Pontifícia Universidade Católica
do Rio de Janeiro

Thales Guimarães Bastos

Sovereign Domestic Debt Management under Fiscal Deterioration: the Brazilian Case

Dissertação de Mestrado

Thesis presented to the Programa de Pós–graduação em Economia, do Departamento de Economia da PUC-Rio in partial fulfillment of the requirements for the degree of Mestre em Economia.

Advisor : Prof. Márcio Garcia
Co-advisor: Prof. Yvan Bécard

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Abstract

Guimarães Bastos, Thales; Garcia, Márcio (Advisor); Bécard, Yvan (Co-Advisor). **Sovereign Domestic Debt Management under Fiscal Deterioration: the Brazilian Case**. Rio de Janeiro, 2022. 59p. Dissertação de Mestrado – Departamento de Economia, Pontifícia Universidade Católica do Rio de Janeiro.

This dissertation studies the effects of the fiscal stance on the composition of public debt in the short run. We use data on Brazilian public debt issuance and assess the impact of fiscal deficits and sovereign risk on the share of short-term debt through reduced-form and VAR methods. Our results suggest that a fiscal deterioration is associated with a higher share of short-term debt. At the same time, a sovereign risk shock increases the reliance on short-term and floating-rate debt. Then, in order to disentangle supply and demand factors in public debt issuance, we estimate the interest-rate elasticity in auctions for short- and medium-term public debt. Using a method of identification through heteroskedasticity, we find that both factors are present. However, market demand is considerably more interest-rate elastic than Treasury supply.

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Keywords

Public Debt; Maturity; Fiscal; VAR.

Resumo

Guimarães Bastos, Thales; Garcia, Márcio; Bécard, Yvan. **Gestão da Dívida Pública Doméstica sob Deterioração Fiscal: o Caso Brasileiro**. Rio de Janeiro, 2022. 59p. Dissertação de Mestrado – Departamento de Economia, Pontifícia Universidade Católica do Rio de Janeiro.

Essa dissertação estuda os efeitos da posição fiscal na composição da dívida pública no curto prazo. Nós utilizamos dados da emissão de dívida pública do Brasil e avaliamos o impacto de déficits fiscais e risco país na participação da dívida de curto prazo através de métodos em forma reduzida e VARs. Nossos resultados sugerem que uma deterioração fiscal está associada a uma maior participação da dívida de curto prazo. Ao mesmo tempo, um choque fiscal aumenta a dependência da dívida de curto prazo e dívida flutuante. Em seguida, visando segregar fatores de oferta e demanda na emissão de dívida pública, nós estimamos a elasticidade juros em leilões para dívida pública de curto e médio prazo . Usando um método de identificação por heterocedasticidade, nós encontramos que ambos os fatores estão presentes. Entretanto, a demanda do mercado é consideravelmente mais elástica do que a oferta do Tesouro.

Palavras-chave

Dívida Pública; Maturidade; Fiscal; VAR.

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1
Introduction

The objective of debt management is to ensure the government's financing needs in a cost minimization framework, consistent with a prudent risk level (World Bank and IMF (2003)). With this goal, public debt managers focus on the structure of the public debt, choosing between different debt instruments in the face of cost and risk trade-offs. Consequently, there is intrinsic relationship between debt management and fiscal policy[1]. While debt structure can impact budget volatility through interest costs, high fiscal deficits may lead to unsustainable debt levels and vulnerable debt structures.

In the last decade, the fiscal deterioration has imposed substantial challenges to Brazil's debt manager. Since the onset of the domestic economic crisis in 2014, the country has experienced recurrent primary deficits and increasing public debt[2] (Figure 1.1). Facing higher government borrowing needs and concerns about public debt sustainability, the structure of public debt has changed considerably. For instance, the trade-off between issuing short or long-term debt became more pronounced with higher long-term interest rates due to fiscal uncertainty. While minimizing the cost of servicing debt could favor the choice of short-term debt as it was relatively cheaper, it could also entail higher rollover risks.

Figure 1.2 shows the evolution of the composition of Federal Public Debt (FPD) from 2007 to 2021. Until 2014, in terms of indexation, there was a significant increase in the share of fixed-rate and inflation-indexed debt, compensated by reducing the exchange rate and floating-rate debt. In terms of maturity, the average maturity has increased substantially, reflecting a lower reliance on short-term debt.

We must highlight that the composition of FPD evolved towards the so-called *optimal composition* during this period. Established by the National Treasury, it is the benchmark structure for the FDP in the long term derived from a stochastic model that considers costs and risk trade-offs[3]. In general,

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[1]See Togo (2012) and World Bank (2017).

[2]Figure 1.1 shows three concepts of public debt in Brazil: i) Domestic Federal Bonded Debt, ii) Federal Public Debt, that also includes External Federal Debt, and iii) General Government Gross Debt, that also includes bank loans from Federal, State and Municipal Governments, and repos from Central Bank.

[3]National Treasury (2011) describes the model that defines the optimal composition of

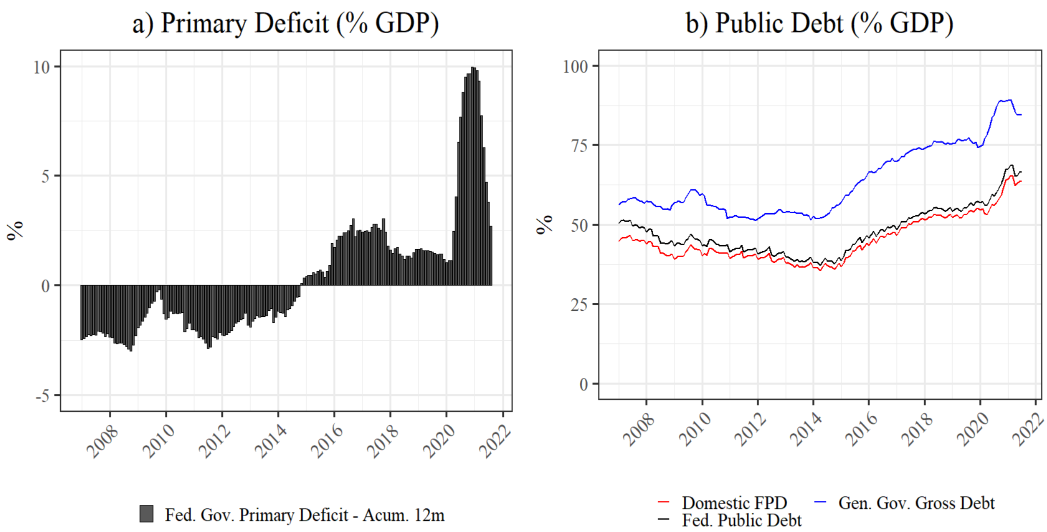

Figure 1.1: Fiscal Deterioration: Primary Deficit and Public Debt

it targets a composition more focused on long-term fixed-rate and inflation-indexed debt to provide a hedge against fluctuations in the primary budget and predictability in interest payments. In an early work, Giavazzi & Missale (2004) proposed a similar structure to the Brazilian public debt.

Nonetheless, since 2015, we observe a reversal of the progress made before towards a riskier structure, characterized by a remarkable expansion of the share of floating-rate and short-term debt (Figure 1.3). According to the National Treasury, this change was due to the higher economic uncertainty and the challenge of financing increasing borrowing requirements[4], leading to adjustments in the short-run targets for the FDP composition[5]. Therefore, it is clear the association of fiscal deterioration to the shortening and indexing of the domestic federal bonded debt.

In this dissertation, we study the impact of the fiscal outlook on the public debt composition in the short run. More precisely, we ask whether the fiscal stance and sovereign risk impact the share of short-term debt issued. Additionally, we try to disentangle supply and demand factors in public debt issuance.

In our analysis, we consider two definitions of short-term debt, according to i) maturity and ii) duration. First, a narrower concept includes all debt due to be paid within 12 months. Second, a broader definition considers all debt

Federal Public Debt. Figure A.2 shows the evolution of the optimal composition defined by the National Treasury.

[4]National Treasury (2015), National Treasury (2017), National Treasury (2019), and National Treasury (2020).

[5]Figure A.1 shows the target ranges for the composition of FPD established by Annual Borrowing Plans.

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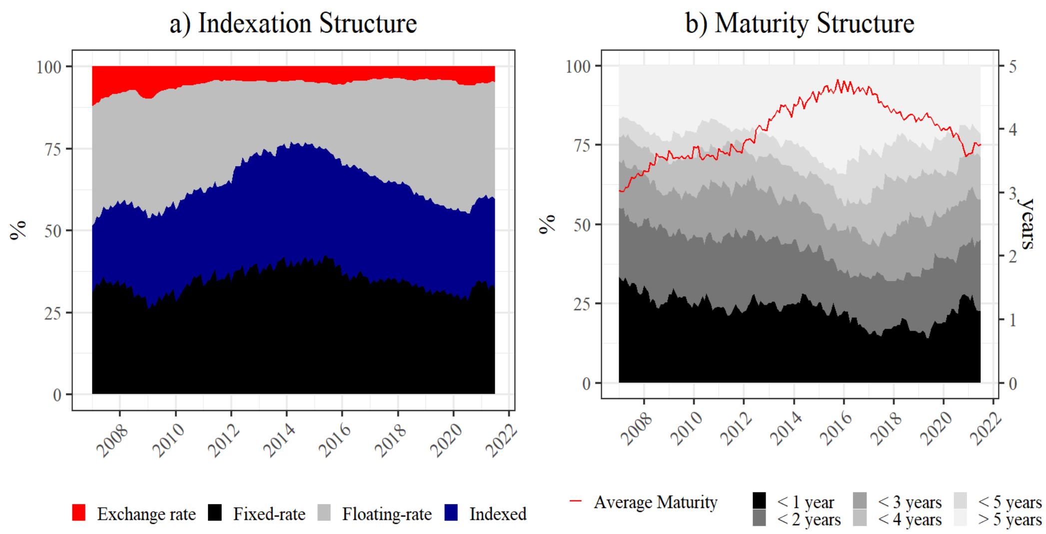

Figure 1.2: Composition of Federal Public Debt

with a duration[6] smaller than one year. Apart from the narrower concept, it also includes the floating-rate debt linked to the Selic rate. A significant difference is that despite the floating-rate debt having a longer maturity and not increasing the rollover risk, it contributes to the build-up of the interest-rate risk.

We evaluate the effect of fiscal stance on public debt composition using monthly data of Brazil's Domestic Federal Public Debt issuance through public offerings for the period 2007:01 - 2021:08. We propose two alternative methods. First, we estimate reduced-form regressions, analyzing the effect of fiscal variables and sovereign risk on the share of short-term debt in total public debt issuance. Second, we exploit a structural approach by estimating a VAR to understand the impact of fiscal and country risk shocks on the composition of debt issuance and their mechanisms. We augment a standard VAR from macroeconomic literature with fiscal variables, the term spread, and the share of short-term debt. In both approaches, we consider the two concepts of short-term debt.

Our results indicate a positive relationship between the share of short-term debt (both definitions) and fiscal deterioration in the short run. In the reduced form, we find that a worse fiscal stance (primary deficit, nominal deficit, change in gross debt or expected primary deficits in 2-4 years ahead)

[6]Central Bank of Brazil (1999) exposes the differences between maturity and duration concepts. While maturity considers only the time until the principal matures, the duration concept is a weighted average of all cash flows. Alternatively, the duration can be interpreted as the bond's price sensitivity to interest rate changes. For example, the LFT (floating-rate debt) is daily indexed to the Selic rate. Then, it has a one-day duration, despite a longer maturity.

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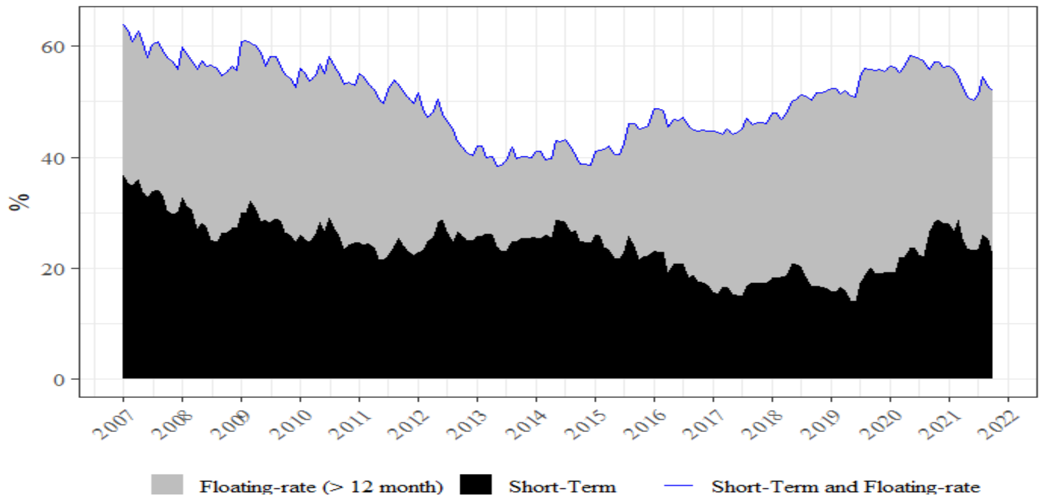

Figure 1.3: Domestic Federal Public Debt: Share of Short-Term Debt (%)

is associated with an increase in the share of short-term debt, especially the maturity concept. Additionally, an increase in country risk is also associated with a higher share of short-term debt, in this case, for both concepts.

The VAR analysis pointed to similar evidence. Despite no significant reactions of other macroeconomic variables, we find that a fiscal shock leads to an immediate increase in the share of short-term debt in terms of maturity. On the other hand, the country risk shock generates a proper response of the macroeconomic variables, leading to a significant increase in both concepts of the share of short-term debt, especially the one that includes floating-rate debt.

Notwithstanding, the significant impact of fiscal stance on public debt composition can result from supply and demand factors, which can be hard to disentangle. Thus, we propose an exercise to understand each factor's role. So, we estimate the interest-rate elasticity of public debt Treasury supply and market demand using a method of identification through heteroskedasticity, following Rigobon (2003).

We consider a standard supply and demand simultaneous equation model. To solve the typical identification problem in these models, we follow Rigobon (2003) and resort to the heteroskedasticity of structural shocks, considering that there are two regimes. Then, we assume that economic uncertainty affects public debt supply and demand differently. Precisely, market demand shifts more than Treasury supply in periods of high exchange rate volatility. Thus, the relatively higher variance of demand in those periods (regime) enlarges the cloud of realizations through the supply schedule, shaping an ellipse and enabling us to estimate the slope of the supply curve.

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Analogously, the regime in which the supply is relatively more volatile than demand enable us to identify the demand slope.

In order to distinguish the two regimes, we use the one-month option-implied exchange rate volatility and define a sample percentile as a cut-off that allows us to identify periods of high volatility linked to well-known crisis regimes domestically or abroad. Moreover, as the method requires data in higher frequencies, we use only the issuance of short- and medium-term fixed-rate bonds (LTN), which are issued weekly. Additionally, we estimate the model for three categories of LTN according to their maturity.

