Difference-in-Pay Leave AY 2015-16

Final Report and Assessment

Claudio Paiva

Proposed Activities

My approved proposal for difference-in-pay leave to be taken at the University of Illinois during AY 2015-16 listed as main expected results:

I. Preparing and finalizing one research paper

II. Collecting the data and performing preliminary empirical analyses for a second paper

III. Participating in the seminar series of the Lemann Institute for Brazilian Studies

IV. Meeting with the leadership of the Economics Department of the University of Illinois to learn about curriculum development and learning assessment activities.

Outcomes

All proposed activities were successfully completed and, in some cases, performance exceeded the proposal as follows:

I. The paper "Deconstructing Credibility: The Breaking of Monetary Policy Rules in Brazil," co-authored with Illinois PhD candidate Gustavo Cortes, was concluded and has already been revised and resubmitted to the Journal of International Money and Finance (Appendix 1). Ironically, as the paper was being concluded, Brazilian president Dilma Rousseff was impeached for breaking the fiscal responsibility law, a variant of the political interference in economic institutions that this paper addressed.

II. Data covering 26 countries was collected and preliminary statistics were obtained for testing my previously published model of electorally-motivated cycles in regulated prices. Preliminary findings suggest the possibility that some governments tend to reduce the price of gasoline and electricity as elections approach. The University of Illinois purchased the dataset for me, and an undergraduate economics student volunteered to perform the data processing and preliminary statistical analysis.

III. I attended various seminars at the Lemann Institute, and was invited by its director to represent the economics department in an inter-disciplinary session about the impeachment of now former president Dilma Rousseff. My presentation was partially based on the research paper described in item (i) above (Appendix 2).

IV. I met several times with the chair of the economics department and the director of the undergraduate program to discuss curriculum development and learning assessment. The basic message I heard from both was that:
    - courses and degree structure have been stable for many years and follow best practices in the major economics department in the country

- the department trusts the faculty they hire are experts in the field and, as such, will deliver the appropriate learning outcomes they define
- confidential, in-class student evaluations of the course are carried out for all courses
- the department pays considerably more attention to monitoring the performance of students, including by flagging students who earn less than a B in foundational math courses; requesting grade feedback for those flagged students from professors during the semester; and requiring those students to meet regularly with one of the staff advisors in the economics department to discuss their academic performance. The idea here being that neither students nor the department should be surprised when students fail a class.
- the department monitors job or graduate school outcomes for its former students, and those validate the appropriateness of the department's strategy

Additional Activities and Outcomes

In addition to the activities listed in my official proposal and their respective outcomes listed above, I engaged in the following activities and obtained the following outcomes:

- I taught a senior undergraduate course on "Macroeconomic Policies" and a required Master's course on "Monetary Policy." Both courses built on my IMF policy and CI teaching expertise, and benefitted from the extensive library resources at the University of Illinois. Most newly developed material will be incorporated into my CI courses. Both courses taught at Illinois received very high student evaluations (4.9 and 4.7 out of 5) and appeared among the best-rated courses that semester.

- At the request of the University of Illinois, I served as co-organizer of a conference in honor of Professor Werner Baer, my former advisor, who died unexpectedly during my stay.

- At the request of the economics department, I helped deliver the final lectures in Professor Baer's course on Latin America's economic development.

- Interaction with other visiting scholars resulted in my arranging for a Fulbright Scholar from Bulgaria to visit CI last year. The same scholar offered to help organize and host a CI student trip to his university, the largest and most traditional in Bulgaria. Talks are ongoing.

- I participated in more than 5 seminars presented by PhD candidates concentrating in macroeconomics, being exposed to new trends in this research field and providing my input and suggestions when appropriate.

- I wrote 4 letters of recommendation to undergraduate and graduate students who ended up accepted at master's programs in the US and a PhD program in the UK.

- I was invited to return next summer to teach another course and provide input for curricula improvement in the Master of Science in Policy Economics.

Appendix 1

Deconstructing Credibility:

The Breaking of Monetary Policy Rules in Brazil

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Abstract

Can political interference deconstruct credibility that was hardly-earned through successful stabilization policy? We analyze the recent switch in the conduct of monetary policy by the Central Bank of Brazil (BCB). Brazil is the largest Emerging Market Economy to formally target inflation, having adopted the Inflation Targeting (IT) regime in 1999. In the early years of IT, the BCB engaged in constructing credibility with price setting agents and succeeded to anchor inflation expectations to its target even under adverse conditions such as exchange rate crises. We argue that this effort to maintain IT rules-based policy ended in 2011, as a new country president and BCB board came to power. We then discuss the consequences of this credibility loss. Our main results can be summarized as follows: (i) we provide strong empirical evidence of the BCB's shift toward looser, discretionary policy after 2011; (ii) preliminary evidence suggests that this shift has affected agents' inflation expectations generating social and economic costs.

Keywords: Monetary Policy, Inflation Targeting, Credibility, Emerging Market Economies, Brazil
JEL Classification: E50, E52, E58

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One basic task of the Central Bank of Brazil has been to build credibility as a monetary authority committed to price stability in the context of large inflationary shocks. This requires actions consistent with the inflation-targeting framework combined with high levels of transparency and communication with the public.

— Minella, Freitas, Goldfajn, and Muinhos (2003), In: "Inflation Targeting in Brazil: Constructing Credibility under Exchange Rate Volatility."

1. Introduction

The Central Bank of Brazil (BCB) has formally followed an Inflation Targeting (IT) Regime since 1999. Even under adverse conditions such as heightened exchange rate volatility in the early 2000s, the BCB was able to keep inflation expectations in check, construct credibility with price-setting agents, and significantly lower inflation. A textbook example of good economic policy, the Brazilian experience with inflation targeting is seen as a successful case study among Emerging Market Economies (EMEs) (Agénor and Pereira da Silva, 2013). The BCB's success in taming inflation and building credibility has been discussed in the pioneering article by Minella et al. (2003) and later by Aragón and Medeiros (2015), among others. Both studies estimate the reaction function of the BCB and conclude that it followed the *Taylor principle* (Taylor, 1993) in reacting more than proportionally to deviations of inflation expectations from the target. By doing so consistently, the BCB ended up establishing good reputation with price-setting agents and gradually making the official inflation target an effective anchor for inflation expectations, as shown by Bevilaqua et al. (2008).

A source of concern for monetary policy in EMEs is that hardly-earned credibility may be reverted due to changes in political preferences of elected governments. In the case of Brazil, this is of special significance since the Central Bank does not possess full and formal independence from the executive branch of the government. This increases the importance of the Central Bank to remain consistent in enacting policy rules to keep inflation expectations aligned with the target, especially after a government transition.

Policy-makers in EMEs may need to exert a relatively higher effort than their peers in Advanced Economies to construct credibility, i.e. convince market agents of their resolve to consistently pursue an inflation target above all other policy objectives. The need for higher effort to construct credibility is mainly due to weaker institutions of EMEs, which favor the perception that rules may be broken by political interference (Mishkin, 2008, 2004; Fraga et al., 2004; Calvo and Mishkin, 2003). An obvious consequence of this disadvantage in EMEs is that shifts toward discretionary behavior can quickly

erode confidence, destabilize expectations, and deconstruct credibility. In other words, the long-run efforts from past administrations to increase macroeconomic stability and to enhance the credibility of policy-making institutions could be wasted due to a new administration with different, non-stabilizing objectives.

In this paper, we analyze evidence of credibility deconstruction in Brazil, the largest emerging economy formally adopting IT. Our analysis begins with some background on how the BCB succeeded in introducing and consolidating IT and managing inflation expectations until altering its behavior following the election of President Dilma Rousseff. We argue that the new administration, which changed in the entire Board of Governors of the BCB as it came to power in 2011, reversed a long-term effort of credibility construction in Brazil dating back to the 1990s. Based on the results of a simple theoretical model showing that credibility deconstruction bears welfare costs, we empirically analyze the problem by applying standard Markov-Switching Regression techniques to detect changes in the forward-looking reaction function of the BCB. We argue that the BCB switched toward an excessively loose monetary policy regime during the starting year of the first Rousseff administration (2011-14) and remained in this excessively *dovish* regime throughout most of that period.

Having detected a policy regime change through the Markov-Switching exercise, we then use Taylor Rule estimations to confirm and assess the magnitude of BCB's deviations from past behavior. We first restrict our sample to the period before President Rousseff in order to capture the standard inflation-targeting behavior of the BCB and use these parameters to predict the policy interest rate (SELIC) during 2011-14. This exercise allows for a comparison between the actual SELIC rate and its counterfactual, i.e. the SELIC that would have prevailed had the BCB maintained its previous monetary policy strategy. We find that deviations from the Taylor principle accumulated throughout the 2011-14 period and widened the gap between the counterfactual, Taylor Rule-predicted interest rates and the actual SELIC rate. The degree of undershooting of the SELIC implied by the different models ranges from about 3 3/4 percentage points to 4 3/4 percentage points. The results are shown to be robust to alternative model specifications and estimation techniques.

We conclude our results with an empirical counterpart of the theoretical prediction that interrupting credibility-building policies bears social welfare costs in the form of higher inflation and product volatility. We find preliminary evidence that the dovish bias of monetary policy during Rousseff's first term contributed to a deterioration in inflation expectations and dynamics, which have become more sensitive to inflationary shocks. Moreover, we calculate widely used macroeconomic loss func-

tions (e.g. Okun's *Sacrifice Ratio*) to show how actual inflation and unemployment have deteriorated sharply following the policy regime change under President Rousseff. [1] More specifically, loss functions recorded their worst performance in 12 years, with both inflation and unemployment reaching double digits in 2015-16. Finally, we argue that this result is not an artifact of a general worsening of global economic conditions, but rather of domestic economic policy mismanagement. A comparison with the median macroeconomic loss function of the G20 countries show that Brazil has widened the gap toward worse macroeconomic conditions.

This paper's contributions to the literature fall into two main categories. First, we add to the empirical literature of the BCB's reaction function and its impact on inflation dynamics. Our strategy incorporates the critique in Siklos and Wohar (2005) by estimating a Vector Error-Correction Model (VECM) in order to account for the presence of stationary and non-stationary time series. While our baseline results are generally consistent with previous estimates of the Brazilian Taylor Rule, we identify a regime change and a break in the behavior of the BCB that took place within a broader context of heightened economic interventionism ushered in by President Rousseff's ascension to power in 2011.

Second, to the extent that our paper shows the risks and costs of political interference in rules-based monetary policy, it could be viewed as a case study for the importance of Central Bank Independence (CBI). Since at least the work of Cukierman et al. (1992), it is generally accepted that CBI is negatively correlated with inflation rates across countries. Acemoglu et al. (2008) refined this argument by conditioning the success of CBI reforms to the development level of preexisting institutions. More specifically, they show that while CBI reforms reduced inflation in countries with intermediate constraints to politicians, it had no or little effect in countries where constraints were strong or weak.[2] Because Brazil is not in either extremes and is rather a typical emerging country in an intermediate level of institutional development, our results may provide additional arguments for the possible benefits of formal CBI. [3]

[1] For an application of similar loss functions for the Federal Reserve Bank, see Nikolsko-Rzhevskyy et al. (2014).

[2] A good example to illustrate their idea is the following: few people would expect CBI to have fundamental effects in Zimbabwe as long as dictator Robert Mugabe is in power. On the other hand, one would not expect a society with a functioning system of accountability and with checks on politicians to be pursuing highly distortionary policies in the first place. For example, inflation was already low in the UK before the Bank of England became independent in 1998. Thus room for a large effect from CBI was limited (Acemoglu et al., 2008).

[3] Indeed, this lesson might have been learned by some politicians in Brazil, for the recent years have seen an increase in the number of parliamentary debates about the formal independence of the BCB. One example is the Constitutional Amendment Project (PEC) 43/2015 presented by Brazilian senators in April 2015. The project intends to establish non-coincident fixed mandates of 4 years for the members of the BCB Board of Governors, and transfers the power to dismiss the Governor or Deputy Governors from the Executive branch to the Senate.

The paper is organized as follows. In Section 2, we describe the background of the credibility deconstruction undertaken by the Brazilian monetary authority. In Section 3, we briefly present a simple model based on the Barro and Gordon (1983) framework to derive the main theoretical implications from the discretionary behavior of a Central Bank. Inspired by the suggestive evidence and the predictions from the model, we tackle a formal empirical analysis of the problem in Section 4 through Markov-Switching regressions and Taylor Rule estimations. Section 5 presents preliminary empirical evidence on how discretionary deviations have affected macroeconomic welfare loss functions and the BCB's credibility. Section 6 concludes.

2. Background and Characterization of the Problem

2.1. Anecdotal Evidence

Despite advocating for a continuation of President Lula da Silva's policies during her presidential campaign, Dilma Rousseff fostered a growing perception about her more interventionist style as soon as ascending to power in 2011. At the onset of President Roussef's administration, market agents did not have major concerns about government intervention in macroeconomic policy. [4] The introduction of a new BCB Board (Governor and Deputy Governors) seemed routine, as newly appointed members of the Board were viewed as highly qualified economists with previous experience in academic, financial, and policy-making institutions. Things began to change by the second half of 2011, when the BCB unexpectedly embarked in an aggressive cycle of monetary easing despite inflation expectations being persistently above the target. At this point, concerns that government intervention had reached the monetary authority started to show up. For example, commenting on the interest rate cut of 50 basis points in Sep 2011, Alberto Ramos, the Chief Strategist for Latin America of Goldman Sachs affirmed that *"the Central Bank's mentality has changed."* [5] Two months later, Alexandre Schwartsman, a former Deputy Governor of the BCB wrote in an op-ed column that the Central Bank was mistakenly lowering interest rates given the macroeconomic fundamentals and engaging in unusual behavior with respect to its history. [6]

[4] In fact, the candidate Dilma Rousseff campaigning in May 2010 criticized her opponent José Serra for affirming that *"the Central Bank is not the Holy See,"* when he argued that the BCB made mistakes during the 2008-09 crisis. Then candidate Rousseff rebuked her opponent by defending the operational autonomy of the BCB under the government of President Lula da Silva (2003-10) and was perceived by financial newspapers and analysts as the candidate more identified with the non-interference of monetary policy. (cf. Estado de São Paulo, May 10th, 2010, *"Autonomia do Banco Central é 'importantíssima', afirma Dilma."*)

[5] See Valor Econômico, Sep 2nd, 2011, "Corte de Juros quebrou 'Liturgia'." Translated by the authors from the original in Portuguese: *"a cabeça do Banco Central mudou."*

[6] See Alexandre Schwartsman, Valor Econômico, Dec 1st, 2011. *"O 'Erro' de 2008 e o Erro de 2011."*

By the end of 2012 and beginning of 2013, some segments of the specialized economic media and market analysts had already consolidated the perception that the interventionist style of President Rousseff was behind the change in behavior of the BCB. Even analysts politically connected to the Rousseff government later boasted openly in the press that President Rousseff's actions with respect to the BCB represented a *"disposition to fight financial speculators"* and that *"lowering the interest rates was an act of courage."* [7] This paper aims at providing a more technical and empirical complement to the abundant anecdotal evidence of the BCB's deviation from its inflation-targeting rule under President Rousseff.

2.2. Preliminary Statistical Analysis

Visual inspection of the time series of inflation expectations for 12 months ahead minus the inflation target for the same period – the so-called *Expected Inflation Gap* – in Figure 1 shows that the sharp reduction in the SELIC in 2011-13 took place while inflation expectations were persistently above the inflation target and trending up. To put in perspective the unusual behavior of the BCB, expected inflation had been above the inflation target for 32 consecutive months when the SELIC was reduced to its lowest level in more than 10 years. Perhaps unsurprisingly, inflation expectations thus remained above the target each month of President Rousseff's entire term in office, in sharp contrast to the earlier period.

The hovering of inflation gap around zero and within the tolerance band until 2011 suggests a perception among economic agents that the BCB was following the stabilizing *Taylor Principle*. As a simple but rather intuitive evidence suggesting a change of BCB's inflation-targeting behavior after Rousseff's election, we use monthly data to compute Cholesky Impulse-Response Functions (IRFs) generated from a 2-variable Vector Autoregression (VAR) with the interest rate and the Expected Inflation Gap in first differences. The IRFs in Figure 2 show that the interest rate responded significantly to increases in the Expected Inflation Gap during 2001M1-2010M12, but that response all but disappeared during 2011M1-2014M12.

The change of behavior in monetary policy was accompanied by more interventionism in other fronts, such as price and tariff controls. The Rousseff administration pushed aside regulatory agencies to enact significant energy price reductions. These measures included keeping domestic gasoline prices

[7] See e.g. André Singer, Folha de São Paulo, Jan 4th, 2014, *"Armadilha Lulista."* and L.C. Bresser-Pereira, Novos Estudos v.95, March 2013, *"O governo Dilma frente ao tripé macroeconômico e à direita liberal e dependente."*

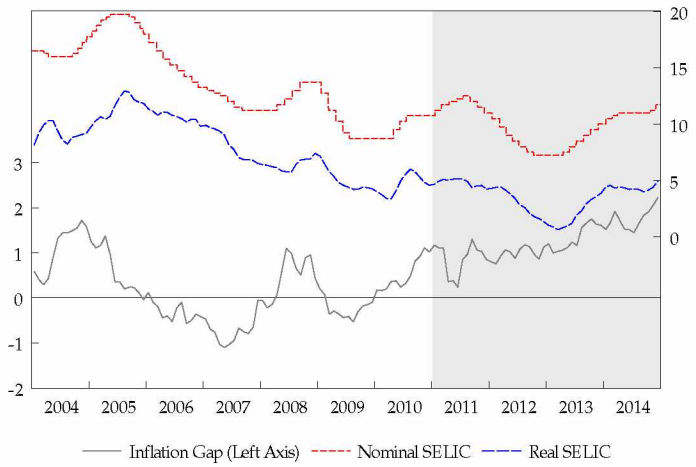

Figure 1. The BCB's Policy Rate: Nominal and Real SELIC Interest Rate. *This figure presents the time-series of the SELIC Interest Rate (Nominal and Real) and the Expected Inflation Gap in Brazil. The shaded area denotes the period of President Dilma Rousseff's first administration.*

artificially below international levels, and lowering electricity tariffs by 16% for households and up to 32% for businesses. As a consequence, the balance sheets of the nationally-owned oil (Petrobras) and electricity (Eletrobras) companies suffered considerable deterioration. This was only part of a generalized effort to repress inflation by fiddling with government-regulated prices, which experienced an average decline of 9% in real terms during 2011-14.

Other government strategies suggested growing interventionism with little regard for its potential impact on inflation and overall economic efficiency, such as the sharp increase in the share of domestic credit given by public banks at subsidized interest rates. Under President Rousseff, the share of public lending increased by more than 20 percentage points, reversing a decades-long downward trend and reaching 57% of total bank credit by the end of 2014.[8] The BNDES Development Bank arguably acted as a parallel policy institution during the Rousseff years, and its active role in the subsidized credit market had spillovers on both fiscal and monetary policy variables, triggering criticism about its excesses.[9]

Anecdotal evidence and preliminary analysis of the data gives us reasons to suspect a discretionary change in the BCB's monetary policy orientation under a broader context of heightened government

[8] Private banks increased their share in total lending since the late 1980s and early 1990s with the rise of privatizations in Brazil (Baer and Nazmi, 2000). Figure B.1 on the Online Appendix plots the historical time series of the public sector's share on total bank credit.

[9] See De Bolle (2015) for an assessment of the impacts of BNDES on the Brazilian economy in the recent years.

