Fiscal Sustainability and Inflation Dynamics: The Case of Brazil

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Abstract

This paper examines the relationship between expectations of fiscal sustainability and inflation in Brazil. I use Vector Autoregressions (VAR) to analyze inflation dynamics and plot impulse responses using empirical data from Brazil from 2001-2019. I also introduce sovereign Credit Default Swaps (CDS) as a signal of expected future fiscal sustainability and find a correlation between CDS premia and unexpected inflation, supporting a fiscal theory interpretation of inflation. This work builds on literature that highlights the interdependent role of fiscal and monetary policy in inflation stabilization by focusing on Brazil, a country with a notable history of fiscal and monetary policy changes.

Keywords: Inflation, monetary policy, fiscal policy, sovereign credit default swaps, fiscal theory of the price level, Brazil.

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1 Introduction

A monetary policymaker's *credible* commitment to fighting inflation is widely considered a critical factor in stabilizing inflation (Sargent, 1982; Clarida et al., 1999; Lin and Ye, 2009; Mendonça and Souza, 2012). However, a less explored factor in understanding inflation dynamics is the significance of credible commitments to fiscal sustainability — manifested as the government's capacity to signal that it can generate future surpluses for inter-temporal deficit financing. This factor is important when understanding inflation dynamics under the fiscal theory of the price level (Leeper, 1991; Sims, 1994; Woodford, 1995; Cochrane, 2023b) framework.

Inflation stabilization policies depend on monetary and fiscal policy credibility to anchor expectations. In the words of Woodford (2001), a central bank with a price stability mandate must also be concerned with how fiscal policy is determined. This interdependence of fiscal and monetary policy underscores the argument in Sargent and Wallace (1981)'s "Some Unpleasant Monetarist Arithmetic," which posits that effective inflation targeting necessitates a commitment to the sustainability of public debt; monetary policy cannot curb inflation in isolation. When there is no credible commitment to fiscal sustainability, the perceived risk of financing public debt through monetary expansion builds inflationary pressures (Mendonça and Silva, 2016).

In Brazil, establishing monetary authority credibility is widely accepted as the reason hyperinflation was brought down by the landmark 1994 *Plano Real* stabilization program (Baer, 1989; Nazmi, 1996; Ayres et al., 2021). Despite gaining monetary credibility through establishing an increasingly independent central bank after 1994, Brazil's post-*Plano Real* inflationary episodes appear correlated with uncertainty surrounding the government's commitment to repay its debt. In this paper, I examine the effects of uncertainty around these fiscal commitments on inflation in post-*Plano Real* Brazil, particularly the period from 2001 to 2019.

I briefly review Brazil's fiscal and monetary policy history before and after the 1994 stabilization (*Plano Real*). Next, I introduce relevant literature on the fiscal theory of the price level, the theoretical framework underpinning this paper. I also review the literature surrounding credibility shocks and ways to measure fiscal credibility. I build on a New Keynesian rational expectations model derived from the fiscal theory of the price level to show how inflation dynamics respond to fiscal variables in Brazil. In addition, I empirically demonstrate the theoretical prediction that inflation shocks are correlated with changes in expectations of future real surpluses and costs on the public debt.

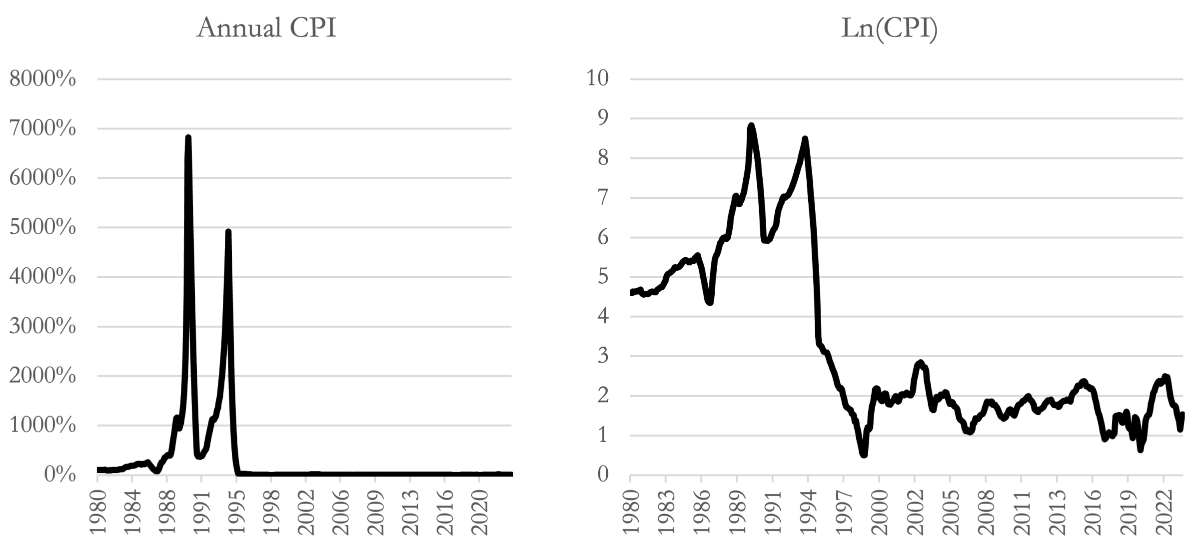
2 Literature Review

I begin with a review of Brazil's fiscal and monetary history through a theory-backed narrative similar to the approach of Sargent (1982), Sims (2011), and Cochrane (2022a). Next, I expand on the fiscal theory of the price level, the concepts of fiscal and monetary credibility, how they relate to inflation dynamics, and methods to measure fiscal credibility.

2.1 A Brief Fiscal and Monetary History of Brazil

The year 1994 marked a turning point in Brazil's economic history. Faced with hyperinflation, where prices doubled every month, Brazil implemented the *Plano Real*, a stabilization program that not only ended a decade-long inflationary spiral (Figure 1) but also laid the groundwork for greater central bank independence and fiscal sustainability. This chapter dissects the essential points of Brazil's fiscal and monetary policies from the pre-1994 era of hyperinflation to the post-stabilization period, highlighting the role of different policies and governments. The importance of considering the fiscal influences on inflation becomes apparent by examining the successes and failures of Brazil's economic policies.

FIGURE 1: Annualized CPI Inflation and Log of CPI Inflation, from 1980 to 2023 (OECD)



2.1.1 Inflation before 1994

Moderate to high inflation was a regular occurrence in Brazil before 1994. Since 1947, Brazil had seen multi-digit inflation every year except for 1953. Until the 1980s, under military rule, economic policy focused on attaining high growth rates (averaging 8% annual GDP growth from 1979 to 1981), while tolerating "moderate" 50% inflation levels. To ease living in an inflationary environment, wages were indexed (Nazmi, 1996). However, in the late 1970s, with the oil crisis, volatile exchange rates, and a failed stimulative low interest rate policy, inflation went up from "tolerable" 50% levels to 100% in 1980 (Ayres et al., 2021).

In the early 1980s, Brazil's macroeconomic policy was more concerned with reducing the need for foreign capital than tackling skyrocketing inflation. The trade balance reversed from a deficit to a surplus, the exchange rate largely devalued, and interest costs on external debt increased. It was only in 1986, after the end of the military rule, that the new democratically elected government introduced the first of what would become a series of six stabilization plans [1] to fight inflation (Ayres et al., 2021).

The first few plans of this series targeted inflation inertia instead of inflation expectations. They temporarily froze prices and exchange rates, prohibited wage indexing, or would introduce new currencies that cut three zeros from the former. All five plans before the 1994 *Plano Real* failed: inflation shot back up a few months later (Figure 1).

Inflation inertialists suggest that the early stabilization plans might have worked better had prices been unfrozen in a timely fashion (Baer, 1989; Bresser-Pereira, 1990), but politicians were unwilling to unfreeze prices before elections. There was a lack of independence of the monetary authority at the time, even though early stabilization plans attempted to reform the central bank to give it some more independence. Still, as Nazmi

[1] Stabilization Plans:
February 1986: *Plano Cruzado I*;
November 1986: *Plano Cruzado II*;
June 1987: *Plano Bresser*;
January 1988:*Política Feijão com Arroz* ;
January 1989: *Plano Verão*;
March 1990: *Plano Collor*;
July 1994: *Plano Real*.

(1996) suggested, the Collor government might not have had credible intentions to bring down inflation. The Collor Plan confiscated private deposits for 18 months in 1990, reducing M4 by up to 80%. Before the 1990 plan, the government benefited from the "inflation tax" that Sargent (1986) described in his "Open Letter to the Brazilian Finance Minister." The government would pay negative real interest on its debt due to inflation, which would no longer be the case if inflation came under control. A way to continue benefiting from the fixed nominal rigidity of debt was to remunerate the confiscated deposits at a rate lower than the actual inflation rate.

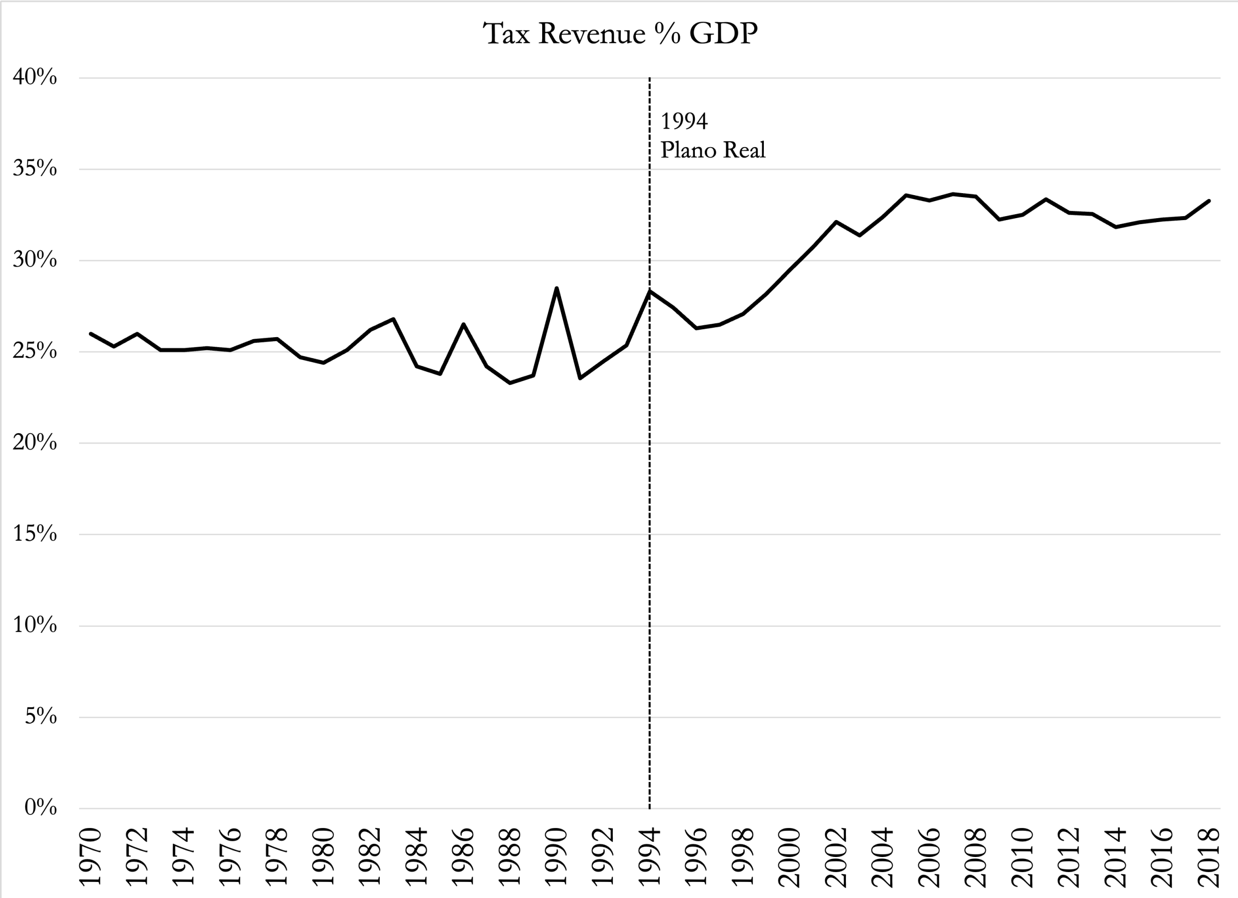
The early stabilization attempts also failed to address forward looking inflation expectations through credible reforms. None of the plans prior to the Plano Real implemented meaningful fiscal reforms. They slightly increased tax revenues, or introduced some microeconomic reforms linked to productivity, such as administrative reforms in the government or privatizations to reduce expenses (Nazmi, 1996), but it was only after the *Plano Real* that bolder fiscal measures ensured that the public accounts would become more sustainable, for instance, by permanently increasing tax revenues to a new level, from 25% to 33% of GDP, as seen in Figure 2. However, as I discuss later, tax revenues plateaued at this level after the *Plano Real* even though government spending continued to increase into the 2010s.

2.1.2 The Successful 1994 *Plano Real* Stabilization

The 1994 *Plano Real* marks a transition in Brazil's fiscal and monetary history, with improved fiscal balances, greater access to debt financing, and the start of a higher degree of independence for the monetary authority. It sent a credibility shock in both fiscal and monetary policy.

First, the 1994 stabilization plan did not set price controls, shifting from the prior focus on inertial inflation to changing expectations. The *Plano Real* introduced a "shadow currency", the "Unit of Real Value" (URV), to facilitate the perception of a stable currency and reduce inflation expectations. The URV was a temporary parallel unit of account to the inflated *Cruzeiro Real* and pegged to the Dollar. Prices were listed in both URVs and

FIGURE 2: Tax Revenue as a percentage of GDP from 1990 to 2023 (Observatório de Política Fiscal FGV-IBRE)



Cruzeiros Reais, but transactions still occurred in *Cruzeiros Reais*. A few months later, the URV was replaced by the new currency, the *Real*, which initially had a crawling peg [2] to the Dollar (Nazmi, 1996; Ayres et al., 2021).

On the monetary policy side, central bank and treasury responsibilities were divided, and the central bank gained more autonomy than before. For example, prior to 1994, the number of members in the National Monetary Council fluctuated significantly and included politicians. After the plan, the council was reduced to only three key members: the central bank governor, the finance minister, and the planning minister.

The imposition of rules over discretion in how the council was composed is associated with better policy outcomes (Ayres et al., 2021). Prior political interference had weakened the effectiveness of monetary policy and undermined the monetary authority's credibil-

[2] The crawling peg was determined through an unannounced mix of past inflation and the Dollar.

ity in its fight against inflation. For instance, in previous plans, there was strong political pressure for the monetary authority to lower interest rates to less restrictive levels (Nazmi, 1996). With newfound credibility, the central bank increased the reserve requirements for banks significantly, limiting the banks' ability to leverage deposited funds, effectively reducing the money multiplier. Inflation dropped dramatically, from 4,005% in July 1994 to 27% the following year, and hyperinflation did not return.

There is, however, debate amongst scholars on the role played by monetary policy in taming hyperinflation. Sargent (2012) contended that monetary policy was but a "sideshow." There is only so much the monetary authority can do to bring down inflation; the other part of the job lies with the fiscal authorities. In 1993, in preparation for the *Plano Real*, the government introduced new taxes to prevent a fiscal imbalance when seigniorage revenues fell the following year. This fiscal reform increased primary surpluses. Persistent inflation "is always and everywhere a fiscal phenomenon, because persistent deficits must be financed by printing money" (Sargent, 2012).[3] Other authors share this view of a fiscal explanation to the hyperinflation (Loyo, 1999).

Another critical achievement was regaining access to international capital markets by reaching an agreement on external debt obligations under the Brady Plan, ending cycles of debt rescheduling (Ayres et al., 2021). By reopening the economy to foreign capital markets, debt became a more viable option of public financing. That, coupled with a more sustainable fiscal path, led to a fall in money growth rates post-1994 that endures to today (Figure 3). The lasting shift in the source of deficit financing after the *Plano Real* is also evident from the significant drop in seigniorage revenues to below 0.5% of GDP from 1995 onwards (Figure 4).

Finally, after 1994, the government continued to promote microeconomic reforms such as privatizing state-owned enterprises and bank reform. After a speculative attack on the *Real*, the crawling peg was dropped to favor a floating exchange rate in 1999. The shift to floating exchange rates also led to the central bank adopting an inflation-targeting regime (Figure 5). Soon after, the government also started announcing fiscal targets and enacted

[3] A deficit can be financed either through debt or money growth:
$\text{Fiscal Deficit}_{(t)} = \Delta(\text{debt})_{(t)} + \Delta(\text{money})_{(t)}$

the fiscal responsibility law, imposing more constraints on spending that ensured the surpluses that Brazil saw in the early 2000s (Ayres et al., 2021). Overall, the *Plano Real* introduced a credible monetary policy that helped anchor expectations and bring down hyperinflation, alongside fiscal reforms that signaled a commitment to fiscal sustainability.

FIGURE 3: Logarithmic scale of M0 Monetary Base in Brazil from 1946 to 2019 (Brazilian Central Bank)

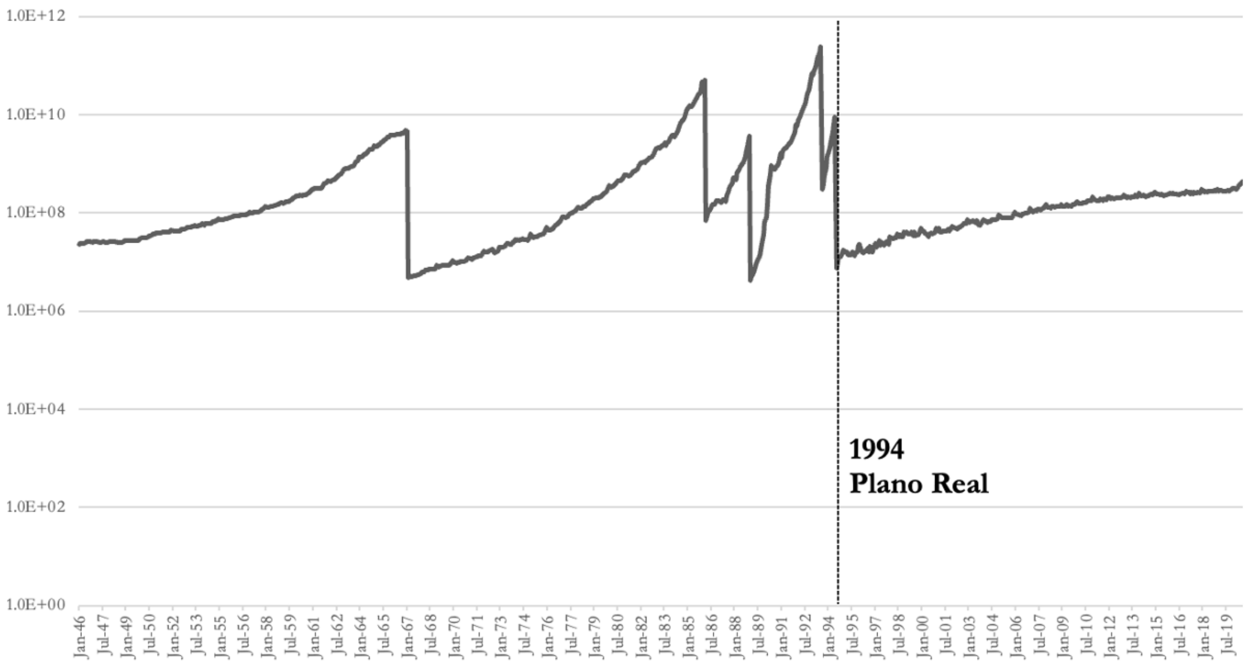
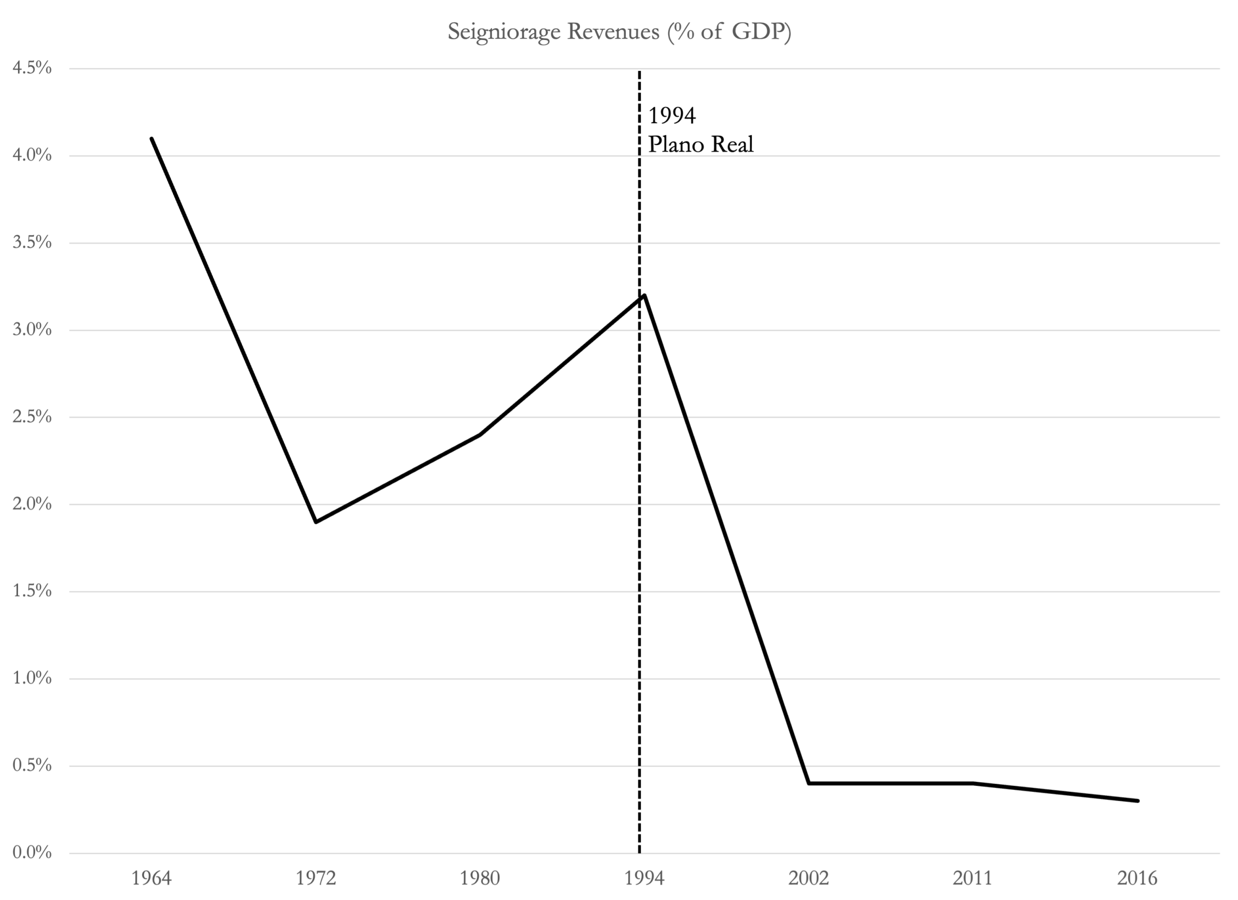


FIGURE 4: Seigniorage Revenues, percent of GDP (Ayres et al., 2021)

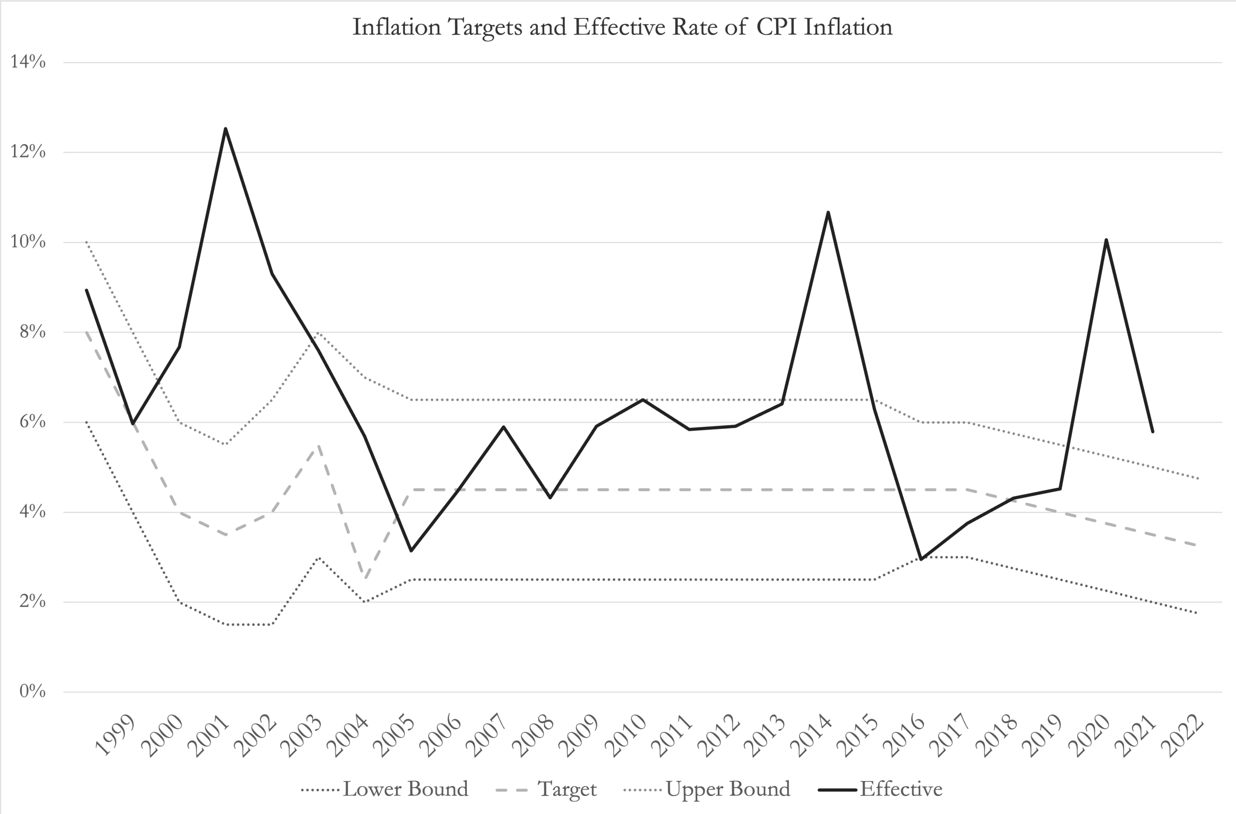


The *Plano Real*'s credibility shock thus closely fits in as an example of Sargent (1982)'s definition of factors that led to the end of the four big inflations in the 20th century: the establishment of credible independent central banks and reforming the fiscal regime. The *Plano Real* is nearly but not a perfect example of this because full central bank independence was not achieved, nor were the fiscal reforms sustainable, as the more recent period will show.

