes the conventional econometric techniques unsuitable to address the problem, even working with different subsamples. A specific model is therefore used to treat supposed structural breaks. That model allows the different stages undergone by monetary and fiscal policies since 2003 to be determined more clearly and accurately (Davig and Leeper, 2011). The model used to estimate fiscal and monetary policy rules is discussed briefly below.

## 1. Markov-switching model

When a linear relationship undergoes a structural break —which can occur in the coefficients of the variables, in the intercept and also in the variance of this relationship— the relevant parameters of the regression model vary over time, producing non-linearities and, usually, violations of the stationarity and normality hypotheses of the errors of conventional models. An alternative approach in this case is to treat structural breaks (and, thus, "regime switches") as exogenous, by introducing dummy variables into the conventional linear models. However, this procedure requires advanced knowledge of the

precise moment at which breaks occurred, which in practice is rarely known. Even in the unlikely case that the researcher "correctly guessed" the exact date of the relevant break or break, as well as their respective durations, by itself the introduction of dummy variables does not resolve the problems related to regime changes in the variance of the model errors. As Sims (2001) stated, it is a serious error to disregard these or any other cause of residual non-normality when considering changes in the parameters of the variables.

Markov-switching models explicitly assume that at any time there may be a finite (and generally small) number of "regimes" or "states", without knowing with certainty which obtains at that time. To cite an intuitive example, it appears reasonable to suppose that an economy in recession will behave differently (or have different parameters) to an economy that is growing rapidly. In this case, two "regimes" with quite different characteristics —one "recessionary" and the other "fast-growing"— could be considered to exist and to alternate every so often, without certainty as to which is occurring at each specific period.

Accordingly, Markov-switching models do not presume that "state switches" —for example, the passage from the "fast-growing" to the "recessionary" regime— are deterministic events. The hypothesis is rather one of "probabilities of transition" from one regime to another, which are endogenous estimated using Markov-switching models.[3] There is nothing to prevent regime switches from being "once and for all", in other words after a switch a given regime may remain indefinitely.

Non-linear time series modelling has been gaining increasing importance for some time now (Hamilton, 1989 and 1994; Krolzig, 1997; Kim and Nelson, 1999; Sims, 1999 and 2001; Franses and Van Dijk, 2000; Lütkepohl and Kratzig, 2004). In the present study we use the Markov-switching model to estimate fiscal and monetary response functions. We thus propose to specify each of these models as follows:

$$y_t = b_0(S_t) + \sum_{m=1}^{P} b_m(S_t)\chi_{mt} + \sigma(S_t)\varepsilon_t \qquad (7)$$

$$\text{with } \varepsilon_t \sim N\left(0, \sigma^2(S_t)\right);$$

where $S_t$ is an unobserved stochastic variable which determines the state $k$ that the model assumes in each period $t$.

Note that, ex hypothesis, the "latent variable" $S_t$ is governed by a stochastic process known as the ergodic Markov chain and defined by matrix of transition probabilities whose elements are given by:

$$p_{ij} = Pr\left(S_{t+1} = j \mid S_t = i\right), \sum_{j=1}^{k} p_{ij} = 1 \quad \forall\, i,j \in \{1, \ldots, k\}$$

$$p_{ij} \geq 0 \text{ for } i,j = 1, 2, \ldots, K \qquad (7.1)$$

Here, $p_{ij}$ represents the probability that, in $t + 1$, the chain will switch from regime $i$ to regime $j$. The idea is thus that the probability of any regime $S_t$ occurring in the present depends solely on the regime existing in the previous period, i.e. $S_{t-1}$. With $k$ existing regimes, the probabilities of transition between states may be represented by the matrix of transition probability $P$, with the dimension ($k$ x k).

The parameters of this model are estimated via maximization of the model's likelihood function by means of the expectation–maximization (EM) algorithm (Dempster, Laird and Rubin, 1977), an iterative technique for models with omitted or unobserved variables. It may be shown that the relevant likelihood function increases with each iteration of this process, which ensures that the final result will be

[3] More technically speaking, Markov-switching models fall within what Chib (1996) denominates "hidden Markov models". For a broad variety of these models, see Kim and Nelson (1999).

close enough to the maximum likelihood in the relevant vicinity.[4] However, it must be recalled that the likelihood function of a Markov-switching models has no global maximum (Hamilton, 1991 and 1994; Koop, 2003). Fortunately, the EM algorithm often yields a "reasonable" local maximum and pathological cases are relatively rare (Hamilton, 1994).

# IV. Fiscal response function

Although relatively small compared to what is termed the "central bank response function" there is an analogous literature concerned with estimated the "fiscal response function" of the National Treasury (Bohn, 1998; Taylor, 2000; Galí and Perotti, 2003; Thams, 2007, among others).

Accurate estimation of the fiscal response function is important for analysis of macroeconomic policy for at least two reasons. The first concerns the sustainability of public debt. Here, it is important to ascertain whether the primary surplus reacts to variations in the public debt to GDP ratio in a manner that keeps that ratio at sustainable levels (Bohn, 1998). The second reason is that estimation of the fiscal response function serves to investigate whether fiscal policy pursues some other objective, such as supporting aggregate demand or helping the monetary authority to control inflation.

Given that we are using the Leeper model to test policy rules for Brazil, it is important to be aware of the specificities, legal aspects and, above all, the calculation methodologies of fiscal indicators. In this contest, Carvalho and Feijó (2015) perform a detailed study of the "below the line" methodologies used by the economic department of the central bank to calculate public sector financing needs, i.e. the primary and nominal balances and the net and gross debt of the public sector. In that work, the authors also describe the main characteristics of the method employed to calculate the fiscal balances used to renegotiate debt with federal bodies, developed on the basis of Act No. 9496 of 1997, and the implicit calculation methodology of the fiscal balance established in the Fiscal Responsibility Act – Complementary Law No. 101 of 4 May 2000.

For the case of Brazil, Mello (2005) estimates the fiscal response function according to various definitions of "public sector" using monthly data for the period 1995–2004 and observes that in all cases the primary surplus shows a strong positive response in the event of a rise in public sector net debt.[5] Mello also finds that output is weakly but positively correlated with several definitions of primary surplus, which suggests that Brazilian fiscal policy was non-cyclical or acyclical during this period. Mello (2005) acknowledges the possibility that structural breaks may occur in the series used and proposes to address these by working with different subsamples. However, this yields significant variations in relevant parameters, in particular a weakening of the primary surplus response to public sector net debt after 2002.

In order to address the uncertainty over the regime changes that may have occurred, Mendonça, Santos and Sachsida (2009) calculate the fiscal response function using the Markov-switching model, with monthly data from January 1995 to December 2007. Their results strongly suggest that fiscal policy in Brazil underwent two different regimes after the Real Plan, and that late 2000 is the most likely moment of transition between the two. The regime after 2000 shows a limited (or even nil) response by the primary surplus to variations in public sector net debt. By contrast, in the regime prior to 2000 (with greater volatility) the primary surplus showed quite an evident response to variations in public sector net debt. It was also seen that in both regimes the primary surplus seemed to respond positively to variations in output and that the government did not appear to have explicitly used fiscal policy to control inflation in either regime.