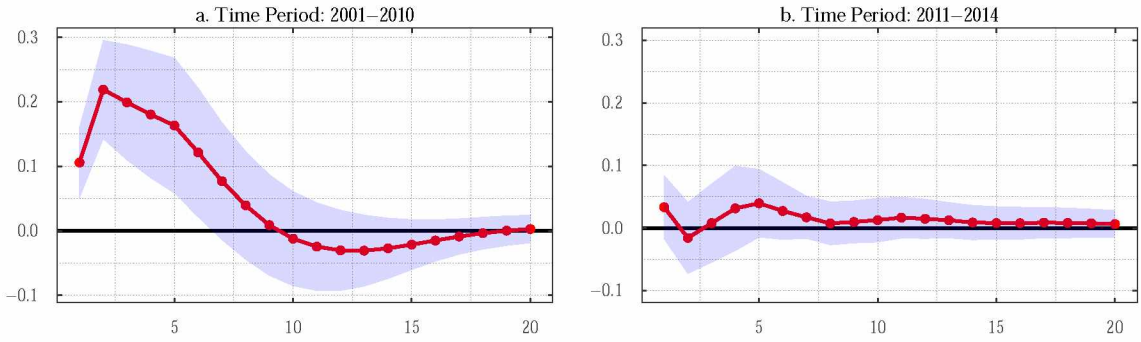

Figure 2. Impulse-Response Functions of SELIC Interest Rate to a Cholesky shock on Expected Inflation Gap. *These figures plot Impulse-Response Functions (IRFs) of the SELIC Interest Rate to a One Standard Deviation shock in the Expected Inflation Gap. The area represents 95% confidence intervals. The left-hand-side panel refers to the pre-2010 period, before the first administration of president Dilma Rousseff. The right-hand-side panel refers to the post-Rousseff period.*

interventionism after 2011. The departure from an established and credible rules-based monetary policy toward discretionary (and perhaps opportunistic) behavior can lead to significant welfare costs, as demonstrated by a simple model of dynamic inconsistency presented below. These welfare implications motivate our search for evidence of a break in BCB's reaction function under President Rousseff and its ensuing negative impact on economic performance as illustrated by various loss functions.

3. A Simple Model

We present a simple model of Central Bank behavior that incorporates the features of credibility construction and deconstruction built upon the classical Barro and Gordon (1983) time-inconsistency model. It shows that deviating from the rules-based equilibrium (deconstructing credibility) is not socially optimal. For conciseness, what follows is a very brief discussion of the model's setup and main implications. The interested reader can find a detailed derivation of the model along with a numerical exercise in the Online Appendix.

3.1. Background

There are two agents: the Central Bank and the Public. The Public consists of agents concerned with price/wage setting in an economy. One can think of labor unions "choosing" inflation expectations when negotiating wages and contracts for a certain year. Assume this economy satisfies a simple Phillips Curve: $\pi_t = \pi_t^E - \alpha\left(\mu_t - \mu_t^N\right)$, where π_t is the inflation rate, π_t^E is the expected inflation rate, μ_t is the unemployment rate at period t, and μ^N is the natural unemployment rate. In each period t, the Public chooses the expected inflation rate and the Central Bank chooses the actual

inflation rate of the economy. Because other terms (α, μ^N) are just parameters, the choices of π_t and π_t^E end up determining the level of unemployment μ_t in that period by the Phillips Curve. Assuming rational expectations, the Public makes its decision on expected inflation by maximizing its objective function: $U_t^P = -\mathbb{E}_t \left(\pi_t - \pi_t^E\right)^2$.

The Public seeks to minimize its loss function by matching the expected inflation to the actual inflation each period. The loss function's quadratic form penalizes when missing either by positive or negative deviations from the actual realization of inflation. Similarly, the Central Bank seeks to minimize a loss function, or alternatively, maximize a utility function given by $U_t^{CB} = -\lambda \left(\mu_t - \mu^N\right) - \frac{1}{2}\left(\pi_t - \pi^*\right)^2$, where the parameter $\lambda > 0$ indicates the preference of the Central Bank toward a lower-than-natural unemployment rate, and π^* represents the inflation target, which we assume to be zero for simplicity.

We assume a one-period nominal wage rigidity with nominal wages being set at the beginning of each period and inflation realized after the contract is signed. [10] The first movement is made by the Public, choosing expected inflation at the time of negotiating nominal contracts. The Central Bank then observes the Public's expected inflation and chooses the unemployment rate, thereby determining the actual inflation rate. [11]

3.2. One-Period Equilibrium

In equilibrium, the Central Bank maximizes its utility function subject to the Phillips Curve. Replacing the Phillips Curve expression into the Central Bank's Utility, we get the following objective function: $U^{CB} = \lambda \left[-\frac{1}{\alpha}\left(\pi_t - \pi_t^E\right)\right] - \frac{1}{2}\pi_t^2$. The first order condition for the optimal choice of inflation taking π_t^E as given is: $\pi_t^* = \frac{\lambda}{\alpha}$.

Given that parameters λ and α are both strictly positive, we have an equilibrium with non-zero inflation. Since we assume perfect information, the Public also knows the Central Bank's preferences and therefore sets $\pi_t^E = \lambda/\alpha$, fully anticipating the inflation rate. Under this discretionary equilibrium, the Central Bank achieves a utility level of $U_t^{CB} = -\lambda^2/2\alpha^2 < 0$. If the Central Bank could commit to deliver a zero inflation rate, the Public would then also match expectations by setting $\pi_t^E = 0$.

[10] This means that wages cannot be renegotiated after the realized inflation rate is observed and once workers negotiate wages based on their inflation expectation, they are locked into the initial nominal contract until the beginning of next period. A consequence of this feature is that there are possibilities for employment expansion whenever the inflation rate exceeds expected inflation: real wages will be relatively cheap and firms will hire more workers, decreasing unemployment. By the same token, if actual inflation is less than expected inflation, real wages rise, firms hire less, and unemployment increases.

[11] The timing of the model allows the Central Bank to have *perverse* incentives to inflate and surprise the Public by acting differently from what the Public expected when writing their contracts under a certain expected inflation.

This would give the Central Bank a utility of $U_t^{CB*} = 0$. Therefore, $U_t^{CB*} > U_t^{CB}$. [12] To incorporate the possibility that a Central Bank delivers the optimal outcome, with credibility building driving the Public's expectations toward the committed target inflation, the model needs to be extended over infinite periods.

3.3. Infinite-Period Equilibrium

Now assume agents maximize an infinite stream of utilities given by their respective utility functions. The Public thus maximizes: $V^P = \sum_{s=0}^{\infty} \beta^s \mathbb{E}_t \left(U_{t+s}^P\right)$, where $\beta \in (0,1)$ is a time discount factor. Similarly, the Central Bank maximizes: $V^{CB} = \sum_{s=0}^{\infty} \beta^s \mathbb{E}_t \left(U_{t+s}^{CB}\right)$.

Additionally, we introduce reputation in the game through the behavior of the Public. Let the new preference of the Public be given by a trigger strategy as follows: $\pi_t^E = \underline{\pi} < \frac{\lambda}{\alpha}$ if $\pi_{t-1} = \pi_{t-1}^E$; and $\pi_t^E = \frac{\lambda}{\alpha}$, if $\pi_{t-1} \neq \pi_{t-1}^E$. That is, if the Central Bank delivered actual inflation equal to the expected inflation in the previous period, the Public expects an equilibrium inflation rate denoted by $\underline{\pi}$ which is lower than the discretion equilibrium inflation λ/α by definition. However, if the Central Bank "cheats" by delivering a different inflation rate, the Public punishes the Central Bank by choosing the high inflation rate of the discretion equilibrium in the following period.[13] This is the reason why reputation matters for the Central Bank: as compensation for behaving as promised, it gets lower inflation in equilibrium. We assume that the punishment happens for one period only, i.e. if the Central Bank decides to reconstruct credibility at t after having cheated at $t-1$, the Public will set the low inflation again at $t+1$ as a reward. Hence, the model deals with both construction and deconstruction of credibility in a very simple fashion.

3.4. The Welfare Costs of Deconstructing Credibility

One of the main predictions stemming from the model is that more short-sighted Central Banks that care less about the future should have more incentives to deviate from the low-inflation equilibrium. We illustrate the consequences of these perverse incentives by conducting a simple welfare analysis: how costly can the deviation of a Central Bank be for society?

[12] In words, society would be better off if the Central Bank was able to commit credibly to zero inflation, or more broadly to a certain inflation target. If this is not possible, then the economy is stuck in a high-inflation equilibrium without employment gains.

[13] There are multiple ways to model the Public's punishment to a deviation undertaken by the Central Bank. We use this one-period trigger strategy for the sake of simplicity. The theoretical predictions we want to emphasize are essentially the same if we had used a multi-period trigger strategy or any similar strategy that punishes the Central Bank by even more than in the one-period trigger.

Consider the following sequence of events: (i) the Central Bank builds credibility up to a period $s < t$; (ii) it then deviates at period t and gets punished at period $t+1$; (iii) finally, it reconstructs credibility at $t+2$ and remains in this equilibrium forever. Define the Social Welfare Function in the case of collaboration as $W \equiv \sum_{s=0}^{\infty} \left(U_{t+s}^{CB} + U_{t+s}^{P}\right)$ and the Social Welfare Function in case of deviation be defined as W^D, for which the only difference between W^D and W is that in periods t and $t+1$ there are different payoffs due to deviation from the Central Bank and punishment from the Public. The following proposition shows that deviation is socially inefficient.

Proposition 1 (Social Inefficiency of Central Bank Credibility Deconstruction)**.** *Credibility Deconstruction by the Central Bank, as measured by a deviation from a low inflation equilibrium to the pure discretionary equilibrium, is not socially efficient.*

Proof. See Online Appendix A. □

A final remark we can draw from Proposition 1's proof is that social costs are maximized as $\beta \to 1$. Even in the limit when $\beta \to 0$, we still have positive social costs because the welfare function also accounts for the loss of utility by the Public, which is unambiguously worse off in the case of deviation.

4. Empirical Analysis

Our empirical strategy begins with a brief review of Taylor Rules and their use in the monetary policy literature in Subsection 4.1. We then specify our empirical model in Subsection 4.2 and describe the data in Subsection 4.3. We present the results of a Markov-Switching analysis in Subsection 4.4, and of Taylor Rules estimation in Subsection 4.5. Finally, we provide a critical assessment of our results and discuss them along with alternative explanations for the BCB's deviation in Subsection 4.6.

4.1. A Brief Review of Taylor Rules Estimation

Taylor Rules or, more broadly, monetary policy reaction functions have been extensively used in academic and policy papers to investigate how a Central Bank adjusts the policy interest rate according to its objectives and economic conditions. In its original formulation, the Taylor (1993) rule was given by the following functional form:

$$i_t^* = \pi_t + r^* + 0.5\left(\pi_t - \pi^*\right) + 0.5\left(y_t\right) \tag{1}$$

where i_t^* is the target (desired) level of the short-term nominal interest rate, π_t is the inflation rate, r^* is the (unobserved) equilibrium real interest rate, π^* is the inflation target, and y_t is the output gap. The two values multiplying the actual inflation gap (i.e., the difference between realized inflation and the implicit or explicit inflation target) and the output gap were assumed to be constant and equal to each other. An implication of this rule is that the Central Bank balances its assessment about inflation and unemployment developments when deciding about the interest rate each period. Later, the weights given to each component of the preference function of the Central Bank were generalized as:

$$i_t^* = \pi_t + r^* + \beta_{1,t}\left(\pi_t - \pi^*\right) + \beta_{2,t}\left(y_t\right) \tag{2}$$

where $\beta_{1,t}$ and $\beta_{2,t}$ can differ from the original values proposed by Taylor (1993) and can be time-varying. Moreover, because most Central Banks usually display preferences for a gradual adjustment of the interest rate (i.e. interest rate smoothing), the actual level of the interest rate will move toward the desired i_t^* rate according to:

$$\Delta i_t = \gamma\left(i_t^* - i_{t-1}\right) + \left(1-\gamma\right)\Delta i_{t-1} \tag{3}$$

Combining (2) and (3) yields:

$$\Delta i_t = \gamma\left(r^* - \beta_1\pi^*\right) - \gamma\left[i_{t-1} - \left(1+\beta_1\right)\pi_t - \beta_2 y_t\right] + \left(1-\gamma\right)\Delta i_{t-1} \tag{4}$$

which empirically would be equivalent to an error-correction formulation that captures how the Central Bank's desired policy interest rate responds to inflation and the output gap (in the term inside brackets), and how quickly the Central Bank adjusts actual rates toward that desired level.[14]

Expressing Taylor Rules in error-correction formulations may serve the dual purpose of capturing the monetary authorities' preference for gradual interest rate adjustments and being compatible with data sets that may include stationary and non-stationary series. [15] Siklos and Wohar (2005) criticize the high number of studies that ignore the statistical properties of the data, likely to include

[14] The term $\gamma\left(r^* - \beta_1\pi^*\right)$ would be estimated as the constant term in the regression equation, and its breakdown could not be determined without further assumptions. See for instance Judd and Rudebusch (1998).

[15] Examples of different error-correction formulations applied to the analysis of monetary policy reaction functions include Judd and Rudebusch (1998) and Clausen and Meier (2005).

non-stationary series, and recommend that in some cases it would be more appropriate to estimate and analyze Taylor Rules accounting for a potential co-integration relationship in an error-correction model.

The thinking around Taylor Rules was later refined to include forward-looking central banks that would react to the expected path for inflation and possibly to current or expected output gaps. This change has been justified on the basis that a Central Bank may focus on the future path expected for these variables, a path that the monetary authority is still capable of affecting. A forward-looking reaction function would have the general form:

$$\Delta i_t = \gamma\,(r^* - \beta_1 \pi^*) - \gamma\,[\; i_{t-1} - (1+\beta_1)\,\mathbb{E}_t(\pi_{t+k}) - \beta_2 \mathbb{E}_t(y_{t+n})\;] + (1-\gamma)\,\Delta i_{t-1} \tag{5}$$

where $\mathbb{E}_t(\cdot)$ is the expectation operator at time t and $k \geq 1$ and $n \geq 0$ reflects the relevant time horizon of a forward-looking Central Bank. Besides, recognizing the usual lags in the effects of monetary policy decisions, the forward-looking specification has the advantage of allowing variables other than inflation and the output gap to affect expectations and thus be indirectly considered by the Central Bank reaction function.

Two main strategies have emerged from influential strands of the literature to capture the forward-looking behavior of Central Banks. Clarida et al. (2000) use revised, actual inflation data and output gap estimates based on revised, actual GDP data as instruments for the forecast of inflation and output gap k and n periods ahead in equations estimated using the Generalized Method of Moments (GMM). The moment-condition structure of the GMM estimator alleviates concerns with the endogeneity between the policy rate and future values of inflation and economic activity and the use of revised data – which contain information available to the Central Banker only in the future. Alternatively, Orphanides (2001) proposes utilizing *real time* data with the actual forecasts for inflation and the output gap that were available to policy makers at the time interest rate decisions were made, in which case the models can be estimated through Ordinary Least Squares (OLS).

There are some conceptual differences from the traditional Taylor Rule models estimated for the US and most European countries as compared to countries like Brazil and other *inflation targeters*. In the Brazilian case, the central bank has formally targeted inflation during the period of interest and, as such, inflation targets for the relevant policy horizon are explicitly determined. Therefore, other possible objectives of monetary policy should be considered less relevant, at least officially.

The literature on the empirical reaction function of the BCB dates back to the seminal article of Minella et al. (2003). These studies have generally found a low response to the output gap and a high (though varying) response to inflation. For instance, Aragón and Medeiros (2015) used data from 2000:M1 to 2011:M12 to estimate forward-looking reaction functions for the BCB with time-varying parameters. Among their main findings is that even though the BCB tended to increase the SELIC more than proportionally to an increase of inflation expectations above the inflation target (i.e. following the Taylor Principle), this response declined sharply during 2010M9-2011M12 and may have even turned negative at the end of this period. A similar qualitative result was obtained by Gonçalves (2015), who used data from 2000:Q1-2014:Q4 and Bayesian VARs to estimate the parameters of a 3-equation model and argued that the SELIC was set below its neutral value in 2010, 2012, and 2013. The author also employed simple correlation analysis to present preliminary evidence that inflation tends to increase in periods following this undershooting of the SELIC rate.

Our paper builds on and contributes to this evolving literature in different ways. First, we follow the theoretical model presented earlier and consider that major and lasting changes in the orientation of monetary policy are likely to be connected to a change in preferences brought about by a new administration. We argue that the political change is likely to be the main determinant of Brazil's monetary policy deviation rather than the fine-tuning policy strategies of the same administration over time. As such, we propose to compare the behavior of the Central Bank under two distinct periods, before and during President Rousseff's first term in office. Second, we apply different econometric techniques to estimate various specifications of the reaction function: (i) backward-looking formulations, with and without the exchange rate among regressors; (ii) a forward-looking rule estimated through GMM with revised data; and (iii) a forward-looking formulation with real time data obtained from market surveys of agent expectations. In every case we find strong statistical evidence of a more *dovish* BCB during President Rouseff's first term. Third, using VAR exercises and data through early 2016, we find preliminary evidence that the looser monetary policy under President Rousseff has contributed to a deterioration of inflation expectations and actual inflation dynamics which have become more sensitive to inflationary shocks. Finally, our paper calculates various specifications of empirical *loss-functions* found in the literature and proposes a new specification that compares the evolution of the usual inflation and employment variables to that of other countries in order to address the official justification at the time that Brazil's deteriorating economic performance reflected a worse international environment.

4.2. The Empirical Model

We follow studies that evolved from the original Taylor Rule and incorporated a lagged term of the policy interest rate to account for smoothing behavior by the Central Bank and start with a general specification:

$$SELIC_t = \beta_0 + \beta_1 SELIC_{t-1} + \beta_2 Inflation\ Gap_t + \beta_3 Output\ Gap_{t-1} + \varepsilon_t \tag{6}$$

To account for the non-stationarity of the $SELIC$ and $Inflation\ Gap$ series, we modify the model above by subtracting $SELIC_{t-1}$ from both sides, which yields

$$\Delta SELIC_t = \beta_0 + (\beta_1 - 1)\, SELIC_{t-1} + \beta_2 Inflation\ Gap_t + \beta_3 Output\ Gap_{t-1} + \varepsilon_t \tag{7}$$

where Δ denotes first-difference of the time series. Next, we add and subtract $\beta_2 Inflation\ Gap_{t-1}$ and $(\beta_1 - 1) Inflation\ Gap_{t-1}$ from the right-hand side and rearrange to obtain

$$\begin{aligned} \Delta SELIC_t = {} & \beta_0 + (\beta_1 - 1)\,(SELIC_{t-1} - Inflation\ Gap_{t-1}) + \\ & + \beta_2 \Delta Inflation\ Gap_t + (\beta_2 + \beta_1 - 1)\, Inflation\ Gap_{t-1} + \\ & + \beta_3 Output\ Gap_{t-1} + \varepsilon_t \end{aligned} \tag{8}$$

The resulting equation is our baseline Taylor Rule for the BCB. It has an error-correction formulation and thus serves the dual purpose of being compatible with non-stationary series and capturing the smoothing behavior of a Central Bank when it gradually adjusts the policy interest rate toward its equilibrium level implied by a persistent deviation of inflation from the official target.

4.3. Data Sources and the Time Series Properties of Brazilian Data

We use data from several sources. Our measure of inflation is derived from the baseline index used for the purpose of the Inflation Targeting Regime in Brazil, the IPCA. It is measured by the official statistics bureau (IBGE, Brazilian Institute for Geography and Statistics). The output gap is obtained from the HP-filtered series of industrial production, also measured by the IBGE. The official Inflation Target, the Selic policy rate, and the exchange rate series are taken from the Central Bank of Brazil. In our GMM estimations, we use the IMF's International Commodity Price Index in the set of instruments. Expected inflation refers to the average of market expectations for inflation 12

months ahead, and are collected and made available by the BCB. An Expected Output Gap series was created by taking the latest available figure for industrial production and applying the average 12-month growth rate expected by market participants as surveyed and made available by the BCB.