2.1.3 After 1994: The 2002 Inflation

After 1994, there were three significant episodes of inflation drifting above the central bank target: in 2002, in 2015, and 2021 (Figures 5 and 6). I focus on the two first episodes of inflation, firstly because these were unique to Brazil and unrelated to the COVID-19 pandemic, but also because the full disinflation cycle of the more recent uptick in inflation

FIGURE 5: Central Bank Inflation Target Range and Effective CPI Inflation (Brazilian Central Bank)

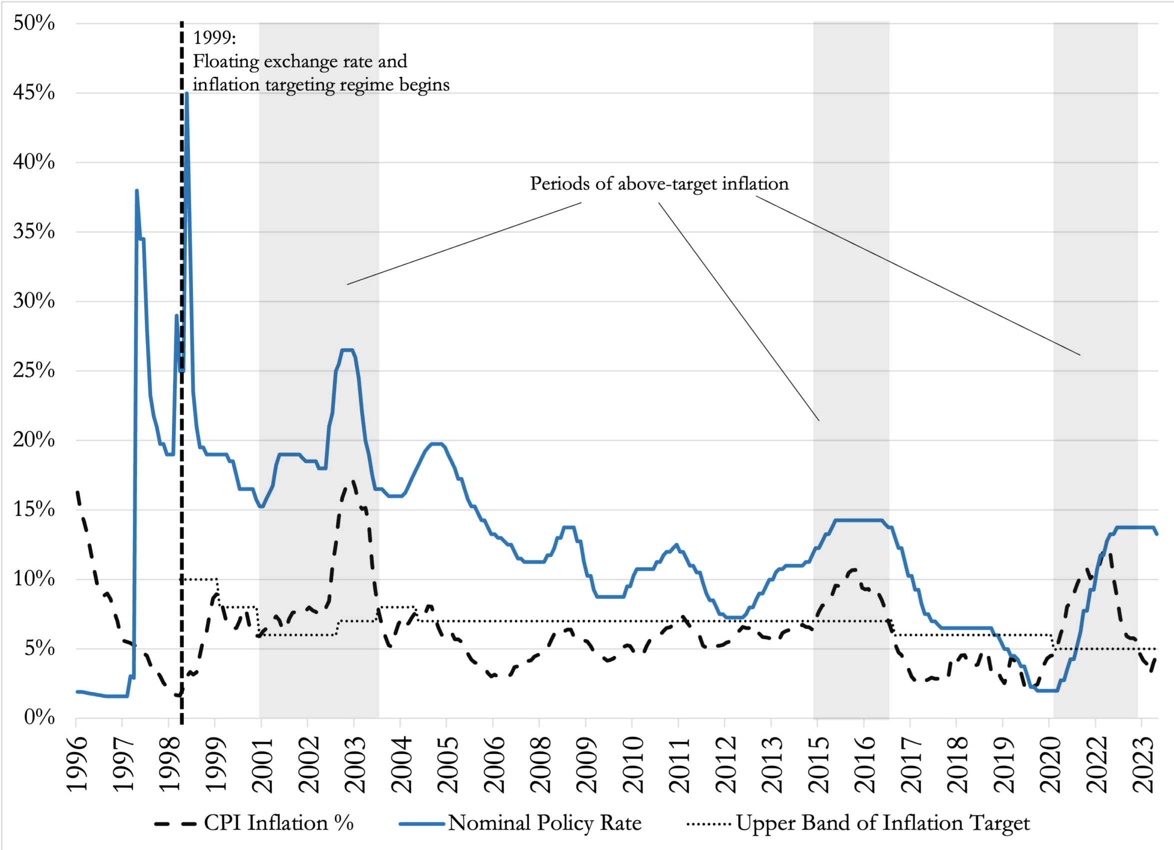


has not come to an end, so there is not a full cycle worth of data to add to regression models.

Prior to the 2002-2003 inflation, there were no significant deviations in monetary aggregates or fiscal spending. However, Luiz Inácio Lula da Silva (Lula), who was then a presidential candidate, rose in the presidential polls and won the elections. He had advocated for national debt renegotiation and even default in the past and his rise caused a change in expectations of future fiscal policy. It is widely agreed that the 2002 inflation was driven by uncertainty over the continuity of the macroeconomic reforms implemented by the *Plano Real* (Ayres et al., 2021). Fear of a default led to a significant devaluation of the exchange rate (passing through as higher import prices) and an increase in interest rates on government debt. Inflation expectations recorded by the Central Bank FOCUS survey unanchored from the target rate in October, between the first and second rounds of the election.

The 2002 inflation episode is a case of the fiscal theory of the price level in action.

FIGURE 6: IPCA Inflation, Selic Interest Rate, and Upper-Band of Inflation Target, from 1996 to 2023. Vertical shading denotes periods of above-target inflation. (Banco Central do Brasil)



Inflation can break out if people expect the government to not be able to repay its deficits in the future through surpluses or a reduction in the cost of the debt, even if there are no current deficits or changes in monetary policy. That appears to be consistent with what happened in 2002. Blanchard (2004) concluded that Brazil experienced fiscal dominance during this period, whereby the government's fiscal policy constrains the effectiveness of monetary policy because higher interest rates raise the cost of the debt that must be repaid in the future.

Once elected, however, Lula bowed to markets by committing to maintain the *Plano Real* era macroeconomic policies — and kept his promise. The central bank raised rates, and inflation slowed by the end of 2002. During his administration, the government recorded fiscal surpluses, GDP per capita grew under the tailwinds of a global boom in commodity prices, Brazil accumulated foreign reserves, and external public debt fell (Ayres et al., 2021).

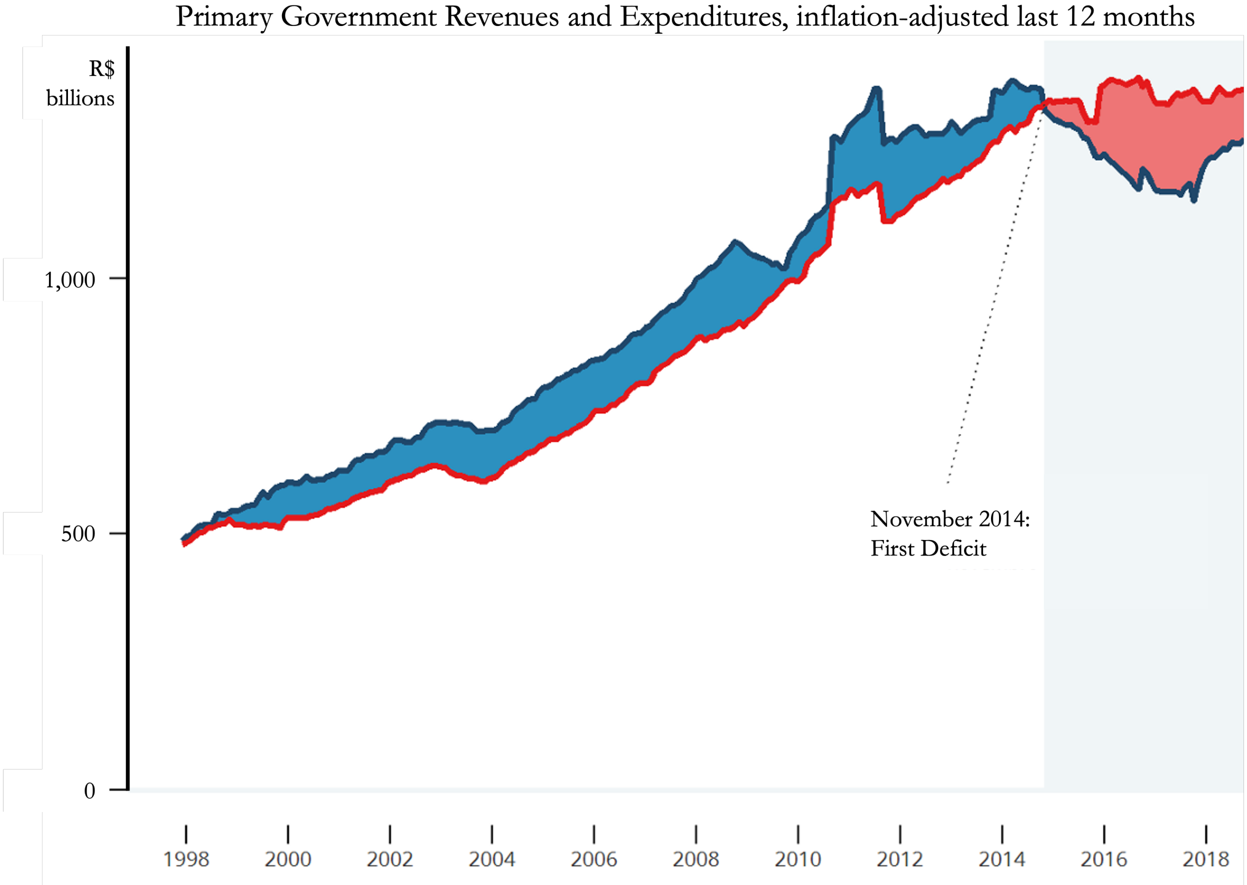
After Lula's re-election in 2006, policy shifted to more extensive state intervention through large infrastructure projects and investments, such as oil exploration. These policies expanded deficits, but they were not accounted for in the official government statistics as they were investments made through state enterprises such as Petrobras or the National Bank for Socioeconomic Development (BNDES). What was referred to as "creative accounting" made measures of fiscal deficits even more difficult to estimate during the second Lula term and eroded the fiscal credibility achieved in the late 1990s after the *Plano Real* reforms (Ayres et al., 2021).

2.1.4 The 2014-2015 Inflation

In the mid-2010s, Brazil experienced another period of double-digit inflation under President Dilma Rousseff, followed by disinflation and stringent fiscal measures implemented by her successor, President Michel Temer. There were no significant changes to monetary policy rules between the two administrations, but there was a radical shift in fiscal policy.

Under the Rousseff administration (2011-2016), government expenditures continued to increase with the expansion of social welfare programs, while at the same time, no significant tax or microeconomic reforms were enacted. Tax revenues as a percentage of GDP had not increased since 2002 (Figure 2) while government spending increased, which led in 2014 to the first deficit since the *Plano Real* period (Figure 7).

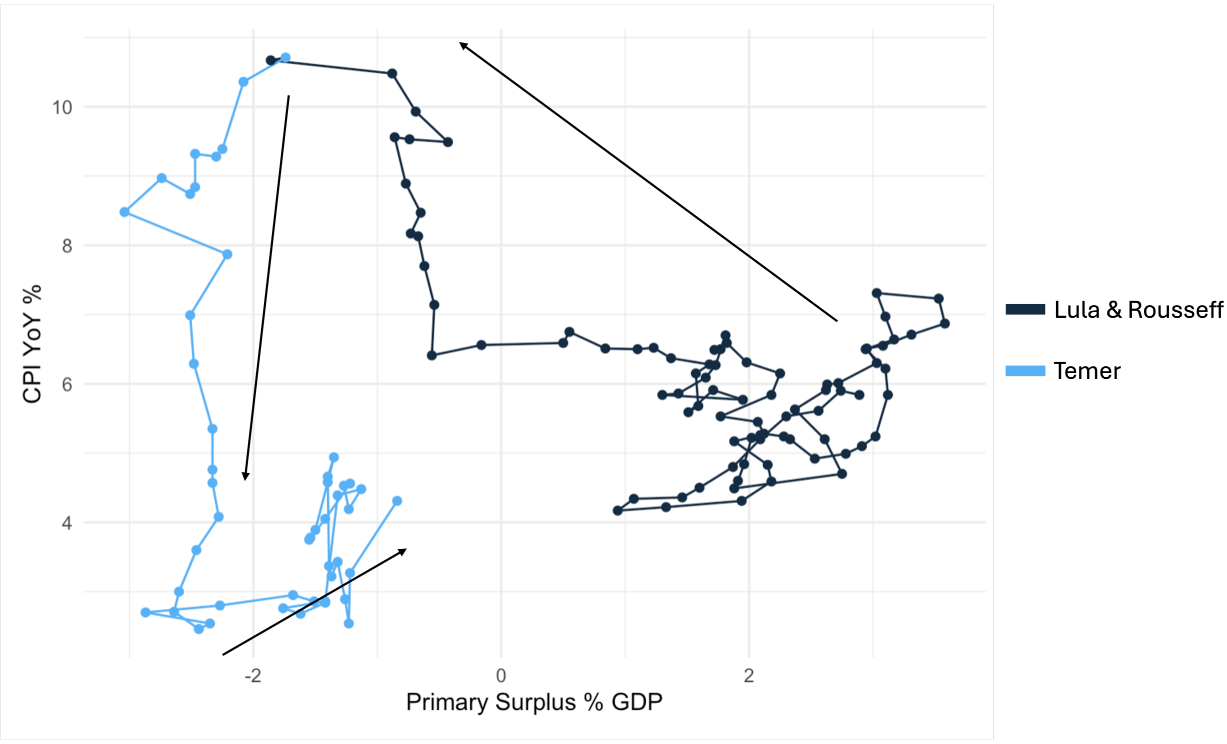
FIGURE 7: Historical primary government revenues (blue) and expenditures (red) (Brazilian National Treasury)



Inflation appears to increase as the surpluses move towards a deficit during this period. Figure 8 plots inflation against real primary surplus as a percentage of GDP with lines connecting them chronologically. It starts in the bottom right in January 2009, inflation peaks by July 2016, and the series ends at the bottom left in December 2019. The dark blue line represents the data points before the major shift in fiscal policy while the lighter blue line represents the years following the inauguration of Temer, when he signaled and followed through with a major constitutional amendment that capped real government spending.

Rousseff was impeached from office in mid-2016 due to an infringement of the fiscal responsibility law (enacted in the *Plano Real* period) linked to the so-called "creative accounting" tactics — social security, for instance, was partially being paid by the state-owned banks, who were never fully reimbursed by the federal government. The Rousseff government also put pressure on the central bank to lower interest rates and, at the same

FIGURE 8: Inflation and Primary Surplus plotted chronologically (Jan 2009 to Dec 2019) (IBGE, Brazilian National Treasury)

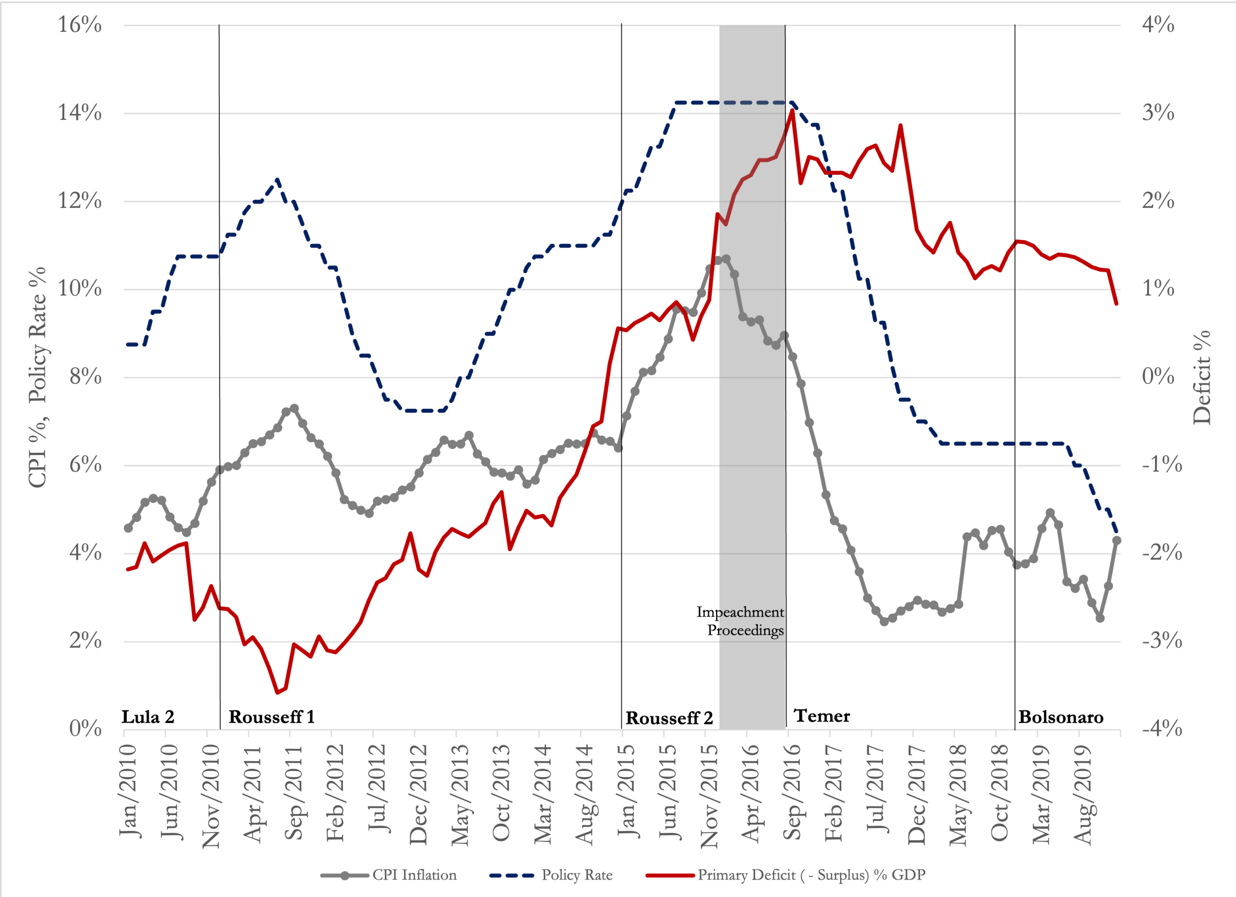


time, tried to use state-owned enterprises to control inflation by managing fuel and food prices, degrading the autonomy of the monetary authority (Ayres et al., 2021).

Her successor, Temer (2016-2018), implemented landmark legislation to restore fiscal discipline later that year. This was in the form of a constitutional cap, formally enacted late in 2016, that limited the annual growth of federal spending to the previous year's inflation rate, effectively freezing real government spending for up to two decades.

The 2015 inflation episode is interesting because what follows Rousseff's impeachment is Temer's radical shift in fiscal policy and a subsequent sharp drop in inflation. Brazilian Central Bank governor Campos Neto cites the series of 2017 fiscal and microeconomic labor reforms as policies that allowed the central bank to cut rates, as well as to lower its neutral rate target (Figure 5) (Campos Neto, 2023). Even before the reforms were approved, during the impeachment proceedings and provisional government period, there was clear political will and momentum which explains why expectations started to change in 2016. Figure 9 shows how inflation, the central bank policy rate and the real primary deficit evolved during this period. Vertical shading indicates the period of transition between the opening of impeachment proceedings against Rousseff, through Temer's provisional government, and his inauguration. Notice how the policy rate responds to inflation throughout the entire period, and the main variation is in fact in the deficit figure.

FIGURE 9: CPI Inflation and Nominal Policy Rate (LHS) and Deficit % GDP (RHS) from 2010 to 2020 in Brazil, with presidential terms indicated (IBGE, Brazilian Central Bank)



In sum, a fiscal interpretation of the two post-*Plano Real* inflations makes sense considering that since 1994, the central bank gained autonomy and followed a consistent policy rule, while in contrast, tax revenues did not increase to finance ever-increasing government spending (Figures 2 and 7).

2.1.5 Relevance to Today

Soon after Temer's reforms, the COVID-19 pandemic and its subsequent economic consequences led the Brazilian congress to excuse emergency spending outside the constitutional cap in 2020. The cap was enforced again in 2021 and 2022. In 2023, Lula da Silva returned for a third term and replaced the spending cap with a new fiscal framework, which connects increased government spending to achieving primary surplus targets, but more loosely. Understanding the history of fragile fiscal and monetary institutions and credibility in Brazil can inform how inflation dynamics behave under governments that demonstrate a weaker commitment to fiscal sustainability.

2.2 The Fiscal Theory of the Price Level

The fiscal theory of the price level (Sims, 1994; Woodford, 1995; Sims, 1997; Cochrane, 2023b) proposes that government debt determines the value of money, and hence the price level. Central to the fiscal theory is the premise that government deficits are financed in real terms by issuing debt. Issued debt is a future fiscal obligation that must be paid for by tax revenues or a reduction in expenditures. When expectations form around the government's inability or unwillingness to fulfill this obligation, the real value of debt must be deflated through a price level adjustment — inflation.

More specifically, the fiscal theory works similar to an asset-pricing framework, stating that the real value of government debt must correspond to the present value of future surpluses in real terms (i.e., the government's ability to repay its debt without inflating it). The price level, then, can be solved for as the factor that reduces the nominal value of debt to its real value (Cochrane, 2001):

$$\frac{\text{Nominal Value of Debt}}{\text{Price Level}} = \text{Present Value of Future Real Surpluses} \tag{2.1}$$

Hence, even if the government does not run a present deficit, but there is an expectation that the government is not committed to finance its outstanding debt through future surpluses, inflation (an increase in the price level) emerges as the mechanism through which the real value of government debt adjusts to the government's expected fiscal reality. Mechanically, when that occurs, people sell government bonds and convert the money into current spending, causing inflation.

Key to understanding the fiscal theory is that debt has a nominal rigidity. It is denominated in nominal terms, meaning it can be inflated away. The fiscal theory sees inflation as the process through which the economy can correct the real value of debt.

