Pontifícia Universidade Católica
do Rio de Janeiro

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The Impact of Monetary Policy on Asset Prices: A High-Frequency Approach for Brazil

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 Gomes Pinto Garcia
Co-advisor: Prof. Carlos Viana de Carvalho

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Abstract

Thomás, Gleizer Feibert; Gomes Pinto Garcia, Márcio (Advisor); Viana de Carvalho, Carlos (Co-Advisor). **The Impact of Monetary Policy on Asset Prices: A High-Frequency Approach for Brazil**. Rio de Janeiro, 2022. 93p. Dissertação de Mestrado – Departamento de Economia, Pontifícia Universidade Católica do Rio de Janeiro.

In this paper we study the impact of monetary surprises on a class of asset prices in the Brazilian financial market. Due to institutional factors that prevent identification of this impact through the association between the monetary surprise and asset price movements in short windows around monetary policy announcements, we use an event study framework at daily frequency, controlling for both domestic and foreign factors that may affect the asset prices under analysis. We find that a surprise monetary tightening has a strong negative impact on stock market returns, and its effect on the yield curve is positive and hump-shaped, reaching a maximum on the 6 months yield. Unlike most of the previous literature focused on Brazil, we find that the Brazilian *Real* appreciates in response to this monetary tightening, which is consistent with the reactions found for currencies of developed economies. Moreover, while we obtain a regime in which the exchange rate is irresponsive to the monetary surprise, the evidence supporting a fiscal cause behind this regime is not strong.

Keywords

Asset Prices; Monetary Shock; Natural Language Processing; Sovereign Risk; Event Study.

Resumo

Thomás, Gleizer Feibert; Gomes Pinto Garcia, Márcio; Viana de Carvalho, Carlos. **O Impacto da Política Monetária sobre Preços de Ativo: Uma Abordagem de Alta Frequência Aplicada ao Brasil**. Rio de Janeiro, 2022. 93p. Dissertação de Mestrado – Departamento de Economia, Pontifícia Universidade Católica do Rio de Janeiro.

Neste artigo estudamos o impacto de surpresas monetárias sobre um conjunto de preços de ativo no mercado financeiro Brasileiro. Devido a fatores institucionais que impedem a identificação deste impacto através de associações entre o choque monetário e variações de preços de ativos em pequenos intervalos ao redor de anúncios de política monetária, utilizamos uma abordagem de estudo de eventos em frequência diária, controlando por fatores domésticos e externos que afetam os preços de ativos relevantes. Os resultados indicam que a surpresa monetária contracionista possui um impacto negativo significativo sobre retornos da bolsa de valores, e o impacto sobre a curva de juros é positivo, atingindo um máximo ao vértice de 6 meses. Diferente de grande parte da literatura focada ao Brasil, os resultados apontam a uma apreciação do Real em reação a esta surpresa monetária contracionista, o que é consistente com reações de moedas de países desenvolvidos a surpresas monetárias. Por mais que obtenhamos um regime no qual a taxa de câmbio não reage significativamente à surpresa monetária, não há forte evidência de que a causa por trás deste regime é de natureza fiscal.

Palavras-chave

Preços de Ativos; Choque Monetário; Processamento de Linguagem Natural; Risco Soberano; Estudo de Eventos.

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List of Abreviations

ARDL – Autoregressive-Distributed Lag

BRL – Brazilian Real

CDS – Collateral Default Swap

COPOM – Comitê de Política Monetária

COVID – Coronavirus Disease of 2019

DI – Depósito Interbancário

ECB – European Central Bank

FED – Federal Reserve

FFR – Federal Funds Rate

FOMC – Federal Open Market Committee

GDP – Gross Domestic Product

IBOVESPA – Índice Bovespa

IGP-M – Índice Geral de Preços do Mercado

IPCA – Índice Nacional de Preços ao Consumidor Amplo

LDA – Latent Dirichlet Allocation

NLP – Natural Language Processing

PCA – Principal Component Analysis

SELIC – Sistema Especial de Liquidação e de Custódia

SVAR – Structural Vector Autoregression

UIP – Uncovered Interest Parity

US – United States

USD – United States Dollar

VAR – Vector Autoregression

VIX – Chicago Board Options Exchange Volatility Index

1
Introduction

As the modernization of monetary policy frameworks expanded across emerging market economies, effects of monetary policy surprises on the exchange rate observed a surge in interest by the literature. As put by Zettelmeyer (2000), three motives drive this literature: (I) The evaluation of economic models of exchange rate dynamics; (II) The understanding of monetary policy effects, as the exchange rate response can be considered an important component of monetary policy transmission and help discriminate between different business cycle models; (III) The role of monetary policy in stabilizing exchange rates during and in the aftermath of currency crises.

Other asset prices, such as the term structure of the interest rates and stock market returns, have also had their responses to monetary surprises analysed, using different empirical methods, the most common being SVARs and high-frequency event study regressions.