Our dataset includes stationary and non-stationary series, and our empirical strategy shall reflect this mix. Siklos and Wohar (2005), among other studies, underscore the importance of considering the time series properties of the variables used in Taylor Rule models and warn against pitfalls of not taking into account the likelihood that unit roots and cointegrating relationships may be present. These authors point toward excessively high R^2 values and estimated coefficients on the lagged dependent variable as possible indicators of spurious equations estimated in the literature. Indeed, using Brazilian data for the period 2005M1-2013M5, Moreira (2015) reported R^2 values of about 0.99 and lagged dependent variable coefficient estimates not statistically different from 1. We thus start our empirical analysis by investigating the time-series properties of the data and by using test results to define an estimation strategy that could yield more reliable results to characterize the behavior of the BCB over the last several years.

A visual inspection of the charts in Figure 3 suggests that the SELIC interest rate and the Actual and Expected Inflation Gaps may be non-stationary. ADF tests indicate that the $SELIC$ and both $Inflation\ Gap$ series should be treated as I(1) and that the *Output Gap* series be treated as I(0), as expected. Cointegration tests determine that the $SELIC$ and either $Inflation\ Gap$ series may be cointegrated. Detailed test analyses can be found in Appendix C of the Online Appendix.

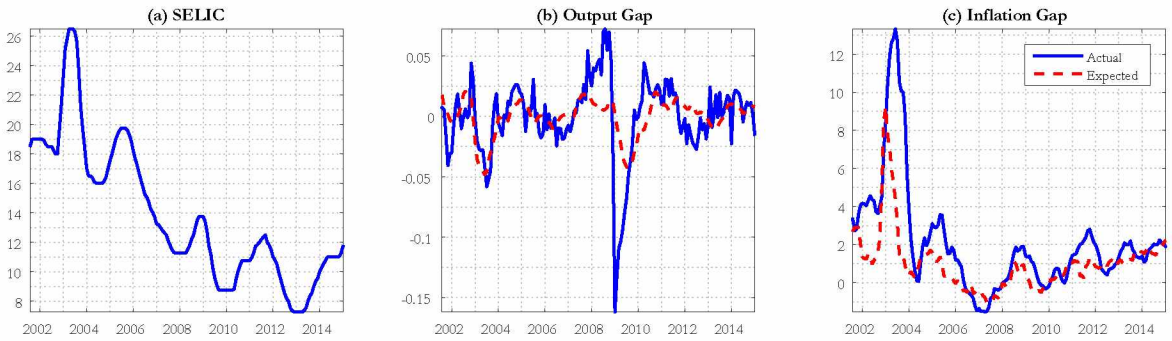

Figure 3. Descriptive Time Series: SELIC Interest Rates, Output Gap and Expected Output Gap, Current and Expected Inflation Gaps. *The left panel shows the levels of SELIC Interest Rate, which is the policy rate of the Central Bank of Brazil (BCB). The middle panel shows the Output Gap and the Expected Output Gap. The right panel shows the Actual Inflation Gap as the difference between the actual inflation and the official inflation target and the Expected Inflation Gap as the difference between market expectations of inflation 12 months ahead minus the inflation target for the same period.*

4.4. Did Monetary Policy Suffer a Regime Change with the Rousseff Government? A Markov-Switching Approach

We follow suggestive evidence that the BCB changed its inflation-targeting behavior after 2011 when the new administration took office in President Dilma Rousseff's first term and consider methodologies to formally detect and date the switch of patterns present in the data. An agnostic approach is to "let the data tell" when a new regime took place in the BCB's reaction function. A frequently used and effective strategy to date regime changes in monetary policy is the Markov-Switching method, which consists of estimating the parameters of the Taylor Rule allowing for more than one state in the parameters. One way to think about this strategy is to estimate the following reaction function:

$$SELIC_t = \alpha_1 SELIC_{t-1} + \beta_{1,s_t} Inflation\ Gap_t + \beta_{2,s_t} Output\ Gap_{t-1} + \varepsilon_t \tag{9}$$

where s_t in the subscript of β parameters is a discrete latent variable that can take values 1 or 2, and ε_t is the error term distributed as an $i.i.d.\ N\left(0, \sigma_\varepsilon^2\right)$. Each value represents a different *regime* for the parameter β: if $s_t = 1$, the reaction of the Central Bank to inflation deviations equals to $\beta_{1,s_t=1}$, which is assumed to be lower than $\beta_{1,s_t=2}$ (the value of the Central Bank's reaction to inflation deviations under state $s_t = 2$). Once set the two possible states, one needs to define how one state transitions to the other, i.e. the dynamics of the system. The latent variable evolves according to a first-order Markovian process with transition matrix

$$\Pi = \begin{bmatrix} \pi_{11} & \pi_{12} \\ \pi_{21} & \pi_{22} \end{bmatrix},$$

where $\pi_{i,j} = Pr\left(s_t = i | s_{t-1} = j\right)$ represents the probability of transitioning from state j to state i. In addition, let us define the following 2×1 vector $\alpha_t = \left[\mathbb{1}\left\{s_t = 1\right\}, \mathbb{1}\left\{s_t = 2\right\}\right]'$, where $\mathbb{1}\{\cdot\}$ is the indicator function taking value 1 if the condition inside braces is met, zero otherwise. Thus, we can back out the current state of the Markov process from the α_t vector so that $s_t = [1,\ 2]\,\alpha_t$.

For the purposes of our main research question and for simplicity, we model only the expected inflation gap coefficient as having two different states: *Dovish* and *Hawkish*. One could also let the output gap take two or more different regimes in the estimation of the Markov-Switching model, and

allow for different *variances*.[16] Let the parameter β_{1,s_t} be state-variant such that $\beta_{1,s_t=1} < \beta_{2,s_t=2}$. In words, State 1 is the *Dovish* state, because a lower reaction coefficient β_1 to the expected inflation gap translates into a more lenient behavior to inflation deviations. Conversely, when β_1 is in State 2, it is considered to be in a relatively *Hawkish* state. The Markov-Switching methodology therefore may be able to capture the change toward more *Dovish* behavior after 2011, when the new administration began.

Although specifications similar to equation (9) have been used by other Markov-Switching Regressions of the BCB Taylor Rule (e.g. Gonçalves (2015)), we take a different route by utilizing forward-looking variables. We follow Orphanides (2001) and use real-time data to provide an information set consistent with the actual information set available to the BCB at the time of decision. As part of the implementation of the IT framework, the BCB started conducting a survey of market expectations for several variables, among which are expectations for inflation and for the growth of industrial production over the next 12 months. The data set is made available by the BCB in daily frequency. We convert the relevant series to monthly frequency making sure to use the most recent observation available when each policy meeting of the BCB Board of Governors took place. For months with no meetings, the value of the observation is referred to the closest day to the midpoint between meetings.[17] The *Expected Inflation Gap* variable is the difference between the average of market expectations for inflation 12 months ahead minus the inflation target for the same period. Our measure of the *Output Gap* in this estimation is calculated by applying the expected annual growth rate of industrial production to the latest actual value of industrial production and then using a standard HP Filter to obtain the de-trended series, thus representing the *Expected* Output Gap. Finally, we follow Gonçalves (2015) and restrict our Markov-Switching sample to the post-2005 period because of the abnormally high levels of the SELIC interest rate experienced previously. These levels were associated with electorally-induced instability and could potentially affect the estimation of transition probabilities. We use the Markov-Switching Dynamic Regression approach in order to allow a quick adjustment after a state change, which is often used to model monthly data as in our case.[18]

[16] We abstract from these complications here due to a relatively short sample, but in unreported regressions our results remain qualitatively unchanged allowing for regime-switching in the output gap.

[17] For instance, because there was a meeting on February 26, 2014, the values for monthly observations in February 2014 referred to those available on February 25. Since the following meeting occurred only on April 2, 2014, the values for monthly observations in March 2014 referred to those available on March 17, 2014.

[18] The parameters and transition probabilities are estimated by the so-called Hamilton Filter (Hamilton, 1989), which is akin to the well-known Kalman Filter. However, the Hamilton Filter is a non-linear algorithm that estimates the probabilities that a discrete latent variable is in one of several states, while the Kalman Filter makes linear estimates of continuous variables.

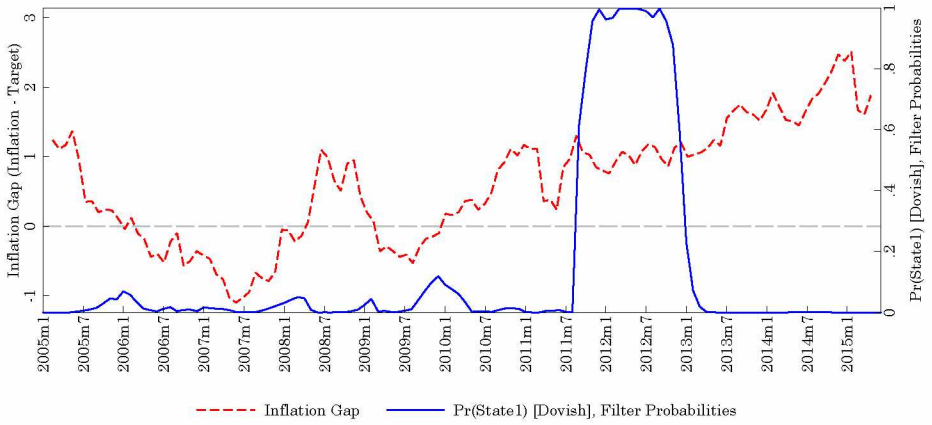

Figure 4. Markov-Switching Transition Probabilities. *This figure shows the estimated transition probabilities of a Markov Regime-Switching model. The continuous blue line (right axis) represents the probability of being on State 1, which is defined as the* Dovish *state. This means that the BCB reacts less to movements in the expected inflation gap (the distance between inflation expectations and the official inflation target). The dashed red line (left axis) represents the expected inflation gap. The grey dashed line represents the line when expected inflation is equal to the target.*

The results presented in Figure 4 indicate that the change of behavior happened on the second half of 2011, the first year of the Rousseff administration. More specifically, the model predicts a regime switch toward a *Dovish* behavior in 2011M09. Interestingly, our "agnostic" regime change approach confirms the perception of market analysts such as Goldman Sachs' Alberto Ramos described in Section 2.1. The estimated probability of a *Dovish* regime increases to almost 100% at this month and remains at levels higher than 80% for the entire year of 2012, converging back to zero only by the half of 2013.

Finally, Table B.1 in the Online Appendix presents the estimated parameters of the Markov-Switching Dynamic Regression. As expected, the estimated parameter for the *hawkish* state is higher than the one estimated for the *dovish* state. In fact, during the dovish state under President Rousseff, the coefficient turns out to be *negative*, indicating a pro-inflationary behavior of the BCB. In other words, under President Rousseff, the BCB reacted to increases in the expected inflation gap by *decreasing* the SELIC interest rate, the opposite behavior to that recommended by the Taylor principle.

4.5. Did Monetary Policy have a Dovish Bias under President Rousseff? Evidence from Taylor Rules

Having presented a simple model characterizing the tradeoffs facing a Central Bank that is constructing credibility and the results of a Markov-Switching exercise that capture a change in Central Bank behavior under President Rousseff, we now present strong econometric evidence that the BCB under Rousseff acted significantly more dovish than in previous years. Our results show that during

2011-14 the SELIC was kept persistently and significantly below the levels implied by traditional Taylor Rules estimated prior to Rousseff's tenure. This main conclusion is robust to the use of backward-looking specifications, with and without the exchange rate among explanatory variables; forward-looking specifications estimated with revised data through the Generalized Method of Moments; and a forward-looking specification that uses real-time data in a conventional error-correction framework. The degree of undershooting of the SELIC implied by the different models ranges from about 3 ¾ percentage points to 4 ¾ percentage points. Note that these estimates are based on static forecast of the SELIC obtained from the interaction of reaction function parameters estimated for the period before Rousseff inauguration and actual, observed data for fundamentals observed during her first term. Naturally, the degree of undershooting would be smaller if initial deviations of the SELIC had been corrected early in the period, thereby keeping inflation and inflation expectations under control.

A Backward-Looking Taylor Rule. In line with previous research on the topic, our first model indicates that the BCB reacted strongly to deviations of inflation from the target and only mildly to the output gap during 2004-10. Given the statistical properties of the series, we estimate **VECM1**, a vector autoregressive model with the SELIC and the lagged Actual Inflation Gap in the cointegrating equation, and the lagged Output Gap appearing among the short-run variables in the error-correction formulation.[19] A dummy variable aimed at capturing some of the additional noise caused by the global financial crisis is also added to the set of exogenous variables.[20] The lag-length p of the differenced variables was selected to minimize the Schwarz Bayesian Criterion while also ensuring the resulting system does not display any significant sign of residual correlation up to lag $p + 1$. Normalizing the cointegrating vector with respect to the SELIC yields the estimated dynamics for the BCB policy rate summarized in column 1 of Table 1.

Our **VECM1** model displays a relatively good fit of the data and seems well-specified: its coefficients have plausible signs and orders of magnitude; the adjusted R^2 is relatively high albeit not too close from unity; and tests confirm the existence of cointegration while failing to detect any significant residual autocorrelation in the system. Our estimates suggest that the BCB tended to raise its desired

[19] We use a specification in which the cointegrating vector combines the SELIC with the Actual Inflation Gap variable lagged one period in order to ensure that the inflation information was available to the BCB at the time of the SELIC decision.

[20] The variable takes the value of 1 for the period 2008M8-2009M3, zero otherwise. The period of non-zero observations was centered around the unusually low trough of the output gap series, which likely reflected temporary over-reaction and disruption of industrial production following the stock market crash in the US.

	VECM 1	VECM 1A	VECM 3	VECM 3A
	(1)	(2)	(3)	(4)
Sample Period	2004:M1-2010M12	2004:M1-2014M12	2001M10-2010M12	2001M10-2014M12
Data Type	Revised	Revised	Real-Time	Real-Time
Cointegrating Equation				
SELIC_{t-1}	1	1	1	1
Inf Gap_{t-2}	-3.0	-2.7	–	–
	[-6.5]	[-7.6]	–	–
$D_{2010-14}\times \text{Inf Gap}_{t-2}$	–	4.8	–	–
	–	[8.9]	–	–
Inf Gap_{t-1}	–	–	-3.7	-3.5
	–	–	[-4.8]	[-4.7]
$D_{2010-14}\times \text{Inf Gap}_{t-1}$	–	–	–	3.8
	–	–	–	[2.6]
Constant	-11.3	-12.1	-12.3	-11.8
Error Correction	Δ(SELIC)	Δ(SELIC)	Δ(SELIC)	Δ(SELIC)
Coint. Equation 1	-0.027	-0.029	-0.026	-0.019
	[-4.7]	[-5.2]	[-2.6]	[-2.5]
$\Delta(\text{SELIC}_{t-1})$	0.58	0.62	0.741	0.748
	[7.9]	[10.1]	[7.6]	[9.1]
$\Delta(\text{SELIC}_{t-2})$	–	–	-0.177	-0.143
	–	–	[-1.5]	[-1.4]
$\Delta(\text{SELIC}_{t-3})$	–	–	0.061	0.079
	–	–	[0.7]	[1.0]
$\Delta(\text{Inf Gap}_{t-1})$	–	–	0.139	0.181
	–	–	[1.9]	[2.8]
$\Delta(\text{Inf Gap}_{t-2})$	0.02	0.00	0.025	0.014
	[0.6]	[0.1]	[0.3]	[0.2]
$\Delta(\text{Inf Gap}_{t-3})$	–	–	-0.004	0.019
	–	–	[-0.1]	[0.3]
$\Delta(D_{2010-14}\times \text{Inf Gap}_{t-1})$	–	–	–	-0.036
	–	–	–	[-0.2]
$\Delta(D_{2010-14}\times \text{Inf Gap}_{t-2})$	–	-0.01	–	-0.085
	–	[-0.1]	–	[-0.6]
$\Delta(D_{2010-14}\times \text{Inf Gap}_{t-3})$	–	–	–	-0.04
	–	–	–	[-0.3]
$\Delta[\log(\text{Ind Prod}_{t-2})]$	–	–	2.35	2.16
	–	–	[1.8]	[2.0]
D_{Crisis}	-0.27	-0.28	–	–
	[-4.2]	[-4.3]	–	–
Output Gap	0.03	0.02	0.056	0.04
	[4.0]	[4.1]	[2.9]	[2.6]
$D_{2010-14}\times$ Output Gap	–	0.05	–	–
	–	[2.1]	–	–
Constant	0.00	0.00	-0.014	-0.011
	[0.2]	[-0.1]	[-0.5]	[-0.5]
N	84	132	110	158
Adj. R^2	0.78	0.75	0.81	0.78
Schwarz SC	-0.51	-0.50	0.52	0.37
Autocorrelation Tests				
Portmanteau Q-Stat (Lag 2)	3.6	6.9	–	–
	[0.73]	[0.96]	–	–
Portmanteau Q-Stat (Lag 3)	16.0	30.0	–	–
	[0.10]	[0.19]	–	–
Portmanteau Q-Stat (Lag 4)	–	–	3.0	7.9
	–	–	[0.80]	[0.92]
Portmanteau Q-Stat (Lag 5)	–	–	4.1	10.6
	–	–	[0.94]	[0.99]
LM-Stat (Lag 1)	2.4	5.6	8.0	11.8
	[0.66]	[0.78]	[0.01]	[0.8]
LM-Stat (Lag 2)	2.9	5.3	1.9	8.4
	[0.58]	[0.80]	[0.7]	[0.8]
LM-Stat (Lag 3)	–	–	3.8	3.4
	–	–	[0.4]	[0.8]
LM-Stat (Lag 4)	–	–	1.2	4.4
	–	–	[0.8]	[0.8]
LM-Stat (Lag 5)	–	–	1.1	3.0
	–	–	[0.9]	[0.9]

Table 1. Vector Error-Correction Models. *Numbers under coefficient estimates are t-ratios, and under test statistics are P-values. The Output Gap variable is the HP-Filtered industrial production for models using Revised Data (VECM1 and VECM1A). For the specifications with Real-Time data (VECM3 and VECM3A), the Output Gap is the Expected Output Gap from market expectations about the industrial production collected on a daily survey by the BCB. See Section 4.5 for more details.*

level for the SELIC by about 3 percentage points for each percentage point that observed inflation exceeded the official inflation target during the period 2004M1-2010M12. The magnitude of the coefficient is in the upper range of other estimates in the literature, possibly reflecting the BCB's attempt to establish credibility and achieve disinflation in the early stages of the inflation targeting regime and following the heightened economic uncertainty associated with the 2002 presidential elections.[21] At 11.3, the estimated value for the constant in the cointegrating relation implies a natural interest rate of about 6 1/2 percent. While this value is in the upper range of estimates for developing countries, it is consistent with many studies on interest rate dynamics in Brazil.[22]

The plots in Figure 5 of actual and fitted values of the SELIC Interest Rate in levels and first-differences provide further indication that our model specifications are appropriate. The fitted and predicted values trace the actual data well over the estimation period. Of greater significance to our study, out-of-sample projections show that during 2011-14 the BCB clearly deviated from past behavior by setting interest rates well below the equilibrium values implied by the model.