[4] In general, this method is robust when the starting values are chosen arbitrarily or inefficiently.

[5] The broadest concept of the public sector is the "consolidated public sector", which includes the union, the states, the municipalities and State enterprises. Mello also works with the primary surplus of the "union" (i.e. the federal public administration) and of the "regional governments" (i.e. all the state and municipal public administrations taken together).

# 1. Empirical analysis

The purpose of econometric analysis of the fiscal response function is to test the hypothesis that the primary surplus adjusts in response to variations in debt to ensure debt sustainability over the long term, or that fiscal policy is used as a tool to stabilize output or inflation. Thus, in accordance with the empirical literature on the subject (Bohn, 1998; Galí and Perotti, 2003; Thams, 2007), we propose to estimate the fiscal response function using a Markov-switching model, specified as follows:

$$PRIM_t = b_0(s_t) + b_1(s_t)DLSP_{t-1} + b_2(s_t)INFLA12_{t-1} + b_3(s_t)TXPIB12_{t-1} + \sigma(S_t)\varepsilon_t \quad (8)$$

where, in this research, we use monthly data from November 2002 to December 2015. The variables used in this study (whose graphics appear below) are described as follows:[6]

*PRIM*: primary balance of the consolidated public sector, not including 12-month cumulative exchange-rate appreciation divided by GDP (also 12-month cumulative).[7]

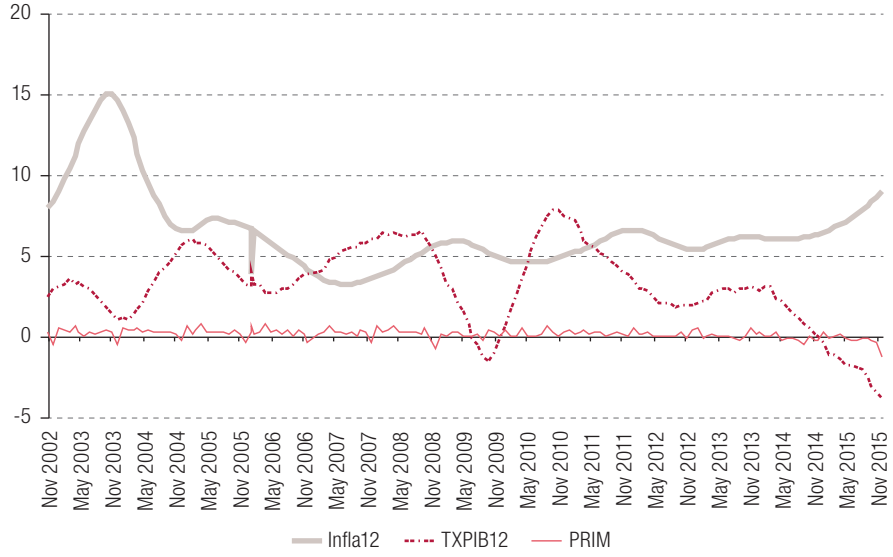
*DLSP*: ratio between the monthly value of the consolidated public sector net debt and GDP (12-month cumulative GDP adjusted by the general price index-domestic supply (IGP-DI)).[8]

*INFLA12*: rate of inflation measured by the broad national consumer price index (IPCA) over a 12-month period.[9]

*TXPIB12*: real GDP growth rate over the past 12 months.[10]

Figure 1 shows the evolution of the inflation rate and the real GDP growth rate, both in 12-month cumulative figures. It also shows the behaviour of economic growth in the Brazilian economy in the period between November 2002 and December 2015.

**Figure 1**
Brazil: evolution of the rate of inflation (Infla12), GDP growth (TXPIB12) and the primary surplus as a percentage of GDP (PRIM), annualized monthly data, November 2002–December 2015




**Source:** Institute for Applied Economic Research (IPEA).

6 Data may be requested directly from the authors.

7 Central Bank of Brazil.

8 Central Bank of Brazil.

9 Brazilian Institute of Geography and Statistics (IBGE).

10 Getulio Vargas Foundation.

The primary balance is defined by the difference between total income and total expenditure, excluding interest on the public debt, as a proportion of GDP. In this case, a positive primary balance means the generation of a primary surplus; a negative primary balance is a primary deficit.

Some relevant aspects may be observed concerning the evolution of the primary surplus, shown by the thin line. Until October 2008, the primary surplus was relatively stable at around 3% of GDP, then rose to 3.69% in November 2008. The primary surplus target initially adopted in Brazil was 3% of GDP. Figure 1 shows that fiscal policy austerity ceased to be applied systematically as from 2009. The empirical results, as will be seen below, show that the fiscal years of 2010, 2013, 2014 and 2015 were characterized by active fiscal policy (see table 5).

Notably, Brazil began to feel the effects of the subprime crisis more strongly in the last quarter of 2008. The annual growth rate (represented by the dashed line), which was 6.5% in September 2008, fell to 0.8% of GDP in June 2009. Between July and December 2009 growth rates were nil or negative. The federal government adopted countercyclical policies, including the reduction of the primary surplus, which averaged 1.90% of GDP during fiscal year 2009.[11] Although the primary surplus recovered up to August 2011, to 3.54% of GDP, fiscal policy showed a deterioration starting in mid-2011, so that in December 2015 Brazil was running a primary deficit of 1.88% of GDP. The empirical results show that fiscal policy was passive in the fiscal years from 2003 to 2009, and in 2011 and 2012. In 2010, 2013 and 2014 there is empirical evidence of fiscal dominance (see table 5).

In fiscal year 1999, Brazil adopted an inflation-targeting regime, which was one of the stages of the Real Plan that had begun in mid-1994, as a policy aimed at stabilizing prices and improving the country's macroeconomic fundamentals.[12] The Real Plan was based on a macroeconomic tripod of monetary stability, fiscal responsibility and a floating exchange rate. In this context, the period covered by the present work was governed by a system of inflation-targeting, fiscal policy geared towards achieving a fiscal surplus and a dirty currency float, in which the central bank tried to avoid excessive exchange-rate fluctuation. However, starting at the time of the subprime crisis, economic policymakers began to gradually dismantle the macroeconomic tripod. See more details in Moreira and Soares (2012) and Moreira, Souza and Ellery (2013).