In this paper, we propose a unified event study approach to study reactions of these three asset prices in the Brazilian economy to monetary policy surprises. Institutional factors, namely the fact that the monetary policy target announcement occurs after trading hours and the non-convertibility of the Brazilian *Real*, prevent us from identifying these effects simply by extracting comovements between the shock measure and assets responses in sufficiently small windows around the announcements, as is standard in the literature looking at FED and ECB policy announcements. We thus resort to daily asset prices changes in a regression based event study, to which we add controls with the objective of capturing domestic and foreign factors affecting asset prices within daily windows used. One paper recently questioning the exogeneity of conventional monetary surprise measures (especially for estimating the macroeconomic effects of monetary policy shocks) is Bauer and Swanson (2022), based on the correlation between these measures and macroeconomic and financial data publicly available before the announcement, which also motivates adding controls to the event study.

One of these controls consists of a binary variable indicating dates associated with fiscal and political turmoil, using a novel approach based on an application of natural language processing (NLP) techniques on news articles. These factors have been associated with significant reactions of asset prices in Brazil, although no empirical work systematically studied these effects. In order to do so, we explore information flows in newspaper articles reflecting this turmoil. We find that the exchange rate depreciates, the slope of the term structure increases and the stock market index decreases on dates associated with fiscal and political turmoil.

Our main event study specification yields a statistically significant appreciation of the Brazilian *Real* in response to the contractionary monetary surprise. As will be discussed in more detail in the literature review, most articles studying such responses in the Brazilian market have found a depreciation or a lack of response of the exchange rate. These results have been found for other developing or small open economies as well.

For the term structure of interest rates we obtain positive and statistically significant reactions of each maturity to the monetary tightening, with reactions increasing up to maturities of six months, and declining monotonically for longer maturities.

The stock market response to the monetary tightening is negative and statistically significant, consistent with the prediction of a broad range of models in which a positive monetary surprise leads to a fall in the present value of future dividends, both due to an increase in the discount rate and a fall in expected dividends due to a worse economic outlook.

Our contribution is threefold: First, a parsimonious and intuitive empirical model is designed to assess monetary policy effects on asset prices when short windows around announcements are not possible to deliver identification; Second, this is, to our knowledge, the first paper to analyse reactions to monetary policy of multiple asset prices in the Brazilian market; Third, we propose a novel method, based on natural language processing tools and a large database composed of nearly 20 years of news articles from a major domestic outlet, to construct a variable describing dates associated with political and fiscal turmoil, both of which have received increased attention in recent years and are often linked to large market volatility and a reduced efficiency of monetary policy in its effect on the exchange rate.

2
Background on Recent Fiscal and Political Turmoil in Brazil

An extreme case to exemplify what we refer to as fiscal or political turmoil is the famous *Joesley day*, on may 17, 2017. On that day, Joesley Batista, controller of the multinational company JBS who was being accused of money laundering and corruption, had an audio secretly recorded by him handled to the attorney general‘s office as part of a plea bargain. The audio contained evidence of then president Michel Temer giving what is widely interpreted as a recommendation for a bribe to be paid to the previous leader of the house of representatives who was in jail for alleged corruption. The fall in the stock market on the following day was sufficiently large so as to trigger a circuit breaker, temporarily halting market transactions for the first time since the 2008 financial crisis. The Brazilian *Real* also faced significant depreciation and an increase in the term structure‘s slope followed.

On the fiscal side, a recent and relevant event was the announcement on February 28, 2020, by president Bolsonaro, accompanied by the economics minister and other members of the government leadership, of a fiscal stimulus program, *Renda-Cidadã*, which would replace the social program *Bolsa-Família*, consisting of income transfers to families satisfying certain criteria, the main one being earnings below a certain amount. Initial sources of financing for the program were claimed to be resources originally allocated to the payment of court-ordered bills by the State and to basic education services. This event marked the beginning of more frequent discussions on the government‘s plan to postpone payments of court-ordered bills which had been previously approved. Around a year later a law change passed, authorizing the government to pay such bills through a series of installments, which led market participants and other organizations to accuse the government of fiscal indiscipline and defaulting implicitly on part of its debt obligations. These events were partially anticipated by markets during the initial announcement on February 28 of the previous year, with a strong depreciation of the exchange rate, stock market index and a steepening of the term structure.

The fact that some of these events may occur on the trading day following the monetary policy announcement is a possible cause for concern, some of them having been informally recognized by market participants as hampering the effects of monetary policy announcements, or offsetting them. One such example occurred on June 18, 2020, when Fabricio Queiroz, who had been advisor to president Bolsonaro‘s son (by then a senator) and is considered to be part of the president‘s inner circle, was arrested for taking part in a corruption scandal under investigation that supposedly had as one of its leaders Bolsonaro‘s son. Moreover, before his arrest he was spending time in the house of the Bolsonaro family lawyer, which added to the controversy. Major news outlets, such as *Estadão* and *Folha de São Paulo*, had articles that day attributing an exchange rate depreciation to both the cut in the monetary policy target (albeit it was expected by market participants according to the *Focus* survey data report) and Queiroz‘s arrest (Bolzani, 2020). Increases in longer maturities of the term structure of interest rates despite the monetary target cut were attributed to political turmoil. On that same day, the minister of education, also considered a devout follower of Bolsonaro, was fired after accumulated controversy during his mandate, being assigned immediately afterwards by the government as executive director in the World Bank representing Brazil and other countries. This event added to the perception of political turmoil occurring on that day.

To systematically study the effect of such political and fiscal turmoil dates on the asset prices under consideration, we apply natural language processing techniques which will be reviewed in the following sections.