The results indicate that both supply and demand factors are present. In other words, we find that both Treasury supply and market demand of short- and medium-term public debt are interest-rate elastic. However, market demand is considerably more interest-rate elastic than Treasury supply, as expected.

Another interesting outcome is that, while the elasticity of demand increases when we include longer maturities, the elasticity of supply decreases in these cases. On the supply side, the Treasury may be more sensitive to issuing short-term debt, with more restrictions that force a certain amount of issuance to finance the debt when we include longer maturities. On the other hand, the financial institutions may have a captive demand for short-term debt, while they are more sensitive to interest rates to demand riskier longer-term bonds.

Our work is embedded in the literature on debt management that tries to explain the debt structure and, even more, defines the optimal debt composition regarding maturity and indexation profile. Goldfajn & de Paula (1999) provides an excellent overview of the crucial answers presented in the literature to the following question: what should be considered when defining the debt structure? They list budget risk, credibility, signaling, rollover risk, liquidity, and reindexation risk.

First, the budget risk argument is related to the debt management's prominent role in minimizing the government's budget volatility. In order to seek a tax smoothing policy, the government should adopt the debt composition that better provides a hedge against budgetary shocks[7]. Second, the credibility and signaling aspects are linked to the capacity of debt managers to generate a commitment mechanism[8] by shortening debt duration. Missale & Blanchard (1994) claim that it can enhance the government's anti-inflationary credibility

[7]See Barro (1979) and Bohn (1990). Faraglia et al. (2008) called this view "the fiscal insurance theory" of debt management (Missale (2012)).

[8]Diamond (2004) remarks the the role of short-term debt as a commitment mechanism to enforce debt contracts.

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as the potential gains of inflating away the debt are diminished. Similarly, Missale et al. (2002) argue that in an environment in which the market doubts the government's commitment to making a fiscal reform, it could signal its responsibility and then refinance it later when the rates are lower due to the fiscal reform.

Third, the potential rollover risks are linked to an excessive debt maturity concentration[9]. If large amounts of debt are due to mature in short periods, the government may incur refinancing risks, be exposed to market mood, or need to default. Nonetheless, Gale (1990) highlights the importance of certain maturity concentration in order to improve the liquidity on secondary markets.

Hence, this literature shows different arguments regarding the optimal debt composition. Specifically, we emphasize the cost and risk trade-off associated with the use of short-term debt. While it is commonly associated with lower costs, it can induce higher rollover and interest rate risks.

Despite numerous arguments favoring lengthening debt maturity, some papers explain why emerging economies repeatedly borrow short-term and then experience recurring debt crises. Broner et al. (2013), Arellano & Ramanarayanan (2012), and Perez (2017) make similar exercises using panel datasets of emerging economies' sovereign bond issuance in international markets and find a negative relation between debt maturity and sovereign spreads[10]. Among the explanations, they mention a higher risk premium on long-term debt during crisis periods, asymmetric information about government commitment, and credibility motivation.

In this context, our work is related to recent literature that has focused on the determinants of public debt issuance structure[11], more specifically on the share of short-term debt. In similar exercises, Hoogduin et al. (2011), Wolswijk & others (2020), and Arnold (2021) use panels of Euro Area countries for different periods and estimate the effect of macroeconomic and market variables on the share of short-term debt through reduced-form estimations. In general, they find that market volatility, total debt, sovereign risk, and crisis periods are associated with a higher reliance on short-term debt.

Another branch of literature relates the effects of fiscal and sovereign risk shocks on the yield curve and public debt issuance composition. Estimating a panel VAR for Euro Area countries, Beetsma et al. (2021) show that shocks

[9]See Alesina et al. (1989), Garcia (2002), Alfaro & Kanczuk (2006), Jonasson et al. (2020).

[10]Broner et al. (2013) uses data on sovereign bond prices and issuance between 1990 and 2009 for 11 emerging economies. Arellano & Ramanarayanan (2012) covers sovereign bonds issued internationally by Argentina, Brazil, Mexico, and Russia between 1996 and 2004. Perez (2017) considers a larger sample, including 34 emerging economies from 1994 to 2012.

[11]González-Fernández & González-Velasco (2018) provides an extensive literature review of this topic.

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to risk aversion, probability of default, and demand for the liquidity services of short debt positively affect the yield curve level and slope and decrease the average maturity of new debt issues. Related to this work, Afonso & Martins (2012) study the effects of a fiscal shock on the yield curve in the U.S and Germany using a VAR analysis.

Finally, our paper relates to the literature that tackles identification problems in simultaneous equation models. As mentioned above, we follow Rigobon (2003), which proposes a method based on the heteroskedasticity of structural shocks that resembles an instrumental variable approach. Moreover, Coelho et al. (2017) is another reference, applying this method to estimate the interest-rate elasticity of aggregate credit supply and demand in Brazil.

Our work differs from others in the literature in two manners: country coverage and type of debt. First, most papers study the determinants of debt maturity using panel data, grouping emerging market economies or Euro Area countries. Here, we concentrate our analysis on Brazil. Second, the literature that relates debt maturity and sovereign risk focus on external debt issuance[12]. However, Brazilian public debt became essentially domestic in the last decades[13]. Therefore, we focus on domestic debt issuance.

Additionally, the Brazilian case can be insightful due to the variability of fiscal regimes experienced in this short period and how the debt management evolved along with them. Despite the two broader periods defined above (with 2015 as the turning point), we can emphasize other changes in the fiscal framework since 2007. Following the early period of recurring primary surpluses, the fiscal expansion during Dilma Rousseff's government resulted in structural deficits, leading to the loss of the country's fiscal anchor. After the fiscal crisis and downward revisions of Brazil's credit ratings, the Spending Cap law enacted at the end of 2016 controlled the growth of government spending, reassuring some fiscal policy credibility. Then, the outbreak of the Covid-19 pandemic led to an (initially) temporary suspension of the Spending Cap law to enable economic and health support measures. Nonetheless, amid political pressures to afford higher government spending, the original law has already been changed permanently, casting doubts on the fiscal credibility in the long term once again.

Hence, we contribute to the broader literature by extending the evidence of the relationship between debt maturity and the fiscal stance to the Brazilian case. In addition, we supplement it by identifying supply and demand factors in the issuance of short-term public debt, taking advantage of Brazil's recurring

[12]See Arellano & Ramanarayanan (2012), Broner et al. (2013), Perez (2017).
[13]Since 2007, at least 90% of Federal Public Debt is domestic debt.

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changes in regime.

Our paper is organized as follows. After this introduction, Chapter 2 relates the fiscal stance and the share of short-term debt. Chapter 3 explores supply and demand factors in public debt auctions. Finally, Chapter 4 provides some conclusions.

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2
Fiscal Stance and Short-Term Debt

This chapter analyzes how the country's fiscal outlook affects the public debt composition in the short-run, focusing on the share of short-term debt. We want to inspect whether the fiscal deterioration in Brazil after 2015 has changed these effects. For that purpose, we implement two approaches: i) a reduced-form through linear regressions, and ii) a Structural VAR, in an attempt to give more structure and estimate the effect of a fiscal and a country risk shocks in the share of short-term debt issued.

In order to capture the short-run behavior, we use a flow measure instead of the stock of public debt. Hence, we analyze the public debt issuance composition in Domestic Federal Public Debt Auctions.

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2.1
Data

The public debt issuance data comes from the Brazilian National Treasury database, containing all Domestic Federal Public Debt (*DPMFi*) issuance through public offerings. It includes the quantity and characteristics of each instrument issued. The auctions are regularly realized weekly, despite many instruments being issued in a lower frequency throughout the sample[1]. Hence, we aggregate all data monthly to best capture the public debt issuance composition. Another aspect that supports this aggregation is that the Debt Management Committee[2] meetings are held only once a month. Hence, the monthly data spans from January 2007 to August 2021.

The figure 2.1 shows the share of short-term debt in total monthly issuance. Moreover, it emphasizes the two concepts of short-term debt adopted here: the debt due to be paid within a year and the debt with a duration smaller than one year, including floating-rate debt (LFT). At first sight, we

[1] The short- and medium-term fixed-rate debt (LTN) is usually issued every week, despite some differences in the composition every two weeks. However, for most of the time, long-term fixed-rate bonds (NTN-F), inflation-linked bonds (NTN-B), and floating-rate bonds (LFT) were issued twice a month.

[2] The Debt Management Committee (*COGED*) is the National Treasury's entity responsible for strategic planning in debt management. After analyzing the borrowing requirements, market conditions, and PAF targets, the *COGED* defines the debt issuance strategy for the following month, including the composition and characteristics of the instruments issued (National Treasury (2011)).

can highlight the higher participation of short-term debt in periods around economic stress, such as the Great Financial Crisis, the fiscal crisis in Brazil, and during the Covid-19 pandemic.

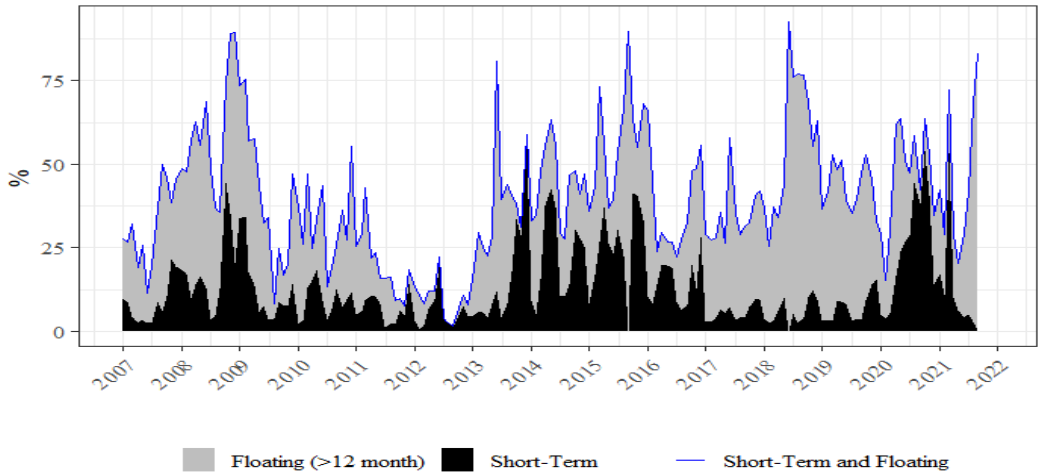

Figure 2.1: Share of Short-Term Debt in Total Issuance

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Besides the share of short-term debt in DPMFi auctions, we also evaluate the quantity of fixed-rate debt DV01 issued. Renascença DTVM[3] kindly provided this data, and it spans from January 2010 to August 2021. It measures the potential loss in the market value of a fixed-rate debt portfolio associated with a one basis point increase (0.01%) in the discount rate of this portfolio. Therefore, this metric represents the level of interest-rate risk issued in the market through public debt bonds. Figure 2.2 shows the fixed-rate debt DV01 issuance through *DPMFi* auctions.

To represent the fiscal stance, we use the primary deficit of the Federal Government over the past 12 months (expressed as a share of GDP). Alternatively, we use the nominal deficit of the Federal Government over the past 12 months (as a share of GDP) or the General Government Gross Debt (as a share of GDP). As a forward looking alternative, we take the average of expected primary deficits for 2, 3 and 4 years ahead from Focus survey[4]. These data are from the Central Bank of Brazil. Additionally, we consider the Brazil 5-year CDS (Credit Default Swap) to measure country risk. It is calculated by J.P. Morgan and was provided by Bloomberg.

Furthermore, as seen below, we include some controls in our estimations. We define the term spread as the difference between 3-year and 3-month interest rates from swap contracts (*DI x pre*), provided by Bloomberg. The

[3]Renascença DTVM is the larger institutional broker of public debt bonds in Brazil.
[4]This is an attempt to isolate current aspects and capture longer term expectations.

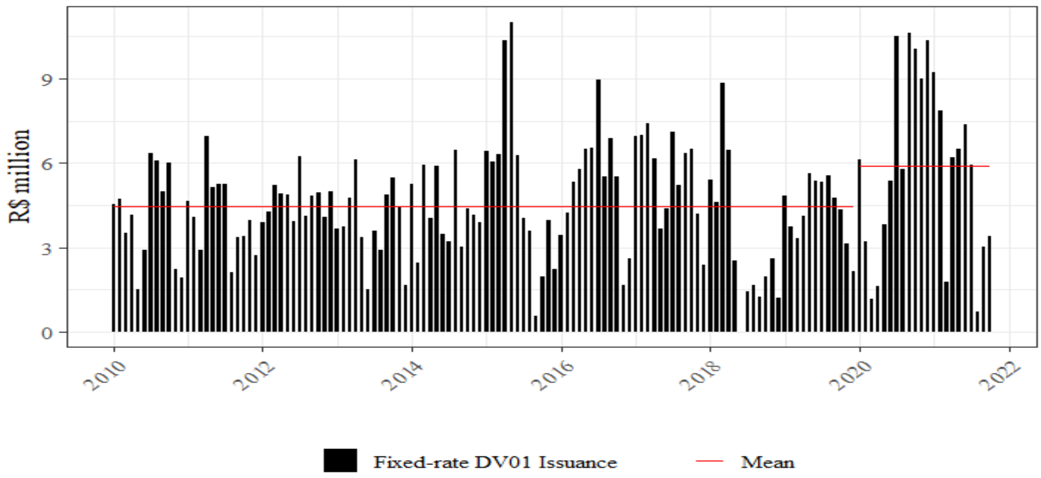

Figure 2.2: Fixed-rate Debt DV01 Issuance

nominal exchange rate (BRL/USD) and the 12-month inflation expectations from the Focus survey are from the Central Bank of Brazil database. Also, we use data of traded volume on secondary markets of public debt bonds from the National Treasury database. The traded volume is seasonally adjusted and is defined as a share of the public debt stock, a relevant metric of liquidity in the secondary market (National Treasury (2021)).

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2.2 Reduced Form

In a first approach, we estimate the effect of the fiscal stance and the country risk on the share of short-term debt on a reduced-form framework through linear regressions. Then, we follow the recent literature on the determinants of debt maturity mentioned above (Hoogduin et al. (2011)), focusing on the fiscal risks. Therefore, we estimate the following equation:

$$Y_t = \beta_0 + \boldsymbol{\beta_1} CountryRisk_{t-1} + \boldsymbol{\beta_2} Fiscal_{t-1} + \gamma' Controls_{t-1} + \sum_{i=2}^{12} d_i + \varepsilon_t \quad (2\text{-}1)$$

where Y is the share of short-term debt, $CountryRisk$ is the monthly percentage change in CDS and $Fiscal$ is the specified fiscal variable[5]. In addition, we gradually include a set of macroeconomic variables as controls, such as term spread, inflation expectations, exchange rate, and traded volume

[5]We use four alternative variables to represent the fiscal stance: i) primary deficit of Federal Government over the past 12 months, ii) nominal deficit of Federal Government over the past 12 months, iii) gross debt of general government, and iv) average of expected primary deficits for 2, 3 and 4 years ahead. All variables are defined as a share of GDP and we take the first difference.

of public debt. We also incorporate the lagged dependent variable, considering the persistence of issuance behavior (Hoogduin et al. (2011)), and dummy variables to control for the monthly seasonality in the public debt issuance[6]. In order to diminish potential endogeneity issues and address the timing of fiscal data release and public debt issuance, we use lagged variables.