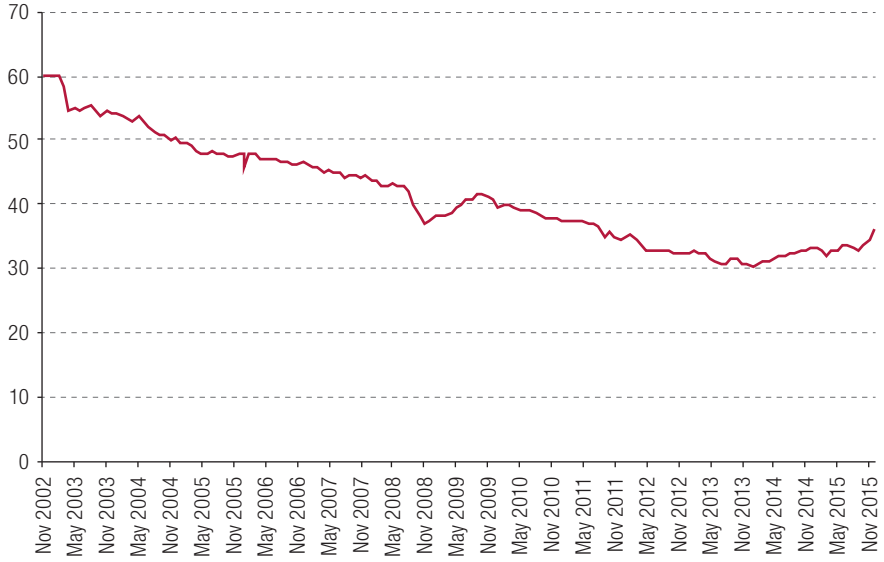
Figure 1 also shows a steep rise in the inflation rate, represented by the thick line, between November 2002 (8.03%) and October 2003 (15.06%), followed by a downtrend until July 2007 (3.29%). Starting in mid-July 2007, inflation trends upwards, to reach 9.03% December 2015. The growth rate began to fall sharply in 2014, however, from 3% December 2013 to -3.8% December 2015. The primary balance went from a surplus of 1.72% of GDP in December 2013 to a deficit of -1.88% in December 2015. In this same period, inflation rose from 6.20% to 9.03%. Lastly, the inflation rate and the GDP growth rate went from 5.44% and 2.3% of GDP in February 2013, respectively, to 9.03% and -3.8% in December 2015.

Figure 2 shows the pattern of the net debt of the consolidated public sector as a proportion of 12-month cumulative GDP. The ratio between debt and GDP falls between 2002 (59.85%) and November 2008 (36.96%). However, with the subprime crisis, the debt climbed to 40.99% in November 2009. Between May 2012 and November 2014, the debt stabilized between 30% and 32% of GDP. From the end of 2014, the public sector's net debt trended upwards, to 36.19% of GDP in December 2015.

[11] For a better understanding of countercyclical policies in this period, see Moreira and Soares (2012).

[12] The inflation-targeting system in Brazil uses the base rate of interest, the Selic rate, as an instrument to control money supply, making it endogenous. The central bank sets an inflation target (4.5% annual rate) with a 2% inflation band on each side. Thus, the ceiling of the band for annual inflation is 6.5% and the floor is 2.5%.

**Figure 2**
Brazil: evolution of public sector net debt, November 2002–November 2015
*(Percentages of GDP)*




**Source:** Institute for Applied Economic Research (IPEA).

Instead of the primary surplus, some studies analysing policies of fiscal or monetary dominance make use of other variables as fiscal policy tools. Leeper (1991 and 2005) uses direct taxation revenue, as do Moreira, Souza and Almeida (2007) in a study for Brazil. Meanwhile, Davig and Leeper (2011) use net government revenues.[13] Like Mendonça, Santos and Sachsida (2009), the present work treats the primary surplus as the most suitable variable to reflect fiscal policy. Leeper's theoretical model (1991 and 2005) uses real debt, while the empirical studies generally use the debt to GDP ratio, as we do here.

A number of remarks are called for before moving on to the econometric results. A positive relationship is expected between the primary balance, PRIM, and net debt (i.e. that $b_1 > 0$), given that when debt rises it is prudent to increase revenues or the primary surplus in order to ensure a sustainable debt trajectory.

On the basis of Leeper (1991 and 2005), if fiscal policy is committed to maintain a sustainable debt trajectory in public debt, the policymaker must act passively, that is, concern itself only with adjusting the ratio between the primary surplus and GDP to give a strong enough positive response to a rise in the public debt to GDP ratio to keep that ratio under control. In this context, a passive fiscal policy, in line with a monetary dominance model, should not respond to other variables such as inflation or output growth. Fiscal policy should adjust passively to monetary policy decisions. If this does not happen, it will mean that the fiscal authority is adopting an active stance, in other words, it is concerned more with controlling aggregate demand to tackle unemployment, for example, than with controlling the trajectory of public debt. By reducing the ratio between the primary surplus and GDP to raise economic activity levels, an active fiscal policy generates two unwanted side-effects: inflationary pressure and a rise in the public debt to GDP ratio. These side-effects undermine the effectiveness of the central bank's response function based on the Taylor rule.

[13] In the case of Brazil, net revenues of the central government are defined as total revenues excluding income from social security, minus grants and net interest on the public debt, the Workers' Support Fund (FAT) and unemployment insurance.

If fiscal policy is passive —by maintaining a primary surplus compatible with a sustainable public debt trajectory— then it will already by cooperating passively with the central bank by not generating inflationary pressure.

In a monetary dominance regime, the primary balance is thus not expected to react to changes in price levels or output. In a monetary dominance regime compatible with an inflation-targeting system, the central bank is only expected to adjust the base rate of interest in response to changes in the (expected) rate of inflation or in the output gap. In this sense, the monetary authority assumes an active monetary policy, as should occur in an inflation-targeting system.

The fiscal response function adopted here is backward-looking in nature.[14] It bears noting that the estimation of the above response function can be defended even when the model variables show a unit root. The spurious regression problem can be avoided by introducing lagged variables I(1) among the explanatory variables of the regression (Hamilton, 1994; Sims, Stock and Watson, 1990). In effect, Hamilton (1994, pp. 561 and 562) notes that this procedure ensures a consistent calculation for the model without regime-switching. It can also be shown that in this case the $t$-statistics for the individual coefficients are asymptotically normal.

Another argument against overemphasizing the order of integration of the variables in question is that Brazil's macroeconomic variables were subject to strong regime breaks[15] in the sample period, which (at least potentially) introduces considerable bias in the results of the conventional unit root tests.

## 2. Econometric results

This section presents the results of the fiscal response function estimations based on the Markov-switching model. Table 1 presents the estimations of the parameters with p-values[16] from equation (8) for a specification of the Markov-switching intercept autoregressive heteroskedasticity (MSIAH) model,[17] while annex A1 shows the graphics of the smoothed probabilities or, in order words, the chronology of regimes.[18] After evaluating several competing models, the two-state or two-regime model was found to be the best fit with the data, based on the different specification tests.[19] In effect, application of the likelihood-ratio (LR) test rejected the null hypothesis of linearity (LR = 189.65,X2(7) = [0.000]** e X2(8) = [0.000]**).[20]

[14] Galí and Perotti (2003) use a forward-looking specification. However, this distinction is not particularly relevant in the case of single-equation models, as it can be proved that, in this case, the forward-looking specification always has backward-looking equivalents (Sims, 1999 and 2001).