One exercise that has some resemblance to ours, but with the goal of selecting relevant dates associated with fiscal policy announcements and studying puzzles related to dynamic responses of real variables to fiscal shocks, is that of Ramey (2011), in which the author selected, through a narrative effort, dates associated with important geopolitical events that led to unanticipated announcements of military spending increase in the US. These dates contain relevant information flows to agents, due to fiscal policy signals that, by affecting the present value of net government expenditure, generate a wealth effect to which an optimal reaction occurs, as predicted by a wide range of models. As this reaction precedes the effective increase in spending or change in taxes (which are used to compute regular fiscal policy shocks used by econometricians), empirical exercises such as SVARs span an information set not aligned with that of agents in the economy being modelled, leading to the recovery of wrong structural fiscal shocks and thus puzzling responses of real variables to these recovered shocks, as formalized in Leeper et al. (2013). Ramey (2011) shows that, while the dates selected by her do not represent fiscal foresight in its entirety, the inclusion of dummies for such dates in recursively identified VARs are enough to generate reactions of real variables to fiscal news as predicted by the Neoclassical model, which were not commonly found in this empirical literature. Given our interest in financial market response and the higher frequency of our data, more important than dates associated with unanticipated fiscal policy changes announcements is the selection of dates in which events perceived as characterising political and fiscal volatility occur, regardless of the magnitudes of the underlying expenditure and tax changes associated with fiscal news, as in some cases these might not materialize at all.

3
Review of the Literature

This paper relates to two strands of the literature. The first consists of articles estimating asset prices responses to monetary surprises through event studies, which we review to present an understanding of the techniques we build upon. Particular attention is given to conflicting results between emerging market and developed economies when it comes to the reaction of the exchange rate, and possible causes found in the literature, specially sovereign risk, are discussed. The second strand is the rapidly expanding literature within macroeconomics using natural language processing tools, and we concentrate on previous research on monetary policy and point to more extensive reviews.

Cook and Hahn (1989) and Roley and Sellon (1995) are early papers studying responses of short and long term interest rates to monetary policy. Both use regression based event studies, finding little or no impact of monetary policy on interest rates, with the latter pointing to loose associations between bond yields and the policy rate. These papers, however, do not distinguish between anticipated and unanticipated components of the monetary policy decision, leading to the proposal, in Kuttner (2001), of using Fed Funds futures prices as a "natural, market-based proxy" for those expectations, as changes of these prices could recover the surprise target rate change. Such surprise measure is shown to have a positive and statistically significant impact on interest rates of different maturities, which decreases monotonically with maturities.

Gürkaynak et al. (2005) assess whether a single factor, the surprise component of the change in the federal funds rate target, adequately captures effects of U.S. monetary policy on asset prices, finding that a second factor, interpreted as future path of policy, is relevant. The authors use standard principal component analysis accompanied by factor rotations to deliver a structural interpretation to factors. This paper is a precursor to a large and developing literature on the informational effects of monetary policy, including Swanson (2017), which formally associates the second factor to forward guidance and a third factor to large-scale asset purchases in the 2009-2015 zero lower bound period in the US economy.

More recently, Bu et al. (2021) return to an analysis of the interest rate curve response to monetary shocks measured by a single factor, constructed using a partial least squares procedure and the full maturity spectrum of interest rates. Their main innovation is bridging periods of conventional and unconventional policymaking without the need to resort to other factors of monetary policy.

The first paper studying reactions for the Brazilian interest rate curve was Tabak (2004), which analysed maturities up to 12 months and used the methodology in Cook and Hahn (1989) for the period of 1996-2001, finding significant responses of each maturity to the target change, with responses falling with maturities.

Using the methodology proposed by Kuttner (2001), de Oliveira and Ramos (2011) find significant and positive responses of the interest rate curve to positive monetary surprises in the period of 2002-2009, which decline with maturity.

Wu (2012) assesses the impact of the monetary surprise on the interest rate curve for the period of 2004 to 2008 using a VAR containing macroeconomic surprises as well as asset prices, namely the exchange rate and the CDS changes, finding a positive reaction of yields of maturities up to 12 months, which declines for the 24 month maturity.

Carvalho et al. (2013) use a similar approach to that in Kuttner (2001) for the period of 2007-2013, however they also quantify informational effects of monetary policy using sentiment analysis applied to statements released by the central bank, and check for non-linearities in the responses. While prior to January 2011 (when Alexandre Tombini became governor of the central bank), effects decreased with maturities, with long rates pricing in a reversal of interest rate surprises, after this period, reactions increased for yields of up to 12 months, and declined for longer rates, which still responded close to one-to-one to interest rate surprises. A closely related paper, Machado (2014), extends Carvalho et al. (2013), including intraday responses on the trading day following the target announcement.

Amarante (2015) combines a recursively identified VAR with factors extracted using PCA to study if the interest rate curve response to the monetary surprise changed in the period of 2011-2015 with respect to 2000-2010. For the first period, an upwards shift occurs in the curve as a response to a positive monetary surprise, but the curve also becomes flatter, this effect persisting for more than a year. In the second period, an initial positive impact on the slope is obtained, which dissipates after 6 months.