Table 2.1: Share of Short-Term Debt - DPMFi Auctions

	Dependent variable: Share of Short-Term Debt							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lagged Dependent		0.580***	0.550***	0.550***	0.563***	0.591***	0.539***	0.633***
		(0.089)	(0.090)	(0.090)	(0.085)	(0.095)	(0.115)	(0.129)
Country Risk (-1)	**0.117*****	**0.085*****	**0.068***	**0.072****	**0.069***	0.041	**0.101****	−0.047
	(0.043)	(0.032)	(0.035)	(0.035)	(0.037)	(0.037)	(0.041)	(0.100)
Δ Primary Deficit (-1)	**8.245*****	**3.970****	**3.930****					
	(2.002)	(1.936)	(1.861)					
Δ Nominal Deficit (-1)				**3.643****				
				(1.800)				
Δ Gross Debt (-1)					**3.078****			
					(1.382)			
Δ E(Primary Deficit) (-1)						5.406	−2.845	**11.048****
						(4.545)	(8.143)	(5.580)
Δ Exchange Rate (-1)			0.108	0.040	−0.049	0.214	0.121	0.480
			(0.204)	(0.214)	(0.243)	(0.190)	(0.257)	(0.337)
Term Spread (-1)			−0.151	−0.154	0.080	−0.158	0.712	0.276
			(0.438)	(0.440)	(0.471)	(0.480)	(0.651)	(0.729)
Δ E(Inflation) (-1)			2.397	2.212	2.662	2.630	−7.712	6.310**
			(2.712)	(2.727)	(2.608)	(2.700)	(5.694)	(2.993)
Traded Volume (-1)			7.410	7.685*	6.086	6.608	16.619***	−6.206
			(4.513)	(4.523)	(4.640)	(4.953)	(5.023)	(9.509)
Constant	9.198***	−1.669	−8.044	−8.323	−6.009	−8.051	−15.581**	0.109
	(2.043)	(3.073)	(5.419)	(5.447)	(5.610)	(5.834)	(6.494)	(9.490)
Monthly dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Period	2007-21	2007-21	2007-21	2007-21	2007-21	2007-21	2007-14	2015-21
Observations	176	176	176	176	175	176	96	80
R^2	0.247	0.514	0.526	0.526	0.539	0.514	0.601	0.565
Adjusted R^2	0.187	0.472	0.472	0.472	0.486	0.458	0.508	0.437
Residual Std. Error	10.695	8.621	8.619	8.620	8.523	8.733	7.689	9.658
F Statistic	4.090***	12.153***	9.684***	9.678***	10.149***	9.207***	6.453***	4.400***

Note: Table reports OLS regressions of share of short-term debt (in monthly issuance) on country risk and fiscal variables (primary deficit, expected primary deficits in 2-4 years ahead, nominal deficit, and gross debt as share of GDP). The term spread, inflation expectation, exchange rate, traded volume of public debt, and monthly dummies are included as control variables. Further, Δ represents the first difference operator and (-1) the lagged variable. Heteroskedasticity and serial correlation robust standard error in brackets. *p<0.1; **p<0.05; ***p<0.01.

Table 2.1 shows the results of the regression of the share of short-term debt (maturity concept) on country risk and fiscal deficit. Columns (1)-(3) represent the specifications with primary deficits and an increasing number of controls. We find positive and statistically significant coefficients associated with the country risk and the primary deficit. Columns (4)-(6) show similar results when considering the nominal deficit and the gross debt as the fiscal variable, respectively, despite no significant result is found when we consider the expectations variable. Finally, we estimate the regression with the forward looking variable to two sub-samples (col. 7-8): before and after 2014, when the period of recurrent primary deficits in Brazil began. While we have a significant

[6] A possible source of seasonal pattern is the maturity calendar of each type of debt: fixed-rate debt matures in the first month of each trimester, inflation-indexed debt in the second month of each trimester, and floating-rate debt in March and September.

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coefficient related only to the country risk in the first period, only the expected primary deficits has a significant (and sizeable) positive coefficient after 2014.

Accordingly, the outcomes presented indicate that a fiscal deterioration and an increase in sovereign risk are associated with a higher share of short-term debt. These findings are in line with the literature's evidence, pointing to credibility issues, cost minimization, and risk aversion as possible explanations[7].

Table 2.2 shows the results of the equivalent estimation proposed above but considering the broader concept (duration) of short-term debt that includes the floating-rate debt. The key difference here is that we find a higher coefficient related to the country risk, and the coefficient related to fiscal stance is no longer statistically significant. In the two sub-samples, we find a higher coefficient related to country risk in the second period.

Table 2.2: Share of Short-Term and Floating Rate Debt - DPMFi Auctions

	Dependent variable: Share of Short-Term and Floating Debt							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lagged Dependent		0.723^{***}	0.710^{***}	0.715^{***}	0.701^{***}	0.707^{***}	0.712^{***}	0.428^{***}
		(0.056)	(0.058)	(0.058)	(0.055)	(0.056)	(0.065)	(0.097)
Country Risk (-1)	$\mathbf{0.320}^{***}$	$\mathbf{0.239}^{***}$	$\mathbf{0.172}^{**}$	$\mathbf{0.168}^{**}$	$\mathbf{0.195}^{***}$	$\mathbf{0.181}^{***}$	$\mathbf{0.166}^{**}$	$\mathbf{0.327}^{***}$
	(0.104)	(0.069)	(0.070)	(0.069)	(0.068)	(0.070)	(0.073)	(0.126)
Δ Primary Deficit (-1)	4.339	−0.942	−1.233					
	(3.130)	(2.687)	(2.588)					
Δ Nominal Deficit (-1)				−1.728				
				(2.395)				
Δ Gross Debt (-1)					$\mathbf{3.056}^{*}$			
					(1.573)			
Δ E(Primary Deficit) (-1)						−2.426	−8.463	2.488
						(6.780)	(18.201)	(9.297)
Δ Exchange Rate (-1)			0.354	0.396	0.098	0.317	0.373	0.148
			(0.279)	(0.296)	(0.331)	(0.272)	(0.410)	(0.382)
Term Spread (-1)			0.307	0.281	0.701	0.301	1.017	1.929^{**}
			(0.606)	(0.604)	(0.659)	(0.643)	(0.903)	(0.961)
Δ E(Inflation) (-1)			2.659	2.789	2.768	2.563	3.890	3.152
			(3.821)	(3.816)	(3.723)	(3.843)	(6.866)	(4.523)
Traded Volume (-1)			1.580	1.471	−0.374	1.705	19.368^{***}	-21.919^{*}
			(7.140)	(7.023)	(7.202)	(7.225)	(6.619)	(12.371)
Constant	37.580^{***}	4.180	2.860	2.814	5.624	2.943	-15.319^{**}	37.254^{***}
	(3.953)	(3.654)	(7.855)	(7.763)	(7.746)	(7.727)	(7.786)	(13.855)
Monthly dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Period	2007-21	2007-21	2007-21	2007-21	2007-21	2007-21	2007-14	2015-21
Observations	176	176	176	176	175	176	96	80
R^2	0.125	0.603	0.609	0.610	0.619	0.609	0.715	0.573
Adjusted R^2	0.055	0.569	0.564	0.565	0.576	0.564	0.649	0.448
Residual Std. Error	18.853	12.736	12.799	12.786	12.654	12.805	11.839	12.561
F Statistic	1.777^{*}	17.470^{***}	13.587^{***}	13.634^{***}	14.110^{***}	13.569^{***}	10.748^{***}	4.556^{***}

Note: Table reports OLS regressions of share of short-term and floating-rate debt (in monthly issuance) on country risk and fiscal variables (primary deficit, expected primary deficits in next 3 years, nominal deficit, and gross debt as share of GDP). The term spread, inflation expectation, exchange rate, traded volume of public debt, and monthly dummies are included as control variables. Further, Δ represents the first difference operator and (-1) the lagged variable. Heteroskedasticity and serial correlation robust standard error in brackets. *p<0.1; **p<0.05; ***p<0.01.

The results above match the National Treasury's debt management strategy exposed in recent publications, such as Annual Borrowing Plans and

[7] Missale & Blanchard (1994), Missale et al. (2002) and Arellano & Ramanarayanan (2012) point to credibility and signaling motivations to shorten the debt maturity. Broner et al. (2013), Perez (2017) and Alfaro & Kanczuk (2006), among others, emphasize the cost minimization and risk aversion motivations.

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Annual Debt Reports[8]. The higher response to sovereign risk when considering the duration concept is related to the crucial role played by LFT in stress periods. In order to avoid higher costs with the issuance of fixed-rate debt paying a high risk premium for long periods, the National Treasury increases the reliance on floating-rate debt, widely accepted by investors in moments of risk aversion and volatility (National Treasury (2016), National Treasury (2016)). Here, it is straightforward the analogy with the signaling argument exposed in Chapter 1.

Another two aspects corroborate the higher response associated with the country risk when considering the duration concept, especially after 2014. First, the floating-rate debt has been preferable to short-term fixed-rate debt. Despite imposing a similar interest-rate risk, it has a longer maturity, and the market demands a lower risk premium[9] (National Treasury (2017), National Treasury (2019)). Second, since 2015, the National Treasury has aimed to achieve a positive net issuance in order to finance the primary deficits and reduce the reliance on Central Bank's repos[10] to sterilize the excess liquidity of the market (National Treasury (2019), National Treasury (2020)). Therefore, the floating-rate debt was expected to replace Central Bank's repos, given the similar characteristics.

Table 2.3 presents the results related to the fixed-rate debt DV01 issuance. Columns (1)-(6) contain the results from the same exercise proposed before. In this case, we highlight the negative coefficient related to the country risk and the positive coefficient related to the fiscal stance, both statistically significant[11]. A possible interpretation is that an increase in sovereign risk could be associated with investors' lower propensity to take risk. This would be the case if investors are subject to risk constrains[12]. Meanwhile, a higher fiscal

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[8]Since 2001, the National Treasury has published the Annual Borrowing Plan (PAF) at the beginning of the year, which announces the financing strategy to be used during the year and sets targets for FPD composition at the end of the year. In addition, at the end of the year, it publishes the Annual Debt Report (RAD), which provides a retrospective analysis of the implemented strategy and its results in light of the PAF targets defined at the beginning of the year.

[9]An exception to this pattern occurred in 2020 when the market demanded higher risk premium on LFT and the National Treasury opted predominantly for short-term fixed-rate debt instead.

[10]The repurchase agreements (repos) made by Central Bank of Brazil constitute an instrument to regulate the liquidity conditions of the economy on the short-term. They are made by selling (buying) government securities in secondary markets agreeing to buy (sell) them back. Its goal is to maintain the market interest rate compatible with monetary policy rate (Central Bank of Brazil (2018)).

[11]An exception is the case with expected primary deficits, where the fiscal variable is not statistically significant.

[12]Reinhart et al. (2003) discuss investors' intolerance to sovereign debt in stress episodes and Garcia & Rigobon (2004) propose a risk management approach to analyze the Brazilian case in 2002.

deficit increases the issuance needs of the National Treasury. In column (7), we include a dummy that identifies the months when the National Treasury made extraordinary auctions[13]. As expected, we find a significant negative coefficient related to this dummy, signaling that the National Treasury indeed seeks to reduce interest-rate risk in moments of stress or the lower market tolerance in these moments. Finally, column (8) shows the result for a shorter window (2015-2021) when we find stronger results in line with previous conclusions.

Table 2.3: Fixed rate Debt - DV01 Issuance in DPMFi Auctions

	Dependent variable: Fixed Rate Debt - DV01 Issuance							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lagged Dependent		0.518^{***}	0.477^{***}	0.471^{***}	0.457^{***}	0.478^{***}	0.456^{***}	0.531^{***}
		(0.087)	(0.083)	(0.084)	(0.084)	(0.087)	(0.088)	(0.098)
Country Risk (-1)	$\mathbf{-0.059}^{***}$	$\mathbf{-0.035}^{***}$	$\mathbf{-0.035}^{**}$	$\mathbf{-0.033}^{**}$	$\mathbf{-0.038}^{**}$	$\mathbf{-0.039}^{**}$	$\mathbf{-0.028}^{*}$	$\mathbf{-0.056}^{**}$
	(0.013)	(0.010)	(0.015)	(0.013)	(0.015)	(0.016)	(0.015)	(0.022)
Δ Primary Deficit (-1)	$\mathbf{0.895}^{**}$	$\mathbf{0.801}^{**}$	$\mathbf{0.753}^{**}$				$\mathbf{0.646}^{*}$	$\mathbf{0.780}^{**}$
	(0.395)	(0.353)	(0.338)				(0.332)	(0.306)
Δ Nominal Deficit (-1)				$\mathbf{0.879}^{***}$				
				(0.295)				
Δ Gross Debt (-1)					$\mathbf{0.377}^{*}$			
					(0.226)			
Δ E(Primary Deficit) (-1)						-0.312		
						(0.864)		
Δ Exchange Rate (-1)			0.004	-0.026	-0.009	0.025	0.008	0.035
			(0.053)	(0.047)	(0.053)	(0.054)	(0.051)	(0.085)
Term Spread (-1)			-0.096	-0.086	-0.072	-0.123	-0.125	-0.111
			(0.108)	(0.110)	(0.116)	(0.113)	(0.105)	(0.112)
Δ E(Inflation) (-1)			-0.676	-0.761	-0.699	-0.657	-0.642	-0.387
			(0.557)	(0.559)	(0.576)	(0.584)	(0.562)	(0.676)
Traded Volume (-1)			3.202^{***}	3.199^{***}	3.178^{***}	3.393^{***}	3.229^{***}	3.574^{***}
			(0.902)	(0.887)	(0.913)	(0.941)	(0.873)	(1.341)
Extraordinary Auction							-1.809^{***}	
							(0.429)	
Constant	5.187^{***}	3.590^{***}	0.917	0.897	1.252	0.823	1.021	0.740
	(0.461)	(0.487)	(0.909)	(0.872)	(0.929)	(0.924)	(0.902)	(1.196)
Monthly dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Period	2010-21	2010-21	2010-21	2010-21	2010-21	2010-21	2010-21	2015-21
Observations	140	139	139	139	139	139	139	80
R^2	0.261	0.479	0.520	0.530	0.509	0.497	0.555	0.627
Adjusted R^2	0.185	0.420	0.448	0.459	0.436	0.422	0.483	0.517
Residual Std. Error	1.995	1.689	1.648	1.631	1.666	1.686	1.594	1.838
F Statistic	3.429^{***}	8.137^{***}	7.215^{***}	7.506^{***}	6.923^{***}	6.595^{***}	7.796^{***}	5.700^{***}

Note: Table reports OLS regressions of fixed-rate debt DV01 issuance (monthly) on country risk and fiscal variables (primary deficit, expected primary deficits in next 3 years, nominal deficit, and gross debt as share of GDP). The term spread, inflation expectation, exchange rate, traded volume of public debt, and monthly dummies are included as control variables. Additionally, we consider a dummy for extraordinary auctions. Further, Δ represents the first difference operator and (-1) the lagged variable. Heteroskedasticity and serial correlation robust standard error in brackets. *p<0.1; **p<0.05; ***p<0.01.