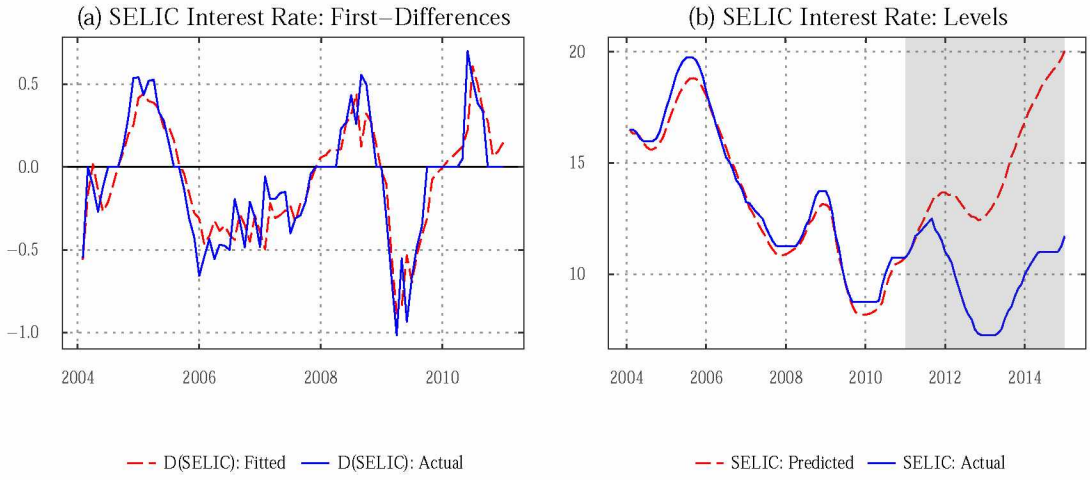

Figure 5. Vector Error Correction Model (Model VECM1: Backward-Looking Taylor Rule) Estimation: First Differences and Levels of SELIC Interest Rates. *Panel (a) shows for the 2004:M1-2010:M12 period the actual and fitted values of first-differenced SELIC interest rate, which is the policy rate of the Central Bank of Brazil (BCB). The predicted SELIC Interest Rate yields from an estimated Taylor Rule of the BCB described in Section 4.5. Panel (b) extrapolates the ending period to 2014:M12 to show the predicted and actual levels of the SELIC Interest Rate. The shaded area denotes the period of President Dilma Rousseff's first administration.*

[21] The 2002 presidential election in Brazil was remarkable in terms of policy uncertainty in the sense that the winning left-wing candidate Luis Inácio Lula da Silva and his party (Workers' Party, PT) historically had market-unfriendly proposals for economic policy. One of the proposals defended in previous elections by candidate Lula da Silva and his group was the default on the Brazilian sovereign debt. A recent exploration of this political-economic uncertainty shock and its impacts on the real economy is undertaken by Carvalho (2015).

[22] See, for instance, Lopes (2014), Segura-Ubiergo (2012), and Bacha et al. (2007).

Further econometric analysis provides strong statistical evidence that the BCB changed its behavior and became significantly more *dovish* during President Rousseff's first term in office. Following the cues provided by the out-of-sample projections in Figure 5, model **VECM1A** in column 2 of Table 1 expands the estimation period to 2004M1-2014M12 and adds slope dummy variables to capture the possibly softer reaction of the BCB to the actual inflation gap and stronger response to the output gap during President Rousseff's first term. The estimated coefficient on the dummy variable interacting with the Actual Inflation Gap is highly significant and implies that the BCB may have ignored the (rising) inflation gap when it reduced the SELIC policy rate to its lowest level on record during 2011-14. The coefficient estimate on the dummy variable interacting with the output gap suggests a statistically significant higher response of monetary policy to the output gap and another signal that BCB priorities may have changed, although the total coefficient remains low for international standards.

As a robustness check, we estimate a version of this backward-looking reaction function augmented with the exchange rate (**VECM2**). Despite the fact that the BCB's inflation target mandate presumes the subordination of all other objectives to achieving the inflation target, some studies have considered the possibility that concerns over movements in the exchange rate may also affect monetary policy decisions. For instance, Furlani et al. (2010) and Minella et al. (2003) have introduced exchange rate variables into the BCB's reaction function and found them to have statistically significant impact.[23] The estimation of an exchange-rate augmented reaction function corroborate our main results: models **VECM2** and **VECM2A** indicate that the BCB reacted strongly to the Actual Inflation Gap during 2004-10 but not so during 2011-14. [24]

A Forward-Looking Taylor Rule. Having found substantial evidence of a change in the monetary policy regime of the BCB during President Rousseff's first term, we now turn to address the following question: would the same change in the BCB behavior be detected if we modeled monetary policy reactions as a function of future rather than recent or current developments? We follow Clarida et al. (2000) and others in assuming that a central bank considers the lagged impact of interest rates on inflation and therefore determines the desired interest rate as a function of expected/projected inflation – or, in the case of Brazil, the expected gap between inflation and the explicit inflation

[23] Pavasuthipaisit (2010) and Lubik and Schorfheide (2007) find similar results for a broader sample of countries.
[24] The Online Appendix presents a full discussion of this model along with respective tables and figures.

target. Adapting the model to reflect this forward-looking behavior yields

$$\begin{aligned}\Delta SELIC_t = \beta_0 + (\beta_1 - 1)\left[SELIC_{t-1} - \mathbb{E}_t\left(Inflation_{t+k-1} - Target_{t+k-1}\right)\right] + \\ + \beta_2 \mathbb{E}_t \Delta\left(Inflation_{t+k} - Target_{t+k}\right) + \\ + (\beta_2 + \beta_1 - 1)\,\mathbb{E}_t\left(Inflation_{t+k-1} - Target_{t+k-1}\right) + \\ + \beta_3 \mathbb{E}_t\left(Output\ Gap_{t+j}\right) + \varepsilon_t\end{aligned} \tag{10}$$

where $\mathbb{E}_t(\cdot)$ denotes the expectation at time t of the future value of the actual inflation gap at time $t+k$ and the *Output Gap* at time $t+j$. In this specification, the cointegration between the SELIC interest rate and the inflation gap would be verified by a negative and statistically significant coefficient $(\beta_1 - 1)$.

The forward-looking specification introduces a problem of endogeneity, as future values of the inflation gap should be affected by present values of the policy interest rate and thus correlated with the current error term, ε_t. To address this issue, estimation of the equation above is carried out through the Generalized Method of Moments (GMM) with heteroskedasticity and autocorrelation (HAC) consistent errors.[25] We follow the literature in using as instruments the lagged values of the differenced interest rate and actual inflation gap series plus lagged values of the output gap, international prices (measured by the IMF index of world export prices), and the quarterly change in the USD/BRL exchange rate.[26] We use up to 12 lags of the instrumental variables while keeping the total number of instruments below one quarter of the sample size, as suggested by Roodman (2009). We estimate equation (10) assuming the BCB reacts to the expected/projected inflation gap 12 months ahead ($k = 12$) and to the expected/projected output gap three months ahead ($j = 3$).[27] An extra lag of the dependent variable is added to account for additional smoothing behavior and help control for residual autocorrelation in the estimation.

The forward-looking specification of the Taylor Rule also provides strong empirical evidence of a more *dovish* BCB during 2011-2014. Model **GMM1** results indicate the error-correction term $(\beta_1 - 1)$ is negative and statistically significant, confirming the cointegration between SELIC and the projected

[25] We opt for a HAC weighting matrix with Bartlett kernel, Newey-West fixed bandwidth, and one lag pre-whitening to reduce possible correlation in the moments condition.

[26] See for instance Clarida et al. (2000).

[27] Results for an estimation with $k = 9$ yielded similar coefficients and were omitted for conciseness.

inflation gap, as shown in Table 2. Deviations between the actual and target SELIC are corrected at a rate of 2.3 percent a month, somewhat faster than the adjustment rate estimated for the US.[28] The estimated constant term implies a natural interest rate of 6.8 percent, in line with our previous model. At 1.9, the long-term coefficient on the inflation gap forecast indicates that the BCB's targeted SELIC level is adjusted more than enough to promote an increase in the forward-looking real rate when projected inflation is above the target during the period 2001M1-2010M12, and *vice-versa*.[29] The output gap forecast three months ahead has a small but significant impact on the BCB policy rate. In theory, a central bank that formally targets inflation would only be concerned with the output gap to the extent that it impacts future inflation and inflation expectations. Conceptually, the inclusion of lagged values of the output gap and exchange rate fluctuations among the instruments consider the two variables part of the existing information set that is used to forecast inflation expectations and therefore influence monetary policy decisions.

	GMM 1 (1)		**GMM 1A** (2)	
Sample Period	2004M01-2010M12		2004M01-2014M12	
Data Type: Revised	Coefficient	Implied Long-Run Coefficients	Coefficient	Implied Long-Run Coefficients
Δ SELIC$_{t-1}$	0.807		0.779	
	[12.5]		[26.3]	
Constant	0.265	11.6	0.236	10.8
	[2.1]		[3.5]	
$\mathbb{E}_t$[Inf Gap]	0.044	1.9	0.044	2.0
	[3.2]		[3.7]	
$D_{2010-14} \times \mathbb{E}_t$[Inf Gap]	–		-0.060	-2.7
	–		[-3.6]	
Error Correction	-0.023		-0.022	
	[-2.3]		[-4.0]	
$\mathbb{E}_t$[Output Gap]	0.014		0.016	
	[2.4]		[4.4]	
$\mathbb{E}_t$[Inflation Gap]	0.037		–	
	[0.8]		–	
Δ SELIC$_{t-2}$	-0.029		–	
	[-0.4]		–	
Adjusted R^2	0.74		0.75	
Instrument rank	28		31	
J-statistic	13.2		19.4	
	[0.9]		[0.78]	
Q-Stat (3 lags)	2.44		2.8	
	[0.48]		[0.4]	

Table 2. GMM Models. *Numbers under coefficient estimates are t-ratios, and under test statistics are p-values.*

The instruments meet the orthogonality condition and residuals do not show any significant auto-

[28] See e.g. Siklos and Wohar (2005).

[29] The long-term coefficient measuring the SELIC response to the projected inflation gap is calculated as $-\beta_2/(\beta_1-1)$.

correlation. The model fits the data well, with adjusted R^2 statistics hovering just above 0.7 percent. A visual inspection of actual and fitted values of $\Delta SELIC_t$ in Figure 6 (left panel) and the comparison of actual values for the SELIC and the values implied by the model estimates (right panel) confirm the goodness of fit. The figure also suggests that authorities maintained a more cautious stance and kept the SELIC above estimated equilibrium levels from the middle of 2006 to the end of 2007, a period that coincided with rising economic activity, falling inflation expectations, and presumably credibility gains for the BCB. On the other hand, it is also evident from the out-of-sample projections for the period 2011M1-2014M12 that the SELIC was held consistently and persistently below the levels implied by our parameter estimates.

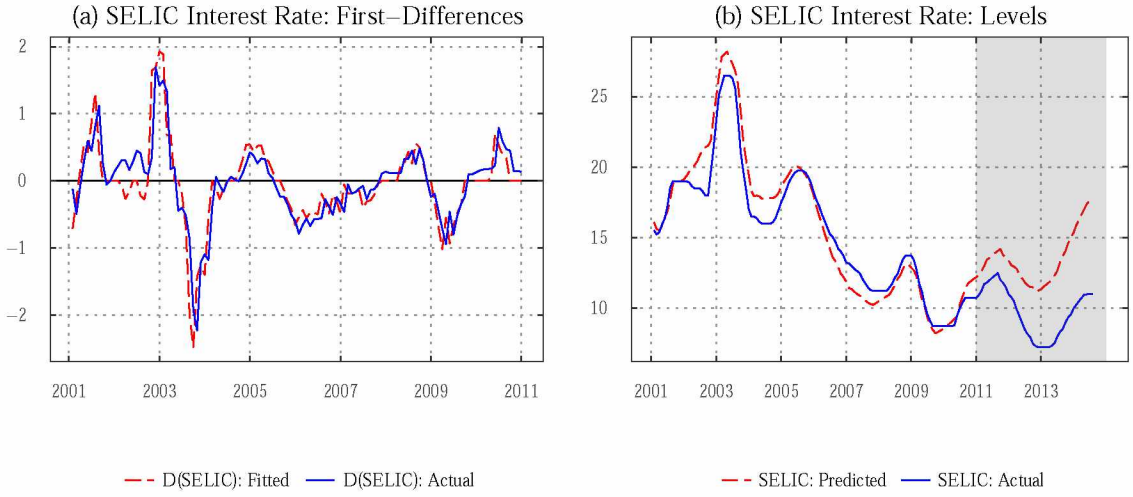

Figure 6. Generalized Method of Moments Model (Model GMM1: Forward-Looking Taylor Rule) Estimation: First Differences and Levels of SELIC Interest Rates. *Panel (a) shows for the 2004:M1-2010:M12 period the actual and fitted values of first-differenced SELIC interest rate, which is the policy rate of the Central Bank of Brazil (BCB). The predicted SELIC Interest Rate yields from an estimated Taylor Rule of the BCB described in Section 4.5. Panel (b) extrapolates the ending period to 2014:M12 to show the predicted and actual levels of the SELIC Interest Rate. The shaded area denotes the period of President Dilma Rousseff's first administration.*

Model **GMM1A** in Table 2 extends the estimation period and adds a dummy variable to differentiate the BCB response during President Rousseff's first term. The significant coefficient estimate on the slope dummy variable confirms that the BCB reacted less strongly than before to rising inflation gap projections and maintained the SELIC rate below the level predicted by fundamentals and the past behavior of the monetary authorities. Contrarily to the backward-looking model, the dummy variable aimed at capturing a different response of monetary authorities to the (projected) output gap during 2011M1-2014M12 did not achieve minimum significance levels and was excluded from reported models.

A "Real Time" Data Taylor Rule for Brazil. In order to address the critique in Orphanides (2001), we use "real-time" data with the actual forecasts for inflation and growth that were available to policy makers at the time interest rate decisions were made. As described in Section 4.4, after adopting IT the BCB started conducting a survey of market expectations for several variables, among which are expectations for inflation and for the growth of industrial production in the following 12 months. The previously defined *Expected Inflation Gap* variable (the difference between the average of market expectations for inflation 12 months ahead minus the inflation target for the same period) returns as the relevant measure for policy decision. The *Output Gap* variable here is also an *Expected* Output Gap. Unit root tests in Table C.1 in the Online Appendix, indicate that Expected Inflation Gap is I(1) and Expected Output Gap is I(0), while cointegration tests in Table C.2 suggest SELIC and Expected Inflation Gap are cointegrated over the period 2001M1-2010M12.

Because the information used referred to actual market expectations available on the date of the COPOM meetings, there is no need to use the instrumental variable approach from GMM. We thus estimate a Vector Error-Correction Model by the system maximum likelihood approach. Given the statistical properties of the series, we estimate **VECM3**, a Vector Error Correction model with the SELIC and Expected Inflation Gap in the cointegrating equation and the lagged Expected Output Gap included among the short-run variables in the error-correction formulation. The second lag of differenced industrial production was also added to the set of exogenous variables to reflect past values of economic activity.[30] Two lags of the differenced *SELIC* and *Expected Inflation Gap* variables were selected to minimize the Schwarz Bayesian Criterion while also ensuring the resulting system displayed no significant residual correlation. Normalizing the cointegrating vector with respect to the SELIC yields the estimated dynamics for the BCB policy rate summarized in Table 1, column 3.

Estimates in **VECM3** suggest that the BCB reacted strongly to market inflation expectations during 2001M10-2010M12 by adjusting its target SELIC rate by about 3.5 percentage points for each percentage point that inflation expected for the 12 months ahead exceeded the official inflation target. Deviations between the long-run, target SELIC and the actual SELIC were eliminated at a rate of about 3 percent per month, with a significantly negative error-correction coefficient confirming that the BCB policy interest rate adjusted in response to the cointegrating relation embedded in the system

[30]The D_{Crisis} dummy variable was not found to be significant in this formulation, which could be interpreted as market expectations of inflation and the output gap having responded to the crisis enough to obviate the need for the separate dummy variable to explain changes in the policy interest rate.

over the estimation period. The constant term in this model implies a natural interest rate of about 7 1/2 percent, slightly higher but broadly in line with our two previous estimates and the Brazilian experience.

The short-run coefficients on lagged differenced variables have the expected sign and continue to capture a high degree of interest rate smoothing by the monetary authority. Model estimates also suggest that the BCB reacts to market expectations of economic activity by raising the SELIC by about 6 basis points for each percentage point that expected (seasonally adjusted) industrial production exceeds its trend. Past values of economic activity are also significant, with lagged values of the growth in industrial production having a small but statistically significant impact on SELIC dynamics. The model has an even higher adjusted R^2 statistic than previous specifications and performs well in residual autocorrelation tests.

Out-of-sample projections of the SELIC rate in Figure 7 indicate that the actual policy rate was kept well below levels implied by model estimates during 2011M1-2014M12, once again capturing a substantial change in policy orientation of President Rousseff's Central Bank. A comparison between actual and fitted values for $\Delta SELIC_t$ in Figure 7 provides a visual confirmation of the model's goodness of fit. As in previous models, the implied projected SELIC rate tracks the actual SELIC well over the estimation period. This specification, however, also suggests that the BCB adopted a tougher-than-expected stance around 2006-08, a period when inflation expectations were substantially reduced.

Model **VECM3A**, summarized in column 4 of Table 1, suggests that the change in BCB's reaction to an increase in inflation expectations during Rousseff's government was statistically significant. Model **VECM3A** is obtained from expanding the sample period and adding a dummy variable for President Rousseff's first term. The significance of the coefficient on the dummy variable provides statistical confirmation that the BCB changed its behavior and reacted to deviations of expected inflation from the target significantly less (or not at all) when setting its policy rate during 2011M1-2014M12.

4.6. Discussion of Empirical Results

Our various empirical exercises uncovered strong evidence that the BCB may have broken with its previous stance to become significantly more *dovish* during the Rousseff administration. We modeled this break as a reduction in the response of the policy rate to deviations of inflation (actual and expected) from the official target. While goodness-of-fit and other test statistics suggest the

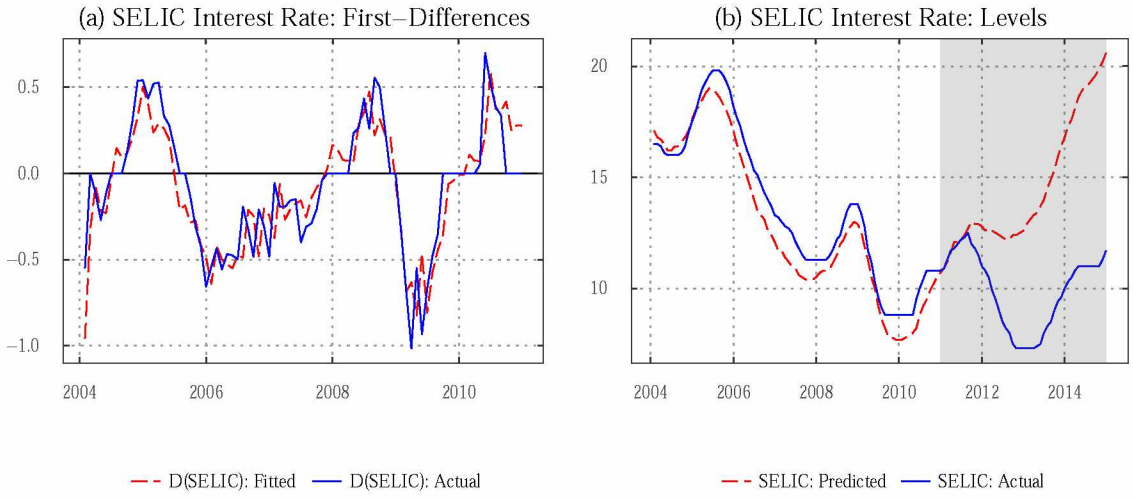

Figure 7. Vector Error Correction Model (Model VECM3: Using Real-Time Data) Estimation: First Differences and Levels of SELIC Interest Rates. *Panel (a) shows for the 2004:M1-2010:M12 period the actual and fitted values of first-differenced SELIC interest rate, which is the policy rate of the Central Bank of Brazil (BCB). The predicted SELIC Interest Rate yields from an estimated Taylor Rule of the BCB described in Section 4.5. Panel (b) extrapolates the ending period to 2014:M12 to show the predicted and actual levels of the SELIC Interest Rate. The shaded area denotes the period of President Dilma Rousseff's first administration.*

appropriateness of our empirical models, one could wonder if, conceptually, the BCB's apparently *dovish* behavior under Rousseff was in fact a justifiable adjustment to a lower natural interest rate for Brazil. We claim this was not the case. First and foremost, and with the benefit of hindsight, it is clear that the easing of the monetary policy stance started in 2011 brought about a de-anchoring of inflation expectations and an acceleration of actual inflation without gains in output. This effect was compounded by the sharp increase in credit extended by public financial institutions at subsidized interest rates.