Regarding the stock market, Thorbecke (1997) employs several approaches, including VAR analysis, to obtain that monthly stock returns respond positively and significantly to expansionary monetary policy in the US economy, with impacts greater for smaller capitalization stocks. Chen (2007) investigates whether monetary policy has asymmetric effects on stock returns using Markov-switching models, finding that monetary policy has larger effects on stock returns in bear markets.

Jardet and Monks (2014) used the method proposed by Gürkaynak et al. (2005) to look at effects of the two dimensions of monetary shocks on a wide range of asset prices. They find that none of the shock factors have a significant relationship with the percentage change of the Eurostoxx 50 index.

A recent literature has explored reactions of stock returns to the monetary policy shock with the aim of, by interacting such reactions with those of the interest rate curve in short windows around announcements, classify monetary surprises according to possible informational effects. Jarocinski and

Karadi (2020) identify a "pure" monetary policy shock by selecting those associated with negative comovements between stock returns and the monetary surprise measure. If, instead, interest rates and stock prices co-move positively, this is read as a reflection of an accompanying information shock. Cieslak and Schrimpf (2019) extend this analysis by drawing on the joint dynamics of government bond yields with equity returns around central bank releases. By exploring the entire maturity dimension of the yield curve, this allows for an analysis on the role of risk premium shocks induced by policy communication, apart from growth and pure monetary shocks. Altavilla et al. (2019) justify instances of lack of significance in the response of stock returns to factors governing monetary policy in light of this recent literature, arguing that any monetary policy decision may not be interpreted "in a textbook manner" by markets, but as a perceived revelation of information about the state of the economy.

For Brazil, Junior and Junior (2011) obtain significant and negative responses of stock market returns to surprise positive changes in the monetary policy target in the period of 1996-2006 using an event study regression with a shock measured as in Kuttner (2001). Soares et al. (2021) obtain, for the period of 2003-2018, similar results, using a Taylor-rule based monetary surprise measure in an ARDL setting.

Our results differ mostly to the previous literature when it comes to exchange rate responses. A large body of research in the 1990s was dedicated to studying connections between monetary policy and the exchange rate, mostly through VAR analysis, such as Eichenbaum and Evans (1995), or estimated structural models, as Cushman and Zha (1997).[1] A high frequency event study approach was first used in the application by Zettelmeyer (2000) to New Zealand, Canada and Australia, allowing for a relaxation of the assumptions necessary to identify the monetary shock and minimize risk of reverse causality, with respect to VAR based exercises. His main result is an appreciation of each

[1] See Zettelmeyer (2000) for a complete list of papers.

currency in response to contractionary monetary shocks.

The high frequency event study surprises are innovations in market participants' information sets, whereas lower frequency VAR shocks are innovations conditional on the actual state of the economy. The former surprise measure is often used as an instrument useful for VAR identification, and Gürkaynak and Wright (2013) point to an overlapping of these two measures under full information. This issue and our interest in the immediate response of the exchange rate to the surprise measure motivates the choice of the high frequency event study for all asset prices.

The first paper analysing responses of the Brazilian exchange rate to the monetary surprise was Guimarães and Gonçalves (2011), using the heteroscedasticity based identification scheme proposed by Rigobon (2003) for the period of 2000-2006. They find unexpected increases in interest rates tend to lead the Brazilian currency to depreciate, opposite to the reaction delivered by the UIP (uncovered interest parity). They rationalize this result through a fiscal sustainability argument, its intuition being that monetary contractions in economies with large debt burdens, by increasing the cost of debt, increase default probabilities, which further raises the cost of debt, possibly leading to loss of value of the domestic currency. Such theme was also studied by Blanchard (2004), and relates to the framework laid out in Sargent and Wallace (1981).

Kohlscheen (2014) runs event study regressions for Brazil, Mexico and Chile between 2003 and 2011, failing, for these three countries, to find an appreciation of their currencies in response to positive monetary surprises. He argues that it is difficult to attribute this exchange rate puzzle to fiscal dominance, as unexpected rate increases are not associated with increases in risk premia measured by the CDS.

Hnatkovska et al. (2016) examine cross-country data on 72 countries to find that exchange rates in developed countries tend to appreciate in response to a monetary tightening while those in developing economies depreciate. These results are shown through simple correlations for each country between both variables, as well as from individual country VARs and different panel VARs for industrial and developing economies. This divergence is explained in a model exploring monetary transmission channels in small open economies incorporating liquidity, output and fiscal channels. When applying their individual country VARs to the countries and time horizon explored by Kohlscheen (2014), results are shown to be robust.

Vicente et al. (2021) also run an event study for the Brazilian exchange rate, looking at the period between 2006 and 2020, being the first to find an appreciation (significant at a 10% level) in response to a monetary tightening.

Alberola et al. (2021) find in an event study that, for the period between 2003 and 2017, the exchange rate in Brazil depreciates in response to contractionary monetary surprises, although effects are not statistically significant. However, when allowing the monetary shock to impact the exchange rate differently between two regimes (chosen in a narrative fashion or through a Markov-switching model), they find that one regime, interpreted as Ricardian, delivers a significant appreciation, while the other delivers a depreciation, being interpreted as non-Ricardian. Arguments are made to back the fiscal interpretation to these regimes and a non-strategic sovereign default model delivering these predictions is built.