2.2.1 The Fiscal Theory applied to Brazil

Several authors have examined cases of fiscal dominance in Brazil over different periods. Loyo (1999) proposed a model for fiscal hyperinflation whereby hiking interest rates has inflationary effects. Even if the government does not increase spending, higher interest rates increase the future cost of debt and unbalance the inter-temporal budget constraint (equation 2.1).The late 1970s and 1980s in Brazil serve as a motivating example of this model. After the *Plano Real*, Blanchard (2004) also argued that the 2002 inflation happened under a fiscally dominant regime. This interpretation is consistent with the historical analysis of that period, when the leading presidential candidate, Lula, threatened to revert the *Plano Real* economic policies and threatened a sovereign default on the debt.

Similarly, Marques and Carvalho (2022) examined the period from the 1990s to 2019 and used an endogeneity test to show that the central bank policy rate was weakly exogenous to the inflation rate. They concluded that price-setters in Brazil learned from the central bank's policy decisions, which impacted future inflation. This result is consistent with the Neo-Fisherian hypothesis that an increase in the nominal interest rate set by the central bank will eventually lead to an increase in the expected rate of inflation.

2.3 Institutional Credibility Shocks

In his analysis of the ends of the German, Austrian, Hungarian, and Polish hyperinflations in the 1920s, Sargent (1982) argued that there are two institutional pre-conditions for successful inflation stabilization. First was establishing an independent monetary authority that was credibly and legally committed to not providing the government additional unsecured credit when needed. Second, a fiscal reform that enabled governments to sell their debt to private parties or foreign governments, enabling the value of the debt to be priced against the government's ability to repay it. Sargent (1982) concluded that stabilization came when there was a *coordination* of monetary and fiscal policy. It was not just the reduction in central bank notes (similar to Brazil's cutting zeros off the *Cruzado*) but the reduction of bank notes not backed by an asset (debt) that would be credibly paid back via future surpluses.

The lesson from these hyperinflations is that for inflation to stabilize, there must be a credibility shock to both the monetary institution and the fiscal institution backing the monetary authority. Similarly, Afonso et al. (2016) analyzed monetary and fiscal reforms in Brazil from the *Plano Real* period through to the Rousseff administration and confirmed the importance of credible institutions for the stability of the Brazilian economy.

Several authors in the early 2000s wrote about fiscal policy rules that could improve fiscal credibility or help stabilize the economy. Woodford (2001) proposed that a nominal deficit targeting rule is required for price stability in addition to the central bank following a Taylor rule. In Brazil, Tanner and Ramos (2002) found little evidence to support a monetary-dominant (as opposed to fiscally-dominant) regime in the 1990s. While that might be due to insufficient data, they argued that further research should be done on fiscal rules. Taylor (2000) recommended counter-cyclical fiscal policy rules through automatic stabilizers, and Cochrane (2001) proposed an optimal debt policy to minimize variations in inflation.

Moreira and Monte (2020) found that mainly after 2014, Brazil had pro-cyclical fiscal policy, the opposite of the Taylor (2000) recommendation of counter-cyclical fiscal policy as a stabilizing measure. Moreira and Monte (2020) further showed that under fiscal deterioration or increasing degrees of fiscal pro-cyclicality, monetary policy loses its effectiveness, with higher fiscal cyclicality leading to higher expected inflation from 2014 to 2019 in Brazil.

Finally, Montes and Curi (2017) showed that disagreements (or surprises) in expectations about public debt affect the risk premia in inflation-linked bonds in Brazil. This connects to the model implications derived in Cochrane (2023a) whereby unexpected inflation comes from revisions in expectations of future real surpluses and interest cost on the debt. This informs the econometric model that I explain in the method section.

2.4 Measuring Fiscal Credibility

More recent literature links fiscal credibility, defined as the commitment to fiscal sustainability, to inflation in emerging economies, including Brazil (Mendonça and Silva, 2016; Anzoátegui-Zapata and Galvis-Ciro, 2021). One way to measure fiscal credibility is by constructing a fiscal credibility index. Mendonça and Machado (2013) built such an index for Brazil by scoring the central bank FOCUS survey of market participants on their forecasted public debt-to-GDP ratios. The ratios were converted into an index, with the worst score given to a ratio above 60%, based on the Maastricht Treaty fiscal guidelines.

While building an index on the market survey of expected public debt-to-GDP ratio is a way of obtaining forward-looking fiscal expectations, the method employed in this literature — namely, the FOCUS market survey for financial and non-financial institutions in Brazil — has limitations. Survey responders have no financial incentive to respond accurately. Moreover, FOCUS only began surveying debt-to-GDP expectations in 2014, meaning there is no data that can be used for earlier inflation episodes.

This paper introduces a new way of measuring fiscal expectations through Credit Default Swap (CDS) premia on sovereign Brazilian Dollar-denominated 5- and 10-year treasuries. A CDS is a financial derivative that serves as insurance against a borrower defaulting on their debt — in this case, Brazil defaulting on its foreign debt. If the underlying bond issuer defaults, the CDS provides a payout to the holder. The price or premium of a CDS reflects the perceived risk of default, with higher premia indicating higher risk, similar to an insurance premium.

Under the fiscal theory of the price level, default and inflation are complements. Because debt is nominally fixed, a government can either default on its debt or inflate it away. The CDS is an insurance premium on a default event, sensitive to the event's probability, and by measuring that chance of default it should analogously measure the level of fiscal stress. Before a government defaults on its debt, it might attempt other measures to manage its fiscal situation. Inflating away debt (reducing its real value) might come before deciding to default straight away. Other authors have shown how CDS spreads are sensitive to measures of fiscal health (Fender et al., 2012; Jeanneret, 2018).

Importantly, sovereign CDS spreads are exogenous to the monetary policy rate because they are traded in U.S. Dollars. A CDS spread should match the spread of the Dollar-denominated sovereign treasury over a risk-free rate for the same maturity, allowing for a more precise analysis of the impact of fiscal expectations on inflation without noise from policy rates.

Moreover, since the CDS holders have actual financial incentives compared to survey participants, the CDS premium is more likely to reflect accurate market expectations of default probabilities. Rodríguez et al. (2019) demonstrated that changes in CDS spreads are better predictors of sovereign events than sovereign ratings and that CDS spreads are forward-looking, much like Cochrane (2023a) argued that inflation shocks are forward-looking. Chan-Lau (2006), for example, identified a hike occurred in Brazilian CDS spreads during the 2002 inflation period, which as discussed earlier was during the same time when expectations on Lula's commitment to fiscal sustainability shifted.

3 Method

Identifying causality in macroeconomics is challenging due to the high-dimensional nature of fiscal and monetary policies. These policies have dynamic effects over time and interact with each other with varying effects, making it hard to isolate the impact of a single policy change (Nakamura and Steinsson, 2018).

Recognizing this inherent difficulty in the object of study, I test specific predictions that the fiscal theory of the price level would make, aiming to provide a more grounded assessment of the theory's applicability to the given scenario in Brazil. I begin by employing a vector autoregression (VAR) method similar to Cochrane (2022b) to identify the fiscal roots of inflation in Brazil, followed by a later analysis of how shocks to fiscal expectations (signaled by CDS premia) relate to unexpected inflation.

3.1 Fiscal Model of Inflation Dynamics

While Lucas (1972) derived a model of the effect of money on inflation dynamics, Cochrane (2023a) built on top of these foundations to derive a model based on interest rates — given the fact that in the real world, central banks directly control interest rates, and not money supply. Cochrane (2023a) started with the first-order condition for consumption or dynamic IS curve in an economy without capital so that output equals consumption. Equation 3.1 shows that the output gap at time t is the expected output gap in the next period minus the effect of monetary policy. Higher real interest rates reduce the output gap.

$$x_t = E_t x_{t+1} - \sigma(i_t - \pi_t^e) \tag{3.1}$$

Where x_t is the output gap, π_t^e is expected inflation at time t, i_t is the nominal interest rate, and σ is the sensitivity of the output gap to monetary policy. Assuming $E_t x_{t+1} = 0$, simplify 3.1 to show that the output gap is affected by the real interest rate:

$$x_t = -\sigma(i_t - \pi_t^e) \tag{3.2}$$

Next, equation 3.3 is the Phillips Curve. Inflation π_t is determined by expected inflation (which can be specified to either be adaptive, $\pi_t^e = \pi_{t-1}$, or rational, $\pi_t^e = E_t\pi_{t+1}$), plus a factor of the output gap.

$$\pi_t = \pi_t^e + \kappa x_t \tag{3.3}$$

Substituting output gap 3.2 into the Phillips Curve 3.3 gives us the inflation dynamics in terms of interest rates and expectations:

$$\pi_t = \pi_t^e - \kappa\sigma(i_t - \pi_t^e) \tag{3.4}$$

$$\pi_t = (1 + \kappa\sigma)\pi_t^e - \kappa\sigma i_t \tag{3.5}$$

Under New-Keynesian rational expectations, $\pi_t^e = \beta E_t \pi_{t+1}$. Let $\beta = 1$ for simplicity, as Cochrane (2023a) showed the conclusion does not change for $\beta < 1$. Incorporating rational expectations into inflation dynamics from 3.5 gives:

$$\pi_t = (1 + \kappa\sigma)E_t\pi_{t+1} - \kappa\sigma i_t \tag{3.6}$$

Rearranging for expected inflation:

$$E_t\pi_{t+1} = \frac{\pi_t + \kappa\sigma i_t}{1 + \kappa\sigma} \tag{3.7}$$

$$E_t\pi_{t+1} = \frac{1}{1 + \kappa\sigma}\pi_t + \frac{\kappa\sigma}{1 + \kappa\sigma} i_t \tag{3.8}$$

Equation 3.8 reveals two things. Firstly, inflation is stable because $\frac{1}{1+\kappa\sigma} < 1$, meaning expectations do not spiral with a shock in inflation. Second, higher nominal interest rates increase inflation, even if by less than one-to-one, since $\frac{\kappa\sigma}{1+\kappa\sigma} > 0$.

So far, I have derived the dynamics of expected inflation, which means inflation is indeterminate in this Neo-Keynesian model.

Inflation is the result of expected and unexpected inflation, where unexpected inflation is the surprise between expected inflation in period t for period $t+1$, and realized inflation in that next period:

$$\Delta E_{t+1}\pi_{t+1} = E_{t+1}\pi_{t+1} - E_t\pi_{t+1} \tag{3.9}$$

$$\Delta E_{t+1}\pi_{t+1} = \pi_{t+1} - E_t\pi_{t+1} \tag{3.10}$$

where innovation $\Delta E_{t+1} \equiv E_{t+1} - E_t$, and $E_{t+1}\pi_{t+1}$ is just the observed inflation in that period, π_{t+1}.

The fiscal theory of the price level introduces an equilibrium condition to solve the indeterminacy issue of Neo-Keynesian inflation dynamics in equation 3.8. Namely, that unexpected inflation should be equal to revisions in the discounted present value of real government surpluses and interest costs on the debt (Cochrane, 2023a).

To see why, consider how the real value of government debt held by the public (and not the central bank), as a percentage of GDP, v_t (hereafter "debt"), evolves. Start with a linearized one-period model for simplicity, as derived in Chapter 3.5 of Cochrane (2023b). The next period debt, v_{t+1}, is equal to the debt in the current period, plus real interest costs minus real primary surplus to GDP ratio, s_{t+1}, (hereafter, "surplus") that pays off the debt:

$$\rho v_{t+1} = v_t + (i_t - \pi_{t+1}) - s_{t+1} \tag{3.11}$$

where $\rho < 1$ is a discount factor. The real value of debt at the current period is given by iterating equation 3.11 forward in expectations:

$$v_t = E_t \sum_{j=0}^{\infty} \rho^j [s_{t+1+j} - (i_{t+j} - \pi_{t+1+j})] \tag{3.12}$$

The current real value of the debt is equal to the expected present value of all future net surpluses: the real primary surplus minus real interest costs on the debt (Cochrane, 2023a).

Take the innovations, or changes in expectations ($\Delta E_{t+1} \equiv E_{t+1} - E_t$), on both sides of equation 3.12. The left-hand side is observed at time t, so $\Delta E_{t+1} v_t = E_{t+1} v_t - E_t v_t = 0$:

$$0 = E_{t+1} \sum_{j=0}^{\infty} \rho^j [s_{t+1+j} - (i_{t+j} - \pi_{t+1+j})] - E_t \sum_{j=0}^{\infty} \rho^j [s_{t+1+j} - (i_{t+j} - \pi_{t+1+j})] \tag{3.13}$$

The $j = 0$ terms of the left-hand side transfer to the right-hand side as:

$$i_t - E_{t+1} s_{t+1} - E_{t+1} \pi_{t+1} - i_t + E_t s_{t+1} + E_t \pi_{t+1} =$$

$$\mathrm{E}_{t+1} \textstyle\sum_{j=1}^{\infty} \rho^j [s_{t+1+j} - (i_{t+j} - \pi_{t+1+j})] - E_t \textstyle\sum_{j=1}^{\infty} \rho^j [s_{t+1+j} - (i_{t+j} - \pi_{t+1+j})] \tag{3.14}$$

$$\Delta E_{t+1} \pi_{t+1} = \Delta E_{t+1} s_{t+1} +$$

$$\mathrm{E}_{t+1} \textstyle\sum_{j=1}^{\infty} \rho^j [s_{t+1+j} - (i_{t+j} - \pi_{t+1+j})] - E_t \textstyle\sum_{j=1}^{\infty} \rho^j [s_{t+1+j} - (i_{t+j} - \pi_{t+1+j})] \tag{3.15}$$

This leaves us with:

$$\Delta E_{t+1} \pi_{t+1} = -\Delta E_{t+1} \sum_{j=0}^{\infty} \rho^j s_{t+1+j} + \Delta E_{t+1} \sum_{j=1}^{\infty} \rho^j r_{t+1+j} \tag{3.16}$$

Where $r_{t+1} = i_t - \pi_{t+1}$, the real ex-post interest rate.

In summary, expected next-period inflation ($E_t \pi_{t+1}$) is set by interest rate targets and current inflation, while unexpected, surprise inflation ($\Delta E_{t+1} \pi_{t+1}$)is equivalent to revisions in expectations (or innovations) of the present value of future primary surpluses and expected real costs on the debt:

$$E_t \pi_{t+1} = \frac{1}{1+\kappa\sigma}\pi_t + \frac{\kappa\sigma}{1+\kappa\sigma} i_t \tag{3.17}$$

$$\Delta E_{t+1}\pi_{t+1} = -\Delta E_{t+1}\sum_{j=0}^{\infty}\rho^j s_{t+1+j} + \Delta E_{t+1}\sum_{j=1}^{\infty}\rho^j r_{t+1+j} \tag{3.18}$$

3.2 Vector Autoregression Identification of Fiscal Roots of Inflation

The model derived above establishes that surprise inflation comes from revisions in expectations of future surpluses or interest costs on the debt. To estimate the response of each variable to unexpected changes in other variables, I run a single-lag VAR on data from Brazil and interpret impulse responses over multiple periods, similar to the method used in Cochrane (2022b). I run a VAR on the debt-flow identity first presented as the single-period debt flow in equation 3.11, specifically an adaptation of Cochrane (2022b)'s linearized government debt flow identity, assuming no growth and a single-interest rate in the economy, which is the central bank's policy rate i_t:ess

$$v_{t+1} = v_t + i_{t+1} - \pi_{t+1} - s_{t+1} \tag{3.19}$$

Note that in the Cochrane (2022b) method, "shocks" and "impulse responses" follow standard VAR conventions, but do not necessarily force a causal structure. A "shock" is an unexpected change or innovation at time 1 not forecast by the VAR model. The "impulse response" is the change in future expectations based on this new information. Finally, including the real value of the debt v_t held by the public is important in the regression because it serves as a state variable.

I compute impulse responses by orthogonalizing the shock covariance matrix using the Choleski decomposition. Because the output of the Choleski decomposition is a lower triangular matrix, I include the shocked variable in the first row and inflation (when it is not the shock) in the last row. The variable in the last row will be sensitive to contemporaneous shocks of all prior variables, while the first row variable is not sensitive to other variable shocks.

Under the fiscal theory framework, contemporaneous shocks allow us to interpret the response of the variables to an inflation shock as the changes in expectations of other variables that led to the inflation surprise, since the movements are happening simultaneously and not causally, a period after inflation. Likewise, an unexpected deficit shock shows how changes in expectations over other variables, on average, account for the fact that future surpluses will have to increase, rates will have to reduce the cost of the debt, or inflation will inflate away the real value of debt.

3.3 Linking Credit Default Swaps to Inflation Shocks

I then add Credit Default Swap (CDS) premia to the VAR specified above. Inflation is the result of expected plus unexpected inflation, and unexpected inflation, under the fiscal theory, corresponds to revisions in expectations on the present value of future surpluses and costs on the debt:

$$\Delta E_{t+1}\pi_{t+1} = -\Delta E_{t+1}\sum_{j=0}^{\infty}\rho^j s_{t+1+j} + \Delta E_{t+1}\sum_{j=1}^{\infty}\rho^j r_{t+1+j} \tag{3.20}$$

As discussed previously, CDS premia are good signals of expectations on fiscal sustainability since they are forward-looking (Rodríguez et al., 2019), determine the probability of default on the debt based on fiscal health measures (Fender et al., 2012; Jeanneret, 2018), align financial incentives to reveal actual expectations, and are denominated in US Dollars, making premia exogenous to direct monetary policy interest rate fluctuations.

CDS are a good signal of fiscal sustainability, which is ultimately correlated with expectations over the right-hand side of equation 3.20: the government's ability to raise real net surpluses.

Specifically, I define that the CDS premium (C) signals a latent fiscal sustainability variable F, correlated with expected future real net surpluses, with some noise:

$$\log C_t = \beta_0 + \beta_1 F_t + \varepsilon_t \quad (3.21)$$

Hence, by running the VAR of the debt-flow identity with the CDS premium, I interpret a CDS shock as a shock that happens simultaneously with news about future fiscal deterioration. By allowing the other variables to respond contemporaneously to the CDS shock, I measure how expectations over the other variables react to that piece of news, including unexpected inflation.

3.4 Data

I use a sample of monthly macroeconomic variables reported by official statistical agencies. The sample window is from January 2001 to December 2019 for non-CDS regressions, from October 2001 to December 2019 for regressions using the 5-year CDS, and from March 2004 to December 2019 for regressions using the 10-year CDS. I go as far back as the date when the instruments were created. I exclude 2020 onwards because of the importance of including complete cycles in the VAR. 2020 marked the start of the COVID-19 pandemic with large amounts of fiscal stimulus and subsequent inflation, but the disinflation cycle is not yet complete as of the time of writing this paper. The COVID-19 shock also created significantly more market noise, ε_t, than before, affecting the CDS signal described above in equation 3.21.

I describe each variable and its source below.

1. **Real Value of the Debt Held by the Public to GDP Ratio (v)**: monthly stock of public treasuries held by the public (not by the central bank), valued at the intrinsic yield curve of each security and reported by the Tesouro Nacional (National Treasury). I then divide it by the nominal GDP for the last 4 quarters to get a real debt-to-GDP ratio.

2. **CPI Inflation (π)**: monthly data on the last-twelve-months and month-over-month percentage change on the IPCA consumer price index calculated monthly by the Instituto Brasileiro de Geografia e Estatística (IBGE). I use the last twelve months of

inflation, which, on a monthly basis, is persistent with a high AR(1) coefficient, but I re-run the VARs on monthly inflation for robustness.

3. **Nominal interest rate (*i*)**: nominal interest rate policy set by the Brazilian Central Bank, also called SELIC rate.

4. **Real Primary Surplus to GDP ratio (*s*)**: primary budget result of the government divided by GDP, reported by the National Treasury.

5. **Sovereign τ-year Brazilian CDS Premium ($C_{BR,\tau}$)**: the annual premium paid (in basis points) as a percentage of the notional value of the $\tau \in \{5, 10\}$ year Brazilian Dollar-denominated treasuries. It should be approximately equal to the spread between the Dollar-denominated Brazilian debt and the risk-free rate for that maturity. I collect the monthly average quote from Bloomberg. Brazil's 5-year CDS data ranges from October 2001 to December 2019, and the 10-year from March 2004 to December 2019. I log the premia to linearize them.

6. **Brazil CDS Premium Spread over Mexico ($C_{BR,\tau} - C_{MX,\tau}$)**: I collect the same data on Mexico as a comparable CDS contract to isolate market-wide shocks and control for some of the market noise ε from equation 3.21 and get a better signal of Brazil's idiosyncratic country risk. Mexico is the only country in the region with a CDS traded with enough liquidity and historical price data as far back as Brazil. The Mexican 5- and 10-year CDS trade as far back as the Brazilian equivalents. To log-linearize spreads that might be negative, I calculate an adjusted log of the absolute value of the spread but preserving the original positive or negative sign: $\text{Sign}(C_{BR,\tau} - C_{MX,\tau}) \cdot \log(|C_{BR,\tau} - C_{MX,\tau}|)$

A brief comment on the stationarity of CDS premia and their spreads: as with any form of insurance, the premia are bounded between 0% and 100% of the insured value. This boundedness is important as it constrains the premia within a fixed range and makes it long-term stationary. Sims (1993) emphasized the value of analyzing economic time series in levels, particularly noting that differencing data can eliminate long-run relationships among variables. Given that differencing could eliminate these potentially meaningful long-term relationships, the bounded nature of CDS premia supports using its levels in logs rather than differencing it. The level of the CDS premium serves as a state variable of fiscal health more than its movements, which may be due to market noise.

Figures 10 and 11 below plot the CDS premia for Brazil and Mexico 5 and 10-year treasuries. I use Mexico as a comparable emerging economy with liquid CDS treasuries that traded as far back as Brazil. The Brazilian CDS premia rose above its comparable in the early 2000s and mid-2010s, around the same two periods of above-target inflation. CDS shocks seem to happen simultaneously with inflation.