In sum, we find that an increase in country risk and fiscal deficits is associated with a higher reliance on short-term debt. Moreover, when considering a broader definition that includes the floating-rate debt, the coefficient related to the sovereign risk is even larger. Finally, regarding the fixed-rate debt DV01 issuance, it is negatively associated with an increase in sovereign risk and positively with fiscal deficits, a reasonable outcome in a context of risk aversion and higher borrowing needs.

[13]In periods of high volatility in financial markets, the National Treasury can realize extraordinary auctions of government securities in the form of i) cancellation, ii) buy and sell auctions, and iii) extra auctions to provide liquidity and support market functioning (National Treasury (2015)). Between 2007 and 2021, it occurred in 10 months (2008, 2013, 2014, 2015, 2016, 2017, 2018, 2020)

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2.3 VAR

The first approach indicated a significant relation between debt maturity and the fiscal stance. However, it is muted about the dynamics between variables through time, and it presents some concerns about possible endogeneity. Next, we consider a second approach trying to address these points. Then, to understand the impact of fiscal and country risk shocks in the composition of debt issuance and their mechanisms, we propose a Structural VAR.

We based our structure on two related works. First, Beetsma et al. (2021) propose a VAR in which they link the average maturity of issued debt and yield curve factors to some variables based on their theoretical framework, such as risk aversion, repayment risk, and demand for the liquidity services of short-term debt. Second, Afonso & Martins (2012) studies the interaction between fiscal stance and the shape of the yield curve, described by level, slope, and curvature factors (Nelson & Siegel (1987)), in a VAR that also includes variables traditionally presented in macro-finance models (output, inflation, monetary policy rate, and a financial index) (Diebold et al. (2006)).

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2.3.1 Structure

Hence, we build our model from standard VAR in the macroeconomic literature (Christiano et al. (1999), Kilian & Lütkepohl (2017)) augmented by fiscal variables. In addition, we include the variable associated with the debt issuance and the term spread as a parsimonious representation of the yield curve.

We include the following variables in the VAR: output gap (y), inflation (π), primary deficit (pd), country risk (CDS), interest-rate (i), term spread (ts), and share of short-term debt ($share$). The VAR model can be represented as:

$$X_t = C + \sum_{i=1}^{p} F_i X_{t-i} + \sum_{j=1}^{11} d_j + \varepsilon_t \tag{2-2}$$

where X_t is the (7x1) vector of endogenous variables given by $X_t = [y, \pi, pd, CDS, i, ts, share]$, C is the (7x1) vector of constants, F is the (7x7) matrix of autoregressive coefficients, d_j is a (7x1) vector of monthly dummies and ε_t is the vector of errors. The lag length p is determined using standard information criteria.

We identify our VAR using a simple recursive method following standard Cholesky decomposition. Therefore, the variables are ordered in X_t from the most exogenous to the least. First, we order the macroeconomic block according to the established literature: output, followed by inflation and primary deficit. The latter is directly affected by output and inflation through automatic stabilizers (Afonso & Martins (2012)), but fiscal shocks do not impact immediately output and inflation due to policy lags. Then, we include the CDS, which is affected by the fiscal stance and macroeconomic conditions. Sequentially, we place the interest rate, which is contemporaneously affected by output, inflation, fiscal, and country risk but does not affect them immediately due to monetary policy lags[14]. Finally, we include the term spread and the share of short-term debt, which can be affected by all variables (Beetsma et al. (2021)).

2.3.2 Data

Following the first approach, we use monthly data from January 2007 to August 2021. The output gap is measured by the Central Bank Economic Activity Index (IBC-Br), which is seasonally adjusted and HP filtered. The inflation variable is the monthly variation in the Broad National Consumer Price Index (IPCA), seasonally adjusted and in annual terms. For the fiscal variable, we use the Federal Government primary deficit over the past 12 months as a share of GDP[15]. We use the Brazil 5-year CDS (Credit Default Swap) for the sovereign risk. The interest rate is the Selic rate. The term spread is the difference between 3-year and 3-month interest rates from swap contracts (*DI x pre*). Finally, we use the two concepts of short-term debt, by maturity and duration. Figure A.3 plots the previous variables.

In order to estimate a stationary VAR, we take the first difference of primary deficit due to non-stationarity in this series[16]. To define the number of lags to be included on the VAR, we used standard information criteria: Akaike (12), Hannan-Quinn (2), and Schwarz (1). We choose to set one lag and estimate a VAR(1).

2.3.3 Results

In this section, we report the results of the VAR analysis proposed above, considering the two concepts of short-term debt separately. First, we present the impulse response functions (IRFs) to a primary deficit shock and a CDS

[14]As a robustness check, we consider a specification which places the interest before CDS.

[15]Alternatively, we use the Federal Government nominal deficit over the past 12 months as a share of GDP.

[16]We test the stationarity of each variable using a Phillips-Perron (PP) and, alternatively, an Augmented Dickey-Fuller (ADF) unit root tests.

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shock with a magnitude of one standard deviation. Jointly, we show their confidence intervals of two standard errors (95%) generated by bootstrap and 1000 simulations. Then, we present the forecast error variance decomposition.

We start with the IRFs to a primary deficit shock (Figure 2.3). First, we note that we do not find any statistically significant response of macroeconomic variables to the fiscal shock. Keeping in mind the statistical significance, we notice an increase in the output gap, inflation, and CDS in the short-run, followed by a recession period. Moreover, the interest rate rises in the short-run, leading to a decline in the term spread. During the recession, we see a reversal of these dynamics. Despite the difficulty in identifying the dynamics of a fiscal shock in the economy, we find a significant increase in the share of short-term debt issued during the first 6 months after the shock.

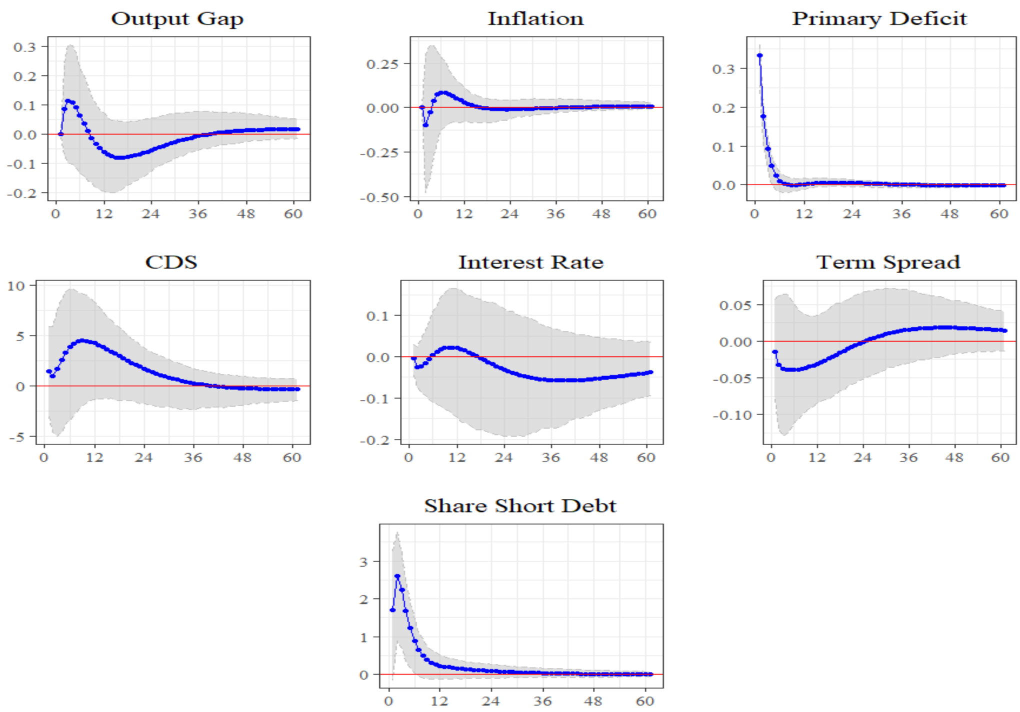

Figure 2.3: IRFs to shock in primary deficit: Short-Term

Note: Impulse response functions to one s.d. shock in primary deficit (blue) and 95% confidence interval.

Figure 2.4 shows the IRFs to a CDS shock. First, there is a significant decrease in the output gap and an increase in inflation for 18 months. Second, we notice a significant deterioration in primary deficit after 12 months. In reaction to the higher inflation and increase in country risk, the interest rate increases for about 12 months, followed by a decrease later. Despite the higher monetary policy interest rates in the short-run, we detect a significant

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increment in the term spread associated with the higher country risk. Finally, we identify a slightly significant increase in the share of short-term debt.

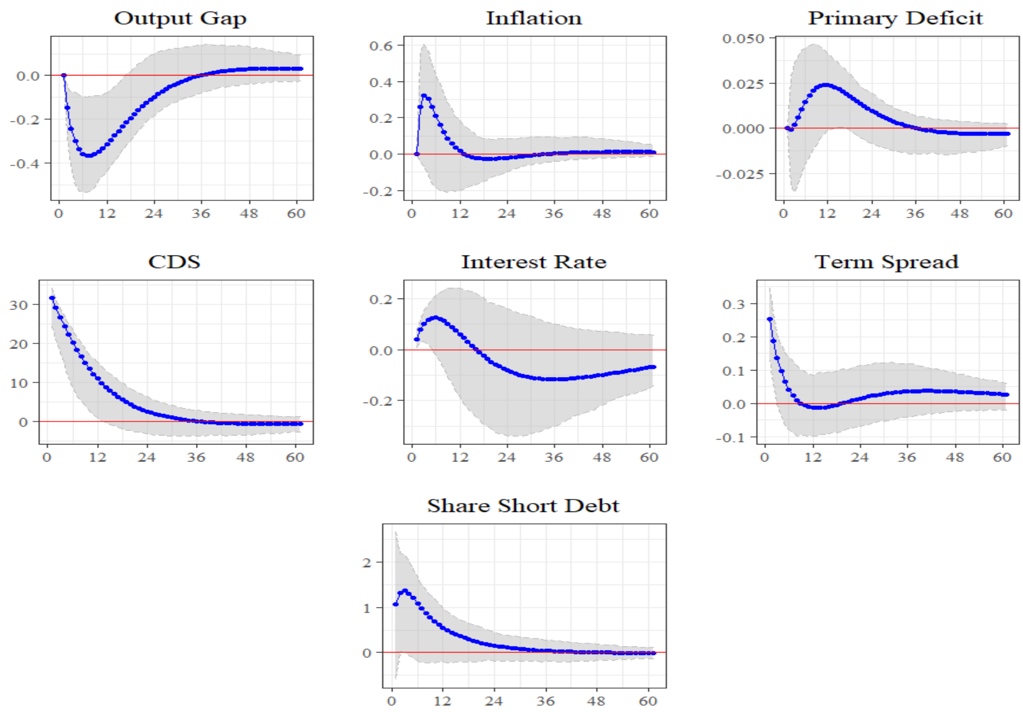

Figure 2.4: IRFs to shock in CDS: Short-Term

Note: Impulse response functions to one s.d. shock in CDS (blue) and 95% confidence interval.

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We present the results considering the broader concept of short-term debt, including floating-rate debt (LFT). Figure 2.5 reports the IRFs to a primary deficit shock, and Figure 2.6 to a CDS shock. In general, the dynamics of macroeconomic variables following the shocks are qualitatively similar. However, we emphasize two remarkable differences regarding the share of short-term debt. First, in the case of the broader concept, we do not find a significant impact of the fiscal shock on this variable. Second, the CDS shock leads to a significant increase in the share of short-term debt. These findings are in line with the results achieved in the reduced-form approach.

Following, we propose some robustness checks. First, we check the results of a fiscal shock replacing the primary deficit with the nominal deficit. Figures A.6 and A.7 present the IRFs for the two concepts of short-term debt, showing similar outcomes. We find that a nominal deficit shock leads to a higher response of inflation, a deeper recession, and a significant increase in CDS. In turn, it promotes a higher increase in interest rates and even a spike in the term spread before it falls due to interest rates increase. Finally, while the

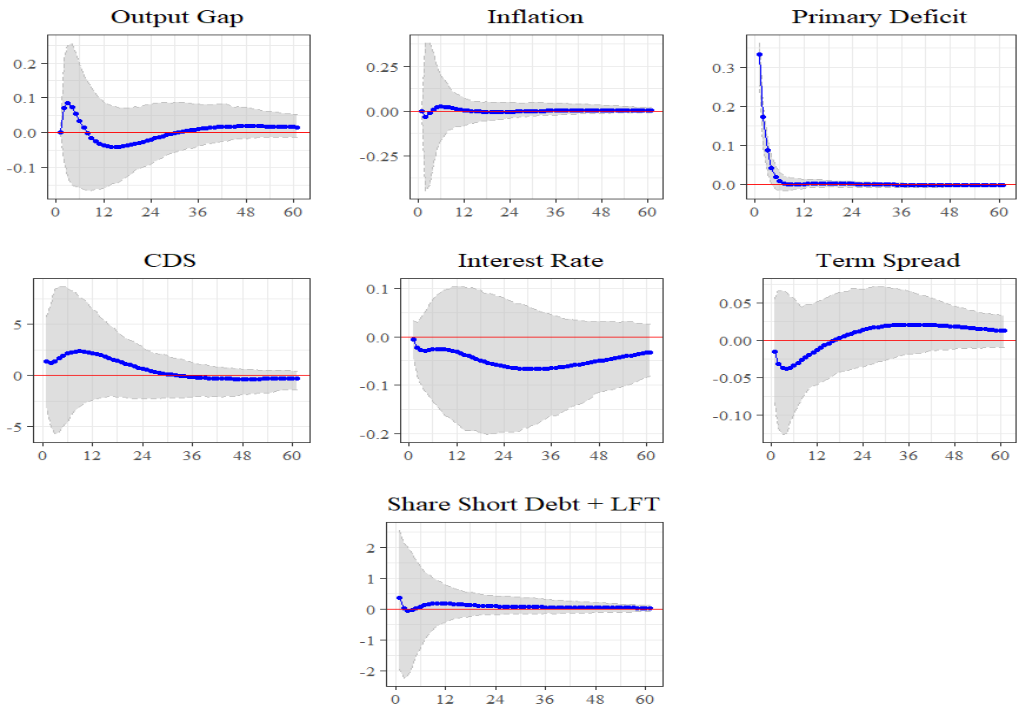

Figure 2.5: IRFs to shock in primary deficit: Short-Term + LFT

Note: Impulse response functions to one s.d. shock in primary deficit (blue) and 95% confidence interval.

narrower concept of short-term debt presents a similar response to the baseline case, the broader concept with LFT has a significant increase in the short-term in this alternative case.

Second, we propose ordering the variables differently in the case of a CDS shock, considering the interest rate ordered before the CDS. Nevertheless, again, the results are pretty similar. As expected, the interest rate reacts to the shock with a lag, leading to a higher term spread in the short-run. However, the responses of share of short-term debt are essentially the same.