[15] Not least the global economic crisis of 2007–2008, which naturally had repercussions on the Brazilian economy.

[16] Standard error statistics were computed numerically using the Hessian matrix of maximum log likelihood function. Unfortunately, these approximations can be somewhat imprecise.

[17] A specification that allows changes in the intercept (I), the parameters of variables (A) and variances (H) in each egime. This terminology was adopted by Krolzig (1997).

[18] Smoothed probability takes into account information from the whole sample and is defined as follows: $p_r[S_t=j|\Psi_T]$, where $\Psi_T$ is the complete set of information up to moment $T$. Filtered probability is an optimal inference on the state of the variable at time $t$ considering the information up to $t$, while predicted probability considers the information up to $t$-1.

[19] No major specification problem was found upon conducting traditional Durbin-Watson serial correlation, normality and autoregressive conditional heteroskedasticity (ARCH) tests. Introducing a larger number of regimes led to issues with the numerical optimization routine, making the transition probability matrix non-ergodic, thereby violating one of the main hypotheses of the model.

[20] The likelihood-ratio (LR) test shows a non-standard distribution and cannot be characterized analytically as the transition probabilities are not identified under the linearity hypothesis. It is possible, however, to show that this distribution can be approximated, as it is in the interval between two chi-squares. We derive from this that if the distribution rejects the null hypothesis, the LR test must do so as well. Conversely, if neither rejects the hypothesis of linearity, then the LR test will not do so either. In any other situation there is nothing to be said (Davies, 1977).

**Table 1**
Model MS(2)-AIH(1)
*Dependent variable: PRIM*

| | Regime 1 | Regime 2 |
|---|---|---|
| Constant | -1.333 (0.183) | -1.7741 (0.317) |
| DLSP(-1) | 0.221 (0.284) | 0.299 (0.000) |
| INFLA12(-1) | 0.453 (0.093) | 0.065 (0.000) |
| TXPIB12(-1) | 0.637 (0.000) | 0.341 (0.000) |
| Standard deviation | 0.123 (0.0000) | 0.048 (0.000) |
| Observations | 156 | |
| Likelihood | 197.923 | |

**Source:** Prepared by the authors, on the basis of data from the Central Bank of Brazil.
**Note:** *p*-value in brackets.

The results shown in table 1, as well as the smooth probability graphics in annex A1, support the affirmation that there is a clear difference in the conduct of fiscal policy between the two regimes. Analysis of the results in table 1 yields the following remarks. A clear difference is seen in the response of the primary balance with respect to debt between the two states. Although net public sector debt has a positive sign in both regimes, it is only significant in regime 2. This means that the fiscal authority reacted to the rise in debt in this regime, which supports the interpretation that it pursued a fiscal target in regime 2. Conversely, in regime 1 fiscal policy did not respond to the rise in public debt, showing an active fiscal policy.

To further defend this thesis, annex A1 also includes the graphic for the ratio between net debt and GDP (public sector net debt). Comparing this graphic with the chronology of regimes, it may be seen that in December 2013 the downtrend in public sector net debt was reversed. In that period, regime 1 comes into play, where the Treasury ceases to treat net debt as a fiscal policy objective. In fact, between December 2013 and December 2015 public sector net debt rose by six percentage points. Between end-2002 and early 2009 regime 2 predominated, in which public sector net debt was statistically significant. It is interesting to note that public sector net debt trended strongly downward almost throughout this period.

Coming back to the analysis of table 1, in both regimes public sector net debt responds positively to output, TXPIB12, which seems to indicate that fiscal policy was countercyclical. However, the fiscal authority responds less strongly to output growth in regime 2 than in regime 1. In this case, there are signs that during regime 1 the fiscal authority may concern itself more with economic performance than with fiscal targets, which suggests an active fiscal policy in regime 1 and a passive one in regime 2.

Although the computed coefficient of inflation is positive in both regimes, its level of significance in regime 1 is low, as it is marginally significant at 10%, while in regime 2 it is statistically significant at 1%. However, the response to inflation by the fiscal balance is much lower in regime 2.

Given the foregoing, the results show empirical evidence that in regime 2, the share of the fiscal surplus in GDP reacts strongly to increases in the ratio between public debt and GDP, while in regime 1 the fiscal indicator shows no response to changes in that ratio. In addition, in regime 2 responses by the primary surplus/GDP indicator to the rate of inflation and to output growth are much weaker than in regime 1. It may thus be observed that although fiscal policy adopts a passive stance in regime 2 —insofar as the coefficient between debt and GDP is positive— it cannot be said to be 100% passive, as it responds less to changes in the rate of inflation and output growth than in regime 1. Symmetrically, regime 1 shows a strongly active stance: this is a necessary but not a sufficient condition to identify a regime of fiscal dominance. For that, monetary policy would have to be passive during the same period of regime 1, following fiscal policy.

Moving to analysis of the transition probability matrix (see table 2), it may be seen that once the economy is within one of the two regimes, it has a high probability of remaining there. In this case, the null hypothesis supposes that migration can occur from one regime to another. However, if the fiscal policy rule is present in regime 1, the computed probability of moving back to regime 2 is very small. Nothing can be said of the opposite case, because the *p*-value of the computed probability of transition from regime 2 to regime 1 is not significant. The fact that the probability of return to regime 2 is small when the fiscal rule obtains in regime 1 suggests that deterioration of the fiscal framework may become structural and ingrained, and thus difficult to reverse.

**Table 2**
Probabilities of transition

| | |
|---|---|
| $P_r(S_t = 1 \mid S_{t-1} = 1)$ | $P_r(S_t = 1 \mid S_{t-1} = 2) =$ |
| 0.973 | 0.018 |
| (0.000) | (0.156) |
| $P_r(S_t = 2 \mid S_{t-1} = 1) =$ | $P_r(S_t = 2 \mid S_{t-1} = 2) =$ |
| 0.023 | 0.982 |
| (0.000) | (0.000) |

**Source:** Prepared by the authors.
**Note:** *p*-value in brackets.

# V. Monetary response function

This section estimates the monetary policy rule followed by the Central Bank of Brazil to determine whether its main policy instrument, the Selic rate, responds to the inflation rate for the period between November 2002 and December 2015. The same Markov-switching model used hitherto is employed, in which regime alternance is determined by means of a Markov chain to model possible deviations from a simple linear response function. As noted earlier, this procedure has the advantage of overcoming uncertainty over the dates on which changes in the parameters occurred.

The discussion concerning the existence of a rule by which the central bank of the United States (the Federal Reserve System) guides its monetary policy began with Taylor (1993 and 2000) and led to the study of how monetary policy can be analysed by means of a response function. Taylor pointed to a strong relationship between changes in the interest rate set by the Federal Reserve System in response to variations in price levels and in output in the United States economy. In other words, the policy instrument, mainly the base rate of interest, has risen in periods of rising inflation. The interest rate also tends to rise when output is well above its potential. This procedure commonly adopted by central banks is aimed at avoiding future rises in the inflation rate.