FIGURE 10: 5-year CDS Premia (bps) for Brazil and Mexico (Source: Bloomberg)

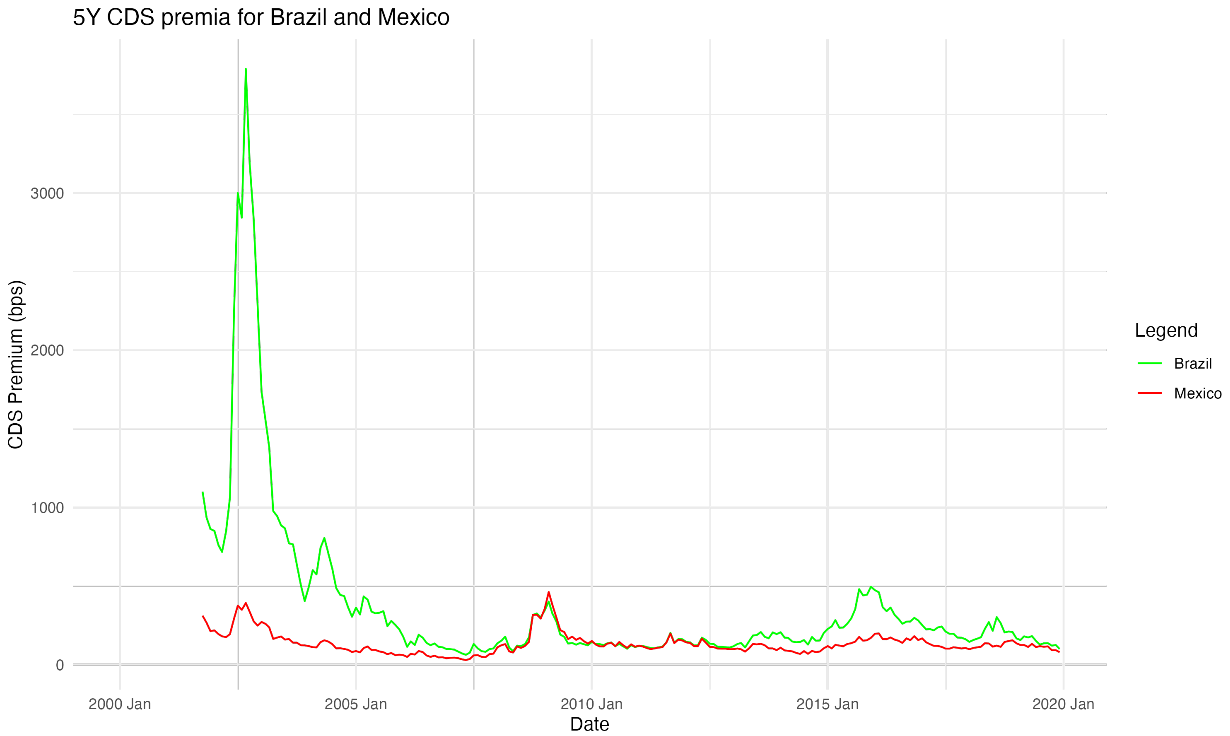
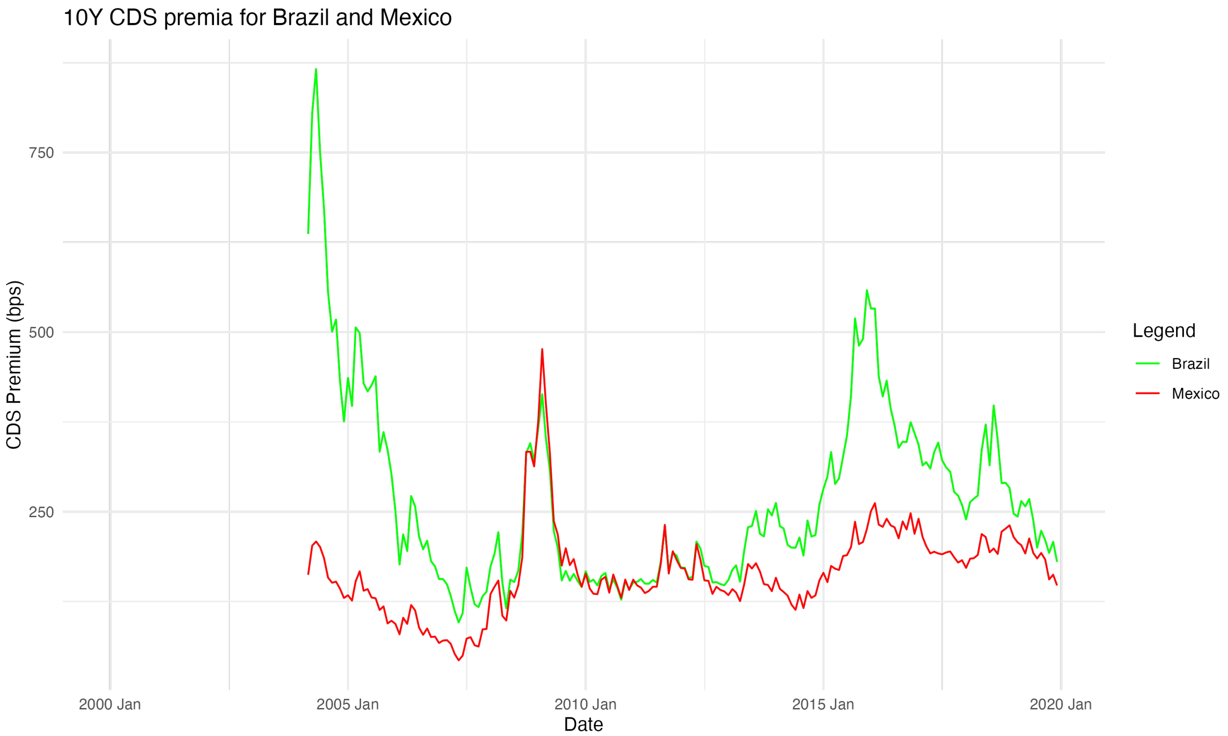
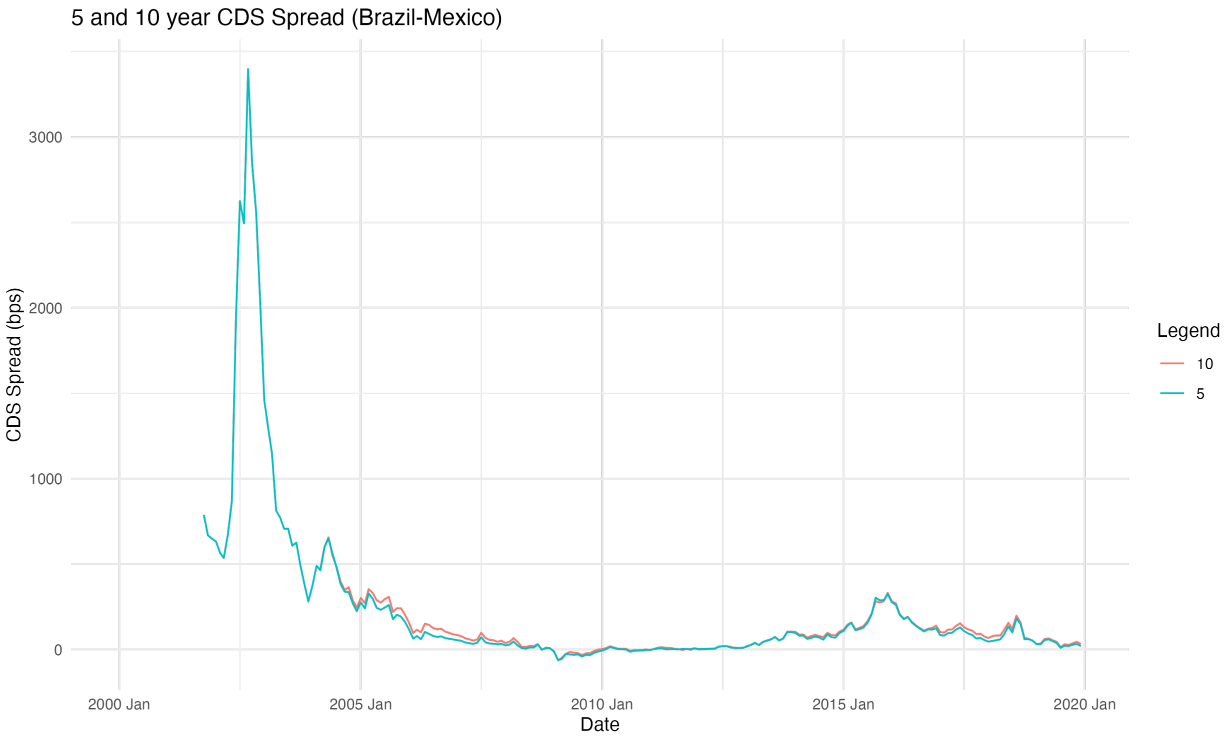


FIGURE 11: 10-year CDS Premia (bps) for Brazil and Mexico (Source: Bloomberg)



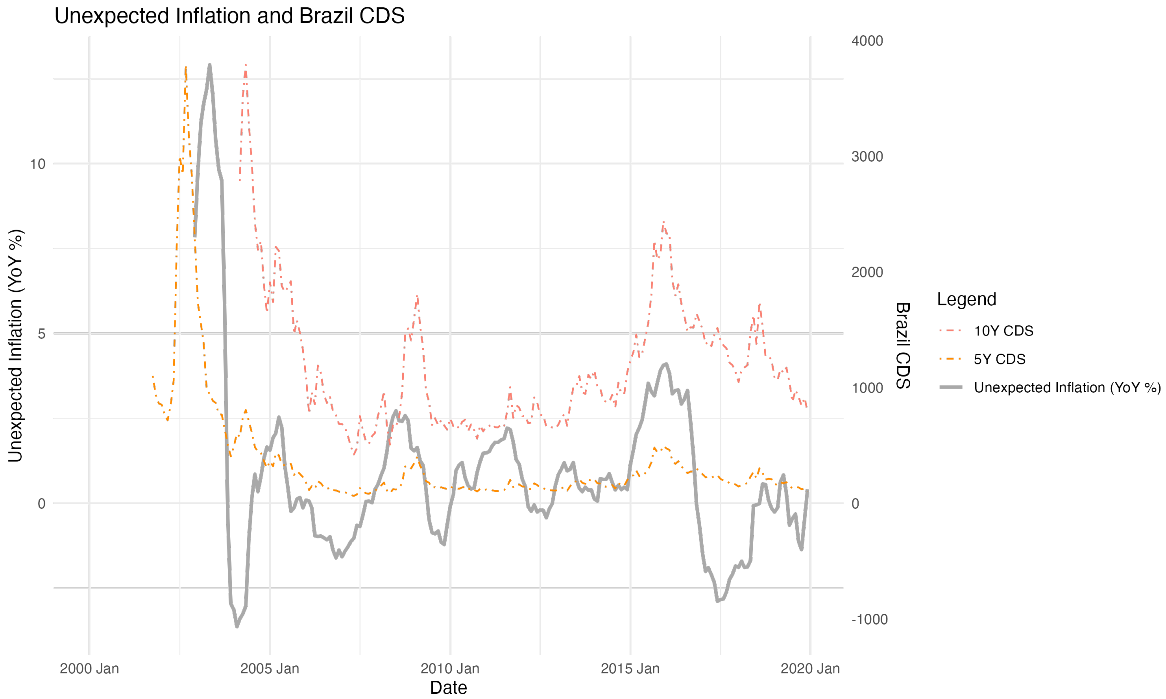
While the 10-year CDS rises much more than the 5-year paper, because there is greater uncertainty further out in the future, Figure 12 shows that the spread of Brazilian CDS premia over Mexican CDS is roughly the same for 5 and 10 year papers. In other words, using Mexico to control for other emerging market noise, the 5- and 10-year premia reflect the same level of spread that signals Brazil's idiosyncratic country risk.

FIGURE 12: 5 and 10 Year CDS Spreads (Brazil - Mexico) (Source: Bloomberg)



Moreover, Figure 13 shows how unexpected inflation (calculated as the realized inflation minus the central bank FOCUS expectations survey for that period, $\pi_t - E_{t-12}\pi_t$) moves closely to CDS premia.

FIGURE 13: Unexpected Annual CPI Inflation (Realized - Expectations) and CDS Premia (Source: Bloomberg)



4 Analysis

4.1 Vector Autoregression

Table 1 shows the VAR coefficients of the single-lag regression on the debt flow identity, described in methods section 3.2. The bottom half of the table presents the correlation coefficients between the residuals of the variables, which indicate the magnitude and direction of the effect of contemporaneous shocks, or innovations, of one variable on another.

TABLE 1: VAR coefficients with yearly inflation rate π_y [4]

	s_{t+1}	i_{t+1}	v_{t+1}	$\pi_{y,t+1}$
s_t	1.000***	0.023	-0.003**	0.011
i_t	-0.002	0.997***	0.002*	0.012
v_t	0.310*	-0.096	0.960***	-0.093
$\pi_{y,t}$	-0.007	-0.002	-0.002	0.967***

Correlation matrix of residuals

	s	i	v	π_y
s	1.00	0.10	-0.06	0.06
i	0.10	1.00	-0.06	0.44
v	-0.06	-0.06	1.00	-0.04
π_y	0.06	0.44	-0.04	1.00

Sample: Jan 2001 – Dec 2019

In Table 1, the AR(1) coefficient of inflation on itself is highly persistent at 0.967. This is because I use a last-twelve-month measure of inflation on monthly data. Table 2 presents the same VAR run on month-over-month CPI inflation, and inflation persistence remains high but goes down to a more moderate level of 0.656.

Another important reason for running the VAR with monthly inflation in Table 2 is because the monthly VAR better estimates monetary policy response to inflation. Specifically, the VAR in Table 1 does not identify a lag-1 coefficient of the policy rate to last-twelve-month inflation. However, the VAR in Table 2 identifies a coefficient of 0.782 policy rate reaction to a 1% surge in monthly inflation. This makes sense as policy might

[4]Significance levels: 0 ***; 0.001 **; 0.01 *; 0.05 . .

be more sensitive to specific new inflation information in the months leading up to the policy decision than the trailing 12-month figure.

TABLE 2: VAR coefficients with monthly inflation rate π_m

	s_{t+1}	i_{t+1}	v_{t+1}	$\pi_{m,t+1}$
s_t	1.002***	0.035*	-0.002*	0.003
i_t	-0.006	0.965***	0.001	0.004
v_t	0.351**	0.240	0.971***	0.077
$\pi_{m,t}$	-0.014	0.782***	-0.002	0.656***

Correlation matrix of residuals

	s	i	v	π_m
s	1.00	0.13	-0.06	0.06
i	0.13	1.00	-0.05	0.16
v	-0.06	-0.05	1.00	-0.09
π_m	0.06	0.16	-0.09	1.00

Sample: Jan 2001 – Dec 2019

Throughout this analysis, while I mostly use yearly inflation to facilitate understanding, I use the monthly inflation VAR for robustness checks and find equivalent results. These robustness checks are outlined in Appendices A for VARs and B for Impulse Responses.

The real surplus to GDP ratio is persistent, with a coefficient of 1.00, and the level of debt is significant in forecasting surpluses, with a positive coefficient of 0.31 to 0.35 in either VAR. This means that, on average, the government follows a fiscal policy rule to increase surpluses for a given increase in the level of debt. This is on average, and it does not mean that in certain periods, the government did not deviate from that rule.

As explained earlier, the value of debt is highly persistent, too, but the surplus is also a good predictor of it, with a negative coefficient. It is easier to understand this relationship in terms of deficits. A deficit decreases surpluses, and the stock of debt must increase to finance it. Even though the value of debt is highly persistent, it is important to be included as a state variable. Overall, the regression coefficients are robust because they are also consistent with the estimates in Cochrane (2022b) for the United States, accounting for possible differences between the two countries.

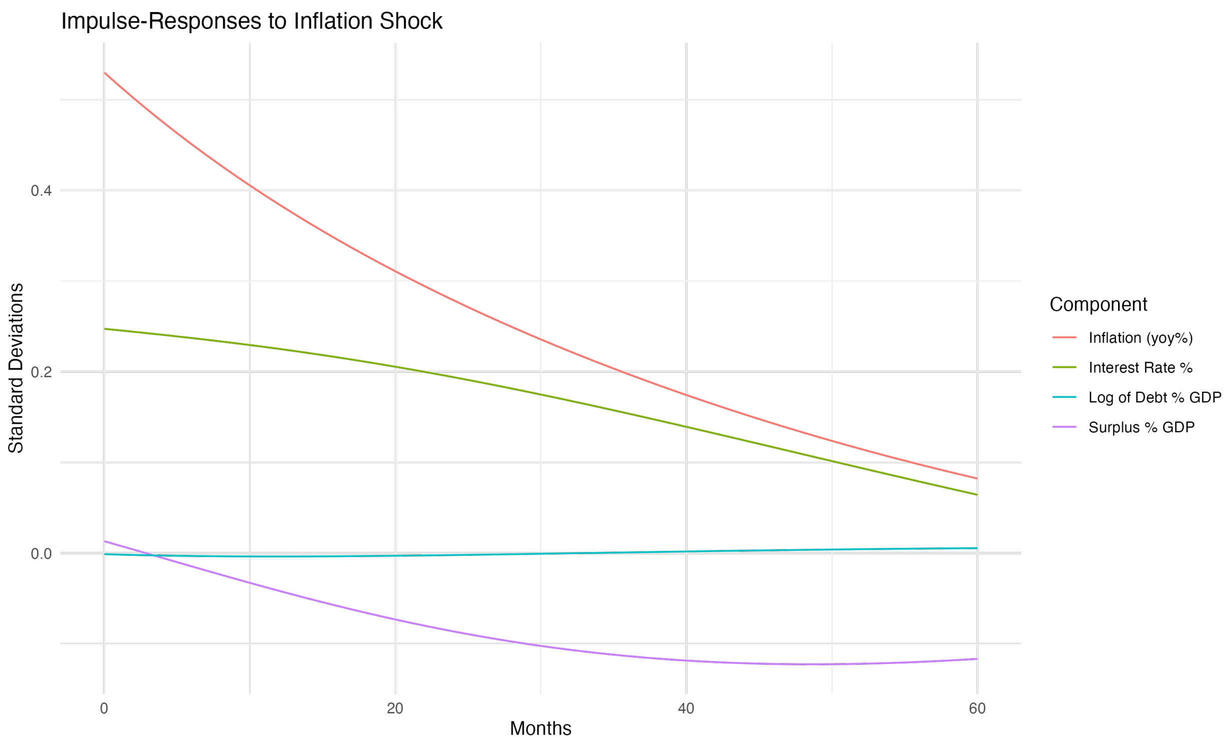
4.2 Impulse Response to Inflation Shock

In this and the following section, I use the VAR with yearly inflation (Table 1) to produce impulse response functions to inflation and deficit shocks. I present the impulse responses to the next two shocks on the monthly inflation VAR for robustness in Appendices B.1.2 and B.2.2 , respectively.

As explained previously, I allow other variables to move contemporaneously to the shocked variable. Because of the contemporaneous shocks, I interpret shocks as an unexpected change in the shocked variable and the impulse responses as changes in expectations for each variable that may have explained this change.

I begin with an unexpected inflation shock, or $\Delta E_1 \pi_1 = 1$. I plot the impulse responses in Figure 14 in standard deviation moves, and the bootstrapped 95% confidence intervals are plotted in Appendix B.1.1.

FIGURE 14: Impulse Response to Inflation Shock



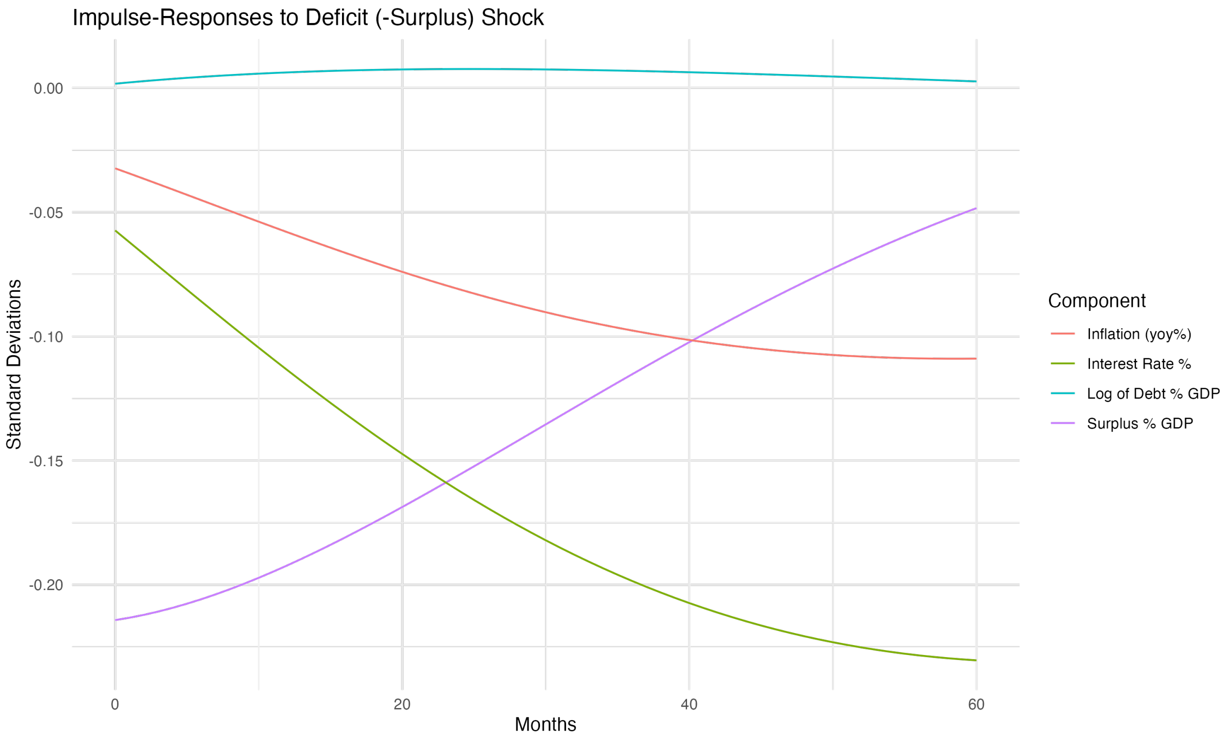
An inflation shock is accompanied by an interest rate shock and a slight surplus shock that quickly falls into negative surpluses. The higher interest rate and expectation of future deficits prompt this unexpected inflation, which is necessary to balance the fiscal theory equation and bring down the real value of the debt. The VAR with monthly inflation exhibits the same dynamics, albeit with a larger increase in the interest rate (above inflation), consistent with the fact that the monthly inflation VAR identified a stronger monetary policy rule to lagged monthly inflation (Table 2).

4.3 Impulse Response to Deficit Shock

I now examine a deficit shock — the negative of a surplus shock — or $\Delta E_1 s_1 = -1$. The impulse responses are plotted in Figure 15, and the bootstrapped 95% confidence intervals are plotted in Appendix B.2.1.

An unexpected deficit shock shows how changes in expectations over other variables, on average, account for the fact that future surpluses will have to increase, rates will have to reduce the cost of the debt, orinflate away the real value of debt. With a deficit shock, debt rises slightly, and surpluses are expected to recover. Interest rates move down, meaning the interest cost on the debt is expected to decrease. From a fiscal theory perspective, inflation does not increase because lower interest rates and the expectation of rising surpluses offset the need to inflate the nominal debt. Expected future net real surpluses pay for the cost of the deficit. Even though this shock did not produce inflation, this result still shows the fiscal dynamics of inflation by showing what fiscal response absorbed the deficit shock and resulted in a lack of inflation.

FIGURE 15: Impulse Response to Deficit Shock



What happens if instead of a surprise deficit shock — which reverted in expectations to normality because the government, on average, follows a fiscal policy rule — we shock expectations on future fiscal sustainability? CDS signals expectations on future fiscal sustainability, and this is what I examine next.

4.4 Impulse Response to CDS Shocks

4.4.1 Updated Vector Autoregression

CDS premia signal expectations on future fiscal sustainability. I add CDS as a variable to the previous VAR. Again, the results for VARs with monthly inflation data, consistent with those presented here but with less persistent inflation, are included in Appendix A.2 for robustness checks.

I estimate VARs using different CDS variables: the Brazilian 5- and 10-year CDS premia, as well as the adjusted log [5] spread between Brazilian and Mexican CDS for these

[5]Adjusted Log: $\text{Sign}(C_{BR,\tau} - C_{MX,\tau}) \cdot \log(|C_{BR,\tau} - C_{MX,\tau}|)$

two maturities to control for market-wide variations, as discussed in the methods section. Tables 3 and 4 present the results for the 5-year Brazil and Brazil-Mexico CDS spread. The results for the 10-year CDS are comparatively less robust due to the smaller sample size. The 10-year instrument only commenced trading in 2004, thus missing one of the two inflation cycles captured by the 5-year CDS. Despite this limitation, the findings from the 10-year CDS are consistent with the broader trends and conclusions drawn from the 5-year data and are included in the Appendix.