While the papers analysing developing economies tend to concentrate on a fiscal cause behind the depreciation of the exchange rate in response to monetary contractions, Gürkaynak et al. (2021) document that these reactions also exist to ECB policy announcements, and they suggest informational asymmetries between the central bank and market participants may deliver them. It is noteworthy that in the 30 minute window used in the paper around the ECB policy announcement, there is both a press release by the ECB and a press conference by its president, these serving as possible channels through which information originally private to the ECB can be made public. Such possible asymmetries are captured by exploring target surprise and path components in the event study used, and the authors build different versions of a two-country New Keynesian model based on several possible informational assumptions. Even after conditioning on information effects, there appear to be other drivers of exchange rates.

The authors mention other possible explanations given by the literature for the depreciation of currencies in response to positive monetary surprises that goes contrary to the UIP, such as policy reversals in Engel and Frankel (1984), inflation surprises in Clarida and Waldman and Clarida (2009), and a combination of information and exorbitant duty a la Gourinchas et al. (2018) in Stavrakeva and Tang (2018).

To study the effects of fiscal and political turmoil discussed above, we apply a generative statistical model based on natural language processing, Latent Dirichlet Allocation (Henceforth LDA), which has been increasingly used in the economics literature as a competitive dimensionality reduction machine learning model.[2]

While our identification of the monetary policy shock follows common asset price and survey based approaches, the use of NLP (in particular, sentiment analysis) is currently being explored by the literature in the identification of the monetary shock itself in Aruoba and Drechsel (2022), who use NLP to summarise verbal information in the documents that Federal Reserve Board economists prepare for the FOMC. Such summary is then used as a predictor, alongside numerical forecasts in these documents, macroeconomic indicators and non-linearities of these variables, in regression of changes in the FFR. The monetary shock is measured as the residual of this regression. Ochs (2021) proposes text-based variables that contain the informational content

[2] For recent surveys on the application of LDA and other other natural language processing methods, see Gentzkow et al. (2019), Bybee et al. (2020) and Martins (2022), this last also exploring Brazilian news articles, but in a context of predictive models of macroeconomic variables.

from changes in the policy rate. He quantifies information within monetary policy decision minutes that explain these decisions, providing a proxy for the signal extraction problem facing private agents, who have to decide whether a surprise move in the policy rate is due to superior central bank information or genuinely exogenous. Dictionary methods and sentiment analysis are used to extract relevant the information.

The LDA algorithm was proposed by Blei et al. (2003) and is used in several areas of economic research, including monetary policy. Hansen et al. (2017) assess the effects of transparency on monetary policy makers' deliberations by extracting topics from FOMC transcripts and analysing them in the lens of a natural experiment in the Federal Open Market Committee. Zaniboni (2019) uses LDA in his analysis of forward guidance by the Federal Reserve. Hansen et al. (2019) apply the method on the publication of the Bank of England's Inflation Report to extract narrative signals and investigate increasingly large effects of economic uncertainty along the yield curve. In a broader analysis of uncertainty as a source of economic fluctuations, Larsen (2021) uses LDA applied on news articles to disentangle different types of uncertainty to find they have different effects on macroeconomic variables.

We apply several standard preprocessing steps to the text content present in the news articles corpus in order to reduce its complexity. This is necessary for algorithms to run within normal processing power and memory capacities and improve the quality of the topic discovery task, as the text is reduced to contain more meaningful content. These steps are discussed in the appendix.

Although refinements of the LDA model are currently being developed and adopted by the literature, the original model allows for a tractable and intuitive approach to classify a very large text database. By generating, through this data-driven approach, textual measures out of the news corpus to capture dates associated with political and fiscal turmoil, we reduce limitations, such as the subjectivity associated with count methods in which specific words are selected to have their frequencies obtained and mapped into indexes representing latent variables, a famous example being uncertainty, as in Baker et al. (2016). The relative complexity of the Portuguese language, which makes the task of preprocessing text data and producing dictionaries mapping words into sentiments harder, as well as the reduced structural coherence between news articles over our large corpus (which is usually not the case when it comes to monetary policy statements or minutes, for example) make us opt for the construction of a qualitative (binary) variable using the LDA method, while some other papers favour the construction of quantitative variables through count and sentiment analysis methods.

4
Event Study Database

Our database spans the period from April 1, 2003 to March 31, 2022. While important structural changes occurred in the macroeconomic policy framework in 1999, namely the adoption of an inflation target regime and of a floating exchange rate which remain to this day, one variable that may be relevant to explain exchange rate dynamics, the fiscal shock (associated with the primary budget net results), can only be computed as of April 2003 due to the availability of data for market expectations. Not only have there been cases where this indicator was released on the trading day following the monetary policy announcement, controlling for it could be particularly relevant given the discussion between sovereign risk and the exchange rate that is common in the literature exploring Brazil.

4.0.1
Monetary Framework and Surprise Measure

The monetary policy committee (henceforth COPOM) conducts regular meetings to vote on the interest rate target (the acronym for this interest rate in Portuguese is SELIC). Up to 2006, these meetings happened monthly, while since then they occur eight times a year, around every 45 days. Meetings last for 2 days (usually on Tuesday and Wednesday), with most announcements happening after trading hours, except for April to August 2003 in our sample. The target is announced in a brief statement right after the end of the meeting, with more detailed minutes released on the following week (which, in principle, would allow for researches to disentangle some informational effects). While there have been extraordinary COPOM meetings, none occurred in our sample, which contains 162 announcements.