In the case of Brazil, the literature on the topic computes the response function of the central bank closely following the Taylor rule or a variant of it. There are many works that study the Taylor rule for Brazil. Lima, Maka and Mendonça (2007) note that the main differences between these studies have to do with the econometric methodology used for the estimation and the dependence of the policy rule on current or expected inflation.

Minella and others (2002) estimate the central bank response function with data from July 1999 to June 2002 and show that the institution responded strongly to expectations of inflation and there was a high degree of interest-rate smoothing. The authors discovered that neither the output gap nor exchange-rate variation were statistically significant in the central bank response function. Holland (2005) found that the central bank adopted an aggressive stance of inflation control starting with the adoption of the targeting regime.

Salgado, Garcia and Medeiros (2005) use a threshold autoregressive (TAR) model) to explain the movement of the nominal interest rate after the adoption of the Real Plan. They conclude that Brazilian monetary policy underwent two different regimes after the Real Plan. The first was associated with times of international turbulence, such as the Asian crisis and the Russian crisis, which affected Brazil through the loss of international reserves. In the second regime, the central bank concerned itself with the movement of the usual domestic variables.

Policano and Bueno (2006) estimate a policy rule for Brazil using a time-varying parameter (TVP) model and conclude that, between 1995 and 2005, Brazilian monetary policy may be divided into two regimes. In the first, associated with a fixed exchange rate, the interest rate responded strongly to output and to international reserves. In the second, the establishment of the Selic rate was linked more to inflation-targeting.

Teles and Zaidan (2010) use the state-space model to estimate a forward-looking central bank response function. This study finds that rigorous central bank control of inflation occurs only from 2003 onward, when inflation expectations converge towards equilibrium.

Lima, Maka and Mendonça (2007) use a Markov model to estimate the central bank response functions between July 1996 and June 2007. Their results show substantial differences in the conduct of monetary policy before and after August 1999, which indicates that monetary was policy substantially affected by the change in the exchange-rate regime with the migration to a currency float.

On the basis of a time-varying vector autoregressive (VAR) model, Balbino, Colla and Teles (2011) attempt to identify differences in the conduct of monetary policy between the administrations of Armínio Fraga and Henrique Meirelles. Their results show no significant differences between the two administrations. Starting in 2003, the interest rate remained higher than was necessary for inflation convergence. During the term of Armínio Fraga, inflation remained above target, owing to the effect of exogenous shocks and not conflict with the stabilization rule in the crisis of 2002.

With a similar aim, Moreira, Souza and Ellery (2013) analyse the degree of tolerance to inflation by the presidents of the Central Bank of Brazil in the period 2001–2012. Their results show that Henrique Meirelles was the least tolerant to higher inflation, compared with Armínio Fraga. In turn, Alexandre Tombini adopted a more tolerant stance than Armínio Fraga.

## 1. Econometric results

Clarida, Galí and Gertler (2000) estimate the monetary response function with a forward-looking specification, where current policy actions depend on expected inflation in the future. As seen in the previous section, several studies treat expected inflation as a monetary policy target in Brazil. Expected inflation could also thus reasonably be treated as a variable to consider in computing the central bank response function. However, according to Sims (1999 and 2001), forward-looking specifications have a backward-looking equivalent. The following specification is thus adopted as a functional manner of computing the monetary response function:

$$SELIC_t = b_0(s_t) + b_1(s_t)INFLA12_{t-1} + b_2(s_t)TXPIB12_{t-1} + \sigma(S_t)\varepsilon_t \quad (9)$$

where $SELIC$ is the annualized base rate of interest set by the Central Bank of Brazil. The other variables were defined earlier, in section IV.

Below, we examine the results of monetary response function computation also estimated using the Markov-switching model. The results are shown in table 2. Taking into account the different specification tests, the three-regime model was the best fit for the data.[21] In effect, application of the likelihood-ratio (LR) test rejected the null hypothesis of linearity (LR = 241.45,X2(11) = [0.000]** e X2(12) = [0.000]**).[22] The graphics of smoothed probability that illustrate the chronology of regimes are presented in annex A2.

Table 3 shows that, whatever the regime, the Selic rate is set taking into account not only inflation but also output growth. In all cases, the coefficients of the variables are significant, and the signs are as expected.

According to the Taylor rule, the central bank should raise the interest rate by more than one unit for a given rise in inflation (or expected inflation), in order to ensure stability of singularity and of equilibrium. Thus, in keeping with the Taylor rule, monetary policy is active or restrictive if the coefficient of inflation from equation 9 is equal to or greater than 1, and passive or accommodative if the coefficient is less than 1 (Woodford, 2003).

Following the Taylor rule, table 3 verifies the existence of two regimes of lesser tolerance to inflation (regimes 2 and 3), while a third regime of central bank stance on monetary policy is accommodative (regime 1). It should be noted, however that regime 2 refers only to sporadic moments of monetary policy in Brazil. Conversely, regime 1 is long-lasting, as it ran from late 2007 to December 2014, and mostly coincided with the administration of Alexandre Tombini, who headed the Central Bank of Brazil from December 2010. It is interesting to note that, although the inflation rate has eased on several occasions since then, it shows a structural uptrend. Only after the second half of 2014 did the Central Bank of Brazil begin to respond more strongly by gradually raising the Selic rate. Throughout 2015, the central bank took a tight monetary policy stance, according to the analysis of regime 3. As will be seen in the following section, the reason why inflation has continued to rise is related to the lack of control on the part of fiscal policy and also to tariff shocks occurring just after the presidential elections of late 2014.

**Table 3**
Model MS(3)-AIH(1)
*Dependent variable: Selic rate*

| | Regime 1 | Regime 2 | Regime 3 |
|---|---|---|---|
| Constant | 0.025 (0.000) | 0.029 (0.000) | 0.169 (0.008) |
| INFLA12(-1) | 0.955 (0.000) | 1.295 (0.000) | 1.780 (0.000) |
| TXPIB12(-1) | 0.600 (0.000) | 0.651 (0.000) | 0.811 (0.000) |
| Standard deviation | 0.013 (0.000) | 0.001 (0.000) | 0.011 (0.000) |
| Observations | | 156 | |
| Likelihood | | 462.137 | |

**Source:** Prepared by the authors, on the basis of data from the Brazilian Institute of Geography and Statistics (IBGE) and the Getulio Vargas Foundation.
**Note:** *p*-value in brackets.

Before Alexandre Tombini, Henrique Meirelles chaired the Central Bank of Brazil from 2003, with a restrictive monetary policy that marked a major difference with respect to his predecessor. In addition, during the term of Meirelles the Treasury's fiscal policy was compatible with debt sustainability.

[21] See note 12.

[22] See note 13.

Table 4 shows the matrix of transition probabilities between states assumed by the monetary rule. Given that regime 2 occurs only occasionally, for simplicity's sake, the table shows the probabilities of transition between regimes 1 and 3. A point to remark is that the probability of switching from state 1 to state 3, and vice versa, is zero, while the sum of probabilities in each column of the matrix of transition is less than 1. This raises the question of whether the transition between these two states will not occur without a shock in the Selic rate.