TABLE 3: VAR coefficients with Brazil 5Y CDS and Yearly Inflation

	$C_{\text{BZ},5_{t+1}}$	s_{t+1}	i_{t+1}	v_{t+1}	$\pi_{y,t+1}$
$C_{\text{BZ},5_t}$	0.972***	-0.061 .	0.401***	0.001	0.304***
s_t	0.001	0.997***	0.030	-0.003**	0.020
i_t	0.001	0.001	0.979***	0.002 .	-0.001
v_t	-0.071	0.442**	-1.224**	0.949***	-0.844*
$\pi_{y,t}$	-0.001	0.000	-0.051*	-0.002	0.931***

Correlation matrix of residuals

	$C_{\text{BZ},5}$	s	i	v	π_y
$C_{\text{BZ},5}$	1.00	0.018	0.071	0.238	0.035
s	0.018	1.00	0.143	-0.054	0.088
i	0.071	0.143	1.00	-0.107	0.404
v	0.238	-0.054	-0.107	1.00	-0.049
π_y	0.035	0.088	0.404	-0.049	1.00

Sample: Oct 2001 – Dec 2019

The variables in Tables 3 and 4 are persistent, as in the previous non-CDS VAR with yearly inflation (Table 1). CDS is highly persistent but not significantly predicted by any other variable in the model. At the same time, it is predictive of next-period interest rates and, in the Brazil 5-year CDS VAR, next-period inflation as well. Debt increases with deficits, and surpluses increase with debt, following a fiscal policy rule. Interest rates respond to lagged inflation, following a monetary policy rule. Notably, inflation has a

TABLE 4: VAR coefficients with 5Y Brazil-Mexico CDS Spread and Monthly Inflation

	$C_{\text{BZ-MX}, 5_{t+1}}$	s_{t+1}	i_{t+1}	v_{t+1}	$\pi_{m,t+1}$
$C_{\text{BZ-MX}, 5_t}$	0.949***	-0.006	0.044**	0.000	0.011
s_t	-0.014	1.000***	0.045*	0.003*	0.007
i_t	0.001	-0.004	0.952***	0.001	-0.000
v_t	0.076	0.379**	-0.169	0.961***	0.004
$\pi_{m,t}$	0.182	0.000	0.784***	0.003	0.668***

Correlation matrix of residuals

	$C_{\text{BZ-MX}, 5}$	s	i	v	π_m
$C_{\text{BZ-MX}, 5}$	1.00	0.037	0.046	0.216	0.008
s	0.037	1.00	0.127	-0.051	0.046
i	0.046	0.127	1.00	-0.087	0.125
v	0.216	-0.051	-0.087	1.00	-0.075
π_m	0.008	0.046	0.125	-0.075	1.00

Sample: Oct 2001 – Dec 2019

positive coefficient on the lagged CDS variable in both tables, which is consistent with how CDS moves closely with unexpected inflation, shown previously in Figure 13.

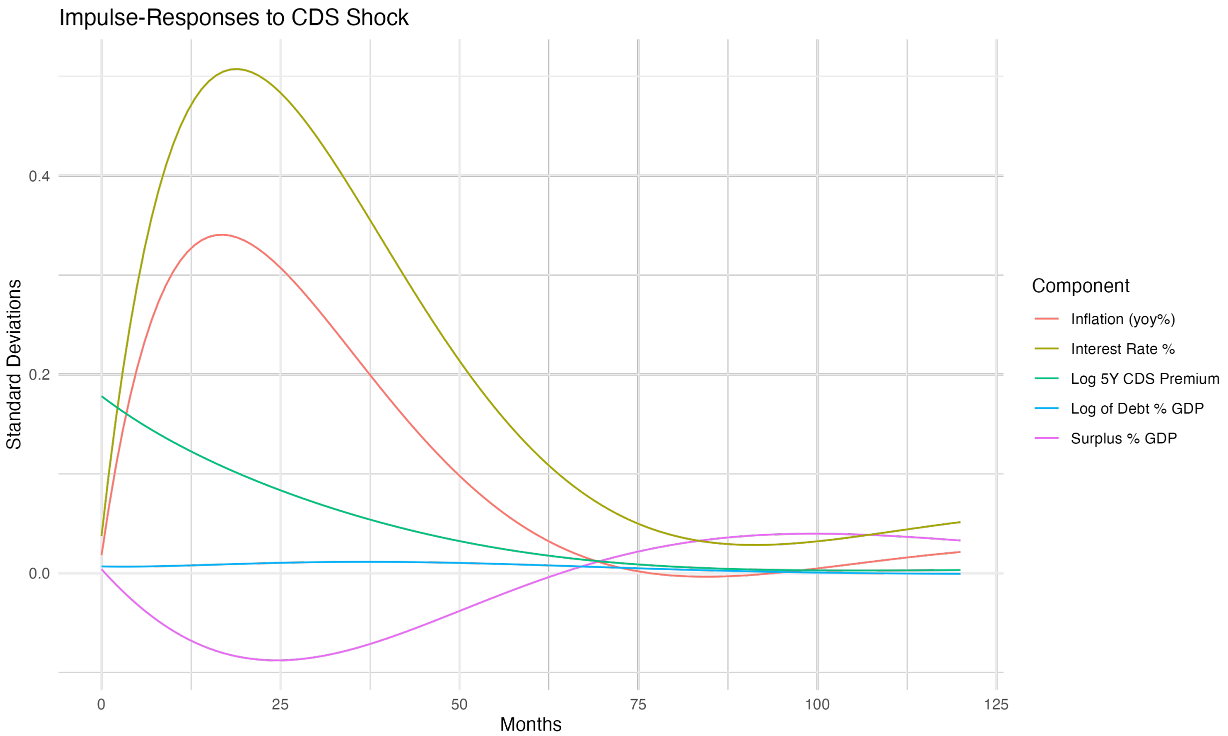
4.4.2 Impulse Response to 5-Year Brazil CDS Shock

I use the above VARs with CDS to plot impulse response functions to CDS shocks, using the same method of allowing for contemporaneous shocks used previously. It is important to clarify that the interpretation here is not that CDS shocks cause inflation directly. Instead, CDS premia react to new information in the economy. An upward shock to CDS is aligned with a higher expected risk of default on the debt. That, in turn, is equivalent to a belief that the government is no longer committed to increasing real surpluses or that the cost of the debt will become unsustainable, to the point that people are even assigning a greater probability of default.

Taking a CDS shock to be the response to news of future fiscal deterioration, we can interpret the other contemporaneous shocks and subsequent impulse responses as the changes in expectations over the other variables. Figure 16 presents the impulse responses to a shock in the 5-year Brazilian CDS premium.

The results are consistent with the theoretical predictions. The shock to CDS happens contemporaneously to a downward shock in surpluses (or a deficit shock) and an

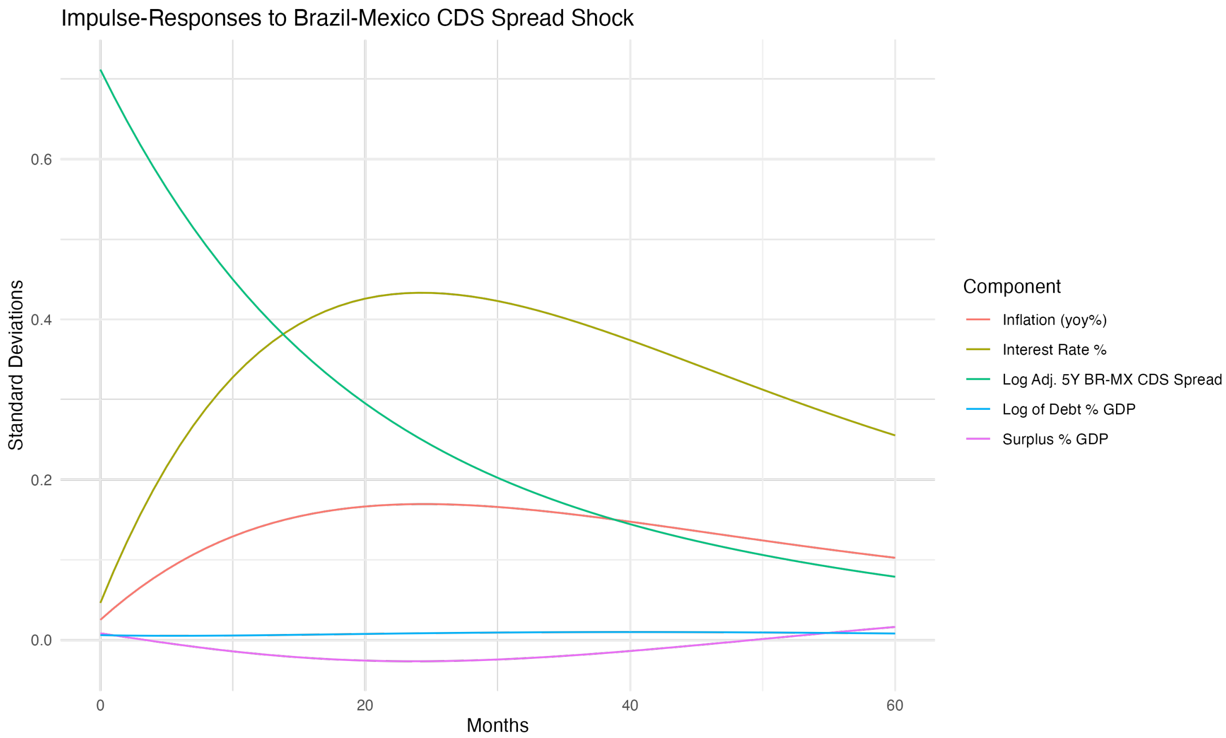
FIGURE 16: Impulse Response to 5-Year Brazil CDS Shock



upward shock in inflation. Interest rates also shock upwards in response to inflation. Surpluses are expected to decrease for the initial periods, and inflation stabilizes only when surpluses increase again.

4.4.3 Impulse Response to 5-Year Brazil CDS Shock over Mexico

FIGURE 17: Impulse Response to 5-Year Brazil CDS Shock over 5-Year Mexico CDS



Finally, I shock the 5-year Brazilian CDS over the 5-year Mexican CDS to check that I am not capturing spurious market noise shocks. Recall that CDS signals a latent fiscal sustainability variable F_t:

$$\log C_t = \beta_0 + \beta_1 F_t + \varepsilon_t \tag{4.1}$$

A shock to CDS may be due to shocks in the latent fiscal sustainability variable F_t, or shocks in market noise in the error term ε_t. Shocking the Brazil-Mexico CDS spread instead controls for some market movement in ε_t and validates the impulse responses to a CDS shock that is tied to expectations specific to Brazil.

Figure 17 presents the impulse responses to the shock over the Mexican CDS. Again, I interpret the CDS shock as a response to unobserved news about fiscal deterioration and the impulse responses as the revised expectations given the news. Like the previously analyzed CDS shock, inflation and interest rates here rise and there is a deficit shock, but in a less pronounced way. Inflation stabilizes once surpluses also begin to converge back to zero.

The results of the CDS shocks present a story consistent with the theoretical prediction that inflation shocks are correlated with revisions in expectations about future real surpluses and costs on the debt:

$$\Delta E_{t+1}\pi_{t+1} = -\Delta E_{t+1}\sum_{j=0}^{\infty}\rho^j s_{t+1+j} + \Delta E_{t+1}\sum_{j=1}^{\infty}\rho^j r_{t+1+j} \tag{4.2}$$

5 Conclusion

The VARs and impulse responses presented in the analysis describe the average response to shocks estimated from empirical data from Brazil over two decades. The interpretation of these average responses supports the fiscal theory describing inflation dynamics in Brazil. First, I demonstrated how inflation shocks are consistent with revisions in expectations of future deficits and how deficit shocks do not cause inflation but are accommodated on average by lower interest costs on the debt and an expectation that deficits will converge to surpluses. Next, I introduced CDS shocks to the model as a signal of latent fiscal sustainability expectations, showing that the news of fiscal deterioration in the economy comes simultaneously with inflation, interest rate shocks, and a deficit shock, again consistent with the fiscal theoretical predictions.

The empirical results and historical case studies suggest how changes in the credibility of future fiscal commitments, which can be signaled through CDS premia, can lead to inflationary pressures. Brazil achieved monetary credibility after implementing the *Plano Real*. Fiscal credibility, however, was compromised in two distinct periods: firstly, when Lula da Silva hinted at a potential debt default before his election, and secondly, under the Rousseff administration, which ran a "creative accounting" scheme and incurred deficits without signaling a repayment plan. These periods of deterioration in fiscal credibility also occur when CDS premia increases. After Rousseff's tenure, inflation rapidly stabilized with a strong fiscal policy credibility shock — the constitutional cap on real government spending.

In macroeconomic research, identifying causality or substantiating that one theory is the definitive explanation for a phenomenon is inherently challenging. Macroeconomists cannot replicate economic conditions to observe outcomes repeatedly, and it is complex to fully account for the interrelationships among variables and their responses to external shocks or policy changes. Running a theory-free VAR on empirical data to interpret the results offers a means to validate theoretical predictions, but this method has limitations. Additionally, while introducing CDS premia as signals of fiscal sustainability expectations is an innovative approach, this signal often contains significant noise from market movements. Even when adjustments are made to control CDS movements in similar economies like Mexico, these signals do not always directly reflect the underlying fiscal fundamentals. Despite these challenges, the robustness of the VAR approach with different CDS variables and degrees of inflation persistence provides a compelling narrative about the importance of fiscal credibility in an economy, building on many prior authors who wrote about Brazil and other countries.

More work can be done to improve the robustness of the results. Incorporating GDP growth rates into the VAR as another state variable could account for business cycles and recessions. Employing a time-varying parameter model could also provide deeper insights into the impacts of fiscal policy changes on inflation. The current analysis estimates the average impulse responses to shocks, but different Brazilian government administrations have pursued varied fiscal policies over the sample period. A time-varying parameter model would account for fiscal policy rule changes. Finally, given that much of the research on fiscal theory has been conducted in the context of the United States, few models introduce exchange rates into fiscal and inflation dynamics. In other economies, exchange rates have a pass-through effect on inflation and can also be frictionless inflation indicators.

Ultimately, fiscal and monetary policies are deeply intertwined, and further research is essential to understand their shared dynamics. Fiscal institutions influence the efficacy of independent central banks, which in turn can impact fiscal outcomes. To maintain stable prices, credible communication of policy objectives is critical for the central bank *and* the fiscal authority.

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Appendix

A Vector Autoregressions Appendix

This appendix contains the VAR tables for all VAR estimations in this paper.

T-test significance level codes are: 0 ***; 0.001 **; 0.01 *; 0.05 . .

A.1 Vector Autoregressions on Debt Identity

VAR coefficients with yearly inflation rate π_y

	s_{t+1}	i_{t+1}	v_{t+1}	$\pi_{y,t+1}$
s_t	1.000***	0.023	-0.003**	0.011
i_t	-0.002	0.997***	0.002*	0.012
v_t	0.310*	-0.096	0.960***	-0.093
$\pi_{y,t}$	-0.007	-0.002	0.03	0.967***

Correlation matrix of residuals

	s	i	v	π_y
s	1.00	0.10	-0.06	0.06
i	0.10	1.00	-0.06	0.44
v	-0.06	-0.06	1.00	-0.04
π_y	0.06	0.44	-0.04	1.00

Sample: Jan 2001 – Dec 2019

VAR coefficients with monthly inflation rate π_m

	s_{t+1}	i_{t+1}	v_{t+1}	$\pi_{m,t+1}$
s_t	1.002***	0.035*	-0.002*	0.003
i_t	-0.006	0.965***	0.001	0.004
v_t	0.351**	0.240	0.971***	0.077
$\pi_{m,t}$	-0.014	0.782***	-0.002	0.656***

Correlation matrix of residuals

	s	i	v	π_m
s	1.00	0.13	-0.06	0.06
i	0.13	1.00	-0.05	0.16
v	-0.06	-0.05	1.00	-0.09
π_m	0.06	0.16	-0.09	1.00

Sample: Jan 2001 – Dec 2019

A.2 Vector Autoregressions with CDS

A.2.1 Vector Autoregression with 5Y Brazil CDS

VAR coefficients with Brazil 5Y CDS and Yearly Inflation

	$C_{BZ,\,5_{t+1}}$	s_{t+1}	i_{t+1}	v_{t+1}	$\pi_{y,t+1}$
$C_{BZ,\,5_t}$	0.972***	-0.061 .	0.401***	0.001	0.304***
s_t	0.001	0.997***	0.030	-0.003**	0.020
i_t	0.001	0.001	0.979***	0.002 .	-0.001
v_t	-0.071	0.442**	-1.224**	0.949***	-0.844*
$\pi_{y,t}$	-0.001	0.000	-0.051*	-0.002	0.931***

Correlation matrix of residuals

	$C_{BZ,\,5}$	s	i	v	π_y
$C_{BZ,\,5}$	1.00	0.018	0.071	0.238	0.035
s	0.018	1.00	0.143	-0.054	0.088
i	0.071	0.143	1.00	-0.107	0.404
v	0.238	-0.054	-0.107	1.00	-0.049
π_y	0.035	0.088	0.404	-0.049	1.00

Sample: Oct 2001 – Dec 2019

VAR coefficients with Brazil 5Y CDS and Monthly Inflation

	$C_{\text{BZ, }5_{t+1}}$	s_{t+1}	i_{t+1}	v_{t+1}	$\pi_{m,t+1}$
$C_{\text{BZ, }5_t}$	0.982***	-0.069*	0.136	-0.000	0.156***
s_t	0.001	0.997***	0.039*	-0.003*	0.015
i_t	0.001	0.001	0.951***	0.001	-0.013
v_t	-0.097	0.465***	-0.170	0.961***	-0.205
$\pi_{m,t}$	-0.041	0.030	0.747***	-0.003	0.598***

Correlation matrix of residuals

	$C_{\text{BZ, }5}$	s	i	v	π_m
$C_{\text{BZ, }5}$	1.00	0.022	0.120	0.236	0.034
s	0.022	1.00	0.136	-0.052	0.081
i	0.120	0.136	1.00	-0.085	0.109
v	0.236	-0.052	-0.085	1.00	-0.076
π_m	0.034	0.081	0.109	-0.076	1.00

Sample: Oct 2001 – Dec 2019

A.2.2 Vector Autoregression with 10Y Brazil CDS

VAR coefficients with Brazil 10Y CDS and Yearly Inflation

	$C_{BZ,\,10_{t+1}}$	s_{t+1}	i_{t+1}	v_{t+1}	$\pi_{y,t+1}$
$C_{BZ,\,10_t}$	0.883***	-0.105	-0.038	0.002	0.071
s_t	-0.008	0.989***	0.046*	-0.004**	0.043*
i_t	0.003	0.005	0.958***	0.002	-0.032 .
v_t	0.056	0.376	0.263	0.935***	-0.083
$\pi_{y,t}$	0.017	-0.011	0.114***	-0.003	1.003***

Correlation matrix of residuals

	$C_{BZ,\,10}$	s	i	v	π_y
$C_{BZ,\,10}$	1.00	0.011	0.109	0.132	0.095
s	0.011	1.00	0.207	-0.093	0.136
i	0.109	0.207	1.00	0.040	0.262
v	0.132	-0.093	0.040	1.00	0.000
π_y	0.095	0.136	0.262	0.000	1.00

Sample: Mar 2004 – Dec 2019

VAR coefficients with Brazil 10Y CDS and Monthly Inflation

	$C_{\text{BZ, }10_{t+1}}$	s_{t+1}	i_{t+1}	v_{t+1}	$\pi_{m,t+1}$
$C_{\text{BZ, }10_t}$	0.904***	-0.126*	0.057	-0.003	0.074
s_t	-0.012 .	0.991***	0.018	-0.003*	0.004
i_t	0.008 .	0.002	0.989***	0.001	-0.002
v_t	-0.102	0.522***	-0.501 .	0.970***	-0.311*
$\pi_{m,t}$	0.007	0.044	0.405***	0.005	0.557***

Correlation matrix of residuals

	$C_{\text{BZ, }10}$	s	i	v	π_m
$C_{\text{BZ, }10}$	1.00	0.004	0.143	0.115	0.024
s	0.004	1.00	0.175	-0.089	0.107
i	0.143	0.175	1.00	-0.013	0.041
v	0.115	-0.089	-0.013	1.00	-0.125
π_m	0.024	0.107	0.041	-0.125	1.00

Sample: Mar 2004 – Dec 2019

A.2.3 Vector Autoregression with 5Y Brazil-Mexico CDS Spread

VAR coefficients with 5Y Brazil-Mexico CDS Spread and Yearly Inflation

	$C_{\text{BZ-MX, 5}_{t+1}}$	s_{t+1}	i_{t+1}	v_{t+1}	$\pi_{y,t+1}$
$C_{\text{BZ-MX, 5}_t}$	0.953***	-0.006	0.062**	-0.00001	0.023
s_t	-0.010	0.997***	0.038*	-0.003**	0.018
i_t	-0.002	-0.0002	0.980***	0.002 .	0.006
v_t	0.075	0.331**	-0.613 .	0.951***	-0.256
$\pi_{y,t}$	0.014	-0.007	0.114**	-0.002	0.966***

Correlation matrix of residuals

	$C_{\text{BZ-MX, 5}}$	s	i	v	π_y
$C_{\text{BZ-MX, 5}}$	1.00	0.038	0.086	0.215	0.047
s	0.038	1.00	0.109	-0.056	0.058
i	0.086	0.109	1.00	-0.098	0.445
v	0.215	-0.056	-0.098	1.00	-0.043
π_y	0.047	0.058	0.445	-0.043	1.00

Sample: Oct 2001 – Dec 2019

VAR coefficients with 5Y Brazil-Mexico CDS Spread and Monthly Inflation

	$C_{\text{BZ-MX, 5}_{t+1}}$	s_{t+1}	i_{t+1}	v_{t+1}	$\pi_{m,t+1}$
$C_{\text{BZ-MX, 5}_t}$	0.949***	-0.006	0.044**	0.000	0.011
s_t	-0.014	1.000***	0.045*	0.003*	0.007
i_t	0.001	-0.004	0.952***	0.001	-0.000
v_t	0.076	0.379**	-0.169	0.961***	0.004
$\pi_{m,t}$	0.182	0.000	0.784***	0.003	0.668***

Correlation matrix of residuals

	$C_{\text{BZ-MX, 5}}$	s	i	v	π_m
$C_{\text{BZ-MX, 5}}$	1.00	0.037	0.046	0.216	0.008
s	0.037	1.00	0.127	-0.051	0.046
i	0.046	0.127	1.00	-0.087	0.125
v	0.216	-0.051	-0.087	1.00	-0.075
π_m	0.008	0.046	0.125	-0.075	1.00

Sample: Oct 2001 – Dec 2019

A.2.4 Vector Autoregression with 10Y Brazil-Mexico CDS Spread

VAR coefficients with 10Y Brazil-Mexico CDS Spread and Yearly Inflation

Variable	$C_{\text{BZ-MX},10_{t+1}}$	s_{t+1}	i_{t+1}	v_{t+1}	$\pi_{y,t+1}$
$C_{\text{BZ-MX},10_{t+1}}$	0.920***	-0.001	0.060***	-0.000	0.036**
s_t	-0.039	0.996***	0.072***	-0.004**	0.052**
i_t	0.011	0.002	0.939***	0.002*	-0.040**
v_t	-0.076	0.219	-0.083	0.940***	-0.148
$\pi_{y,t}$	-0.004	-0.022	0.108***	-0.003	1.009***

Correlation matrix of residuals

	$C_{\text{BZ-MX},10}$	s	i	v	π_y
$C_{\text{BZ-MX},10}$	1.00	0.12	0.17	0.15	0.05
s	0.12	1.00	0.23	-0.10	0.13
i	0.17	0.23	1.00	0.05	0.21
v	0.15	-0.10	0.05	1.00	0.01
π_y	0.05	0.13	0.21	0.01	1.00

Sample: Mar 2004 – Dec 2019

VAR coefficients with 10Y Brazil-Mexico CDS Spread and Monthly Inflation

	$C_{\text{BZ-MX, 10}_{t+1}}$	s_{t+1}	i_{t+1}	v_{t+1}	$\pi_{m,t+1}$
$C_{\text{BZ-MX, 10}_t}$	0.913***	-0.002	0.055***	-0.001	0.008
s_t	-0.03	1.004***	0.033*	-0.003**	-0.001
i_t	0.003	-0.007	0.977***	0.001	0.001
v_t	0.362	0.437**	-0.741**	0.971***	-0.294 .
$\pi_{m,t}$	0.438 .	0.021	0.366***	0.005	0.565***

Correlation matrix of residuals

	$C_{\text{BZ-MX, 10}}$	s	i	v	π_m
$C_{\text{BZ-MX, 10}}$	1.00	0.119	0.125	0.147	-0.028
s	0.119	1.00	0.177	-0.084	0.090
i	0.125	0.177	1.00	-0.002	0.028
v	0.147	-0.084	-0.002	1.00	-0.125
π_m	-0.028	0.090	0.028	-0.125	1.00