Next, we present the forecast error variance decomposition to the share of short-term debt. It represents the contribution of exogenous shocks of each variable in the forecast error of the share of short-term debt. Table A.1 reports the results for the 12-month horizon considering the narrower concept of short-term debt. We can see that the surprises to primary deficit play a relevant role, explaining around 15% of variance of the error in forecasting the share of short-term debt in the 12-month horizon. Next, innovations to CDS contribute to around 9% in the same horizon. Nonetheless, most of the variance is explained by innovations in the share of short-term debt itself.

Table A.2 reports the results for the share of short-term debt that

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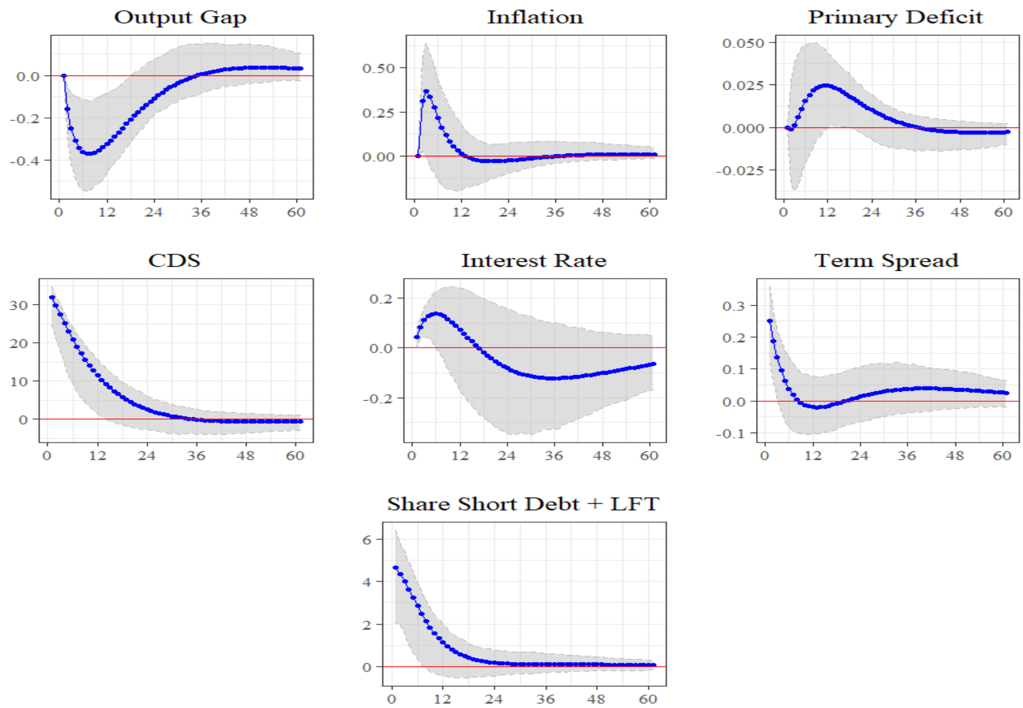

Figure 2.6: IRFs to shock in CDS: Short-Term + LFT

Note: Impulse response functions to one s.d. shock in CDS (blue) and 95% confidence interval.

includes LFT. Here, innovations to CDS explain a sizeable share of variance of the forecasting errors, reaching around 27% in the 12-month horizon, while the primary deficit is almost negligible. In addition to the share of short-term debt itself, we must highlight the contribution of inflation and output gap to around 3% each.

Altogether, we exhibited a relevant relationship between public debt composition and the fiscal stance in the short run. First, through univariate regressions, we showed that the share of short-term debt is positively associated with country risk and fiscal deficits. Then, through Structural VARs, we found that shocks to CDS and primary deficit lead to an increase in the share of short-term debt. Most importantly, the maturity concept of short-term debt is more responsive to fiscal deficits, while the duration concept reacts more to the country risk.

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3
Supply and Demand Factors in Public Debt Auctions

Previously, we have seen the effects of fiscal position on the composition of public debt issuance. In the face of higher country risk or larger primary deficits, the share of short-term debt increases significantly. However, it may be hard to disentangle supply and demand factors. For instance, this movement can result from investors' risk aversion, concentrating demand only in short-term bonds. On the other hand, it can be caused by the debt manager's focus on cost and risk trade-offs, choosing to shorten the debt maturity, or because of one of the considerations argued in Chapter 1. Finally, it can be a mix of supply and demand factors.

Once we have established the relationship between fiscal stance and short-term debt issuance, our goal is to disentangle the supply and demand factors of debt issuance. Therefore, we estimate the interest-rate elasticity of public debt Treasury supply and market demand to understand each factor's role. Following Rigobon (2003) and Coelho et al. (2017), we base our analysis on a method of identification through heteroskedasticity using weekly data of public debt auctions[1].

Our identification strategy is centered on assuming that economic uncertainty affects public debt supply and demand differently. More specifically, market demand shifts more than Treasury supply in periods of higher exchange rate volatility, possibly due to capital flows and uncertainty[2].

This chapter is organized as follows. First, we describe the data used in the empirical analysis. Second, we present the method based on Rigobon (2003). Third, we describe the estimation in detail. Finally, we show the results and some conclusions.

[1]To our knowledge, this is the first work to use this methodology to study the interest-rate elasticity of public debt markets.

[2]Central Bank of Brazil (2021) shows that several factors may explain the FX volatility, from systemic to "idiosyncratic domestic" factors, such as the country's fiscal outlook and the market structure

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3.1 Data

The primary data source is the same one described in Chapter 2: a database of the National Treasury including Public Debt Auctions results with the quantity and characteristics of every instrument issued. However, we restrict our analysis to short- and medium-term fixed-rate bonds (LTN) for two reasons. First, we would like to focus on short-term debt issuance. Second, that is the only instrument regularly issued weekly during our sample. According to Coelho et al. (2017), the high-frequency data is a crucial feature in terms of the method. Therefore, we aggregate the LTN issuance data weekly, and it spans from January 2007 to August 2021.

Our measure of exchange rate volatility is the one-month option-implied exchange rate volatility from Reuters. Gomes et al. (2008) argument that the option prices can provide information that may work as a signal for stress events. Moreover, they indicate that implied volatility is also a good predictor of observed volatility.

In addition, we consider some variables as controls in our estimations. The country risk is measured by Brazil's 5-year CDS, calculated by J.P. Morgan and provided by Bloomberg. The stock market variable is the growth rate of Brazilian stock market index (Ibovespa), from B3. The exchange rate is the growth rate of Brazilian nominal exchange rate (BRLUSD), and the expected inflation is from the Focus survey, both from the Central Bank of Brazil. Finally, we use the term spread of US, defined as the difference between 10-year and 3-month interest rates, from FRED/Fed.

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Table 3.1: Summary Statistics: LTN Issuance in DPMFi Auctions

Categories	Mean Share (%)*	N Auctions	Mean	Median	SD
All Maturities	49.89	723			
Interest Rate			10.18	10.68	2.87
Amount (R$ billion)**			8.26	7.32	5.83
Below 2 years	25.42	715			
Interest Rate			9.77	10.53	3.15
Amount (R$ billion)**			4.51	2.97	5.02
Below 1 year	12.8	525			
Interest Rate			9.56	10.1	3.32
Amount (R$ billion)**			3.18	1.78	4.71

Note: Table reports the summary statistics of weekly LTN issuance in DPMFi Auctions. The data is aggregated into 3 categories according to maturity: all maturities, below 2 years and below 1 year. *: mean share in total DPMFi issuance (4-week rolling window). **: inflation adjusted: 100 - Sep 2021.

Table 3.1 summarizes the information about LTN issuance, focusing on the interest rates and the amount issued in each auction.

We aggregate the LTN issuance into three categories according to the instrument maturity: i) all maturities (from 6 months to 4 years), ii) maturities below 2 years, and iii) maturities below 1 year. Besides, the amount issued is inflation-adjusted using IPCA and is reported in September 2021 value. Additionally, the interest rate is the weighted average of the interest rate in each period.

Table 3.1 shows that our data covers, on average, almost half of total public debt issuance in a 4-week rolling window. When we consider maturities below 2 years, we still cover 25% of total issuance and do not lose many observations. However, the sample with shorter maturities is considerably less representative. As expected, the amount issued and the interest rates increase in broader samples with higher maturities. Finally, we have a total amount of R$ 8.26 billion of LTN issued per auction, paying 10.18% of interest rate, on average. Figure 3.1 plots the evolution of LTN issuance.

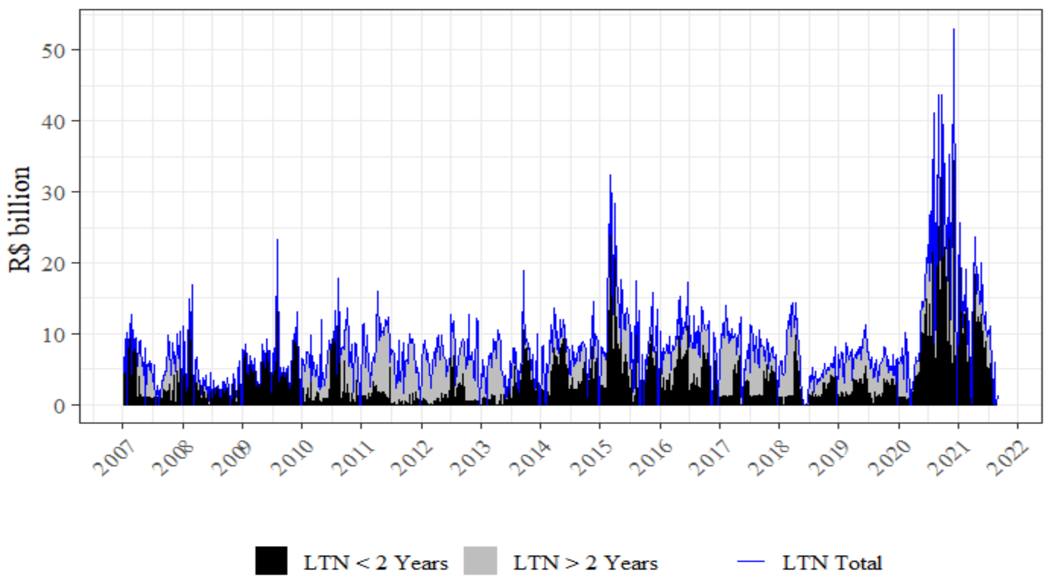

Figure 3.1: LTN Issuance in Public Debt Auctions (Inflation Adjusted)

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3.2 Method

We follow the method proposed by Rigobon (2003) closely and its application in Coelho et al. (2017). Consider the following public debt demand and supply simultaneous equation model (market demand (3-1) and Treasury supply (3-2)):

$$\tilde{r} = \alpha a_t + BX_t + \varepsilon_t \tag{3-1}$$

$$a_t = \beta \tilde{r}_t + AX_t + \eta_t \tag{3-2}$$

where $\tilde{r}_t = ln(Int\bar{e}rest_t)$, $a_t = ln(Amount_t)$, X_t is a vector of exogenous variables, and ε_t and η_t are the structural components. Therefore, β is the interest rate elasticity of Treasury supply, and α is the inverse of interest rate elasticity of market demand, the two structural parameters which we are interested in.

If we solve the system of equations 3-1 and 3-2 for $\tilde{r}_t$ and a_t, then:

$$\begin{bmatrix} \tilde{r}_t & a_t \end{bmatrix} = \begin{bmatrix} 1 & -\alpha \\ -\beta & 1 \end{bmatrix}^{-1} \left[\begin{bmatrix} B & A \end{bmatrix} X_t' + \begin{bmatrix} \varepsilon_t & \eta_t \end{bmatrix} \right] \tag{3-3}$$

Define the covariance matrix of structural shocks as Σ:

$$\Sigma = \text{Var}\left(\begin{bmatrix} \varepsilon_t \\ \eta_t \end{bmatrix} \mid X_t \right) = \begin{bmatrix} \sigma_\varepsilon^2 & \sigma_{\varepsilon\eta} \\ \sigma_{\varepsilon\eta} & \sigma_\eta^2 \end{bmatrix} \tag{3-4}$$

Thus, we can find Ω, the variance of the observable endogenous variables as a function of structural terms:

$$\Omega = \begin{bmatrix} \omega_{11} & \omega_{12} \\ \omega_{21} & \omega_{22} \end{bmatrix} = \text{Var}\left(\begin{bmatrix} \tilde{r}_t & a_t \end{bmatrix} \mid X_t \right) = \begin{bmatrix} 1 & -\beta \\ -\alpha & 1 \end{bmatrix}^{-1} \begin{bmatrix} \sigma_\varepsilon^2 & \sigma_{\varepsilon\eta} \\ \sigma_{\varepsilon\eta} & \sigma_\eta^2 \end{bmatrix} \begin{bmatrix} 1 & -\beta \\ -\alpha & 1 \end{bmatrix}^{-1} \tag{3-5}$$

Despite relating the variance-covariance matrix of observable data to structural parameters, Ω does not allow us to identify the structural parameters. System (3-5) provides us 3 equations but only 5 parameters (α, β, σ_ε^2, σ_η^2,$\sigma_{\varepsilon\eta}^2$). Therefore, Rigobon (2003) proposes three assumptions to theoretically identify the system: i) elasticities are time-invariant; ii) uncorrelated structural shocks; and iii) heteroskedastic structural shocks.

The first two assumptions are common in much of applied macro literature. First, it is the idea of a single model for the entire sample. Second, we assume that structural shocks are uncorrelated. In order to avoid violating this assumption, we take two steps: i) control for macroeconomic variables to mitigate this common component, and ii) use data on relatively high frequency (weekly), which could reduce the aggregate co-movements.

The third assumption is that there are two regimes in the variance of structural shocks, namely high and low volatility. Together with the first assumption, we have that reduced-form variance is also heteroskedastic. Ex-

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pressly, we assume that each regime has a different form of structural variance matrix Σ. Hence, we define each regime by the exchange rate volatility.

Considering two regimes (Low, High) and a specification of Ω to each one (indexed by $s \in \{L, H\}$), we have two mappings between structural parameters and observable variance-covariance matrix:

$$\Omega^s = \begin{bmatrix} \omega_{11}^s & \omega_{12}^s \\ \omega_{21}^s & \omega_{22}^s \end{bmatrix} = \begin{bmatrix} 1 & -\beta \\ -\alpha & 1 \end{bmatrix}^{-1} \begin{bmatrix} \sigma_{\varepsilon,s}^2 & \sigma_{\varepsilon\eta,s} \\ \sigma_{\varepsilon\eta,s} & \sigma_{\eta,s}^2 \end{bmatrix} \begin{bmatrix} 1 & -\beta \\ -\alpha & 1 \end{bmatrix}^{-1} \tag{3-6}$$

Therefore, we are able to recover the structural parameters. First, remember that we assume uncorrelated structural errors ($\sigma_{\varepsilon\eta,s} = 0$ for $s = H, L$). Then, we have six equations (three from each regime) and six unknowns (α,β,$\sigma_{\varepsilon,L}^2$,$\sigma_{\eta,L}^2$,$\sigma_{\varepsilon,H}^2$,$\sigma_{\eta,H}^2$). Thus, solving (3-6), α and β satisfy the following:

$$\beta = \frac{\omega_{12}^L - \alpha\omega_{11}^L}{\omega_{22}^L - \alpha\omega_{12}^L} \text{ and } \beta = \frac{\omega_{12}^H - \alpha\omega_{11}^H}{\omega_{22}^H - \alpha\omega_{12}^H} \tag{3-7}$$

Then, α solves the following:

$$\left[\omega_{11}^L\omega_{12}^H - \omega_{12}^L\omega_{11}^H\right]\alpha^2 - \left[\omega_{11}^L\omega_{22}^H - \omega_{22}^L\omega_{11}^H\right]\alpha + \left[\omega_{12}^L\omega_{22,2} - \omega_{22}^L\omega_{12}^H\right] = 0 \tag{3-8}$$

As Rigobon (2003) shows, if (α, β) is a solution to the quadratic equation, then $(1/\beta, 1/\alpha)$ is the other solution. That is, "the system is identified up to row permutations of the original model".