**Table 4**
Transition probabilities

| | |
|---|---|
| $P_r(S_t = 1 \mid S_{t-1} = 1)$ | $P_r(S_t = 1 \mid S_{t-1} = 3) =$ |
| 0.979 | 0.000 |
| (0.000) | (0.000) |
| $P_r(S_t = 3 \mid S_{t-1} = 1) =$ | $P_r(S_t = 1 \mid S_{t-1} = 3) =$ |
| 0.000 | 0.962 |
| (0.000) | (0.000) |

**Source:** Prepared by the authors.
**Note:** *p*-value in brackets.

# VI. Determination of fiscal and monetary dominance

Tables 1 and 3 showed the parameters estimated for the fiscal and monetary response functions, respectively, to compute the absolute values of the roots of the Leeper model (1991). As was seen in section II, characterization of the roots of the system indicates when monetary or fiscal policy behaves actively or passively. In this context, assuming an intertemporal discount rate $\beta = 0.95$, the four situations presented in the Leeper model (1991) can be identified, once the computed values of $\alpha$ and $\gamma$ are known for each of the policy (monetary and fiscal) response functions, considering also the respective regimes.

To determine the period corresponding to each of the four possible combinations of active and passive policies, we compare the graphs shown in annexes A1 and A2. For each pair of policy rules (fiscal and monetary) seen in table 5, we observe the intersection between the shaded areas that relate a given monetary authority function with a given regime of the fiscal authority function.

For example, consider regime 1 of the Treasury response function and regime 3 of the central bank response function, where $\gamma = 0.000$, $\alpha = 1.781$, considering $\beta = 0.95$, which is naturally the same for all cases. It may be observed that $|\alpha\beta| = 1.691$ and $|\beta^{-1} - \gamma| = 1.052$. On the basis of the Leeper model (1991), considering the parameters computed, the results show that in this case both monetary policy and fiscal policy were active, that is, monetary policy prioritized pursuit of the inflation target, but fiscal policy did not prioritize pursuit of a primary surplus in alignment with public debt sustainability. But in what period did this situation occur? Comparison of the shaded areas of annex figure A1.1 with those of annex figure A2.3 shows that the two policies were active only in fiscal year 2015.

Table 5 helps to explain why the inflation rate continued to rise in 2015, even when the central bank took an active monetary policy stance. The fact is that, even though monetary policy was restrictive, fiscal policy also took an active position instead of accommodating by seeking budget equilibrium. This is an explosive situation, in which agents will demand higher and higher interest to take on government securities and ever-rising interest rates will drive up expectations of inflation, putting inflation control in jeopardy. Thus, in 2015 both monetary policy and fiscal policy are seen to be active.

**Table 5**
Brazil: definition of policies as active or passive on the basis of Leeper (1991)

| | Parameters<br>Central bank response function | | |
|---|---|---|---|
| Parameters<br>Treasury response function | Regime 1<br>$\alpha = 0.955$ | Regime 2<br>$\alpha = 1.295$ | Regime 3<br>$\alpha = 1.781$ |
| Regime 1<br>$\gamma = 0.000$ | $\lvert\alpha\beta\rvert = 0.907$<br>$\lvert\beta^{-1} - \gamma\rvert = 1.052$<br>FD<br>Periods: 2010; 2013 and 2014 | $\lvert\alpha\beta\rvert = 1.225$<br>$\lvert\beta^{-1} - \gamma\rvert = 1.052$ | $\lvert\alpha\beta\rvert = 1.691$<br>$\lvert\beta^{-1} - \gamma\rvert = 1.052$<br>Active fiscal and monetary policies: 2015 |
| Regime 2<br>$\gamma = 0.299$ | $\lvert\alpha\beta\rvert = 0.907$<br>$\lvert\beta^{-1} - \gamma\rvert = 0.721$<br>Passive fiscal and monetary policies: end-2003, 2004, 2008, 2009, 2011 and 2012 | $\lvert\alpha\beta\rvert = 1.225$<br>$\lvert\beta^{-1} - \gamma\rvert = 0.721$<br>MD | $\lvert\alpha\beta\rvert = 1.691$<br>$\lvert\beta^{-1} - \gamma\rvert = 0.721$<br>MD<br>Periods: most of 2003, 2005–2007 |

**Source:** Prepared by the authors, on the basis of E. Leeper, "Equilibria under 'active' and 'passive' monetary and fiscal policies", *Journal of Monetary Economics*, vol. 27, No. 1, Amsterdam, Elsevier, 1991.
**Note:** $\beta = 0.95$; FD: fiscal dominance, MD: monetary dominance.

This may explain to some extent why the term of Tombini was marked by an accommodative position, even when inflation approached the ceiling of the band, indicating that it could "get out of control". Should the Central Bank of Brazil have taken a more active stance at that point, increasing interest rates more steeply?

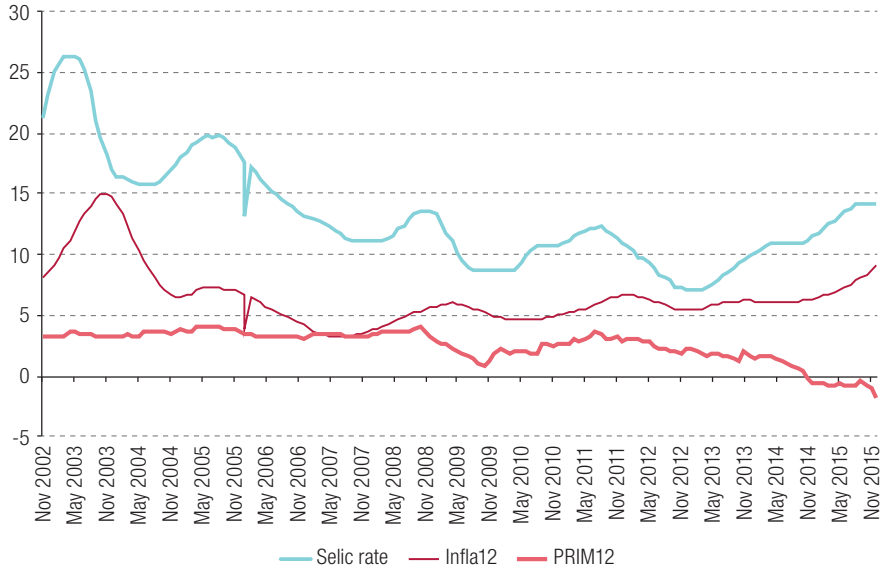
As noted by Sargent and Wallace (1981), in a situation of loose fiscal policy, the adoption of tight monetary policy leads to an increase in the money supply and, thus, higher inflation in the future. The question about how the central bank should administer monetary policy must therefore take into account how fiscal policy is being conducted. The action of the monetary authority can thus be seriously compromised if fiscal policy does not act to ensure public debt sustainability, as appears to be the case in Brazil's fiscal policy since 2013.