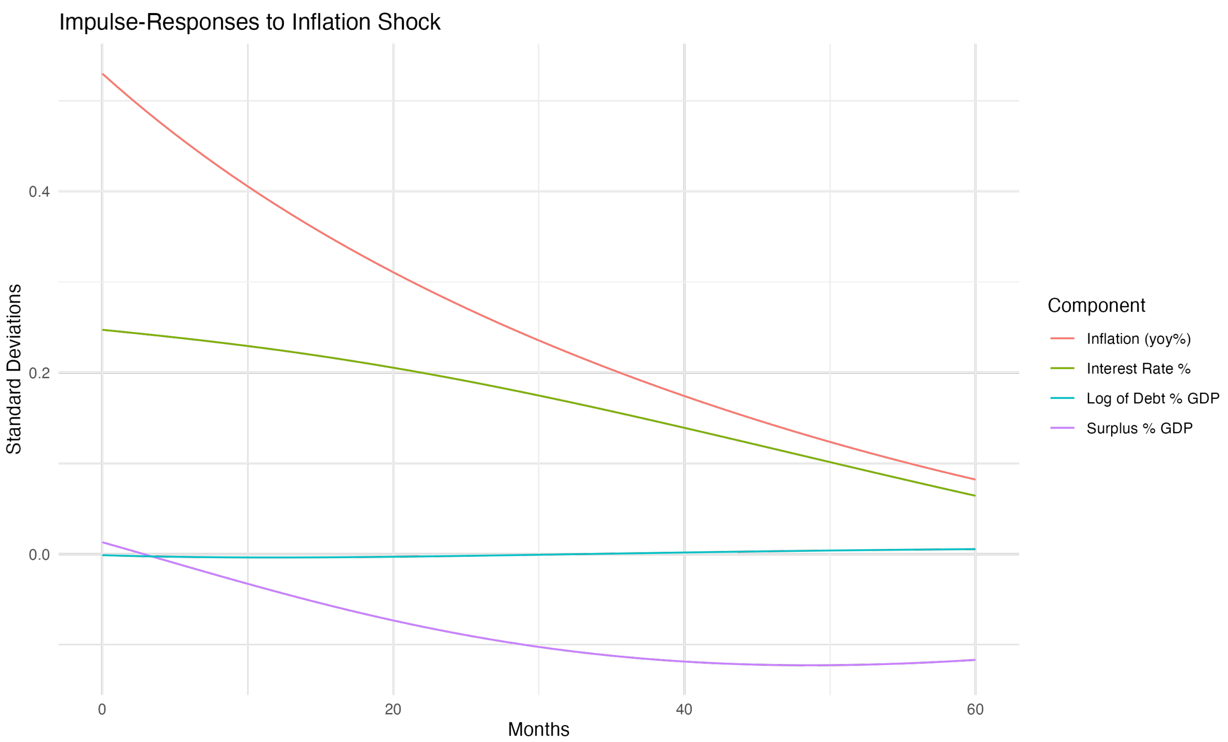
Sample: Mar 2004 – Dec 2019

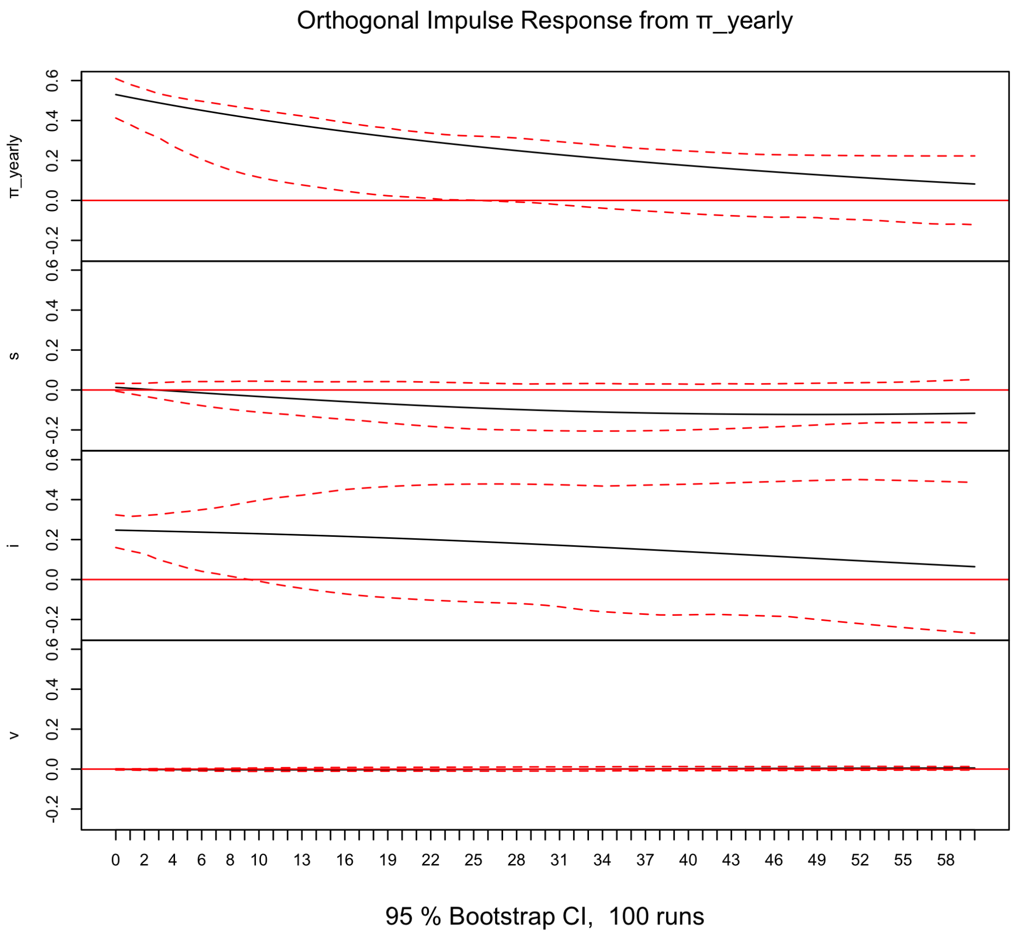
B Impulse Response Appendix

This appendix contains all impulse-response functions discussed in this paper, plotted first together and then separately with their respective 95% bootstrapped confidence intervals.

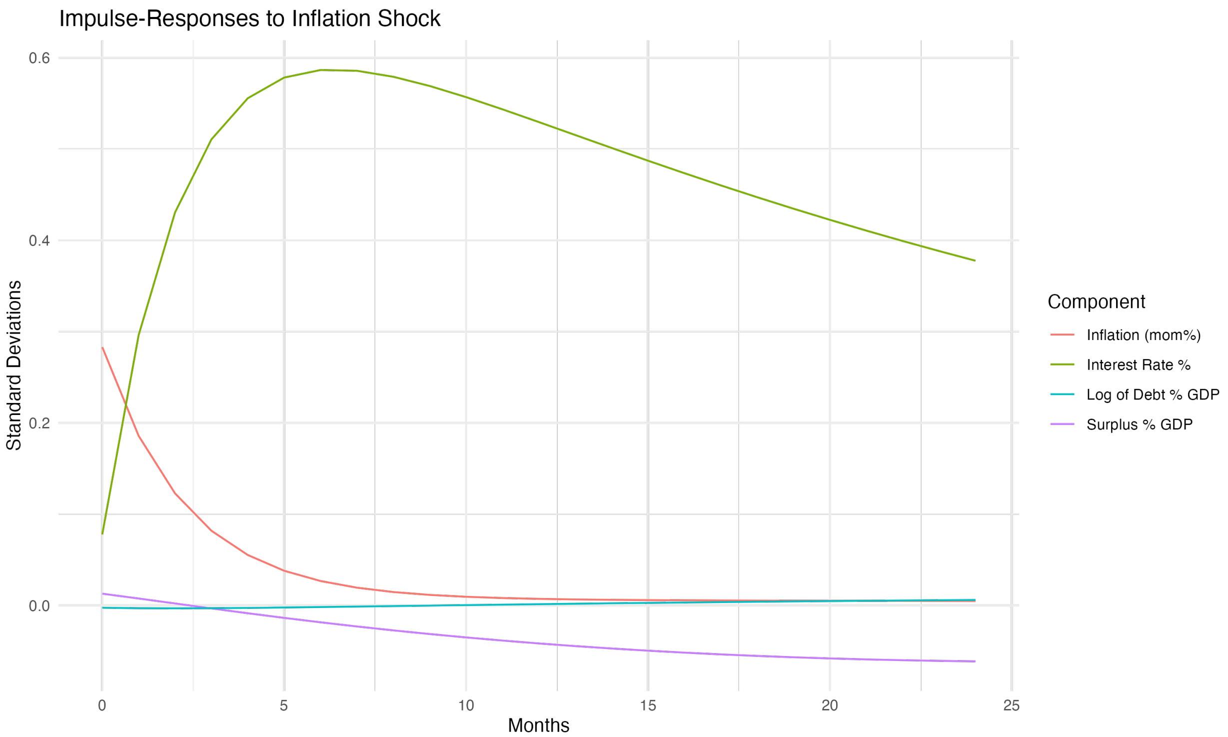
B.1 Impulse Responses to Inflation Shock

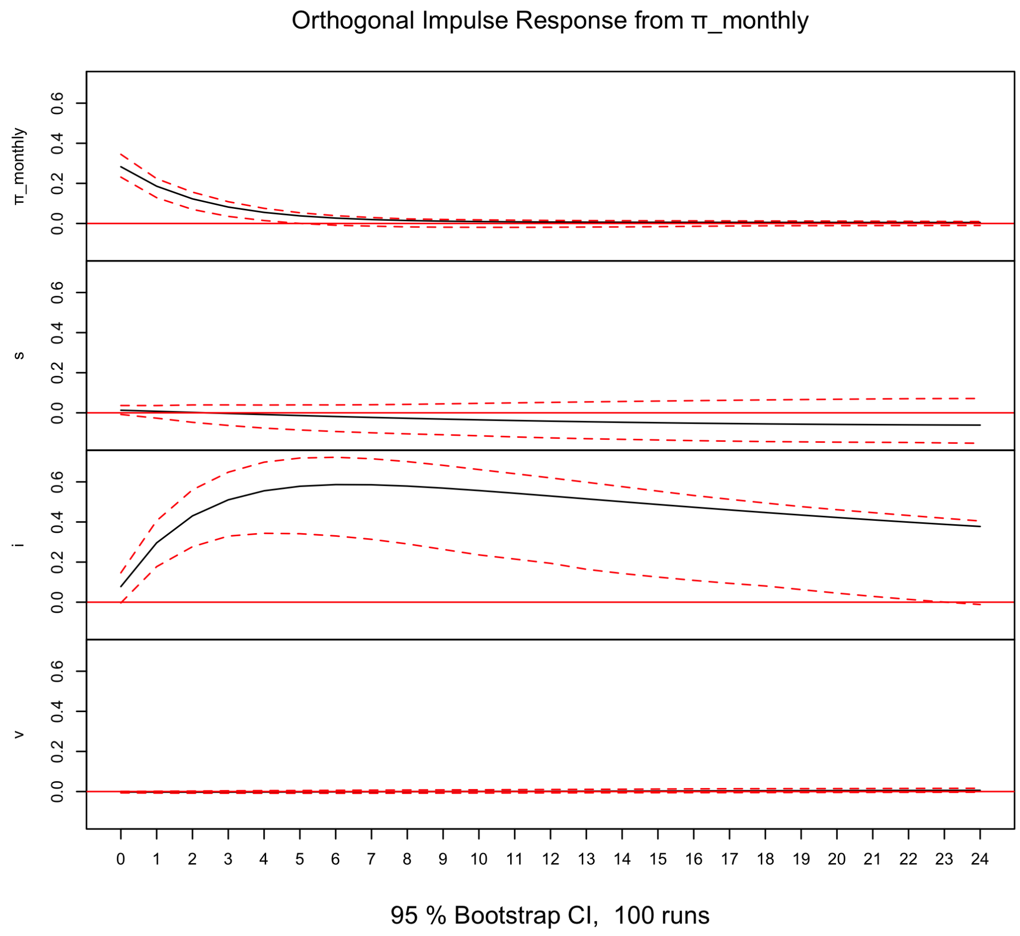
B.1.1 Inflation Shock Impulse Response with Yearly Inflation




Orthogonal Impulse Response from π_yearly
π_yearly
s
i
v
-0.2
0.0
0.2
0.4
0.6
0 2 4 6 8 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52 55 58
95 % Bootstrap CI, 100 runs

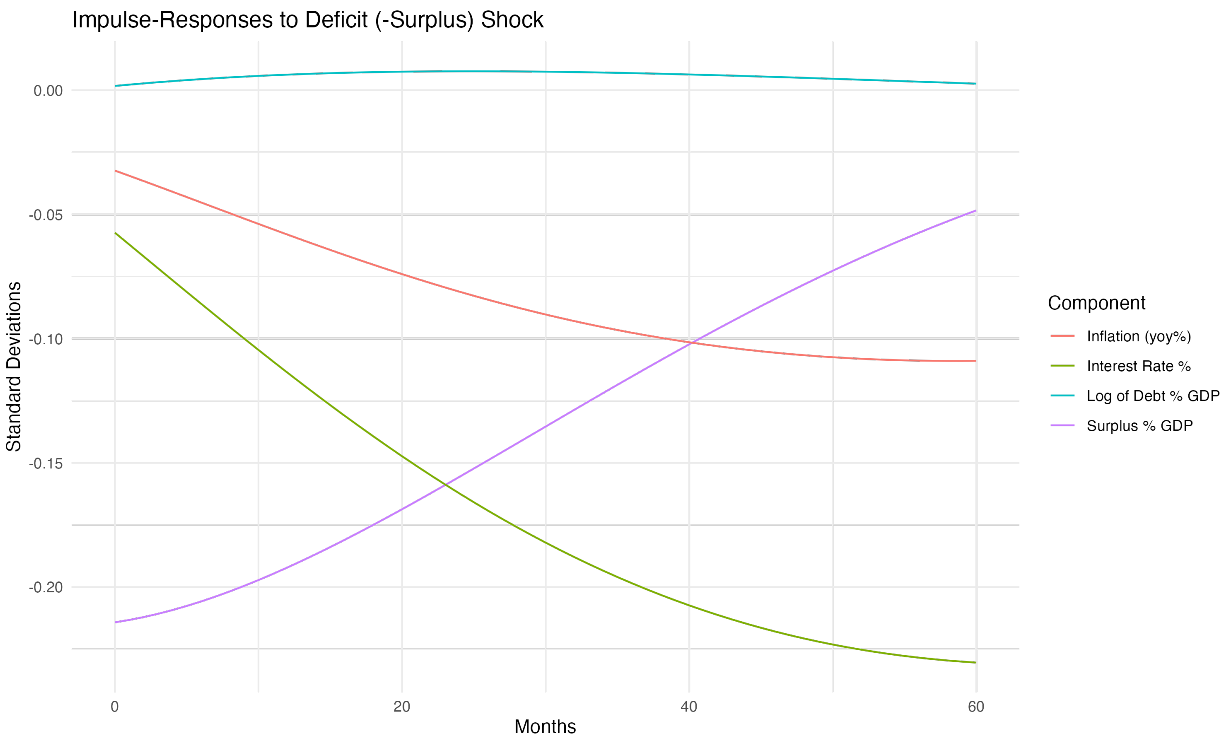
B.1.2 Inflation Shock Impulse Response with Monthly Inflation

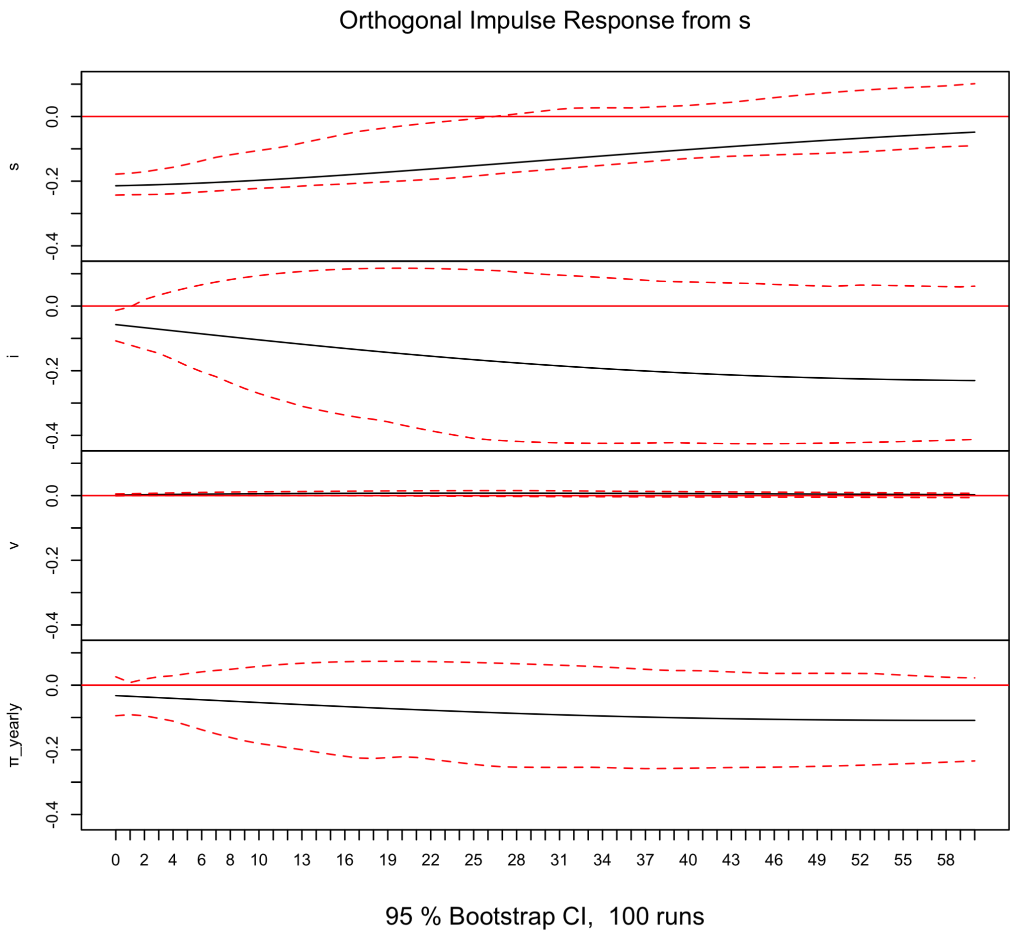



Orthogonal Impulse Response from π_monthly
π_monthly
s
i
v
0.0
0.2
0.4
0.6
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
95 % Bootstrap CI, 100 runs

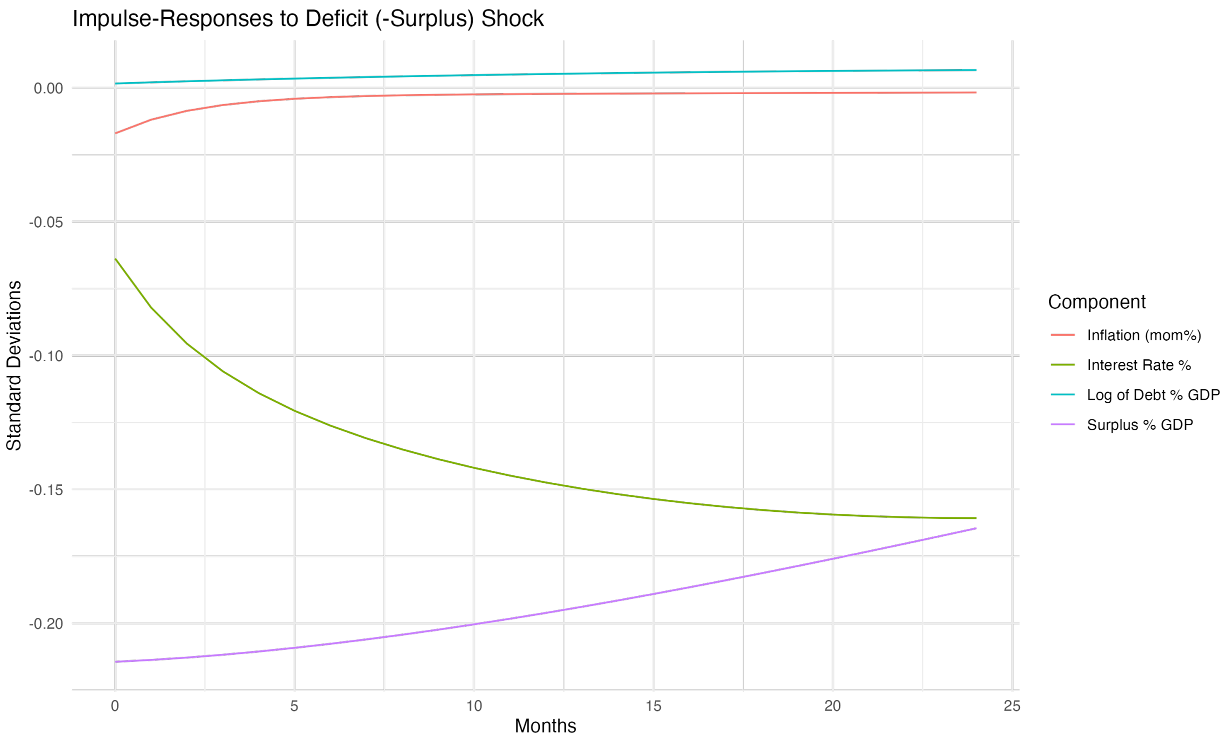
B.2 Impulse Responses to Deficit Shock

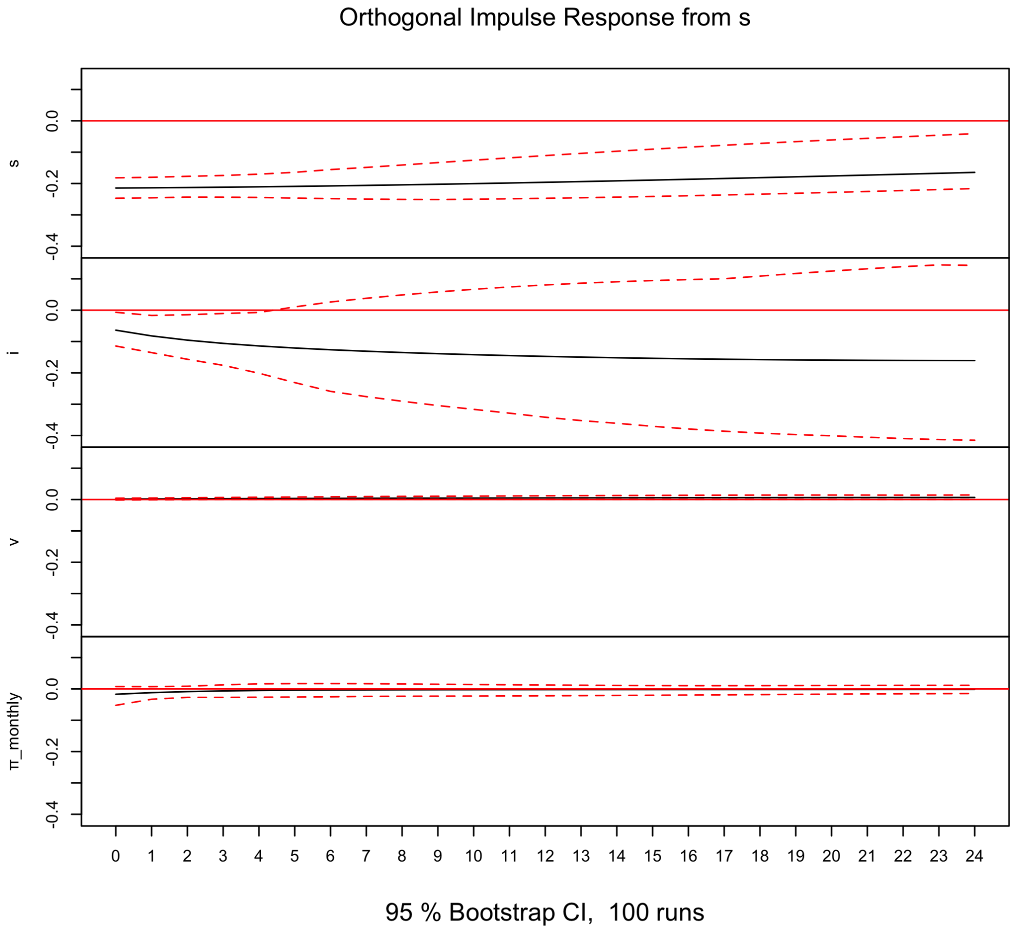
B.2.1 Deficit Shock Impulse Response with Yearly Inflation