Additionally, it is essential to mention that (3-7) has a solution only if the relative structural variances are not constant across regimes. That is:

$$\frac{\sigma_{\varepsilon,H}^2}{\sigma_{\eta,H}^2} \neq \frac{\sigma_{\varepsilon,L}^2}{\sigma_{\eta,L}^2} \tag{3-9}$$

As stressed before, our identification strategy comes from exchange rate volatility affecting public debt supply and demand in different ways. In periods of higher volatility, the variance of demand increases relatively more than the variance of supply[3]. Then, the "cloud" of realizations is more distributed along the supply curve, enlarging the ellipse along this curve and allowing us to trace out more supply than demand. As we assumed that structural shocks are uncorrelated, this would be enough to estimate the slope of the demand curve too. This is an instrumental variable interpretation of the method.

[3]This is a reasonable assumption since the Treasury might be obligated to roll over the debt while the market could change the demand more easily in periods of stress.

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3.3 Estimation

The estimation process is easily described in a few steps, as follows:

1. Split the sample into sub-samples according to the exchange rate implied volatility: high (H) and low (L) volatility.

2. Split at a determined cut-off: all weeks in which the volatility is higher than the cut-off are classified as H regime, and vice-versa. Below, we provide further details for the determination of the cut-off.

3. For each regime, compute the sample analogs of the conditional variance:

$$\widehat{\text{Var}}\left(\begin{bmatrix}\tilde{r}_t & a_t\end{bmatrix} \mid X_t\right) = \widehat{\Omega}^s = \begin{bmatrix}\widehat{\omega}_{11} & \widehat{\omega}_{12} \\ \widehat{\omega}_{21} & \widehat{\omega}_{22}\end{bmatrix}, s = H, L \tag{3-10}$$

4. Using point estimates in $\widehat{\Omega}^s$, recover sample counterparts of the structural parameters by solving the following system for ($\hat{\alpha}$,$\hat{\beta}$):

$$\hat{\beta} = \frac{\widehat{\omega}^L_{12} - \hat{\alpha}\widehat{\omega}^L_{11}}{\widehat{\omega}^L_{22} - \hat{\alpha}\widehat{\omega}^L_{12}} \text{ and } \hat{\beta} = \frac{\widehat{\omega}^H_{12} - \hat{\alpha}\widehat{\omega}^H_{11}}{\widehat{\omega}^H_{22} - \hat{\alpha}\widehat{\omega}^H_{12}} \tag{3-11}$$

5. Finally, compute the standard errors of estimation by bootstrap.

3.3.1 Regime Identification and Volatility Cut-off

There are different possible manners to identify volatility regimes. For instance, Coelho et al. (2017) split the sample in an *ad hoc* k-percentile: the median. On the other hand, Rigobon (2003) follows a narrative approach to identifying international crises. We define a cut-off that allows us to identify periods of higher volatility linked to well-known "crisis" regimes domestically or abroad.

We propose the 65th percentile of the exchange rate volatility in the sample as the baseline cut-off that identifies crisis regimes[4]. Next, we highlight some episodes identified in the high volatility regime according to this cut-off:

1. Great Financial Crisis between 2008 and 2009;

2. Start of the European Sovereign Debt Crisis in 2010 (Lane (2012));

[4]Further, we make some robustness checks on this cut-off assumption.

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3. Central Bank of Brazil shifts in monetary policy in 2011[5];

4. Taper Tantrum in 2013, the financial panic caused by the announcement by Fed's chairman Ben Bernanke that asset purchases (QE) might soon be slowed (Bernanke (2020));

5. Presidential elections in Brazil in 2014 and 2018;

6. Turbulent period in Brazil between 2015 and 2016, characterized by the fiscal crisis, the impeachment of president Dilma Rousseff, and investigation of corruption cases by *Lava Jato* operation;

7. Joesley Day in 2017, when an alleged corrupt association between Joesley Batista, a relevant Brazilian businessman, and Michel Temer, the then-president of Brazil, was leaked to the press;

8. Covid-19 crisis between 2020 and 2021.

In Figure 3.2, the shaded area represents the periods identified in the high volatility regime in our baseline cut-off. Additionally, Figure 3.2 plots the exchange rate implied volatility and a 12-week rolling window correlation between interest rate and the amount issued. In volatile periods, the demand shifts relatively more, and the correlation between interest rate and amount issued is usually negative. Thus, the variation traces out the supply slope more closely, indeed.

Table A.3 shows the results of regressions of the 12-week rolling window correlation between interest rate and the amount issued on the exchange rate implied volatility. We find a significant negative effect of exchange rate volatility on the correlation between interest rate and amount issued in all specifications, in line with the previous analysis. We correct the standard errors for autocorrelation in all cases.

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[5]In a moment of rising inflation, Central Bank of Brazil surprised the markets by cutting the monetary policy interest rate, leading to a period of higher volatility and rising concerns about political interference on monetary policy (Reuters (2011)).

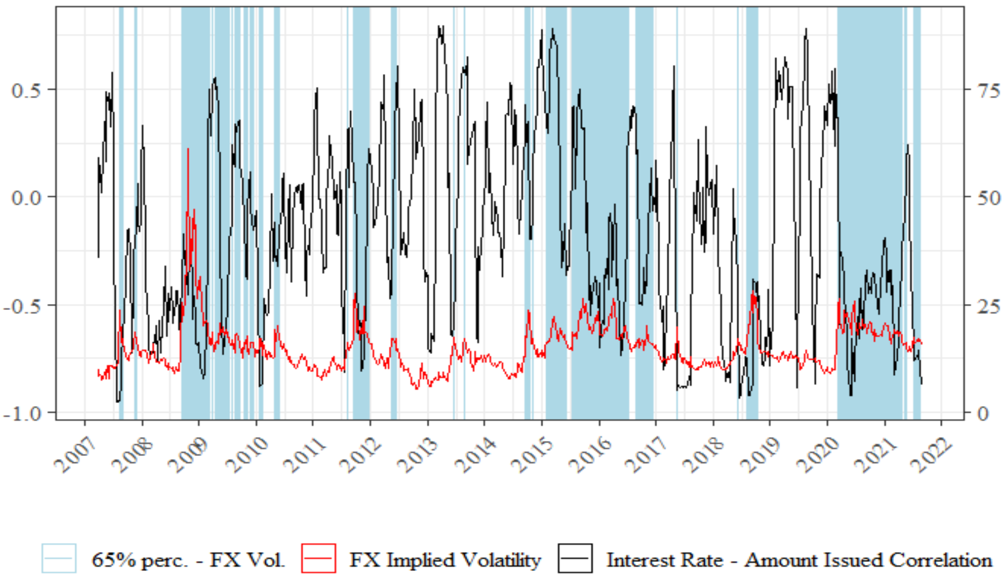

Figure 3.2: FX Volatility and 12-week rolling window Interest Rate - Amount Issued Correlation

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3.4 Results

3.4.1 Main Results

We present the estimation results for the structural parameters: supply elasticity (β) and inverse of demand elasticity (α)[6]. Moreover, we report the outcomes for the three categories of LTN presented before: i) all maturities, ii) maturities below 2 years, and iii) maturities below 1 year. In the main results, we use the baseline 65th percentile cut-off and estimate five models with an increasing number of controls. Apart from the macroeconomic variables, we also include as control a linear trend due to non-stationarity and seasonal dummies[7].

In general, we need to emphasize that we could identify reasonable economic parameters with correct signs: positive interest rate elasticity for demand and negative for supply. First, Table 3.2 shows the results for LTN of all maturities. We find that the Treasury supply of LTN is interest-rate elastic, and point estimates are statistically significant in standard levels in all

[6]We estimate the inverse of demand elasticity (α). However, we also report the demand elasticity for the sake of comparison.

[7]In all specifications, we include monthly dummies due to seasonal patterns in debt issuance. In addition, we propose a model with biweekly dummies due to different compositions in the supply of bonds every two weeks in the case of LTNs.

specifications. The estimates range from -1.44 to -1.37. On the other hand, the market demand is quite elastic, with estimates ranging from 11.55 to 14.85 depending on the specification. However, the inverse of demand elasticity estimates are not statistically significant.

Table 3.2: Estimation: LTN All Maturities - Baseline Cut-off

Models	1	2	3	4	5
Demand elasticity	11.55	11.67	11.62	14.82	14.85
Inverse of Demand elasticity	0.09	0.09	0.09	0.07	0.07
t-statistic	1.39	1.4	1.4	1.36	1.35
Supply elasticity	-1.44	-1.38	-1.38	-1.37	-1.37
t-statistic	-2.19	-2.19	-2.18	-2.44	-2.43
Constant	Yes	Yes	Yes	Yes	Yes
Linear Trend	Yes	Yes	Yes	Yes	Yes
Monthly dummies	Yes	Yes	Yes	Yes	Yes
CDS	Yes	Yes	Yes	Yes	Yes
Stock Market	No	Yes	Yes	Yes	Yes
Exchange Rate	No	Yes	Yes	Yes	Yes
Expected Inflation	No	No	Yes	Yes	Yes
Term Spread US	No	No	No	Yes	Yes
Biweekly dummies	No	No	No	No	Yes

Note: Table reports estimation results for the structural parameters: demand and supply elasticities. We consider the baseline cut-off: 65th percentile. Each column represents a model with a different set of control variables.

Table 3.3 shows the results for LTN of maturities below 2 years. Again, the Treasury supply is interest-rate elastic, and the estimates are statistically significant. However, we have larger point estimates that range from -2.4 to -2.3. That is, an increase of 1% in interest rate leads to a reduction of 2.4% in the amount issued, approximately. Additionally, the market demand is elastic, with demand elasticity parameters ranging from 10.06 to 10.84. In this case, the point estimates are statistically significant in all specifications.

Finally, Table 3.4 shows the results for the narrower category: LTN of maturities below 1 year. In this case, both supply and demand parameters are statistically significant. The point estimates of the Treasury supply parameter range from -2.7 to -2.37. On the other hand, the demand elasticity ranges from 7.25 to 8.76.

Overall, we find that both supply and demand of short- and medium-term public debt are interest-rate elastic. In other words, there are factors related to Treasury supply and market demand in the variation of public debt issuance due to changes in interest rates. For instance, it is not the case that

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the Treasury issues debt at whatever cost to fund the borrowing requirements, simply accommodating demand pressures. Neither the other extreme with the market funding the Treasury without asking for higher interest rates.

Table 3.3: Estimation: LTN Below 2 Years - Baseline Cut-off

Models	1	2	3	4	5
Demand elasticity	10.22	10.06	10.08	10.84	10.84
Inverse of Demand elasticity	0.1	0.1	0.1	0.09	0.09
t-statistic	2.01	2.11	2.11	2.35	2.35
Supply elasticity	-2.32	-2.31	-2.3	-2.4	-2.4
t-statistic	-1.61	-1.67	-1.67	-1.89	-1.89
Constant	Yes	Yes	Yes	Yes	Yes
Linear Trend	Yes	Yes	Yes	Yes	Yes
Monthly dummies	Yes	Yes	Yes	Yes	Yes
CDS	Yes	Yes	Yes	Yes	Yes
Stock Market	No	Yes	Yes	Yes	Yes
Exchange Rate	No	Yes	Yes	Yes	Yes
Expected Inflation	No	No	Yes	Yes	Yes
Term Spread US	No	No	No	Yes	Yes
Biweekly dummies	No	No	No	No	Yes

Note: See Notes in Table 3.2.

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First, the supply parameter is significant in all baseline specifications, with point estimates between -2.7 and -1.37, depending on the category. In fact, the Treasury reduces the supply of public debt due to higher interest rates. Additionally, we observe that the supply elasticity is higher if we consider only the shorter-term bonds, i.e., it is more sensitive to choose short-term debt due to interest rate changes. However, when we consider a broader set of bonds, the Treasury may be restricted, with less space to change the amount issued due to its need to refinance the debt. Then, we find a lower supply elasticity when considering all maturities of LTN.

The market demand is considerably more interest rate elastic than Treasury supply, with point estimates between 7.25 and 14.85 depending on the category. Furthermore, we notice the opposite pattern seen in supply: the demand elasticity is larger when we include longer maturities. This finding may be explained by financial institutions' captive demand for short-term debt[8], while they are more sensitive to higher interest rates to demand riskier longer-term bonds. Then, the demand for shorter-term bonds is less sensitive to interest rates than the total LTN demand, despite being quite elastic

[8]See Guibaud et al. (2008) for a preferred habitat explanation.

(7.25 - 8.76). Notwithstanding, some estimates are not statistically significant, especially those relative to the broader category.

Table 3.4: Estimation: LTN Below 1 Year - Baseline Cut-off

Models	1	2	3	4	5
Demand elasticity	7.25	7.25	7.3	8.84	8.76
Inverse of Demand elasticity	0.14	0.14	0.14	0.11	0.11
t-statistic	2.65	2.66	2.64	2.6	2.69
Supply elasticity	-2.7	-2.69	-2.68	-2.37	-2.38
t-statistic	-1.9	-1.95	-1.95	-2.04	-2.1
Constant	Yes	Yes	Yes	Yes	Yes
Linear Trend	Yes	Yes	Yes	Yes	Yes
Monthly dummies	Yes	Yes	Yes	Yes	Yes
CDS	Yes	Yes	Yes	Yes	Yes
Stock Market	No	Yes	Yes	Yes	Yes
Exchange Rate	No	Yes	Yes	Yes	Yes
Expected Inflation	No	No	Yes	Yes	Yes
Term Spread US	No	No	No	Yes	Yes
Biweekly dummies	No	No	No	No	Yes

Note: See Notes in Table 3.2.

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3.4.2 Robustness Checks

Our identification strategy defines the 65th percentile of FX volatility in the sample as the baseline cut-off. It allowed us to identify periods of higher volatility linked to well-known "crisis" regimes. However, it may be relevant to check how our results change depending on the identification of the crisis regime through the chosen cut-off. Figure A.8 and Figure A.9 are similar representations of Figure 3.2, but show alternative regime identification using 50th and 75th percentile, respectively.

We relax the baseline assumption for robustness check and re-estimate the preferred specification (Model 5) for each category considering different cut-offs (from 50th to 75th percentile).