Even considering only the information available at the time, the case for a fast and substantial drop in the natural rate in 2011 was weak, at best. Contributing to a possible decline in the natural rate were global saving-investment trends and Brazil-specific factors such as an improved net foreign assets position, lower sovereign risk premium, gains in policy-making credibility, and better public sector debt ratios. Most of these gains, however, took place before 2011 and had already been reflected by the policy rate. Indeed, an indication that the real value of the SELIC had not been too far from the natural rate is the fact that during the period 2005M6-2010M6 the BCB's Index of Economic Activity (IBC-Br) increased by about 22% while the average output and expected inflation gaps were close to

zero. Moreover, domestic saving remained low, hovering around 19% of GDP for nearly a decade. [31]

Although the international scenario in 2011 pointed toward a deceleration of economic growth, the aggressive monetary policy easing triggered soon after the new administration took over and amidst an unfavorable inflation environment had more potential to be interpreted as a discretionary change in the BCB's priorities than a move to align the policy rate to a suddenly lower natural rate. The response of inflation expectations and other market indicators at the time were early signs that markets did not see the new BCB policy stance as supported by fundamentals. Curiously, one of the last Inflation Reports issued by the BCB before the change in administration had emphasized that the stability of inflation expectations and actual inflation around the target was key to attest that reductions in the policy rate reflected lower natural rates (Inflation Report, Sep 2010, pp. 94-103). In addition, the IMF, in its comprehensive assessment of the Brazilian economy issued in July 2012, considered that the SELIC at 8 1/2 at the time was already enough to *"support a robust cyclical recovery"* and called for the BCB to prepare for a rapid withdrawal of monetary stimulus citing concerns over inflation and the credibility of the IT regime. [32] The same report pointed to low structural domestic savings as an obstacle to higher sustainable growth.

The possibility of an implicit change in the BCB's monetary policy objective motivates an interesting counter-factual exercise. Using the parameter estimates for the forward-looking reaction function estimated over the period 2004-10, our **VECM3** model, but assuming that the BCB began pursuing an inflation target of 6 1/2 percent during 2011-14 (the upper limit of the tolerance band), we are able to closely replicate in Figure 8 the path for the SELIC during the Rousseff administration. [33] In other words, we are able to reconcile the behavior of the BCB before and after Rousseff if we assume that the Rousseff Central Bank worked with an *implicit* inflation target 2 percentage points above the official target.

[31] That the ex-ante real SELIC rate averaged 8% in that period is another indication that Brazil's natural interest rate is high for international standards.

[32] From the IMF Staff Report: *"... given the rise in inflation expectations and the hard won disinflation gains of the past decade, the staff believes that the authorities should stand ready to unwind monetary stimulus through 2013 and before the end of this year if needed."* (p. 28).

[33] Results for the counter-factual exercise using the estimated parameters of other models were similar to the ones presented here and are not reported for conciseness.

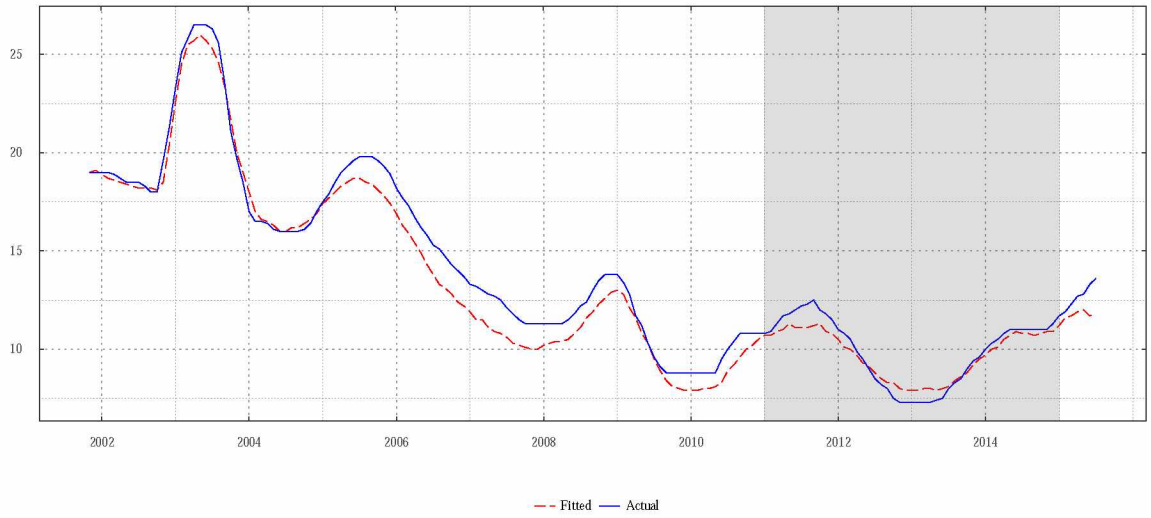

Figure 8. Counterfactual Analysis: Explicit Inflation Target of 6.5%. *This figure shows the estimated SELIC Interest Rate if the BCB had an explicit inflation target of 6.5%. It uses the Taylor Rule parameters estimated by Model VECM3 with data up to 2010:M12, as shown in Table 1.*

5. Assessing the Welfare Costs of Central Bank Discretion

5.1. Preliminary Signs and Consequences of De-Anchoring Inflation Expectations

By persistently deviating from the Taylor principle and setting its policy rate well below levels implied by fundamentals and previous strategy, the BCB under President Rousseff may have lost some of its credibility and contributed to the recent macroeconomic instability in Brazil. Survey measures of long-term inflation expectations shown in Figure 9 surpassed the inflation target and started to trend higher in the second half of 2011 following the BCB's unexpected decision to lower the policy rate.[34]

The negative consequences of deviating from a rules-based framework in favor of discretionary (and sometimes opportunistic) policies have been discussed in numerous studies since the seminal papers by Kydland and Prescott (1977) and Barro and Gordon (1983), including Clarida et al. (2000) and more recently Nikolsko-Rzhevskyy et al. (2014). In Brazil, the importance of taming inflation expectations for the success of the inflation targeting framework and broader macroeconomic stability can be illustrated by two separate studies conducted by BCB deputy governors and economists: Bevilaqua et al. (2008) and Minella et al. (2003). They investigate the determinants of market expectations of inflation by using linear equations to estimate the relative impact of different fundamentals on survey-

[34] Long-term inflation expectations are defined as the 30-day moving average of the inflation rate expected at the end of the 4^{th} year in the future.

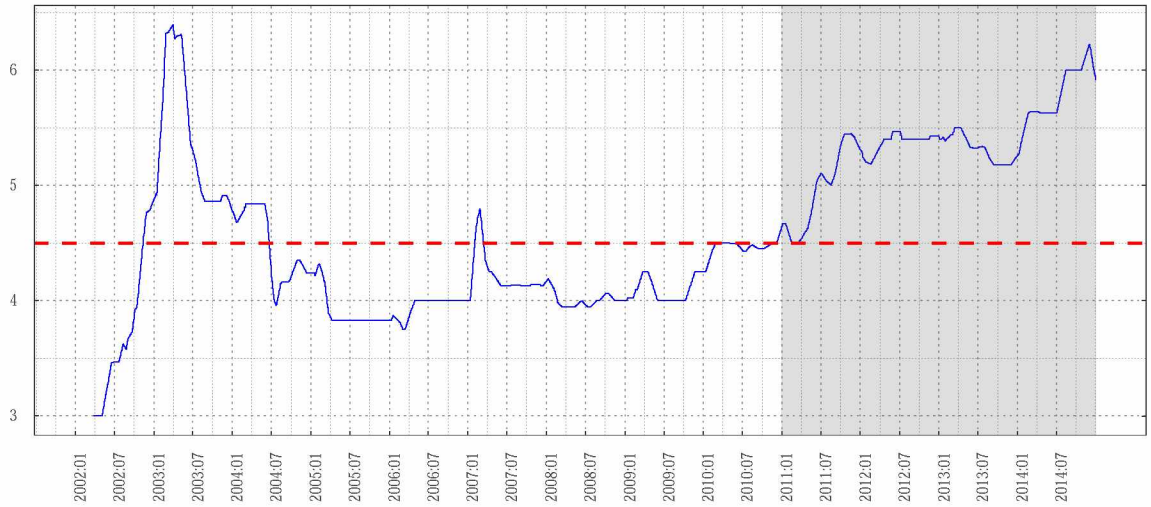

Figure 9. Long-Term Inflation Expectations of the Market. *This figure shows the 30-day moving average of long-term (4 years ahead) inflation expectations of professional forecasters calculated from the BCB daily survey. The red dashed line indicates the inflation target of 4.5%, which is the official target since mid-2003. The shaded area is the period under President Dilma Rousseff's first term (2011:M1-2014:M12).*

measured inflation expectations 12 months ahead. Although their sample periods are different and model specifications vary slightly, both papers show that inflation expectations became increasingly determined by the inflation target over time, thereby being better anchored and less affected by past inflation, exchange rate, and output shocks. The main conclusion borne by those results is that monetary policy gained credibility as the country worked to consolidate its inflation targeting regime.

Our analyses point to a clear break in the power of the official inflation target to anchor inflation expectations in Brazil during the Rousseff government. As in Bevilaqua et al. (2008) and Minella et al. (2003) we also focus on the role of market expectations for inflation 12 months ahead, but here we express them as deviations from the inflation target, our Expected Inflation Gap variable.[35] We compare the series' characteristics over the periods 2004M1-2010M12 (*Before* President Rousseff) and 2011M1-2016M2 (*During* President Rousseff) in Table 3.

Under President Rousseff, inflation expectations were on average 1.43 percentage points above the official target, an overshooting that is substantially above the 0.2 percentage point average recorded in the previous period. A test for the equality of means provides strong evidence that the role of inflation target as an anchor for inflation expectations was significantly eroded under President

[35] Because the oficial inflation target remained the same throughout our main period of study – President Rousseff's first term in office – using the target as a variable, as both papers did, is not an option.

Rousseff. Further inspection also reveals that all 62 observations for *Inflation Gap* under President Rousseff were above the median of 0.17 percentage point observed in the previous period.

Sample	Ex-Ante	During
	2004:M1-2010M12	2011M1-2016M2
Mean	0.20	1.43
Median	0.17	1.27
Max	1.72	2.79
Min	-1.10	0.24
Std. Deviation	0.71	0.59
N Observations	84	62
t-Stat H_0: Mean Ex-Ante = Mean During		-11.2
Pr(Mean Ex-Ante = Mean During)		0.00

Table 3. Summary Statistics for the Expected Inflation Gap Series. *This table shows summary statistics for two subsamples: before President Dilma Rousseff's first administration (Ex-Ante, 2004M1-2010M12) and after her first term (During, 2011M1-2016M2).*

Expanding into a broader yet simple econometric analysis, we now focus on comparing the dynamics of actual inflation and inflation expectations vis-à-vis the target over the two sample periods (*Ex-Ante* vs. *During* President Rousseff). We follow Bevilaqua et al. (2008) and Minella et al. (2003) in considering the impact of past inflation, exchange rate depreciation, and the output gap on expectation formation and on inflation dynamics. Rather than estimating single equation through OLS, as in those papers, we favor the use of a VAR and their implied Impulse-Response Functions (IRF) in order to capture potential feedback and more complicated dynamics among the variables. Our VAR model follows the previous literature and comprises the usual variables: *Expected Inflation Gap*, *Inflation*, *Exchange Rate Devaluation*, and *Output Gap*.[36]

Variance decomposition shown in Table 4 suggests that under President Rousseff deviations between inflation expectations and the inflation target reacted more strongly to actual inflation, exchange rate, and output shocks than in the previous sample period. This can be interpreted as expectations being less anchored by the inflation target under a less credible BCB. In other words, agents expect inflationary shocks to last longer into the future given a more *dovish* behavior of the Central Bank.

Further evidence pointing toward a possible loss of monetary policy credibility under President Rousseff comes from Impulse-Response Functions. We present the results for both subsamples: *Before* and *During* the Rousseff administration. The IRF point estimates indicate that there has been a stronger pass-through from exchange rate depreciation to inflation (Figure 10, Panel A); greater

[36] *Exchange Rate Devaluations* are calculated on a year-over-year basis, i.e. the exchange rate variation vis-à-vis the previous 12 months.

Sample	2004:M1-2010:M12			2011:M1-2016:M2		
Months Ahead	12	18	24	12	18	24
Actual Inflation	1.3	1.3	1.3	8.3	12.0	13.1
Exchange Rate	5.8	10.5	11.9	7.4	12.7	17.1
Output	6.7	6.3	6.2	2.9	4.8	5.6
Total	13.8	18.1	19.4	18.6	29.5	35.8

Table 4. Variance Decompositions. *This table shows variance decomposition statistics for the Expected Inflation Gap as it responded to actual inflation, the exchange rate, and output gap before President Rousseff's first term (ex-ante, 2004:M1-2010:M12) and since her coming to power (During, 2011:M01-2016:M02).*

inflation persistence (Figure 10, Panel B); and a somewhat larger impact of the business cycle on inflation (Figure 10, Panel C). Because the *During* Rousseff period is recent and comprises a small sample of observations, one should take these results with caution due to the relatively wide confidence intervals around the IRFs.

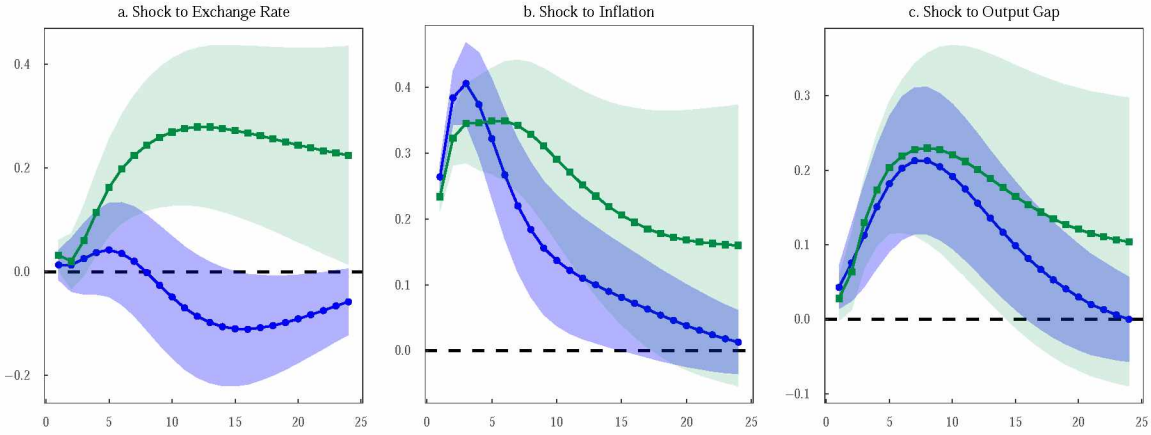

Figure 10. Impulse-Response Functions: Before- vs. During-Rousseff Administration. *IRFs with* ± 1 *standard error intervals estimated from a small-scale VAR model as described in Section 5. The blue line with rounded markers refers to the model estimated with data before the Rousseff administration (2004M1-2010M12) period, and the green line with squared markers refers to the model estimated only with data from the period under President Rousseff (2011M1-2016M2).*

5.2. Welfare Costs: Evidence from Loss Functions

The welfare costs of a substantially more *dovish* BCB under Rousseff have started to appear more strongly after 2014. In line with the theoretical prediction (Proposition 1) derived in Subsection A.1.4. of the Online Appendix on the non-zero welfare costs of a less credible Central Bank, here we show alternative empirical measures of the welfare costs of the policies pursued by the BCB after 2011. We follow Nikolsko-Rzhevskyy et al. (2014) and the previous literature on rules-versus-discretion

policy evaluation to calculate three alternative loss functions commonly used in the literature. Figure 11 illustrates the combination of high inflation and high unemployment in Brazil following the first Rousseff government, which is the shaded area in the figures. The first loss function (left panel) is the well-known *Okun Sacrifice Ratio*, i.e. the sum of unemployment and inflation. It is straightforward to understand that the higher the sum of these two components, the worse off is the country's economy. Even though it is a simple and intuitive empirical measure of welfare loss, the Okun Sacrifice Ratio assumes an economy's optimal inflation and unemployment are zero. Because this is unrealistic for all countries, we discuss a modified loss function that considers deviations from the inflation target and the output gap. Therefore, the second loss function (middle panel) is the sum of the actual inflation gap and output gap considering both the inflation target and the natural unemployment rate as having non-zero values. Finally, in order to penalize higher deviations by more than smaller deviations in the second loss function, we calculate a third loss function (right panel) that sums the square of the actual inflation gap and the square of the output gap.

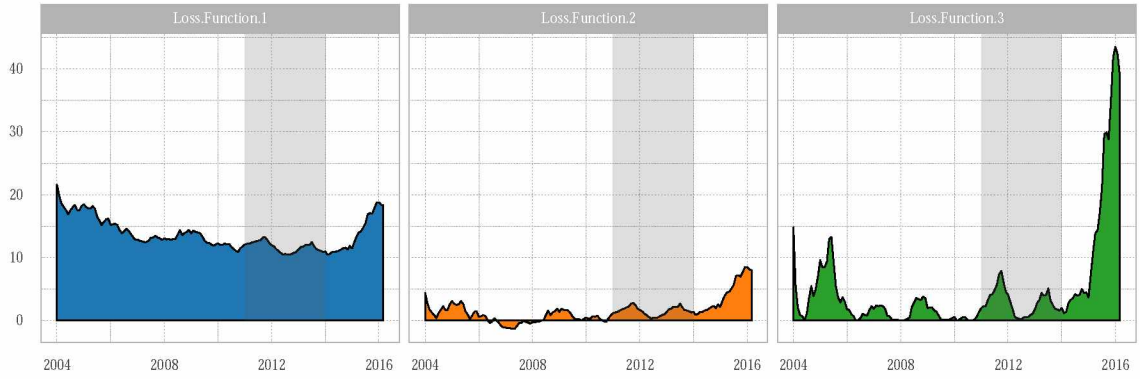

Figure 11. The Welfare Costs of a Less Credible Central Bank: Empirical Loss Functions. *Loss Function 1 (left panel) is the* Okun Sacrifice Ratio*, i.e. the sum of unemployment and inflation. Loss Function 2 (middle panel) is the sum of the actual inflation gap and the output gap considering both the inflation target and the natural unemployment rate as having non-zero value (see Section 5 for details). Loss Function 3 (right panel) carries the same idea as Loss Function 2, but sums the square of inflation gap and the square of output gap. The shaded area denotes President Dilma Rousseff's first administration (2011M1-2014M12).*

Welfare losses accelerated sharply and two measures of the loss function reached record territory at the end of 2015. It is important to notice that most of the welfare costs come with a certain lag, as can be seen by the increase on the loss functions after the first Rousseff administration (shaded area), when the more significant policy deviations occurred. As illustrated by our simple model, price-setting agents start expecting higher inflation after the Central Bank deviates from its previously credible policy strategy. This effect can be highly persistent, which makes credibility deconstruction even more

costly, for it suggests the necessity of another long and gradual process of building reputation with price-setting agents once again.