Our main monetary surprise measure is that based on Kuttner (2001). Following Carvalho et al. (2013), the surprise is the difference between the

30-day Swap DI × Pré on the first trading day after the COPOM decision and the 30-day rate on the decision day. Because COPOM meetings occur at least 30 days apart, and assuming negligible risk premia for short-term contracts, 30-day contracts on the day of the announcement essentially reflect market expectations of the upcoming interest-rate decision, such that by analysing their change after the announcement, we extract the desired shock.

An alternative measure we use is identified from survey data available in the central bank‘s Market Expectation System, which consolidates daily surveys made by the central bank with professional forecasters for several macroeconomic indicators. The surprise measure is constructed by taking the difference between the target rate decided by the COPOM and the last available market expectation on that target (we use the median of all forecasters expectations given on the day before the announcement).

In the following plot we see series for both surprise measures. As the target change is null or a multiple of 25 b.p., often the surprise obtained from survey data equaled zero, which leads to a smoother series for the Kuttner surprise which could also reflect information provided by the statement, although maturities equal or shorter than 30 days should reduce these effects and deliver a similar value to the target surprise.

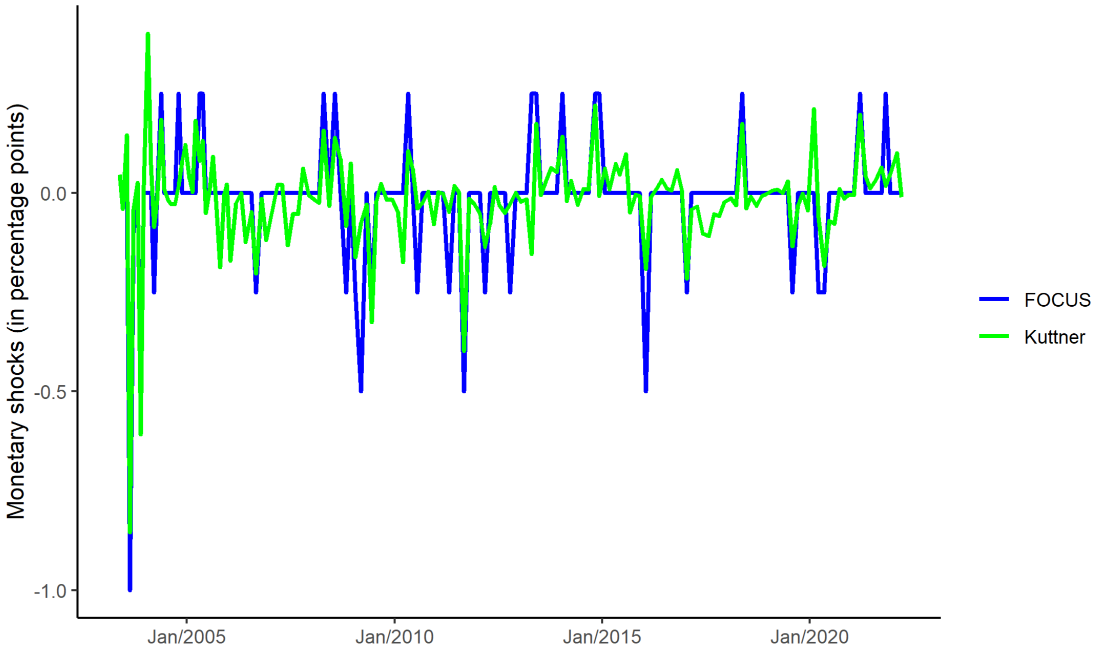

Figure 4.1: Series for both measures of monetary shocks, for the 162 announcements from April 2003 to March 2022.

Considering the monetary shock as measured in Kuttner (2001), 72 were positive and 90 were negative over our sample. When measuring the shock using survey data, 15 were positive, 19 were negative and the rest was zero. Out of the 162 announcements, 110 were followed by the release of macroeconomic indicators or exchange rate interventions conducted by the central bank.

While results are similar for both measures, or main specification uses the first one. Survey data is provided by professional forecasters, and in most cases they are not the ones directly engaged in operations that shape the yield curve, such that by identifying the monetary shock directly from the yield curve, we hope to more adequately capture innovations to the information set of those directly involved with trading.

4.0.2
Domestic Macroeconomic Surprises

As a few widely monitored macroeconomic indicators have had releases following COPOM announcements, we construct surprise measures for them to be used in our baseline model for each asset price. They consist of the public primary budget result (with an increase interpreted as a larger deficit), the YoY GDP growth rate, YoY industrial production growth rate, and two MoM consumer price indexes: IPCA and IGP-M. The first is the official consumer price index, measuring change in prices in final goods and services on a representative basket, while the second does not restrict itself to goods and services at the end of the supply chain, being a broader price index.