Orthogonal Impulse Response from s
s
i
v
π_yearly
0.0
-0.2
-0.4
0 2 4 6 8 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52 55 58
95 % Bootstrap CI, 100 runs

B.2.2 Deficit Shock Impulse Response with Monthly Inflation

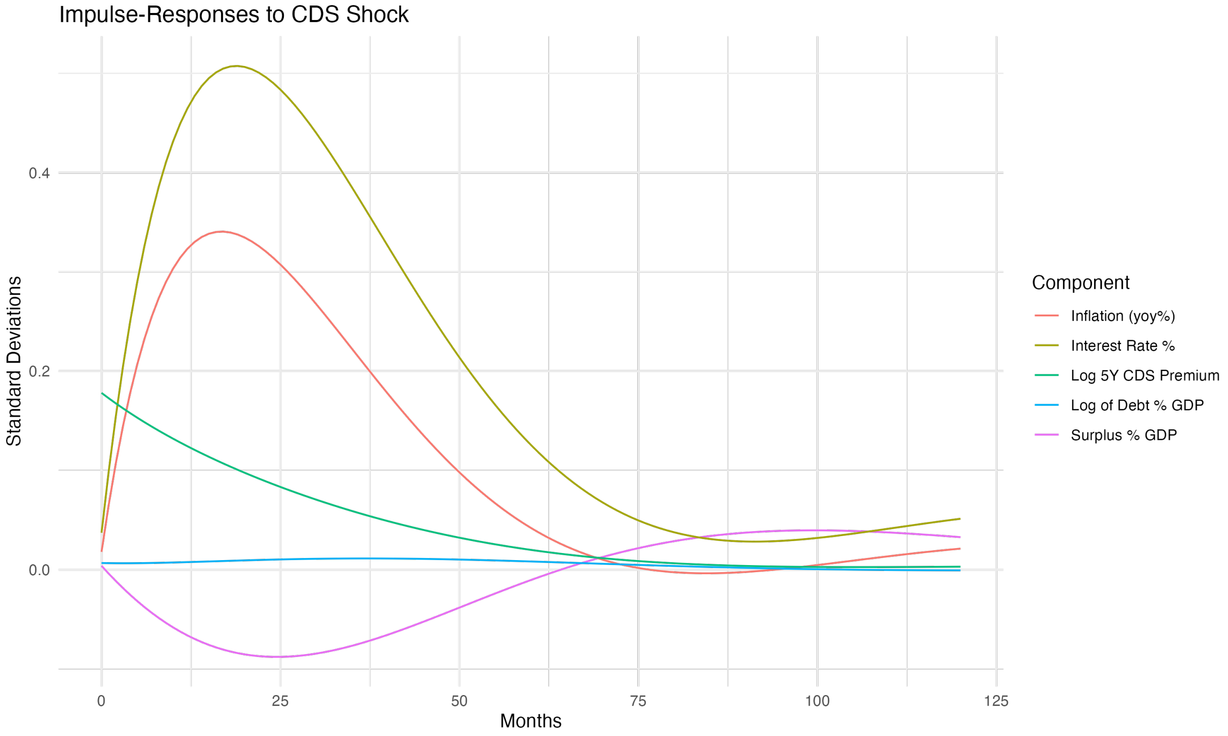


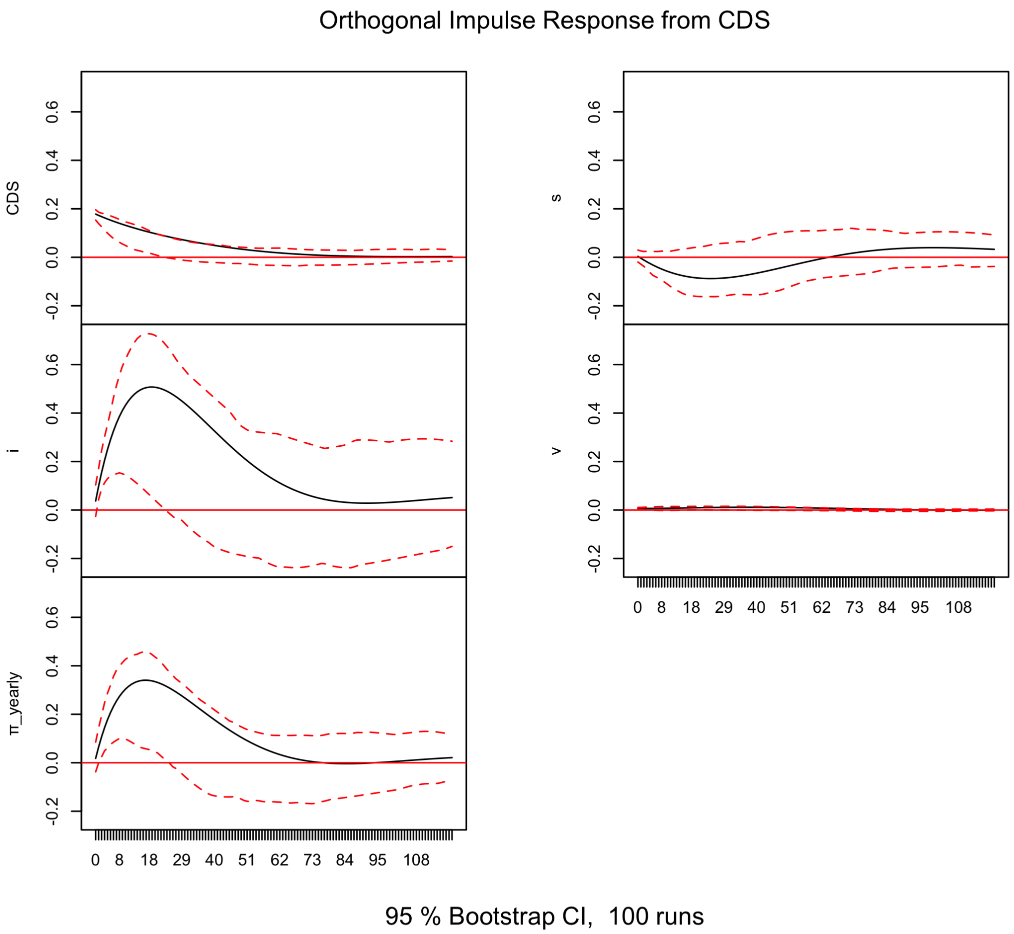


B.3 Impulse Responses to CDS Shocks

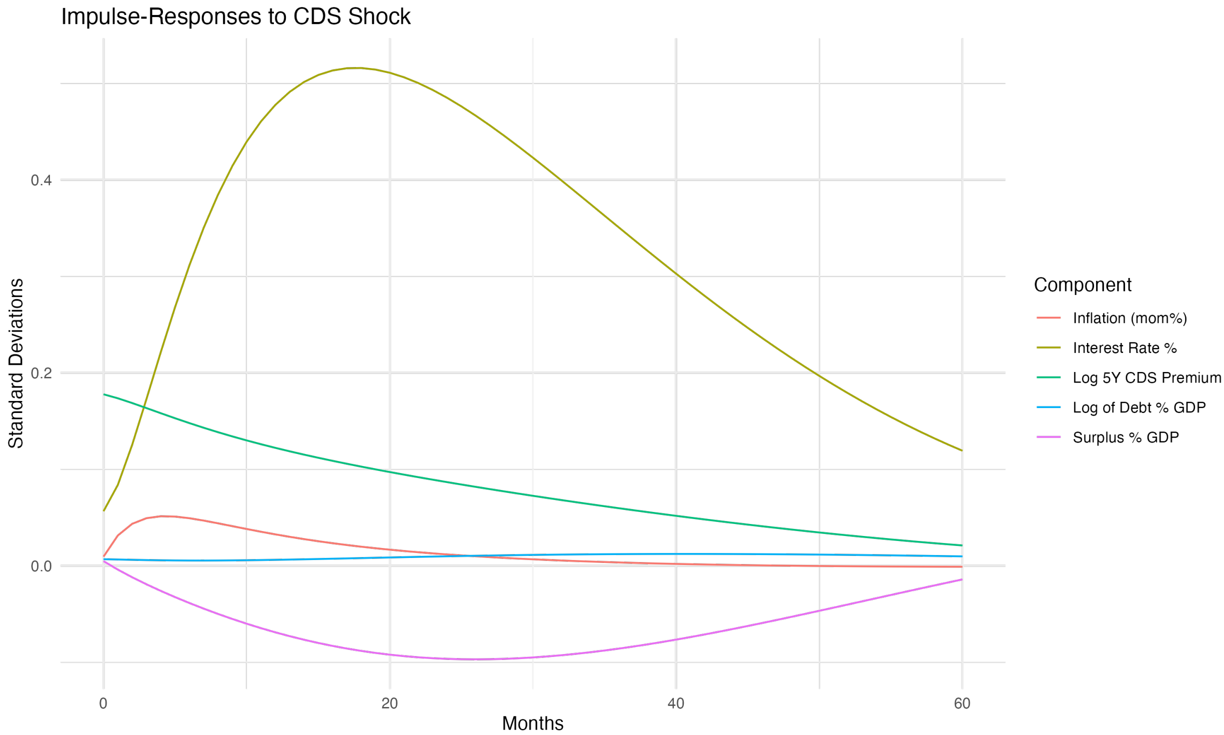
B.3.1 Impulse Responses to Brazil 5Y CDS Shock

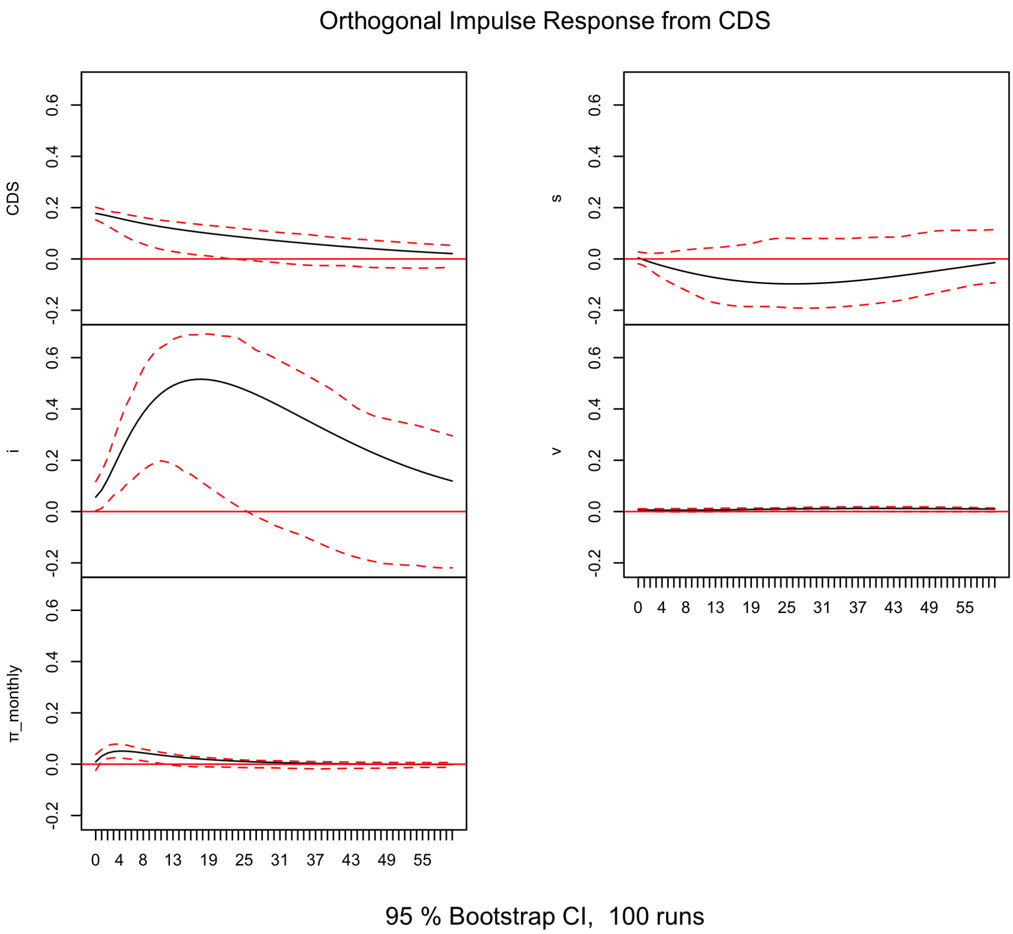
With Yearly Inflation





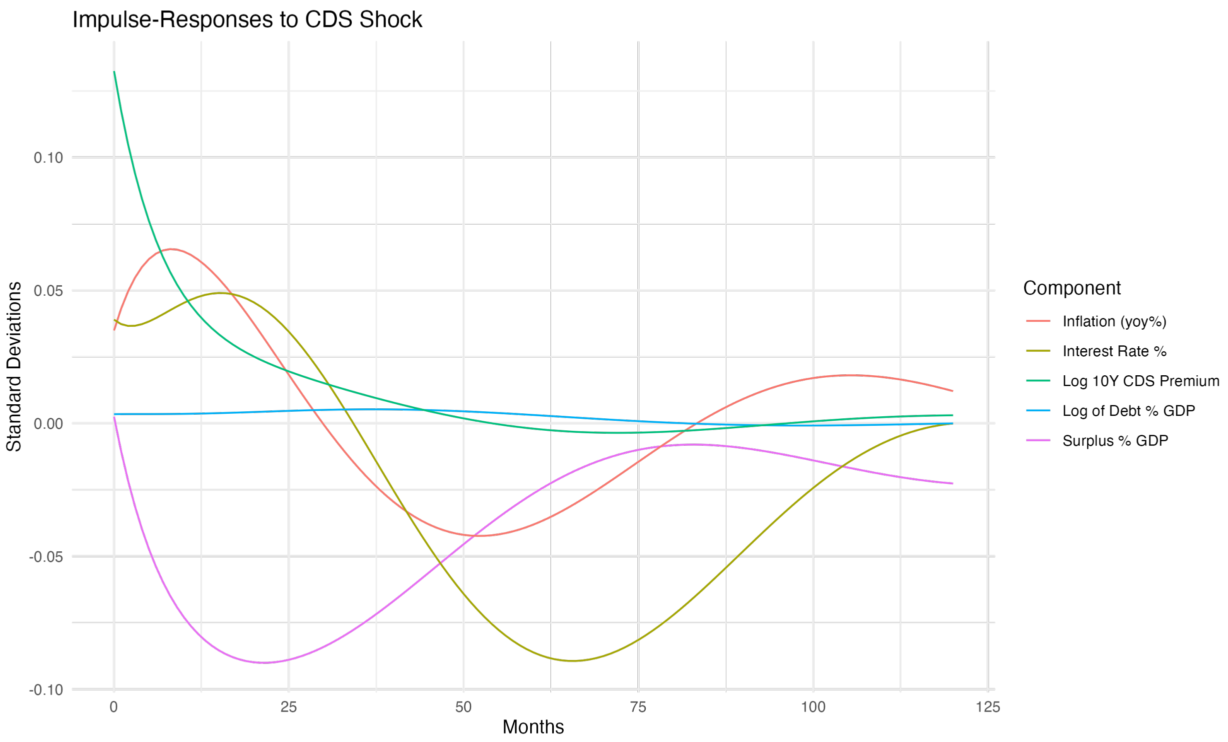
With Monthly Inflation

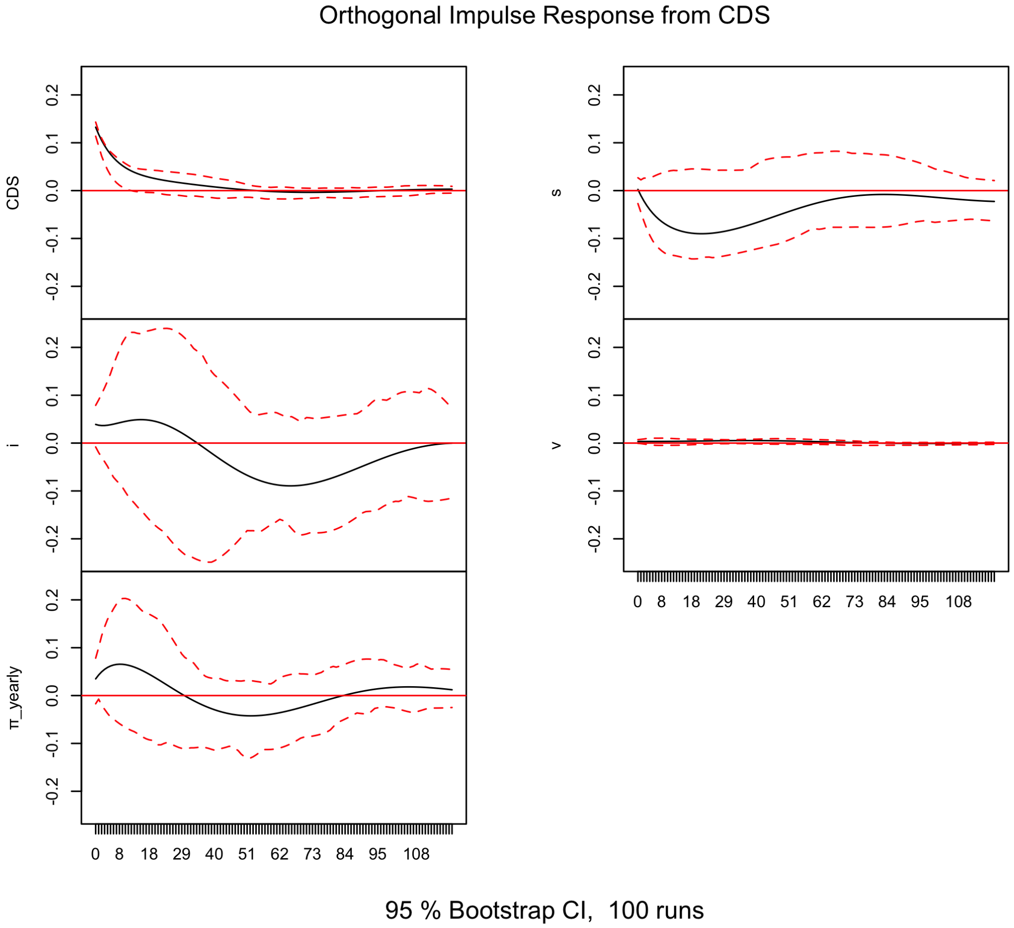




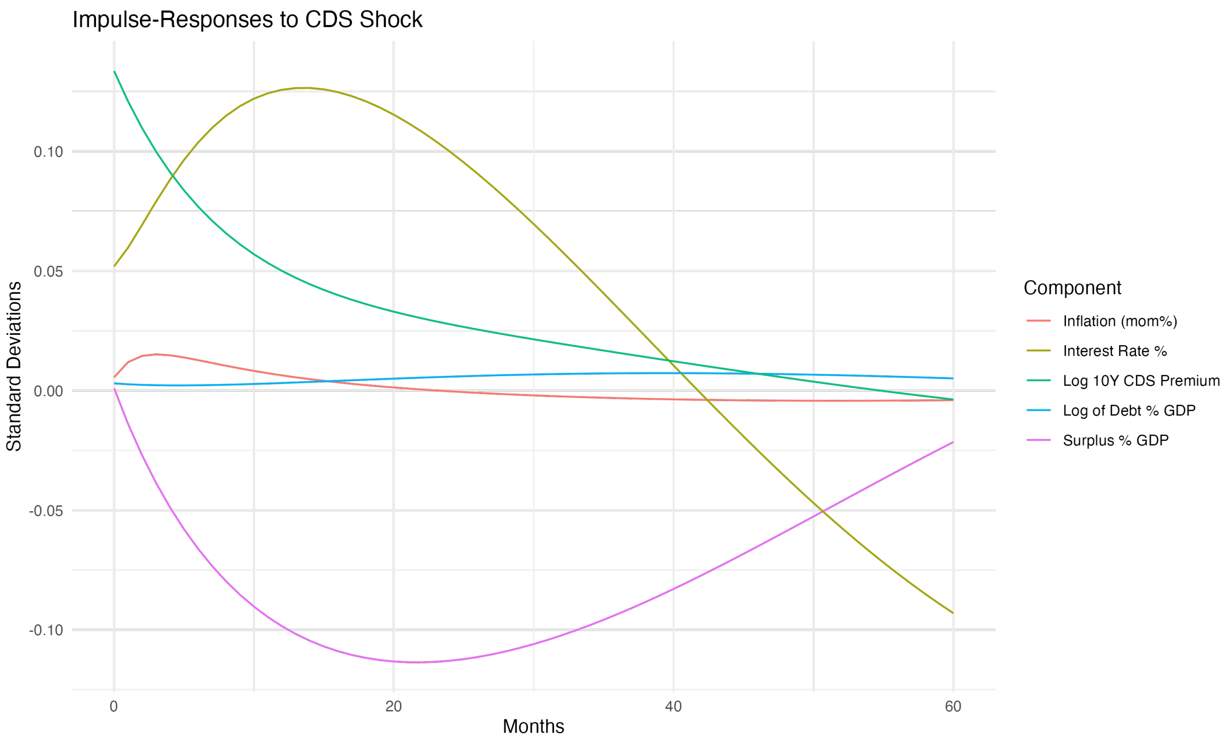
B.3.2 Impulse Responses to Brazil 10Y CDS Shock