Finally, the observed welfare loss in Brazil is not an artifact of negative global economic conditions since Brazilian macroeconomic indicators worsened comparatively to the rest of the world. Making this distinction is important to avoid confounding the Brazilian deterioration with a general, worldwide deterioration. In Figure 12, we plot the Okun Sacrifice Ratio (Loss Function 1) of Brazil minus the median of the G20 countries. Higher bars indicate a worse situation of the Brazilian economy vis-à-vis the median of G20 countries. As expected, the sum of unemployment and inflation became significantly higher after 2014 when it reached levels comparable to the 2003-04 political crisis.

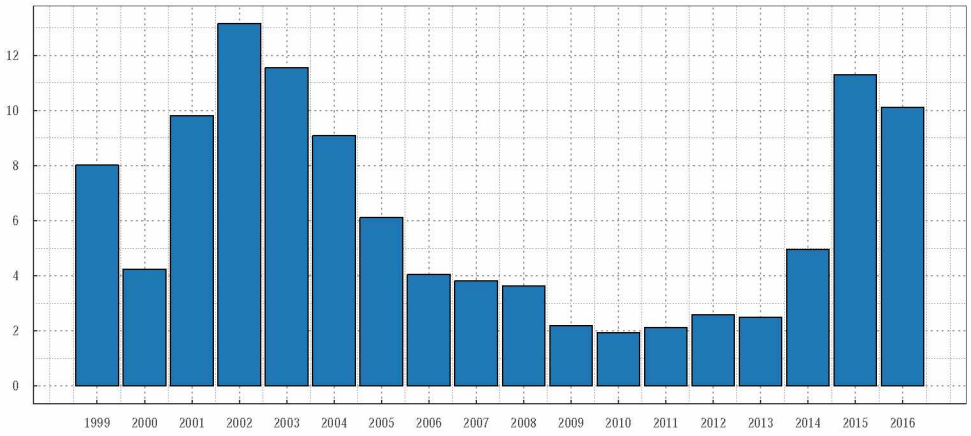

Figure 12. Okun Sacrifice Ratio: Brazil vs. G20 Median. *This figure plots the Okun Sacrifice Ratio (the sum of inflation and unemployment rates) for Brazil subtracted by the Median Okun Sacrifice Ratio of G20 Countries. Data for 2016 is based on projections.*

6. Conclusions

In this paper, we argued that a long-term effort of credibility construction in Brazil dating back to the 1990s suffered a setback in 2011, when the Board of Governors of the BCB was changed at the onset of the Rousseff government. We used a simple theoretical model to illustrate how credibility deconstruction, or deviations from target inflation to exploit short-term employment gains, bears welfare costs. In the empirical analysis, Markov-Switching Regression techniques showed that the BCB moved to an excessively loose monetary policy regime during the first year of the Rousseff administration (2011-14).

Reaction function estimations confirmed and assessed the magnitude of the BCB's deviations from previous behavior, indicating that monetary policy remained in this excessively dovish regime

throughout most of that period. During 2011-14, the degree of undershooting of the SELIC implied by the different models ranges from about 3 3/4 percentage points to 4 3/4 percentage points. The results were robust to alternative model specifications and estimation techniques.

We found preliminary evidence that the looser monetary policy under Rousseff's first term has contributed to a deterioration of inflation expectations and dynamics, which have become more sensitive to inflationary shocks. Lastly, widely used macroeconomic loss functions showed that actual inflation and unemployment worsened sharply following the monetary policy change under President Rousseff. More specifically, loss functions recorded their poorest performance in 12 years, with inflation and unemployment near double digits in 2015-16. This result cannot be explained by global economic conditions, since Brazilian macroeconomic indicators have deteriorated *relatively* to the median loss function of G20 countries. By showing the risks and costs of political interference in rules-based monetary policy, the Brazilian case might be viewed as providing support for Central Bank Independence.

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Appendix 2

Maybe illegal, maybe impeachable… but certainly a severe case of

Macroeconomic Mismanagement in Brazil

Claudio Paiva

Background

- As part of the consolidation of monetary stability finally achieved in Brazil after the "Real Plan," the **Fiscal Responsibility Law (FRL)** was enacted in 2000.

- It made **illegal** for the government to engage in **bad fiscal practices** that may be politically appealing in the short run but had long been recognized by economists as being a cause of inflation, macroeconomic instability, and low levels of sustainable growth

  - The FRL was therefore conceived to help preclude politicians from exploiting these practices for short-term political gains while hurting the country in the long run.

- As we will see, the FRL was not enough to stop the macroeconomic mismanagement and ensuing economic crisis at the heart of the impeachment process for President Rousseff.

The Rules in the FRL and the Evidence

Some Rules:

1. The government cannot carry open positions ("overdraft") in accounts that pay for current expenditures (recurring expenses)
2. The government cannot have open positions in financial institutions it controls

Some Evidence:

A. The government subsidizes credit to agriculture and to some manufacturing sectors. These subsidies are current expenditures (they happen every year and do not refer to the purchase of public assets). In 2014, the government failed to pay for some R$30 billion worth of subsidies that had been granted to businesses by Banco do Brasil and by the BNDES (development bank). Both institutions are controlled by the Government.

B. Still in 2014, the government also failed to cover some R$10 billion in social transfers made by Caixa Economica Federal, another financial institution controlled by the government.

The Government's Arguments

1. We didn't do it
   - there were simply some delays in transferring the money from the Treasury to the banks
   - the fact that these delays happened every month for the several months leading up to the presidential elections was a coincidence - we had no intention of hiding a severe budget shortfall before the elections

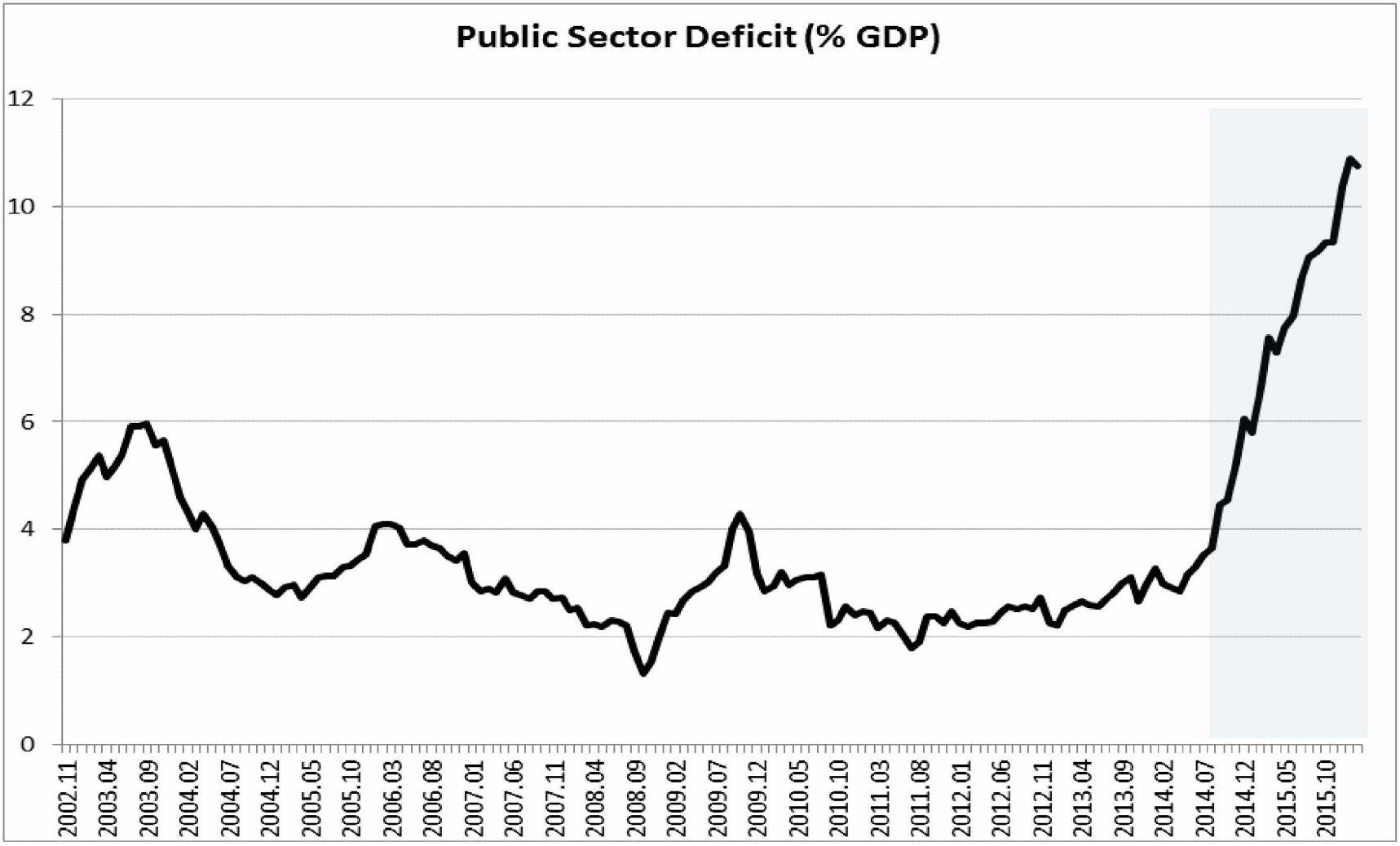
2. Even if we did it, other governments also did it
   - during President Cardoso's government, these delays summed up to about 0.01% of GDP
   - during President Lula's government, these delays summed up to about 0.05% of GDP
   - the examples in the previous slide are about 1% of GDP, and they are <u>not</u> believed to be all

3. We may have done it, but it was in the previous term; since Rousseff was re-elected and this is a new term, she cannot be impeached for those "slippages"
   - from a purely legal perspective: maybe (not my specialty)
   - from an economic and logic perspective: really?!

Was there an intention to mask a severe budget shortfall before the elections? Let's look at the next graph…

Deficit explodes after elections

Evidence of "pedaladas" to hide true state of public accounts during the campaign?



The Fiscal Mismanagement was Accompanied by Additional Policy Mistakes and Macro Mismanagement

1. **Monetary policy was too loose for too long:**
   - There is evidence of political interference in the Brazilian Central Bank: interest rates were forcibly reduced to record lows even though the inflation gap was at record highs
   - Inflation expectations were above the inflation target every single day of the Dilma administration; yet, interest rates were reduced to record lows

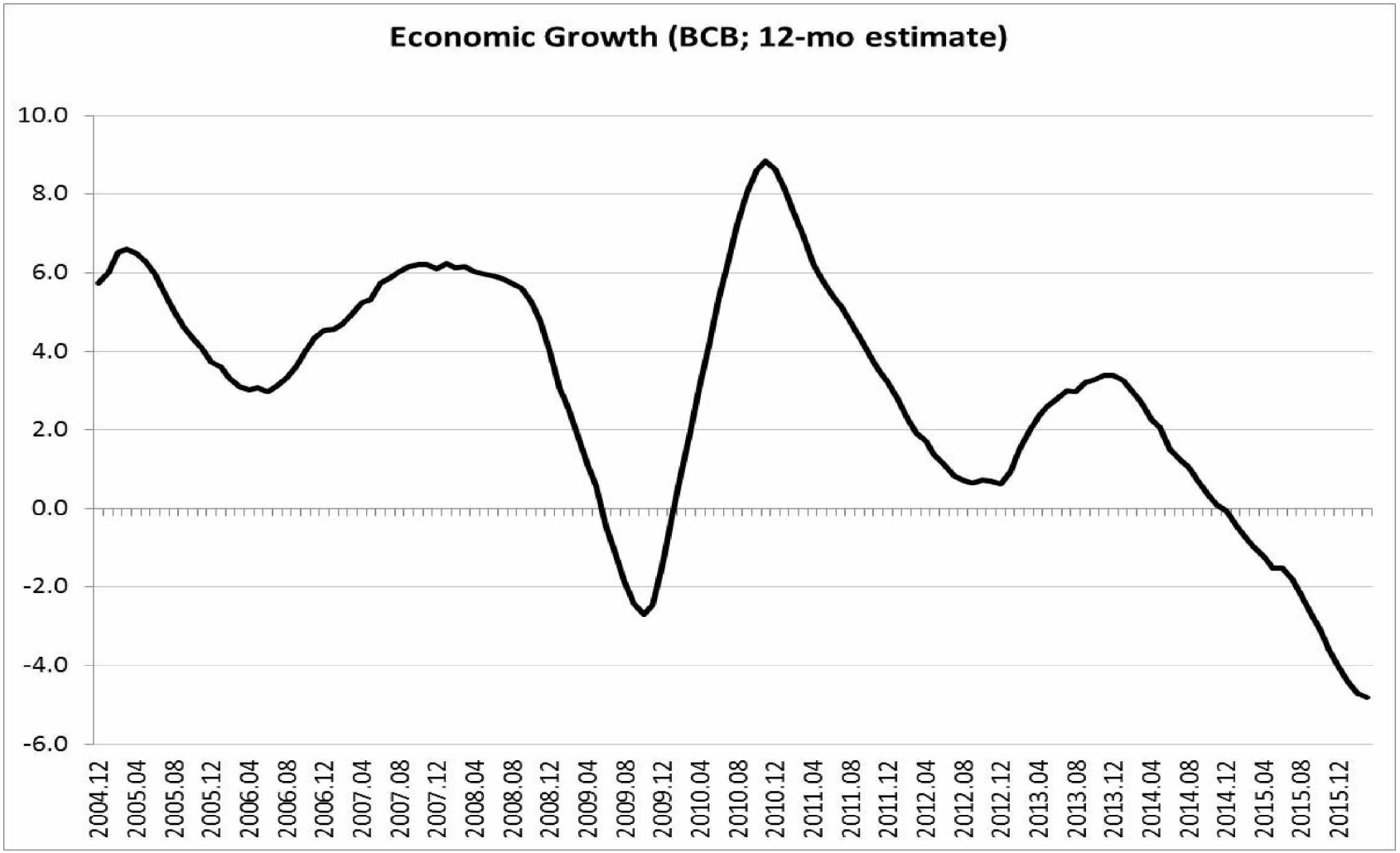
2. **The share of government-directed and subsidized credit rose to nearly 50% of total private sector credit**
   - What's the criteria to approve a business loan? Profitability, efficiency, or political expediency?

3. **In addition to the budget practices that may have broken the FRL, other (legal) practices were also bad choices;**
   - Excess emphasis on ad hoc subsidies and stimulus to consumption
   - Trying to hold inflation back by setting energy prices artificially low
   - Overall disregard for well-established economic principles of fiscal and monetary management
   - Ignoring the impact of short-term patch solutions on long term investment

Did all these interventionist policies work?

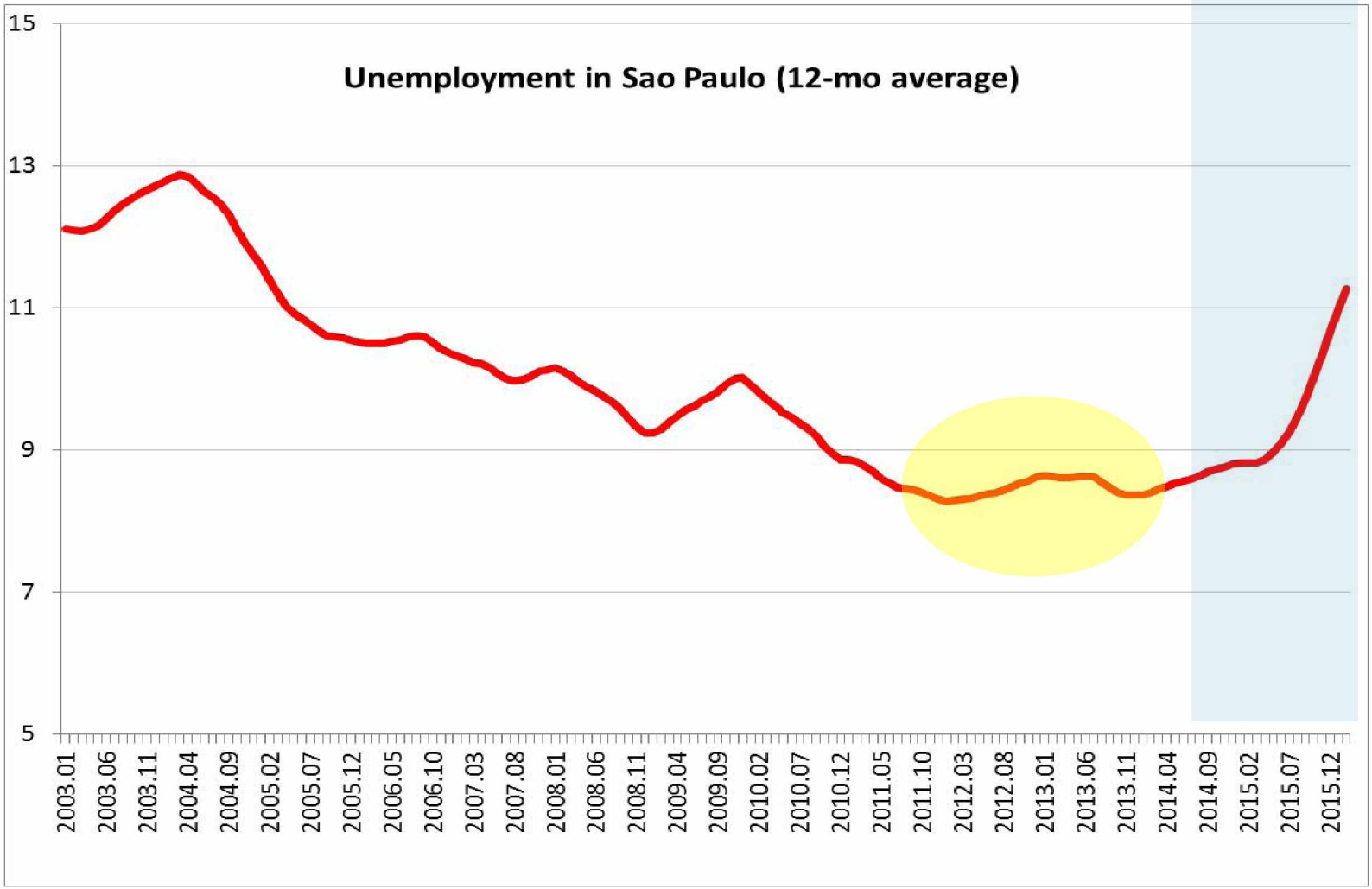
The Early Stages of the Worse Economic Crisis since the Great Depression