The two policies are also seen to have acted passively at the end of fiscal 2003, at the end of fiscal 2004 and in the period 2008–2012 (except 2010). That period is obtained from the intersection between the shaded areas of the graph for regime 2 with respect to the fiscal policy response function and of regime 1 with respect to the monetary policy response function. This means that fiscal policy followed a sustainable path in relation to public debt. In the same period, however, the Central Bank of Brazil did not respond adequately to the increases in the inflation rate. On the basis of table 5 and observing the graphs of the chronology of regimes in annexes A1 and A2, it is apparent that there was fiscal dominance in 2010 and between 2013 and 2014. Monetary dominance obtained for much of 2003 and in the period 2005–2007.

As shown in figure 3, in late 2014 the Brazilian economy began to run primary deficits. This is strongly characteristic of an active fiscal policy and tighter monetary policy in the same period, since the Selic rate[23] rose from 10.92% in October 2014 to 14.15% in December 2015. The results show empirical evidence of active conduct of both monetary policy and fiscal policy in 2015.

[23] The Selic rate is the base rate of interested used by the Central Bank of Brazil as a monetary policy instrument. The data source is the Central Bank of Brazil.

**Figure 3**
Brazil: evolution of the inflation rate, the Selic rate and the primary surplus
(as a percentage of GDP), annualized monthly data, November 2002–September 2015




**Source:** Institute for Applied Economic Research (IPEA).

The Selic rate came down sharply from mid-2003 and during much of 2004, and from the last quarter of 2008 to mid-2009. It then held steady at 8.65% until the first quarter of 2010 (subprime mortgage crisis). From mid-2011 to mid-2013, the Selic declined considerably, in the context of a high rate of inflation, around 6%. Although the interest rate then rose until the end of 2013 and remained relatively stable in 2014, this rise was evidently not enough to slow the inflation rate. This may suggest that monetary policy could have been more active, as these are indications of a passive monetary policy.

The empirical results presented suggest that, in the ex post analysis, there are indications of coordination or attempted coordination between fiscal and monetary policies, as well as signs of lack of coordination between them, especially when there is a clear conflict of interest between the two. As an example of lack of coordination between fiscal and monetary policies, in mid-2013 the Central Bank of Brazil began to reverse its successive cuts in the Selic rate and to gradually increase it to try to reduce inflation. At the same time, the federal government continued to reduce the primary surplus in order to boost economic activity, which put upward pressure on inflation. The results of this conflict of interest between economic policies were recession, fiscal deterioration and high rates of inflation.

# VII. Final remarks

This article has evaluated the monetary and fiscal policies implemented in Brazil in the period between November 2002 and December 2015. In this context, considering that monetary and fiscal policy rules in Brazil may have undergone different regimes, the present study used the Leeper model (1991 and 2005) to establish the chronology of policy rules in terms of their active or passive nature.

Policy rules are estimated by means of a Markov-switching model in which the regimes are generated endogenously. The results support the affirmation that fiscal dominance occurred in 2010 and between 2013 and 2014. Monetary dominance obtained for much of 2003 and in the period 2005–2007. During the rest of the period, monetary and fiscal policies were seen to be conducted sometimes actively (2015) and sometimes passively (end-2003, 2004, 2008, 2009, 2011 and 2012).

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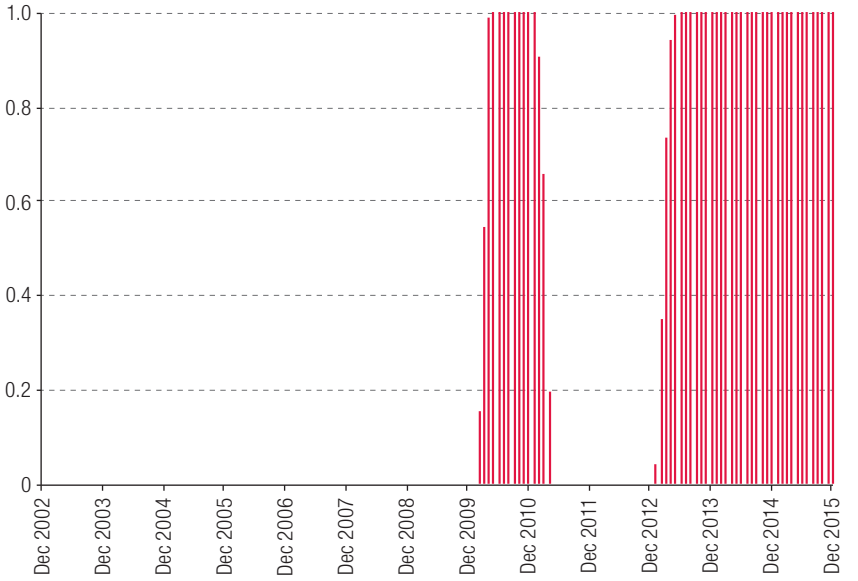
# Annex A1. Fiscal response function