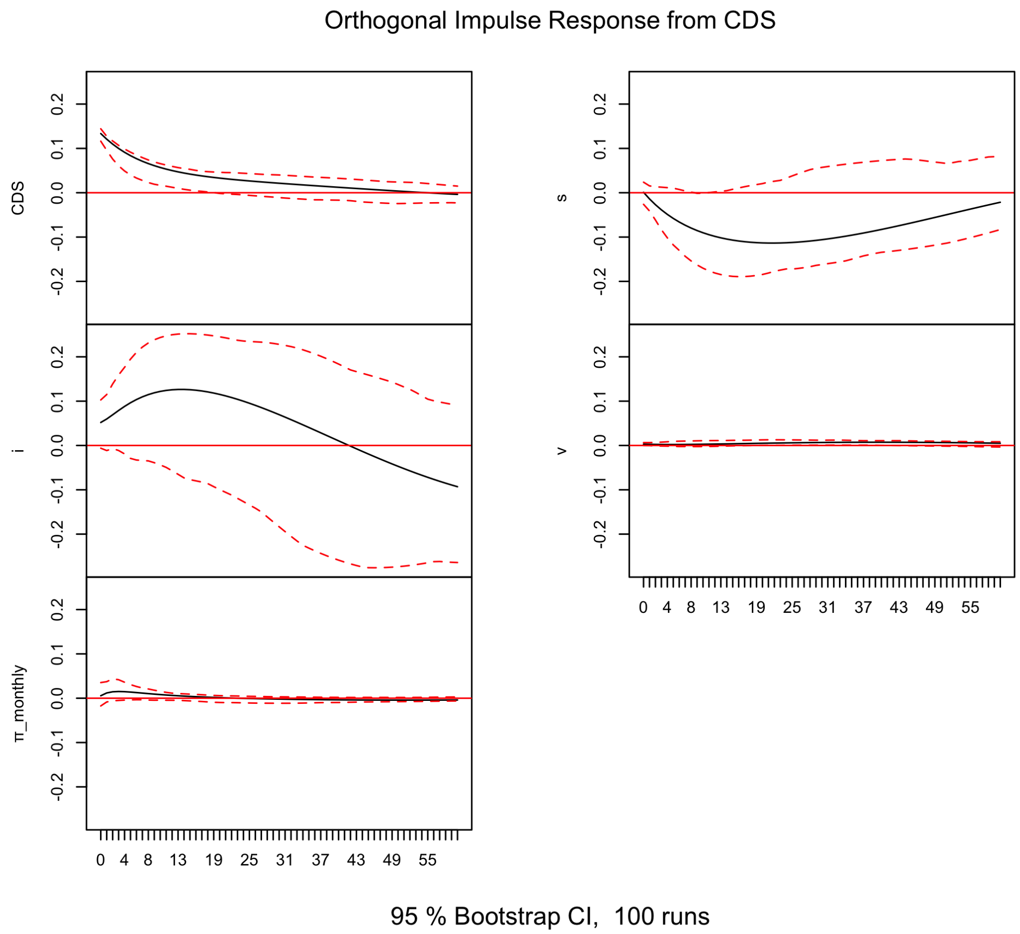
With Yearly Inflation





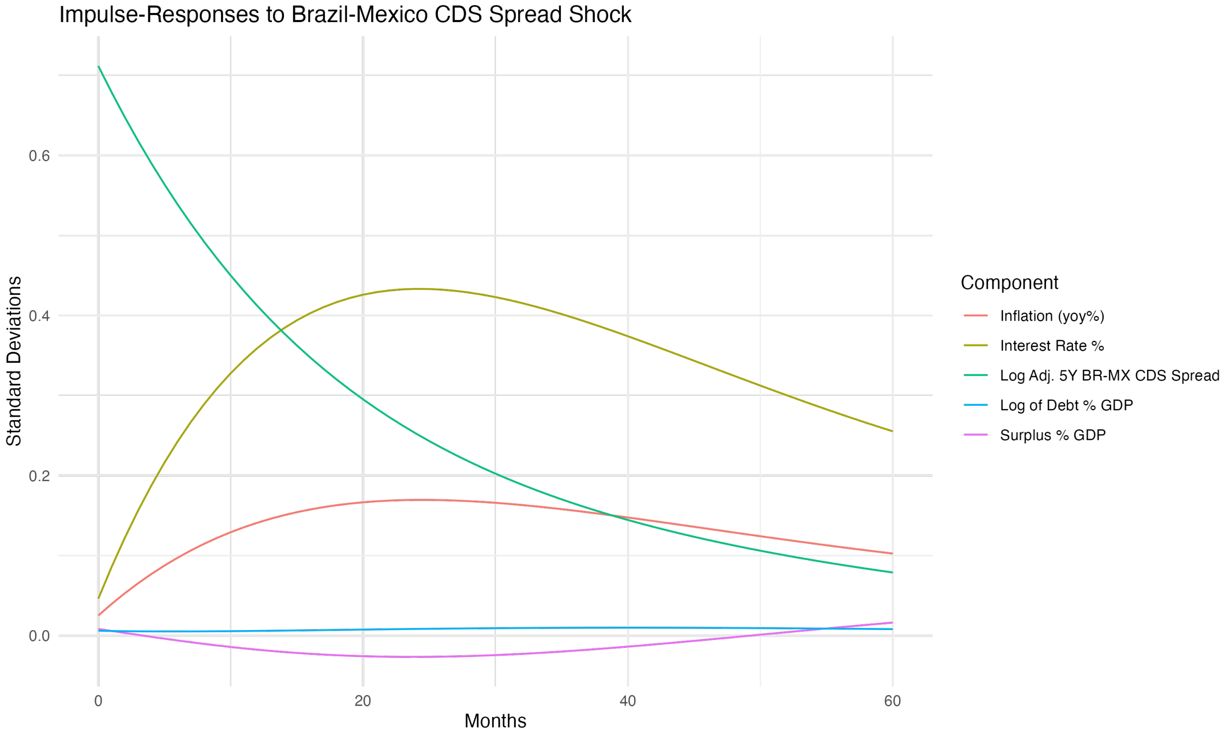
With Monthly Inflation

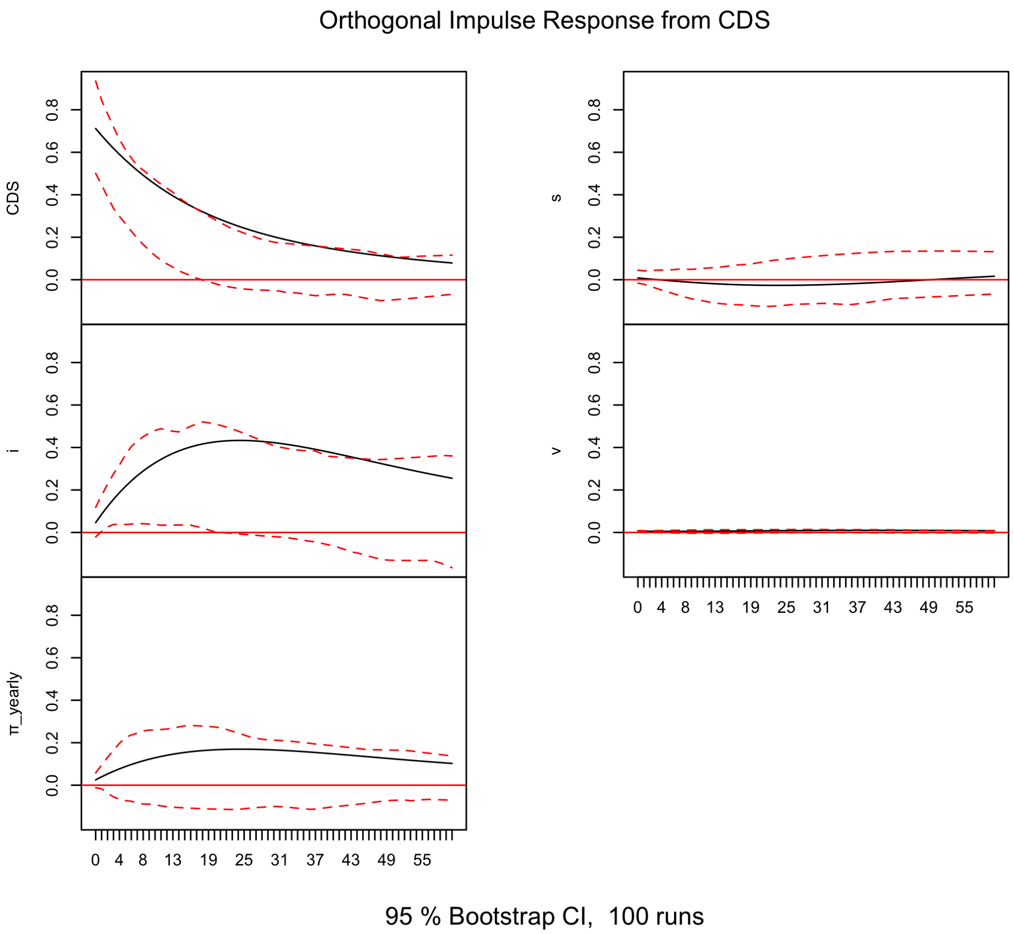




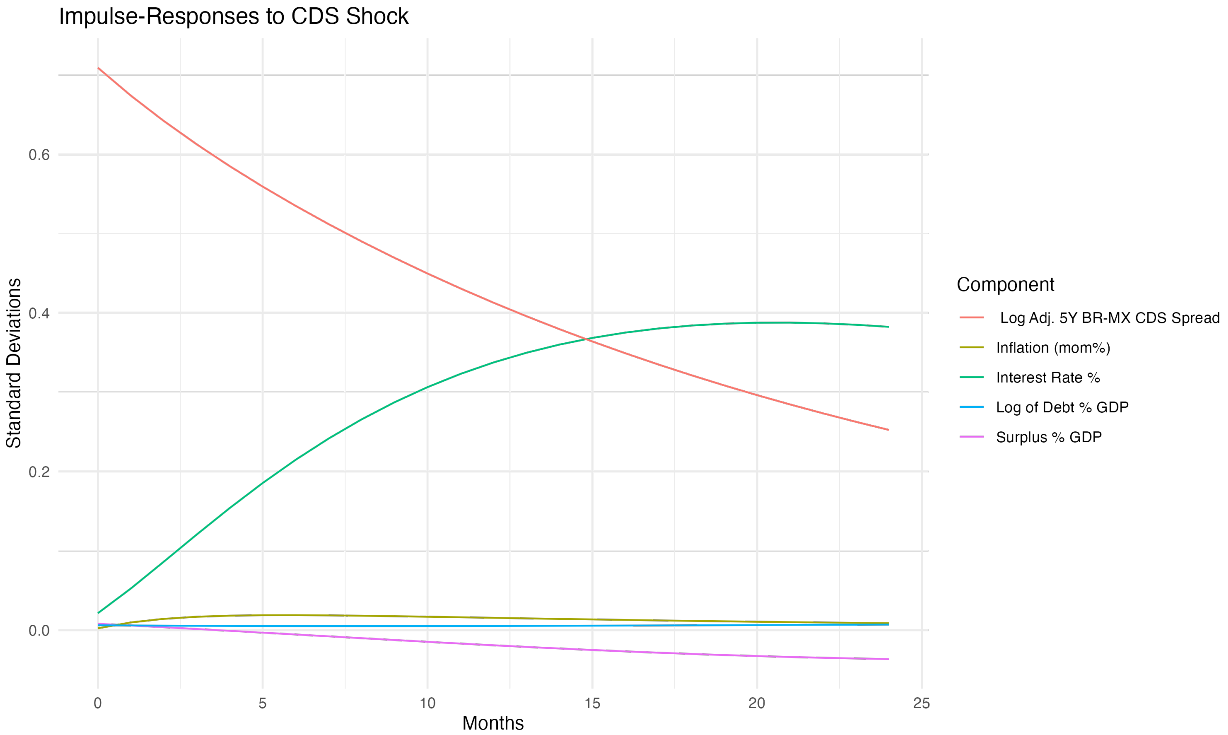
B.3.3 Impulse Responses to Brazil-Mexico 5Y CDS Spread Shock

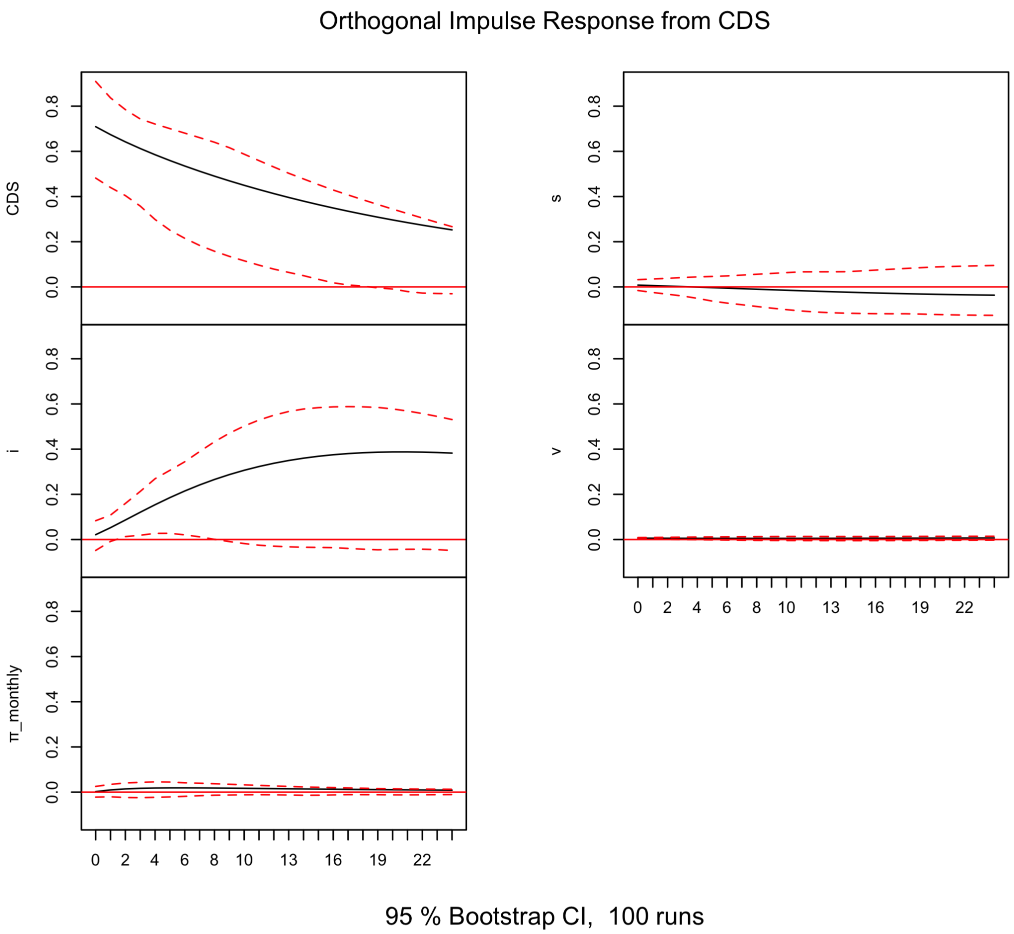
With Yearly Inflation





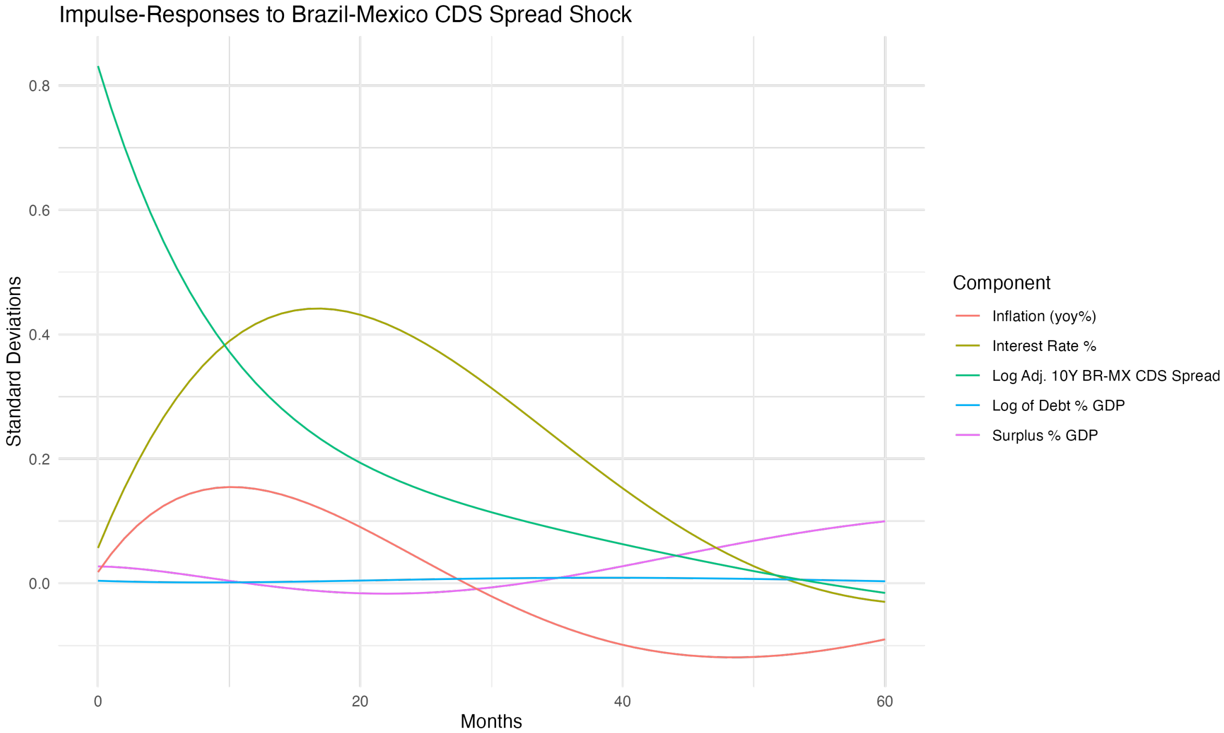
With Monthly Inflation



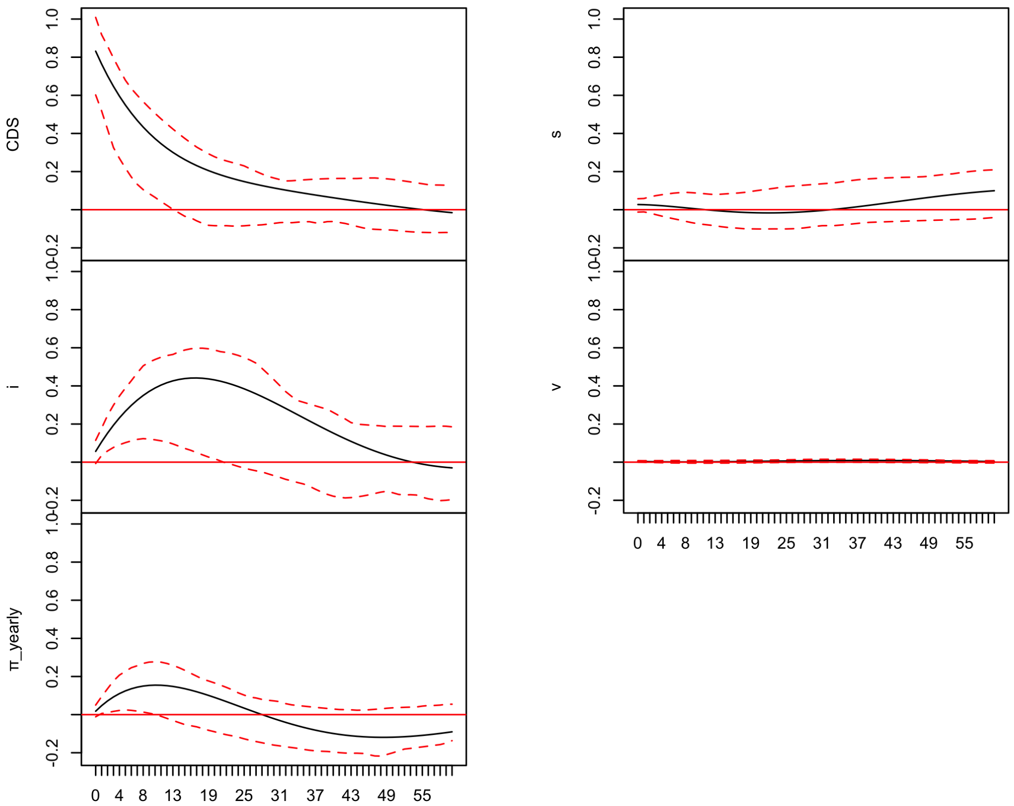


B.3.4 Impulse Responses to Brazil-Mexico 10Y CDS Spread Shock

With Yearly Inflation



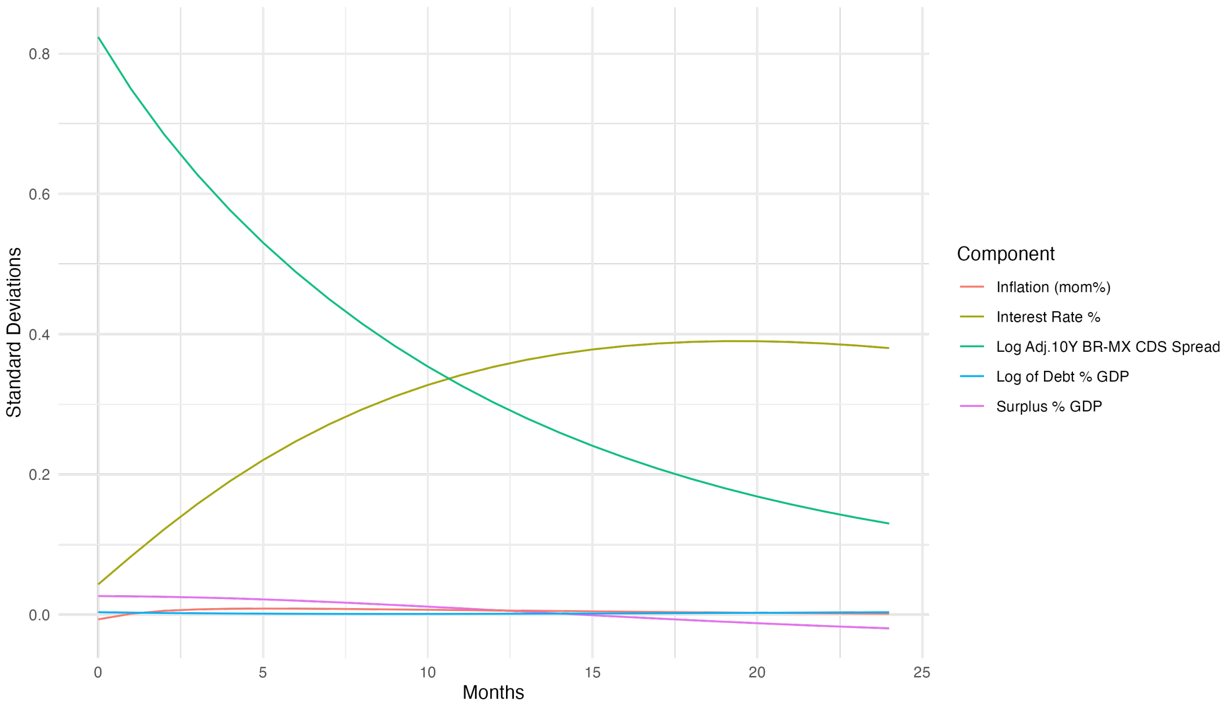
Orthogonal Impulse Response from CDS

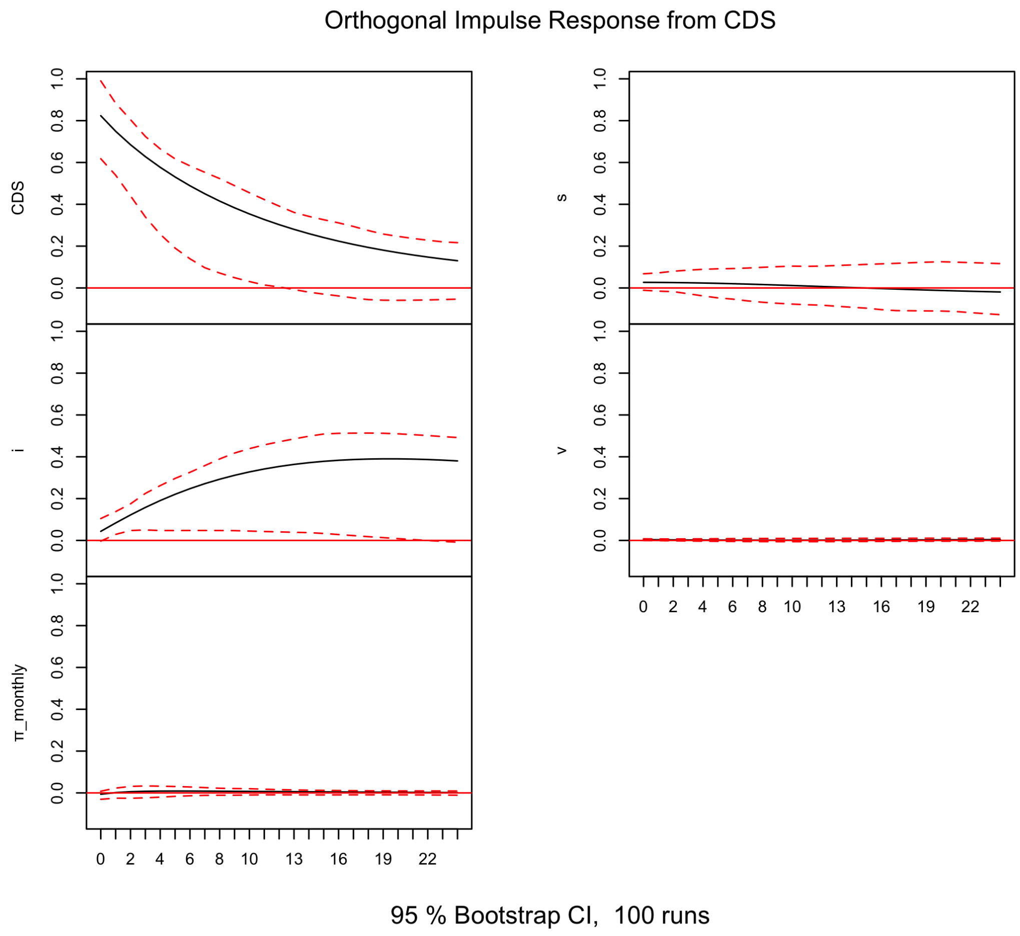


95 % Bootstrap CI, 100 runs

With Monthly Inflation

Impulse-Responses to CDS Shock




Orthogonal Impulse Response from CDS
CDS
i
π_monthly
s
v
1.0
0.8
0.6
0.4
0.2
0.0
0 2 4 6 8 10 13 16 19 22
95 % Bootstrap CI, 100 runs