Tables 3.5, 3.6, and 3.7 present this sensibility analysis for the three categories defined before. In general, the results are robust to the definition of crisis regimes[9]. For total LTN (Table 3.5), the supply elasticity is significant in all cut-offs and point estimates lie in a short range (from -1.69 to -1.35). On the other hand, the demand elasticity is still not precisely estimated, despite quite large in all cases (from 10.62 to 15.92).

[9]In this sense, Rigobon (2003) states that "the estimated coefficients should be consistent for small perturbations of the regime definitions".

Table 3.5: Estimation: LTN All Maturities - Robustness Check

Percentile (-th)	50	55	60	65	70	75
Demand elasticity	11.49	11.3	10.62	14.85	15.72	15.92
Inverse of Demand elasticity	0.09	0.09	0.09	0.07	0.06	0.06
t-statistic	1.63	1.56	1.73	1.35	1.40	0.94
Supply elasticity	-1.52	-1.58	-1.69	-1.37	-1.35	-1.43
t-statistic	-2.51	-2.53	-2.65	-2.43	-2.21	-1.67

Note: Table reports estimation results for the structural parameters: demand and supply elasticities. We consider the preferred specification: Model 5. Each column represents a different percentile used as the cut-off from 50 to 75.

Table 3.6 shows the results for LTN of maturities below 2 years. Except in the case of stricter definitions of crisis (higher percentile cut-offs), in which estimates are not significant, we find robust results for both supply and demand parameters. While supply elasticity ranges from -2.58 to -2.4, demand elasticity is also estimated in a short range (9.94 to 11.01).

Table 3.6: Estimation: LTN Below 2 Years - Robustness Check

Percentile (-th)	50	55	60	65	70	75
Demand elasticity	9.94	10.24	10.04	10.84	11.01	10.87
Inverse of Demand elasticity	0.10	0.10	0.10	0.09	0.09	0.09
t-statistic	3.00	2.86	2.47	2.35	2.09	1.51
Supply elasticity	-2.54	-2.51	-2.58	-2.40	-2.41	-2.58
t-statistic	-2.54	-2.36	-1.95	-1.89	-1.56	-1.46

Note: See Notes in Table 3.5.

Finally, Table 3.7 shows the results for LTN of maturities below 1 year. Again, the conclusions are similar to those of the above categories: results seem robust to regime definition, except for the 75th percentile, which leads to insignificant parameters. Ultimately, the patterns observed in the baselines specifications are preserved in this robustness check: i) both supply and demand are interest rate elastic, with demand considerably more sensitive, and ii) while demand elasticity increases when considering higher maturities, supply elasticity decreases.

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Table 3.7: Estimation: LTN Below 1 Year - Robustness Check

Percentile (-th)	50	55	60	65	70	75
Demand elasticity	9.11	8.93	8.62	8.76	8.01	6.15
Inverse of Demand elasticity	0.11	0.11	0.12	0.11	0.12	0.16
t-statistic	2.39	2.55	2.39	2.69	2.00	1.52
Supply elasticity	-2.03	-2.16	-2.25	-2.38	-2.54	-3.18
t-statistic	-2.01	-2.02	-1.98	-2.10	-1.71	-1.63

Note: See Notes in Table 3.5 .

4
Conclusions

In the last decade, Brazil went through a significant fiscal deterioration. Meanwhile, the composition of the public debt has also considerably changed. After achieving a profile close to its so-called optimal, the debt structure became riskier, more focused on floating-rate and short-term debt.

Literature on debt management has many explanations for the determination of public debt composition. More specifically, the choice of short-term debt is often explained by the lower issuance costs, despite entailing higher rollover and interest-rate risks. Besides, the literature also suggests other possible factors, such as investors' risk aversion, signaling, and credibility.

This dissertation studies the effects of the fiscal stance on the composition of public debt in the short-run in Brazil. For this purpose, we evaluate the impact of the fiscal outlook on the share of short-term debt in public debt issuance using monthly data from 2007:01 to 2021:08. Hence, we propose two alternative methods: reduced-form regressions and VAR analysis.

The results from reduced-form indicate that the fiscal deterioration is associated with an increase in the share of short-term debt issued. Moreover, we find that a surge in country risk is also associated with a higher reliance on short-term debt, especially when considering a broader concept that includes floating-rate debt. The VAR analysis pointed to similar evidence. Despite no significant response of other variables in the system, a fiscal shock entails an increase in short-term debt. On the other hand, a country risk shock generates a sound response and significantly increases short-term debt in the duration concept.

Still, it is challenging to disentangle supply and demand factors in the composition of public debt. Thus, to understand each factor's role, we estimate the interest-rate elasticity of short- and medium-term public debt Treasury supply and market demand using a method of identification through heteroskedasticity proposed by Rigobon (2003).

In general, we find that both supply and demand factors are present. However, market demand is considerably more interest-rate elastic than Treasury supply, as expected. Furthermore, while the elasticity of demand increases when we include longer maturities, the elasticity of supply decreases. On the

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demand side, this pattern may be explained by a captive demand for short-term debt and risk aversion on longer-term maturities. On the supply side, the Treasury may be more sensitive to interest rates on the short-term debt, while it is restricted by its funding needs when we include longer maturities.

Finally, our findings suggest some policy implications. First, it is straightforward that a fiscal deterioration is followed by a worse public debt profile, characterized by a shortened maturity and a more volatile debt cost, increasing the likelihood of a debt crisis. Second, the shorter debt maturity and the higher reliance on floating-rate debt as a response to the fiscal deterioration weaken the transmission of monetary policy, as its wealth channel becomes less efficient with a higher share of public debt indexed to the short-term interest rate. Therefore, we reinforce the importance of fiscal consolidation to guarantee macroeconomic stability in Brazil. It is a path of primary surpluses and lower country risks that would enable the country to reassure a sustainable public debt and a convergence to the optimal debt composition after the deviation to a riskier and more vulnerable structure in recent years.

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A
Appendix

A.1
Introduction

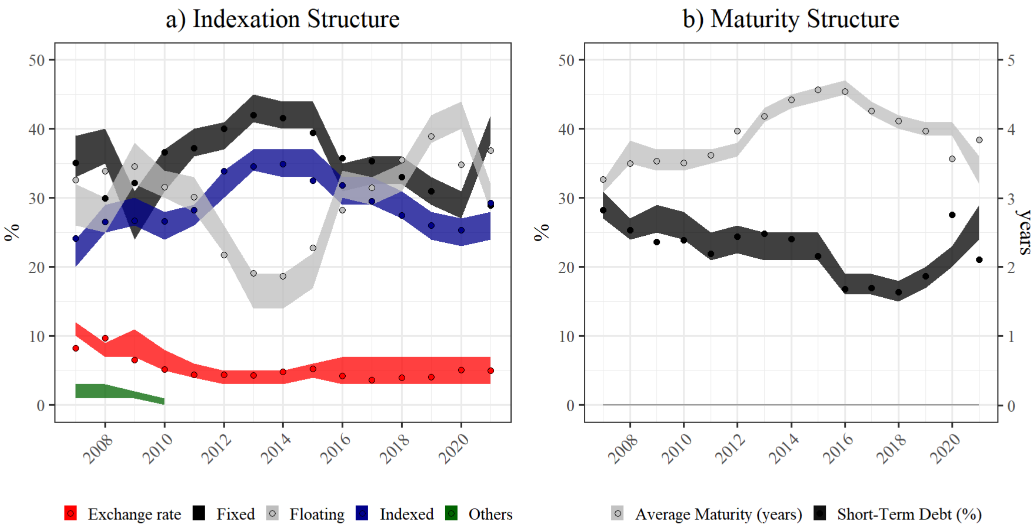

Figure A.1: Composition of Federal Public Debt: Target Ranges from Annual Borrowing Plan

Note: The shaded areas represent the target ranges established by the Annual Borrowing Plan at the beginning of every year. The dots correspond to the realized composition at the end of the year.

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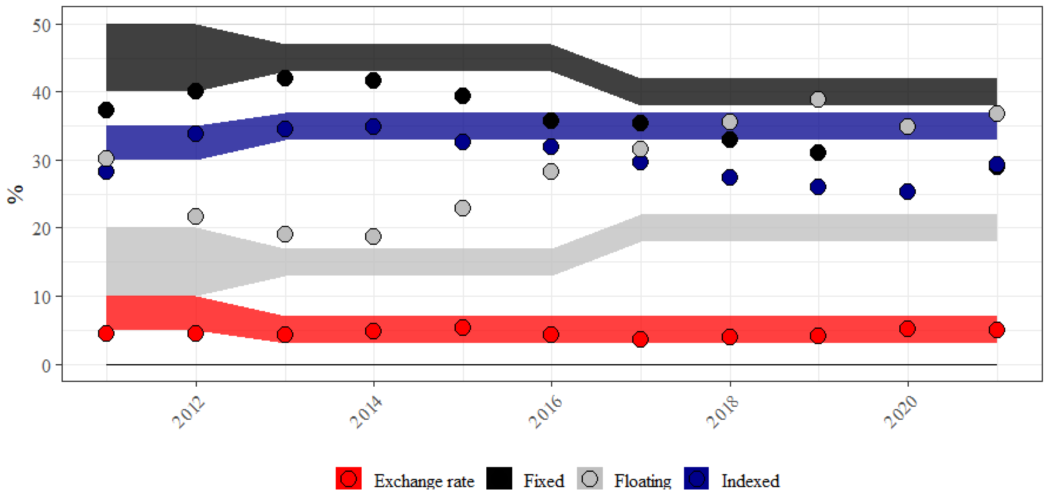

Figure A.2: Optimal Composition of Federal Public Debt: Annual Borrowing Plan

Note: The shaded areas represent the long-term optimal composition defined by the National Treasury and published in the Annual Borrowing Plan. The dots correspond to the realized composition at the end of the year.

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A.2 Fiscal Stance and Short-Term Debt

Table A.1: Forecast Error Variance Decomposition: Short-Term Debt

Months	Output Gap	Inflation	Primary Deficit	CDS	Interest Rate	Term Spread	Short Debt
1	0.45	1.05	3.90	1.54	1.52	3.11	88.42
2	0.37	2.94	9.53	2.83	1.36	2.80	80.17
3	0.40	3.63	12.82	4.14	1.26	2.61	75.14
4	0.42	3.81	14.44	5.31	1.20	2.50	72.32
5	0.43	3.82	15.19	6.30	1.17	2.42	70.67
6	0.43	3.79	15.51	7.10	1.15	2.38	69.63
7	0.43	3.76	15.65	7.74	1.14	2.36	68.92
8	0.44	3.73	15.69	8.25	1.13	2.35	68.40
9	0.44	3.71	15.69	8.65	1.13	2.36	68.01
10	0.45	3.70	15.68	8.97	1.13	2.38	67.70
11	0.45	3.68	15.67	9.22	1.12	2.41	67.44
12	0.46	3.67	15.65	9.42	1.12	2.44	67.24

Note: Table reports the contribution in percent of the total at various horizons.

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Table A.2: Forecast Error Variance Decomposition: Short-Term Debt + LFT

Months	Output Gap	Inflation	Primary Deficit	CDS	Interest Rate	Term Spread	Short Debt + LFT
1	5.27	1.20	0.07	12.17	0.40	1.42	79.47
2	4.46	1.79	0.05	15.31	0.34	1.62	76.44
3	3.91	2.23	0.04	18.18	0.29	1.75	73.59
4	3.60	2.53	0.04	20.59	0.27	1.82	71.16
5	3.44	2.71	0.04	22.50	0.26	1.84	69.21
6	3.38	2.83	0.04	23.95	0.25	1.84	67.72
7	3.37	2.90	0.04	25.03	0.25	1.82	66.60
8	3.38	2.94	0.05	25.82	0.25	1.80	65.77
9	3.39	2.96	0.06	26.39	0.26	1.78	65.17
10	3.41	2.97	0.06	26.80	0.26	1.76	64.73
11	3.42	2.97	0.07	27.09	0.26	1.76	64.42
12	3.43	2.97	0.08	27.30	0.27	1.76	64.19

Note: Table reports the contribution in percent of the total at various horizons.