Growth Collapses Despite or Because (?) of Loose Money and Loose Fiscal Policies



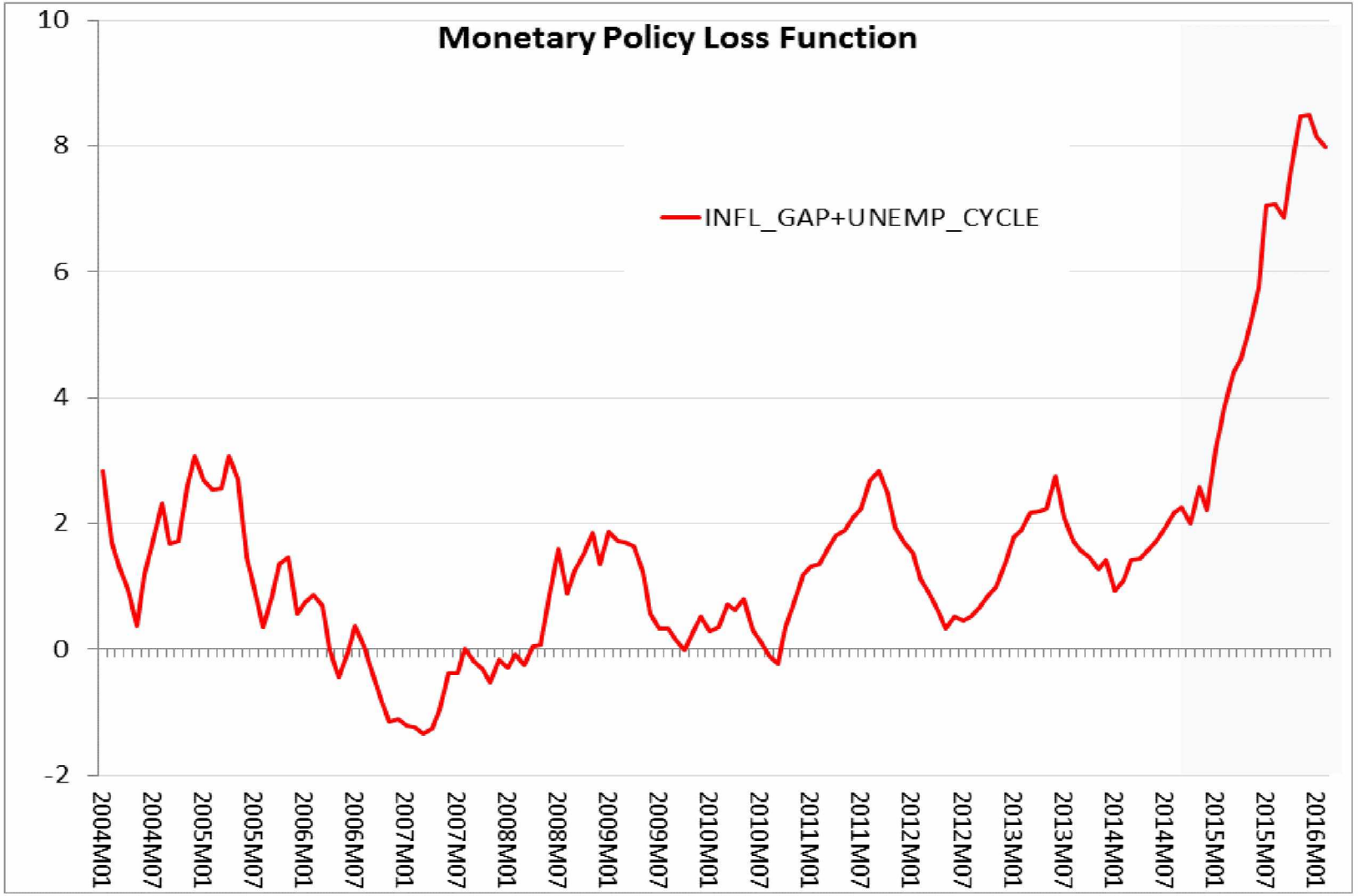
Macroeconomic Mismanagement

Unemployment changed little following "unconventional" policies and exploded after elections



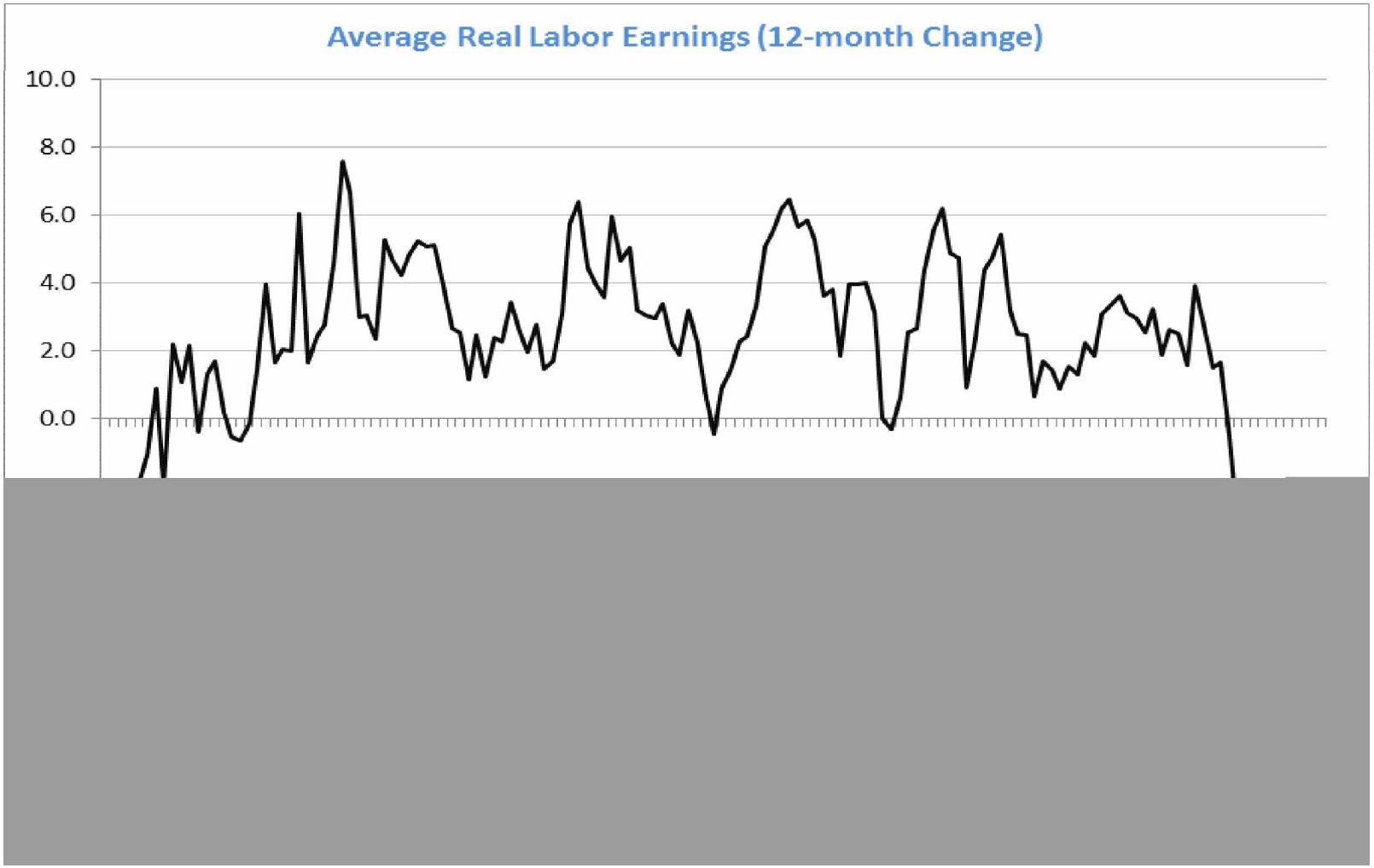
Macroeconomic Mismanagement

Worse of both worlds: high inflation and high unemployment



Pro-poor?

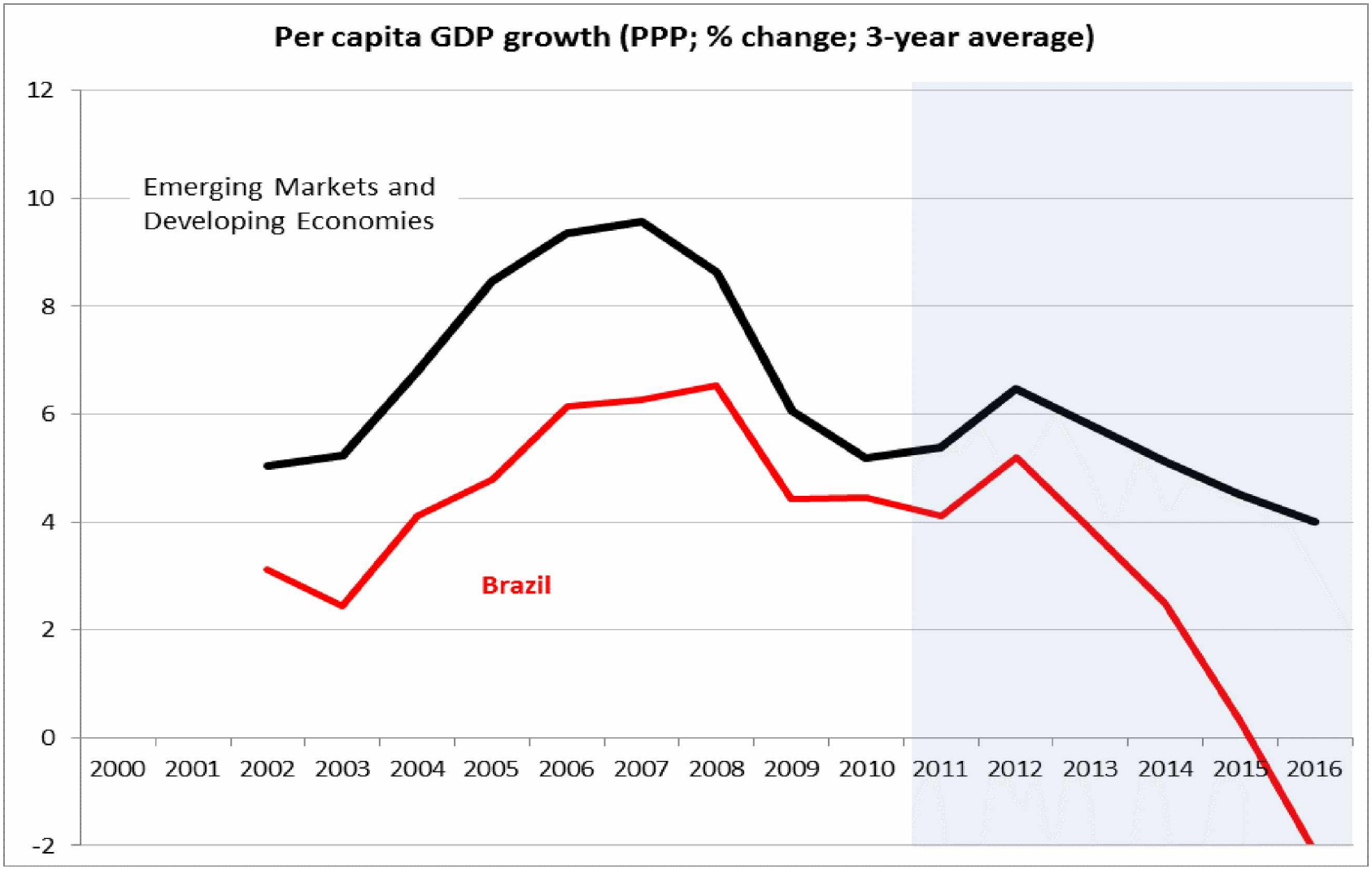
Macro mismanagement already hurting workers



Macroeconomic Mismanagement

Economic crisis not due to external environment

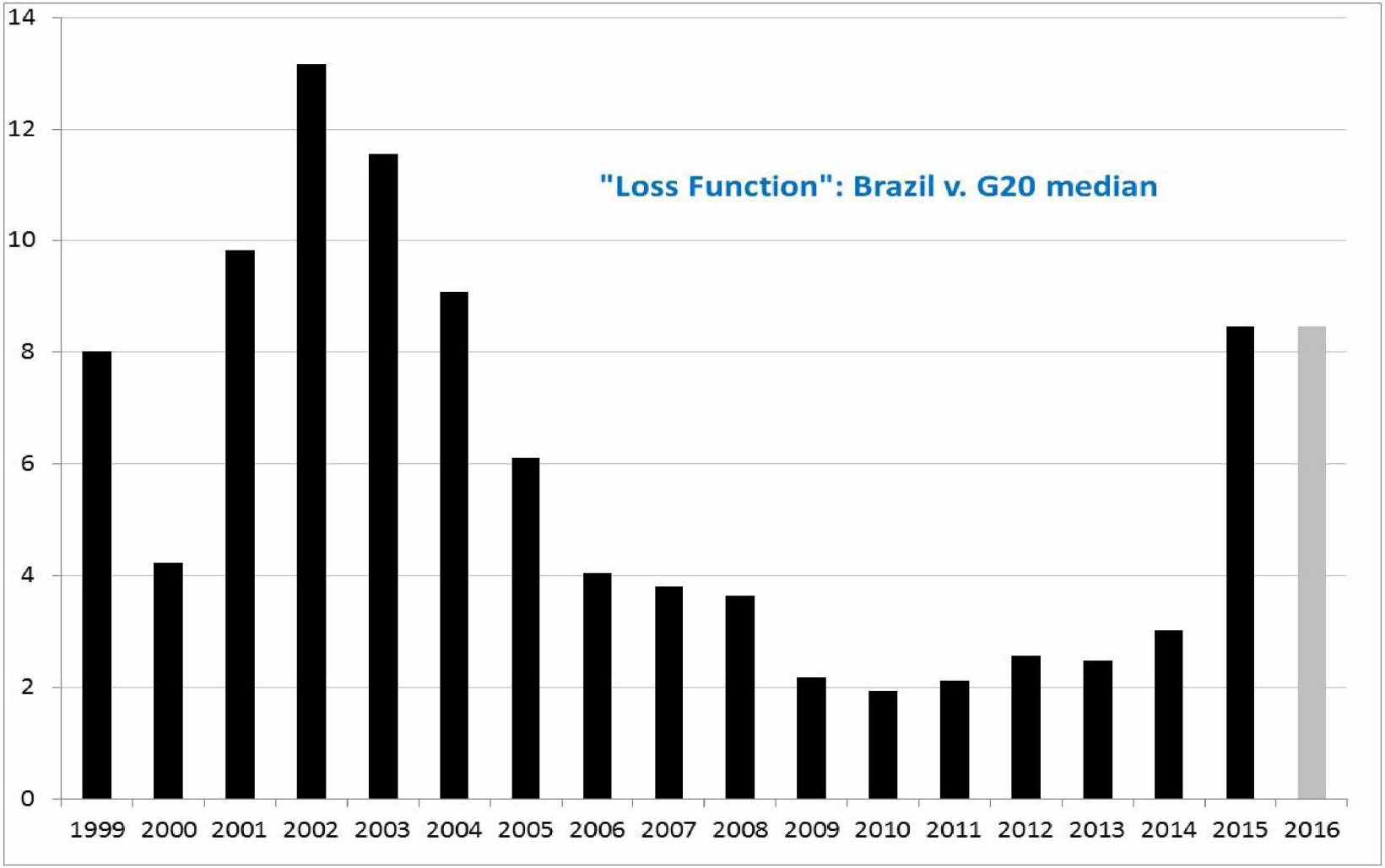
Brazilian indicators got worse compared to the rest of EM and Developing Countries



Macroeconomic Mismanagement

Economic crisis not due to external environment

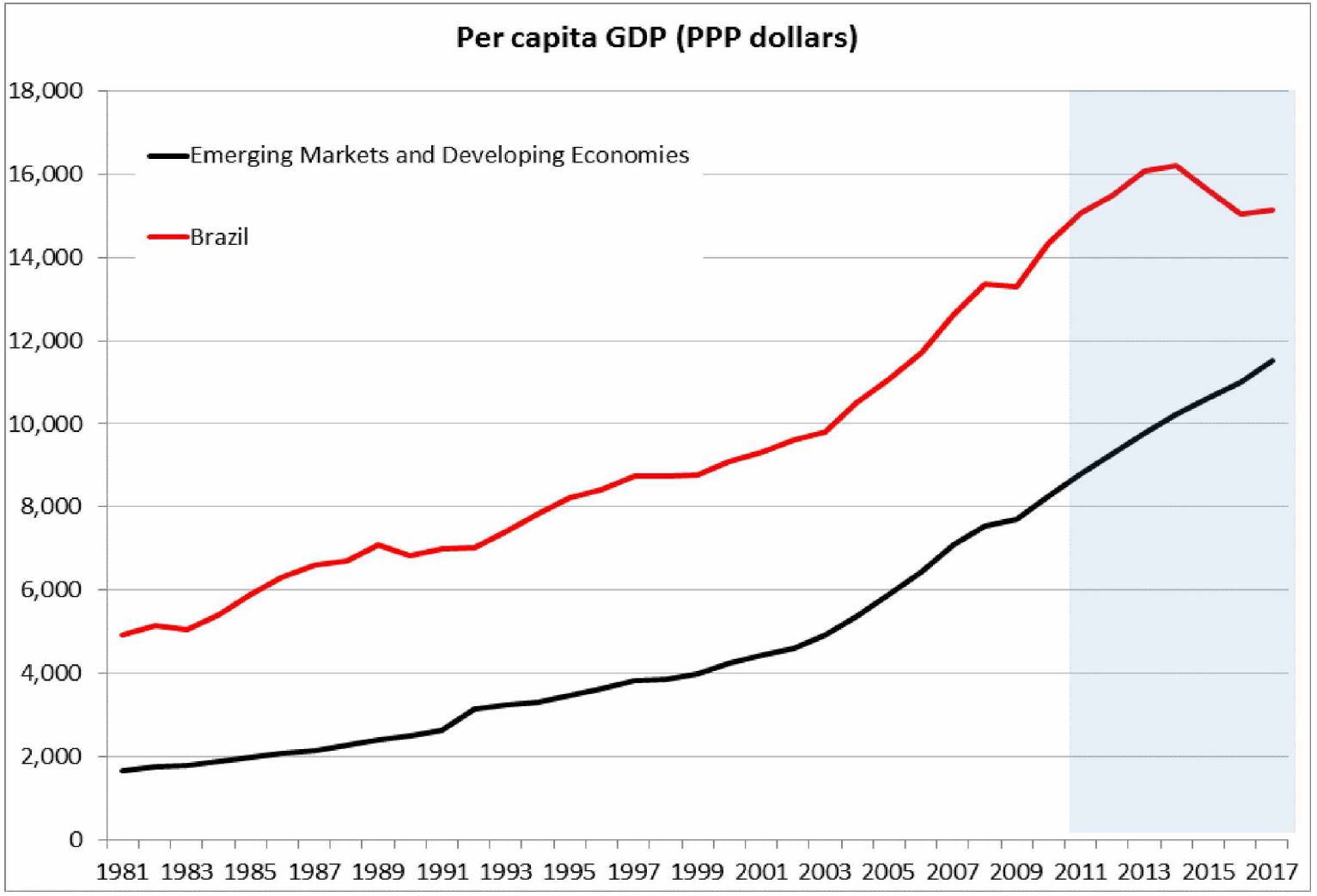
Brazilian indicators got worse compared to the rest of the G-20



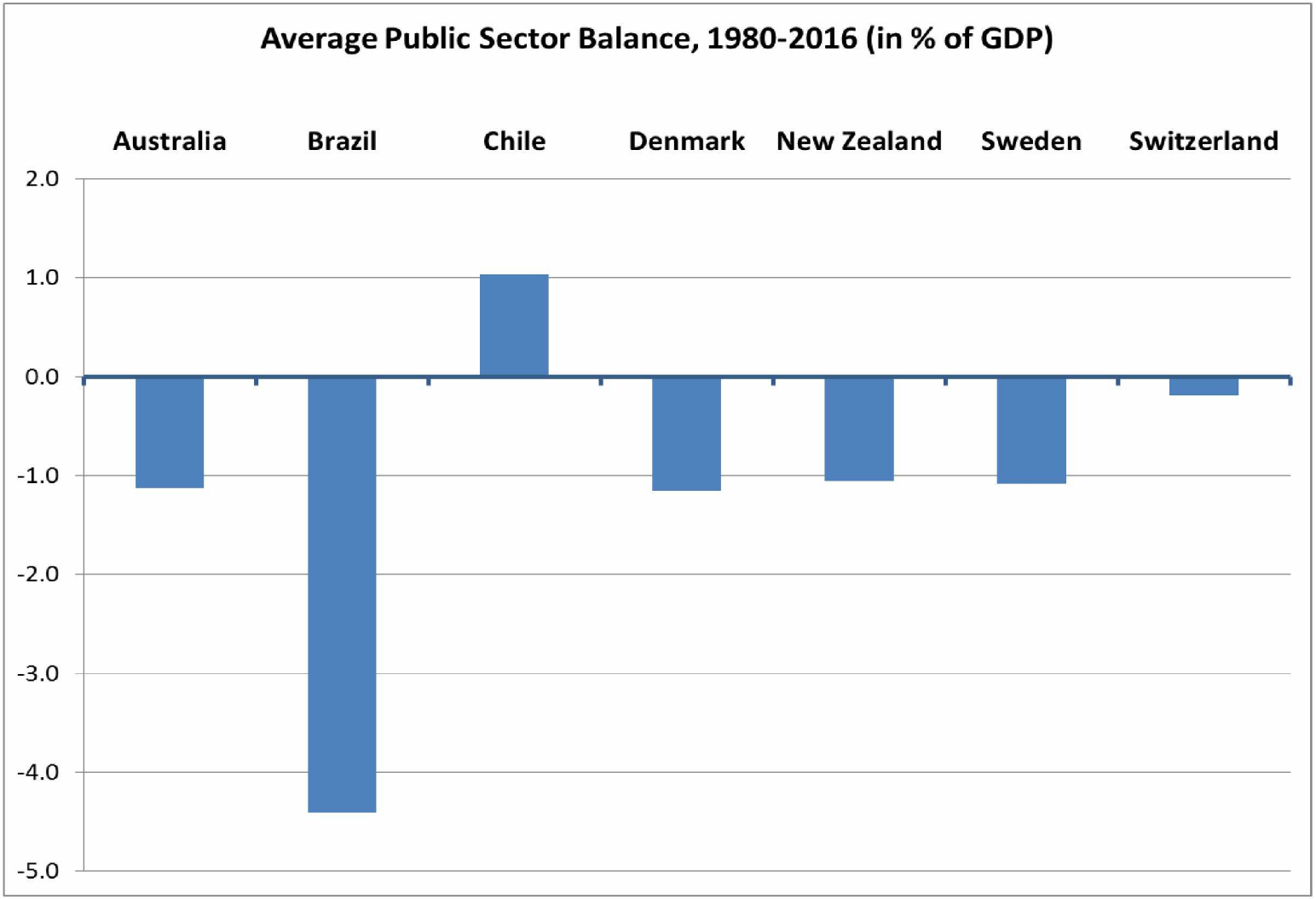
Macroeconomic Mismanagement

Economic crisis not due to external environment

Brazilian indicators got worse compared to the rest of EM and Developing Countries



Spurring Social Development and Lower Inequality Does NOT Require Government Deficits! In fact, there is a near-consensus among non-ideological economists that social development requires fiscal sustainability



The Usual Leftonomics Thought

"Enquanto Lula viu-se beneficiado pelas "benesses do ciclo de commodities", a presidente (Rousseff) pegou uma longa fase de depressão da economia mundial.