The GDP growth rate is available at a quarterly frequency, while the others are monthly. For all indicators except the IGP-M, the shock of which we measure using forecasts in the *Focus* report, expectations were available in Bloomberg. Bloomberg‘s ECOC function provides the time of release of each indicator, which we use to adjust the date associated with each release one day forward in case it occurred after trading hours. If for a certain date an indicator had no announcement, its surprise is reported as zero. On dates of releases, surprises are measured by the difference between the realized value and median market expectation of the release, scaled by the standard deviation of its series.

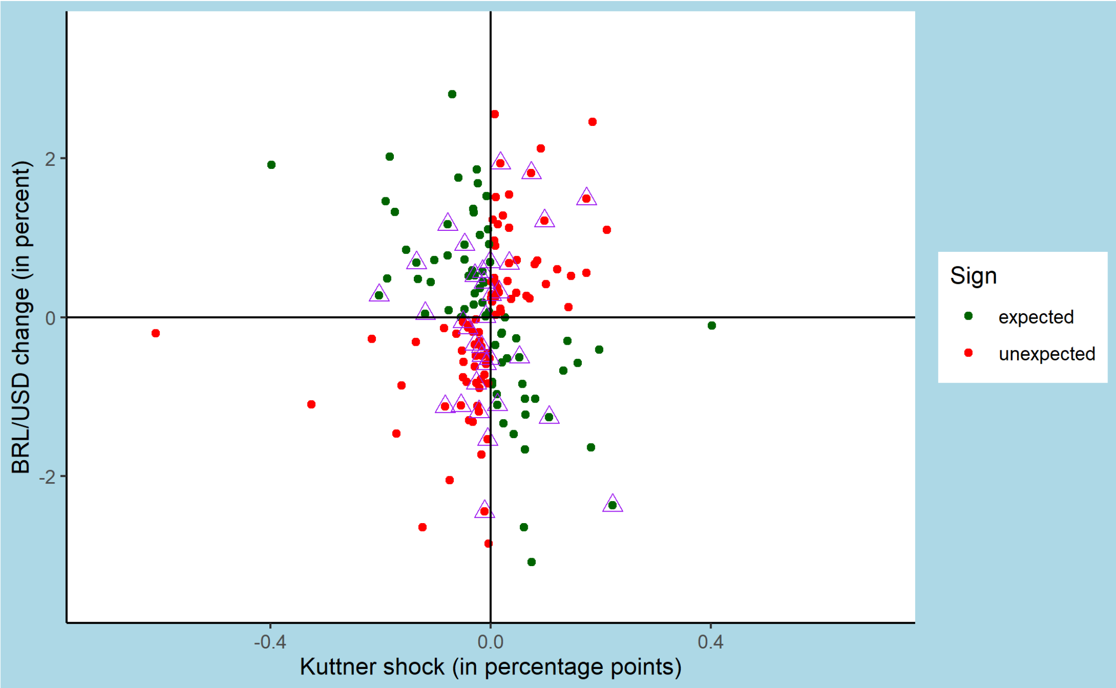

Figure 4.2: Kuttner shocks and corresponding changes in the exchange rate, for the 162 announcements from April 2003 to March 2022. Data points are inside purple triangles if they happened on days when at least one Brazilian macroeconomic indicator was released. Negative associations between the monetary shock and the exchange rate (measured in terms of units of the Brazilian currency per US dollar) return would be expected following the uncovered interest rate parity.