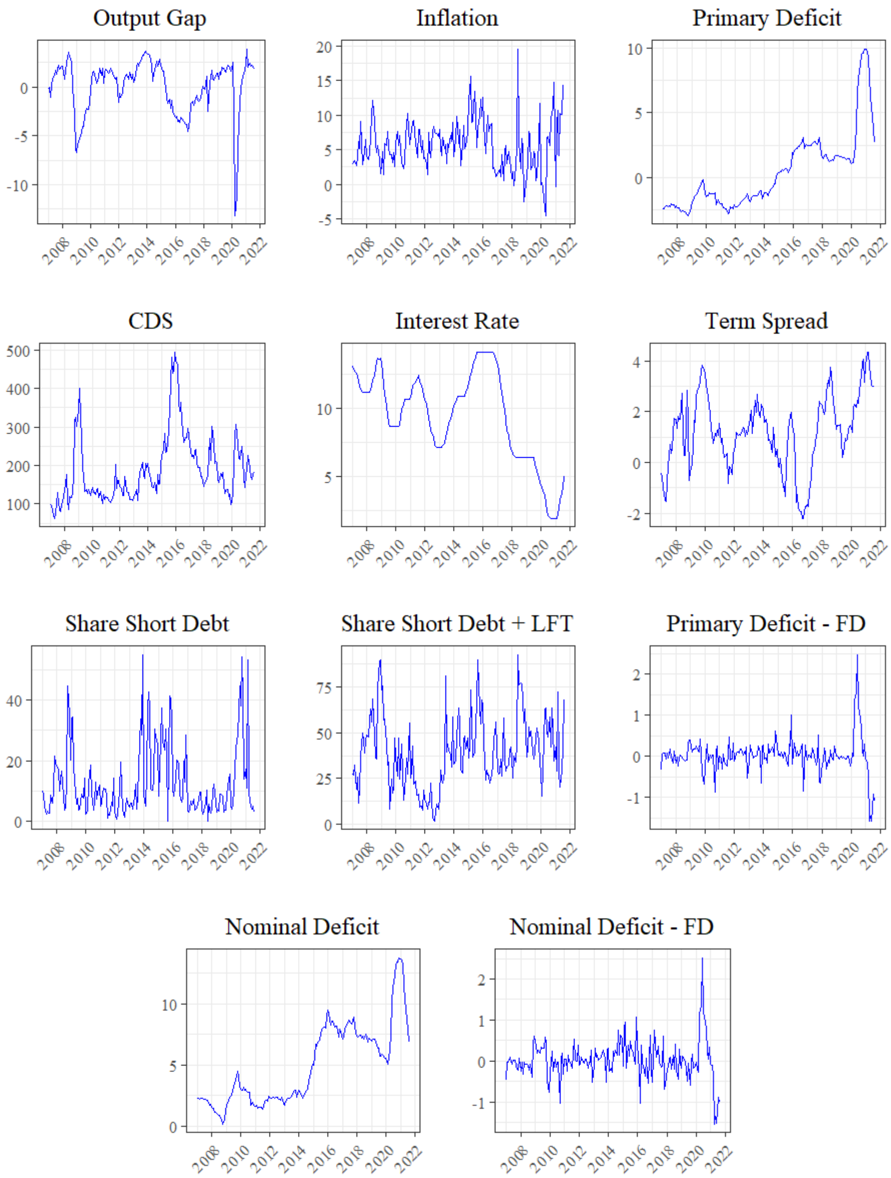

Figure A.3: Evolution of Variables in VAR

Note: FD - First Difference

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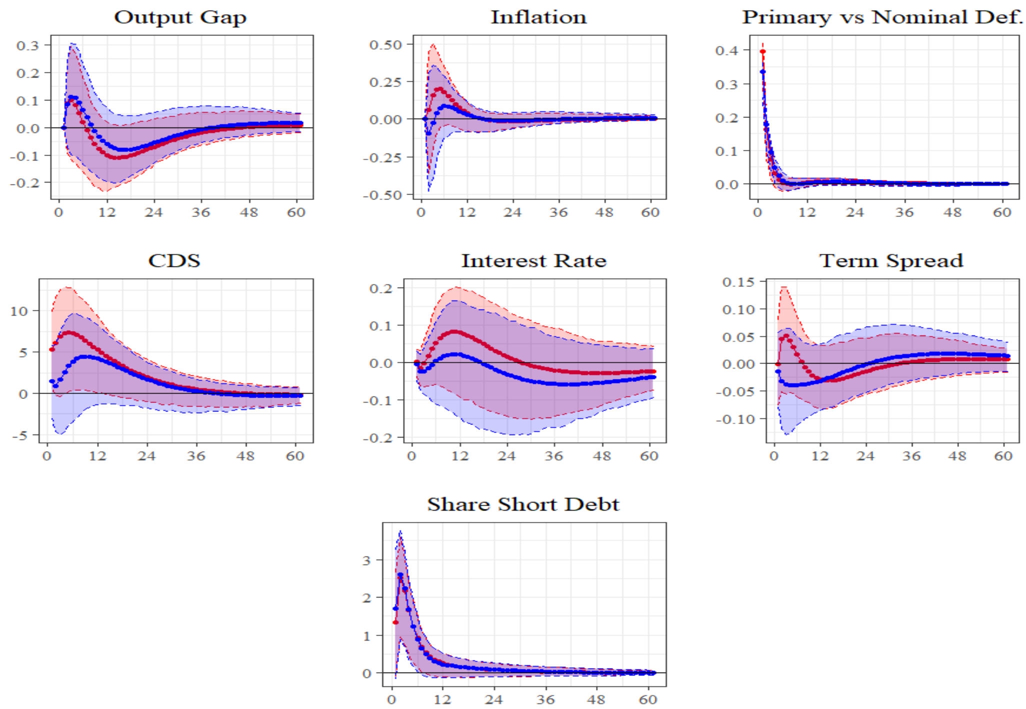

Figure A.4: Robustness: IRFs to shock in Primary vs Nominal Deficit: Short-Term

Note: Impulse response functions to one s.d. shock (dots) and 95% confidence interval (shade). Baseline (Primary deficit) in blue and alternative (Nominal deficit) in red.

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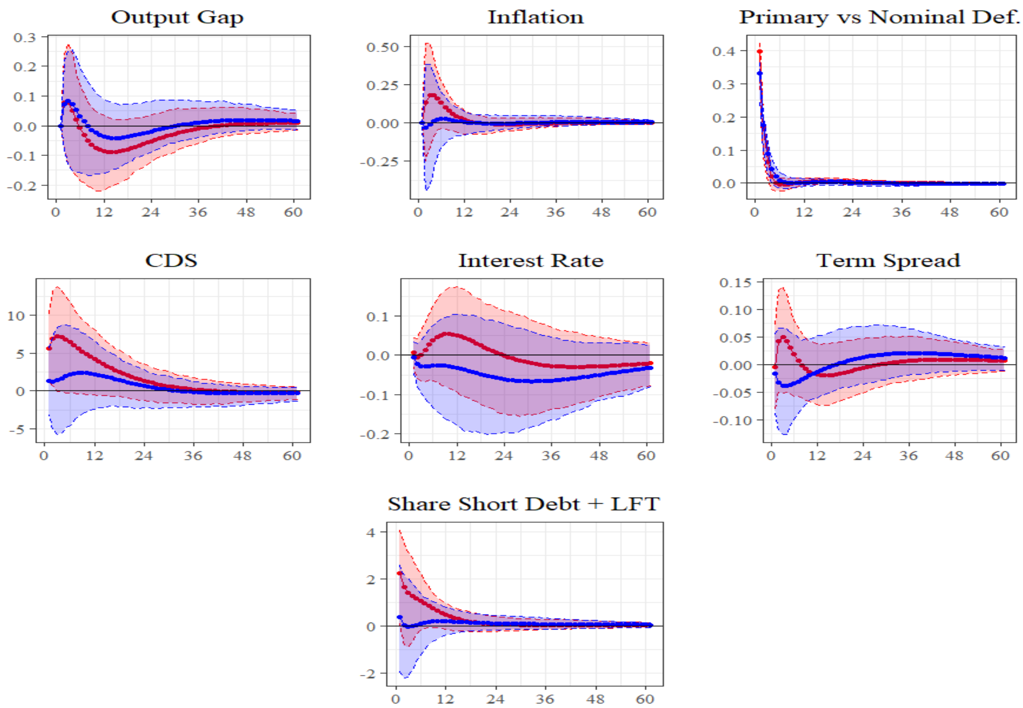

Figure A.5: Robustness: IRFs to shock in Primary vs Nominal Deficit: Short-Term + LFT

Note: Impulse response functions to one s.d. shock (dots) and 95% confidence interval (shade). Baseline (Primary deficit) in blue and alternative (Nominal deficit) in red.

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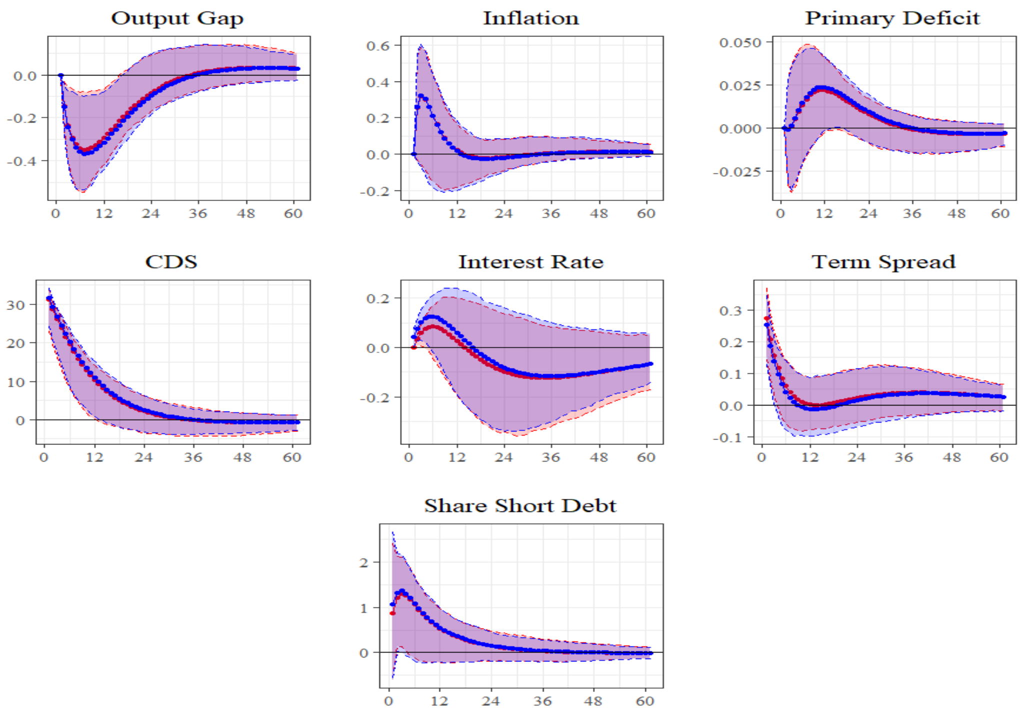

Figure A.6: Robustness: IRFs to shock in CDS: Short-Term

Note: Impulse response functions to one s.d. shock in CDS and 95% confidence interval. Baseline (CDS ordered before Interest Rate) in blue and alternative (CDS ordered after Interest Rate) in red.

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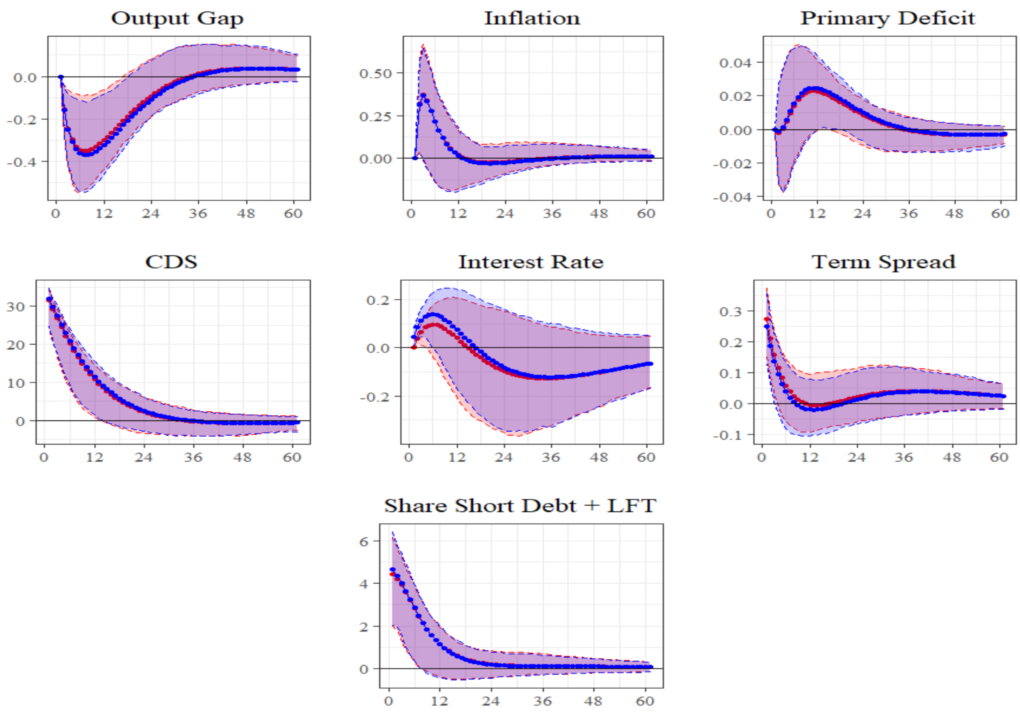

Figure A.7: Robustness: IRFs to shock in CDS: Short-Term + LFT

Note: Impulse response functions to one s.d. shock in CDS and 95% confidence interval. Baseline (CDS ordered before Interest Rate) in blue and alternative (CDS ordered after Interest Rate) in red.

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A.3
Supply and Demand Factors in Public Debt Auctions

Table A.3: Correlation and FX volatility

	Dependent variable:		
	Interest Rate - Amount Issued Correlation		
	LTN	LTN	LTN
	(1)	(2)	(3)
Exchange Rate Volatility	-0.019^{***}	-0.021^{***}	-0.021^{***}
	(0.007)	(0.007)	(0.007)
log Interest Rate		0.180	0.178
		(0.125)	(0.155)
log Amount Issued		0.084^{*}	0.084^{*}
		(0.050)	(0.050)
Trend			-0.000
			(0.000)
Constant	0.123	-0.999	-0.981
	(0.111)	(0.671)	(1.083)
Observations	754	713	713
R^2	0.057	0.095	0.095
Adjusted R^2	0.055	0.091	0.090
Residual Std. Error	0.430	0.422	0.423
F Statistic	45.040^{***}	24.886^{***}	18.640^{***}
Note:			*p<0.1; **p<0.05; ***p<0.01 HAC Robust Std. Error

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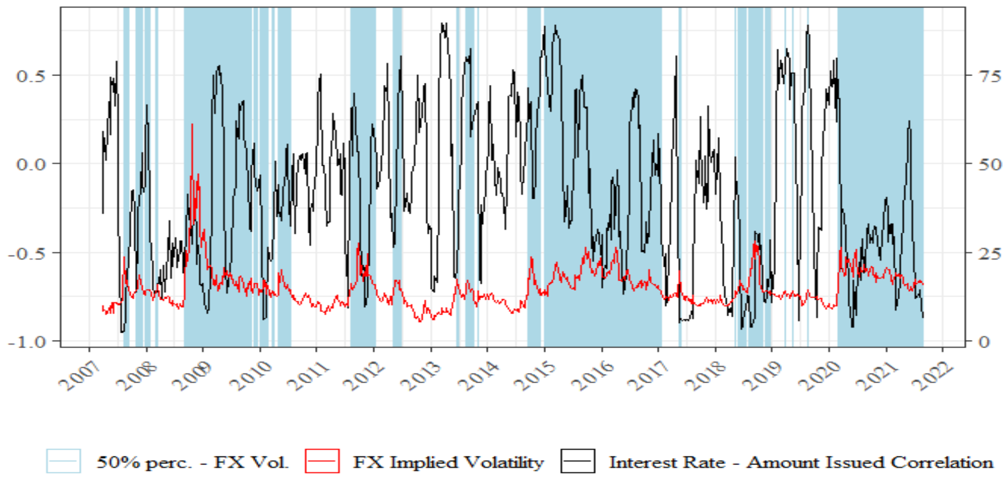

Figure A.8: FX Volatility and 12-week rolling window Interest Rate - Amount Issued Correlation: 50th percentile

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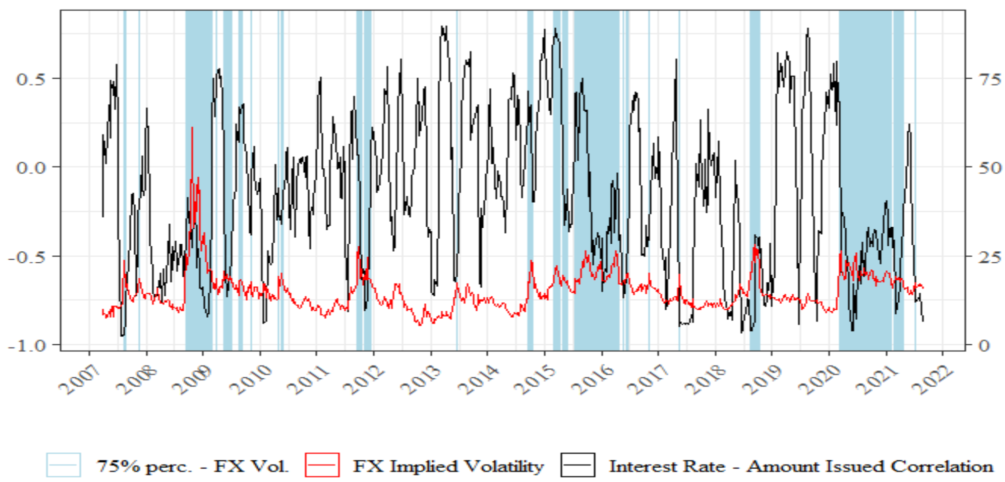

Figure A.9: FX Volatility and 12-week rolling window Interest Rate - Amount Issued Correlation: 75th percentile