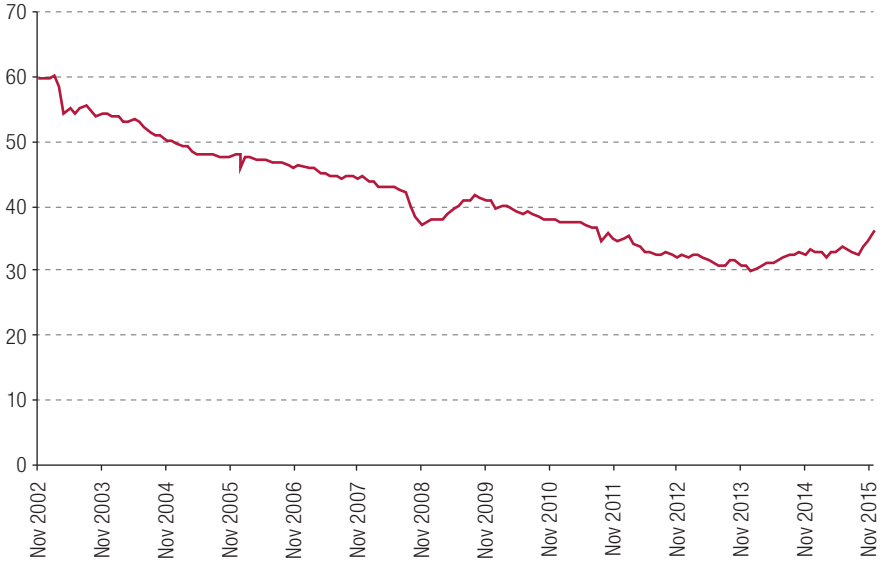
## Smoothed probability of regimes

**Figure A1.1**
Regime 1



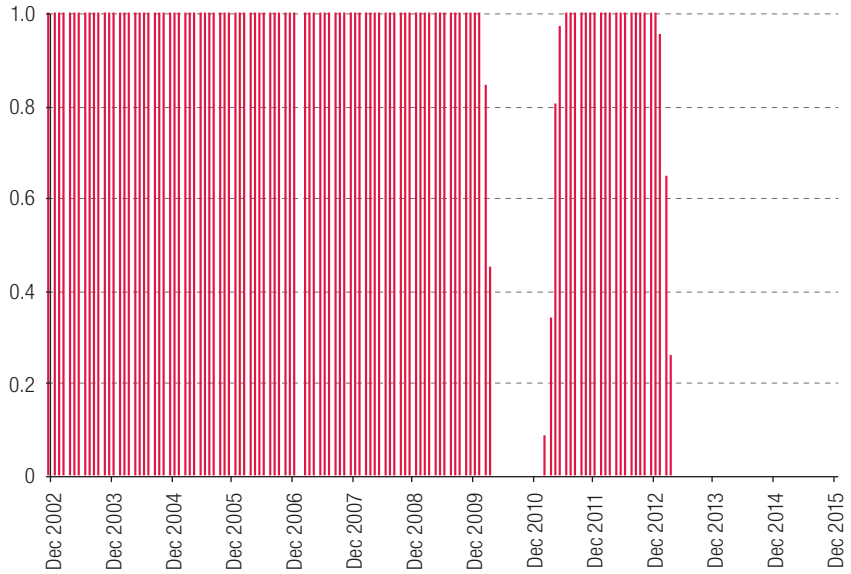

**Source:** Prepared by the authors.

**Figure A1.2**
Public sector net debt
*(Percentages of GDP)*




**Source:** Prepared by the authors.

**Figure A1.3**
Regime 2

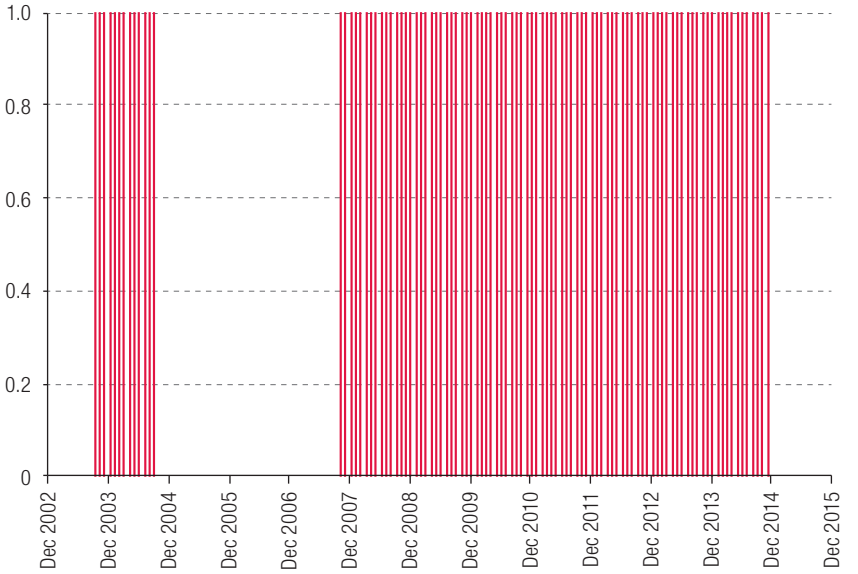



**Source:** Prepared by the authors.

# Annex A2. Monetary response function

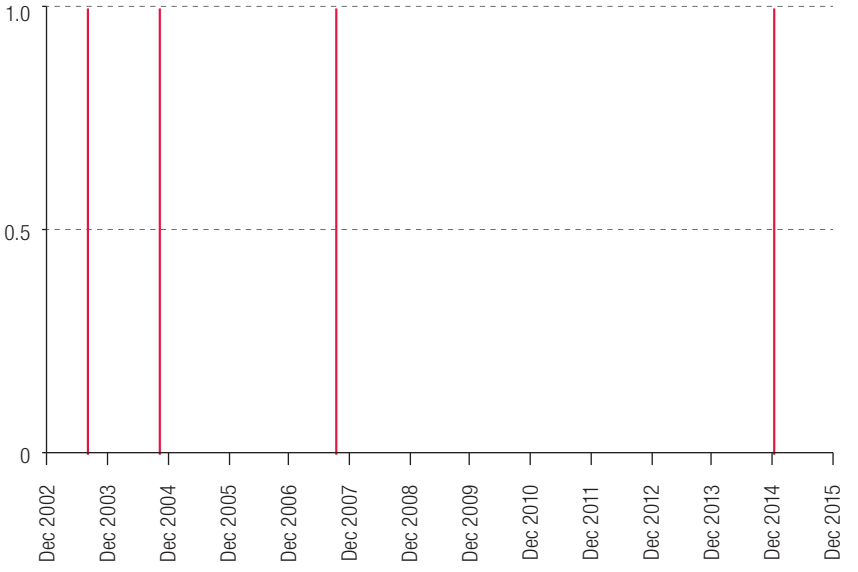
## Smoothed probability of regimes

**Figure A2.1**
Regime 1



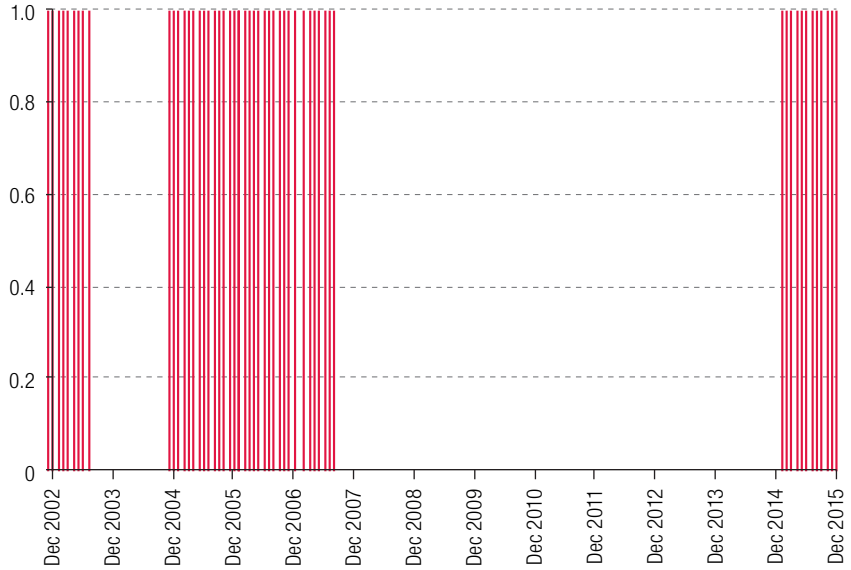

**Source:** Prepared by the authors.

**Figure A2.2**
Regime 2




**Source:** Prepared by the authors.

**Figure A2.3**
Regime 3




**Source:** Prepared by the authors.

**Figure A2.4**
Inflation
*(Percentages)*


**Source:** Prepared by the authors.