Para sustentar o dinamismo do Brasil em um contexto de desaceleração global seria necessário ter uma indústria forte. Mas, para tanto, o país precisava ter desvalorizado bastante o real, como já vinha alertando há alguns anos o ex-ministro Bresser-Pereira.

A presidente teve a coragem de enveredar na direção necessária, realizando significativa redução da taxa de juros contra o desejo do mercado financeiro.

Ao diminuir o ganho rentista, reduz-se a atratividade do Brasil como plataforma de valorização do capital especulativo internacional e, dessa forma, ajuda-se a controlar o sobrepreço da moeda.

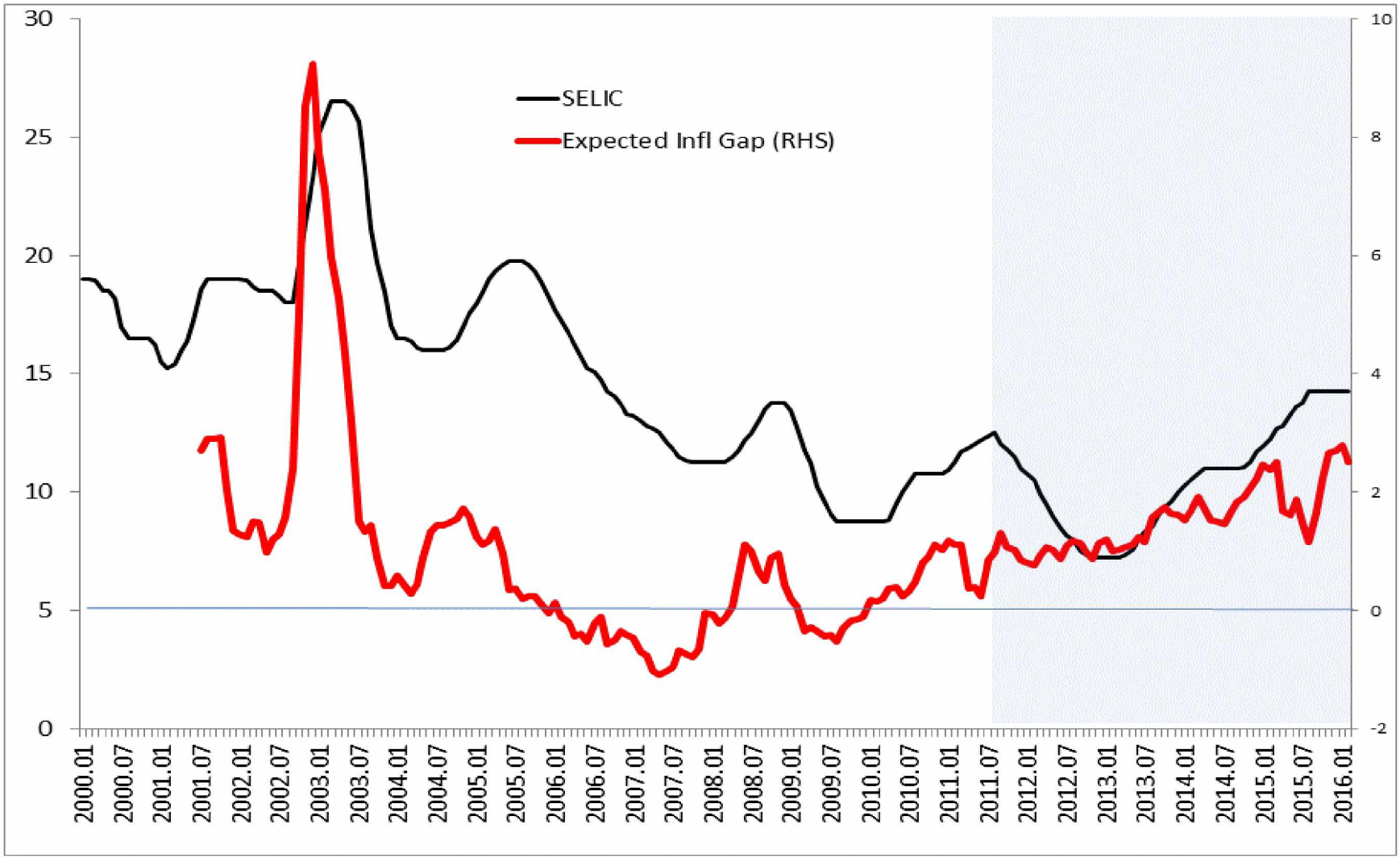
Ato contínuo, a equipe econômica e o Banco Central, orientados por Dilma, provocaram uma midides valorização do real, além de reforçar as medidas voltadas para restringir a liberdade de entrada e saída dos especuladores. ***Em outras palavras, mesmo que, como aponta Bresser-Pereira, não tenham sido na proporção devida, foram dados passos ousados para romper as amarras que impediam o Brasil de retomar o crescimento"***

(Andre Singer, Lula's Press Secretary, FSP, Jan 4 2014)

Monetary Mismanagement

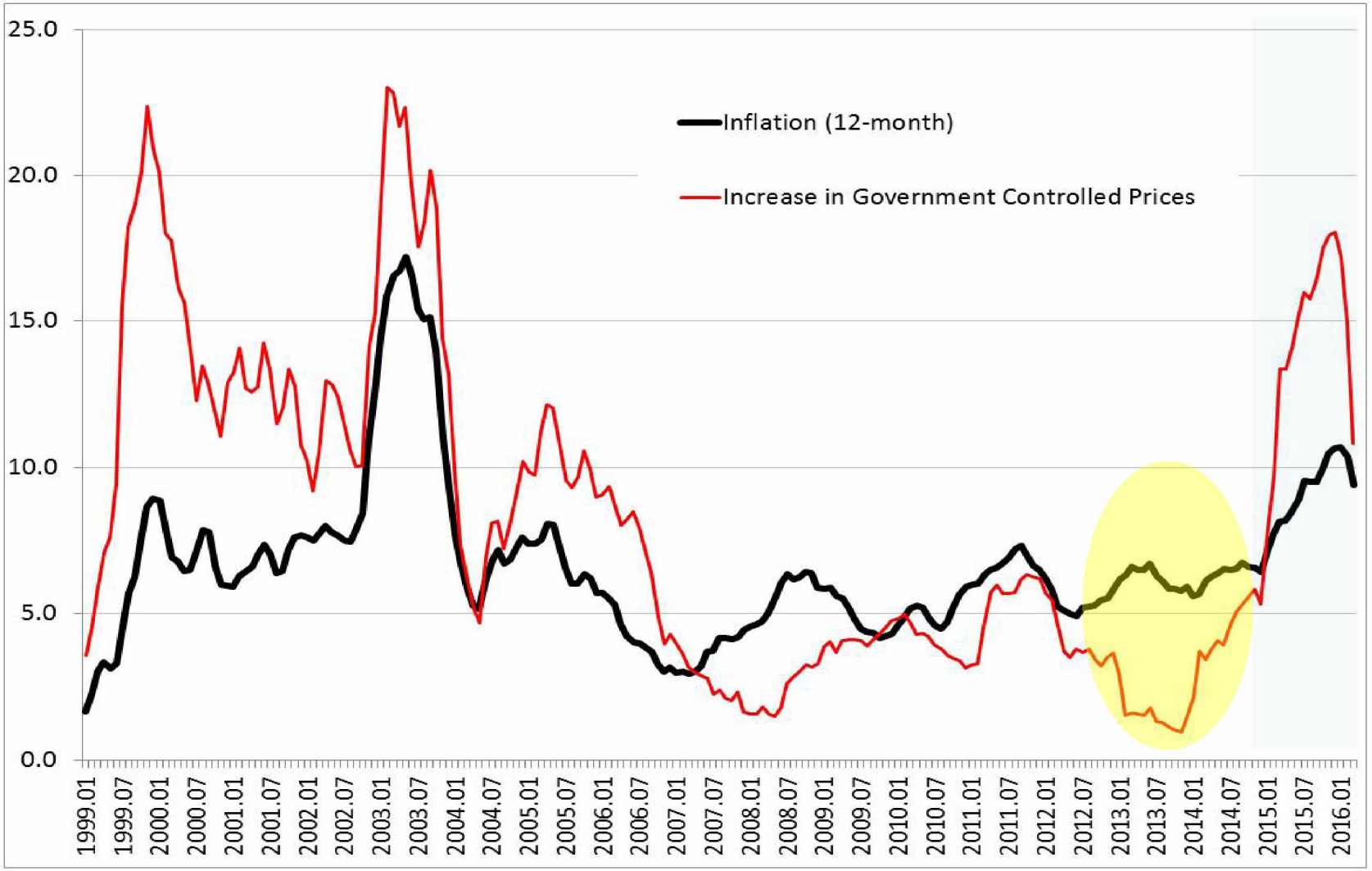
Monetary Mismanagement

SELIC reduced to record lows as inflation expectations are persistently above target



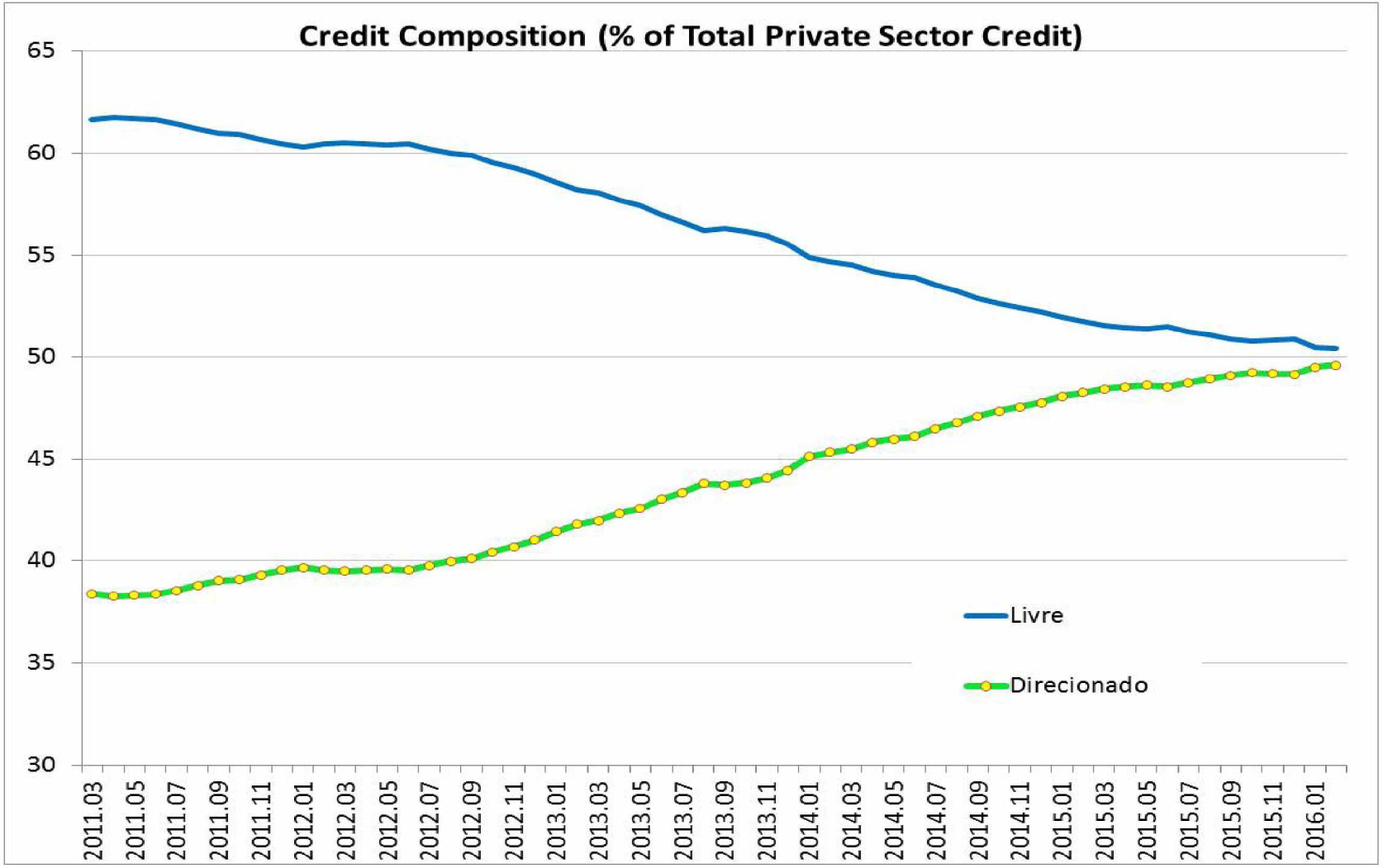
Macroeconomic Mismanagement

Strategy of adjusting energy prices below costs to artificially contain inflation leads to heavy losses, lower investment by energy companies. Prices jump after elections



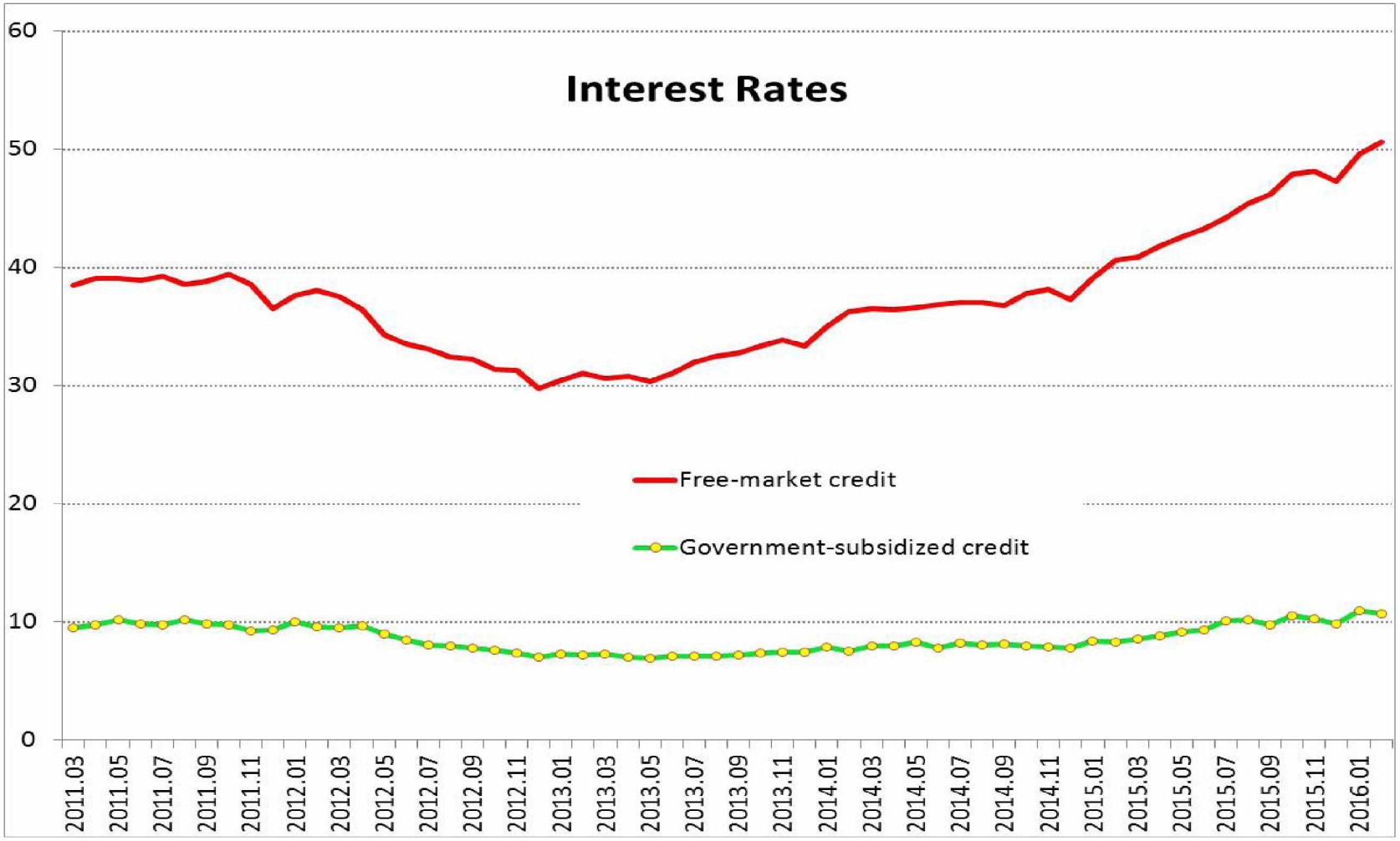
Macroeconomic Mismanagement

Increased government intervention and more subsidies



Macroeconomic Mismanagement

Interest rates below market for the government-chosen at the expense of more fiscal deficit and instability



Full Disclosure

- I studied at Unicamp under the "guidance" of many of President Roussef's closest advisers
  - Some of the same people who thought freezing prices 5 times and arresting shop owners would solve our inflation problem
- I later learned (a bit) of economics here at Illinois and at the International Monetary Fund (the much I don't know is all my fault)
- I did NOT want Rousseff to be impeached and PT to leave power…
  - (in fact, I am on record in early 2014 expressing my desire that Rousseff would be re-elected and remain as president through 2018)
- … because I wanted the Brazilian voters to associate the (then upcoming) worse economic crisis since the Great Depression with those who created it all by themselves.