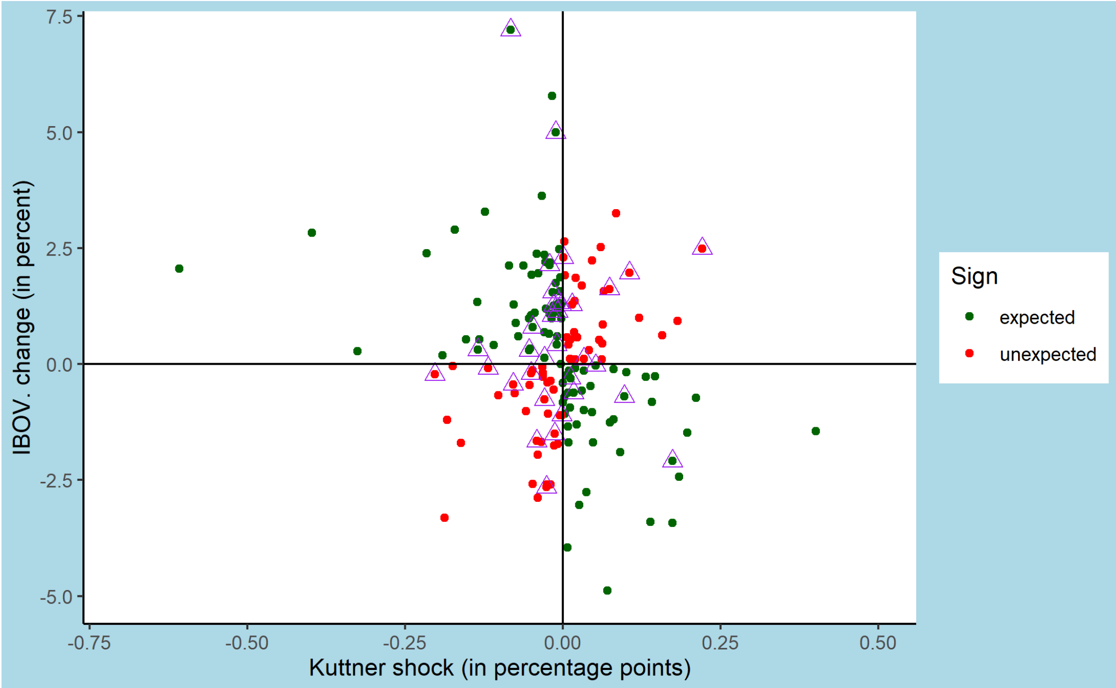

Figure 4.3: Kuttner shocks and corresponding changes in the stock market index, for the 162 announcements from April 2003 to March 2022. Data points are inside purple triangles if they happened on days when at least one Brazilian macroeconomic indicator was released. Negative associations between the monetary shock and the stock return would be expected following the predictions of a wide range of models.

4.0.3 Exchange Rate Interventions

Although Brazil adopted a floating exchange rate regime in 1999, several instruments have since been used to intervene in the exchange rate, both in the spot market as well as in the futures market, in order to reduce its volatility, preventing excessive depreciation or appreciation.

In the appendix we detail how series for each spot and swap instruments used in the model for the exchange rate were constructed. One issue is that, as our analysis is carried out at a daily frequency, simply including a control for each intervention instrument used by the central bank likely yields inconsistent estimates due to the simultaneity problem. A common solution found in the literature to consistently estimate these effects is using event studies based on short term windows around the interventions or around the announcements by the central bank that they will occur (with a time interval in between that can last from a few minutes to a few days), as announcements on their own lead to changes in exchange rate expectations through a signalling channel.

In our case, one possibility is to use an instrumental variable, such as the realized volatility of the exchange rate proposed by Barroso (2014). Due to limitations on the data availability of tick-by-tick exchange rates since 2003, we do not use this approach here, so estimates for exchange rate intervention effects are to be interpreted cautiously. In particular, the "leaning against the wind" behaviour by the central bank, in which interventions respond to exchange rate pressures and which likely is a feature of the data at a daily frequency, may contribute to quantitatively irrelevant estimates, if not inverted, whereby a sale of USD would seem to cause a depreciation of the Brazilian currency, instead of the opposite effect.

4.0.4 Foreign Factors

We condition the asset prices responses on factors capturing foreign conditions that, for the exchange rate in particular, are widely considered in the literature of its determinants. Returns in commodity prices are measured using the Bloomberg Commodity Index and, as a measure of change in global sentiment we consider the returns of the VIX, both available in Thompson Reuters database. One caveat is that commodity price changes could eventually reflect other factors, including monetary policy of relevant exporting economies such as Brazil, such that these changes may not be interpreted as shocks. One way to circumvent this potential issue is by considering the synthetic currency and stock changes described below.

In order to capture other foreign conditions, such as policy announcements that spill over into Brazil's domestic market or even more general events that affect responses on a range of economies, we build an index based on a basket of foreign currencies and stock market changes of countries often viewed as being peers to Brazil, due to similar interest rate differentials, balance of risks and/or reliance on commodity exports.

We build synthetic changes of the *Real* and *Ibovespa* using a data-driven approach to select the weights assigned to each peer country's exchange rate and stock market change, based on a rolling window estimation using non-negative least squares.[1] We regress the returns of the Brazilian currency (or stock market index) against those of currencies (or stock market indexes) of the peer countries. We eliminate from the sample all dates with domestic macroeconomic indicator releases and exchange rate interventions. The algorithm estimates these synthetic stock market and exchange rate changes which we use to proxy for foreign factors affecting domestic prices.[2][3] It is noteworthy that the impact of global sentiment and changes in global commodity prices on the Brazilian currency also occur through the use of the synthetic *Real* that reflects these changes. One advantage, however, is that we eliminate from the sample dates associated with domestic monetary announcements, reducing the risk of contamination that commodity price indexes may face. In fact, as discussed in the results section, conditional on the synthetic, the omission of the VIX and commodity prices generates insignificant changes in the responses of the exchange rate to the other variables.

This approach has three advantages. First, it allows us to document the evolution of the importance of each peer country, based on their weights series, shown in the graph below for the exchange rate. Second, by eliminating dates associated with possibly relevant domestic shocks, we mitigate the possibility of reverse causality in which asset prices of peer countries could respond to Brazilian news and policies. We want the synthetic changes to capture effects

[1] The algorithm proposed by Lawson and Hanson (1974) is employed. Coefficients are restricted to be non-negative and their sum to equal unity, conveniently being interpreted as weights.

[2] For any date in which macroeconomic indicators discussed previously were released or the central bank intervened in the exchange rate market, synthetic changes are generated by taking the inner product between the vector of weights of the most recent "uncontaminated" date with the vector of asset price changes in peer countries on the "contaminated" date.

[3] In the appendix we detail which variables were used for stock market changes, while for the exchange rate we used the spot for each country.

of global events on the Brazilian asset prices through the impact that peer asset prices, by also responding to such events, have on Brazilian assets. Third, an intuition arises for the specifications used in which asset prices changes are driven by reactions to domestic shocks and by the counterfactual reaction in the absence of such domestic shocks.[4] Figures 4.4 and 4.5 describe the exchange rate synthetic.

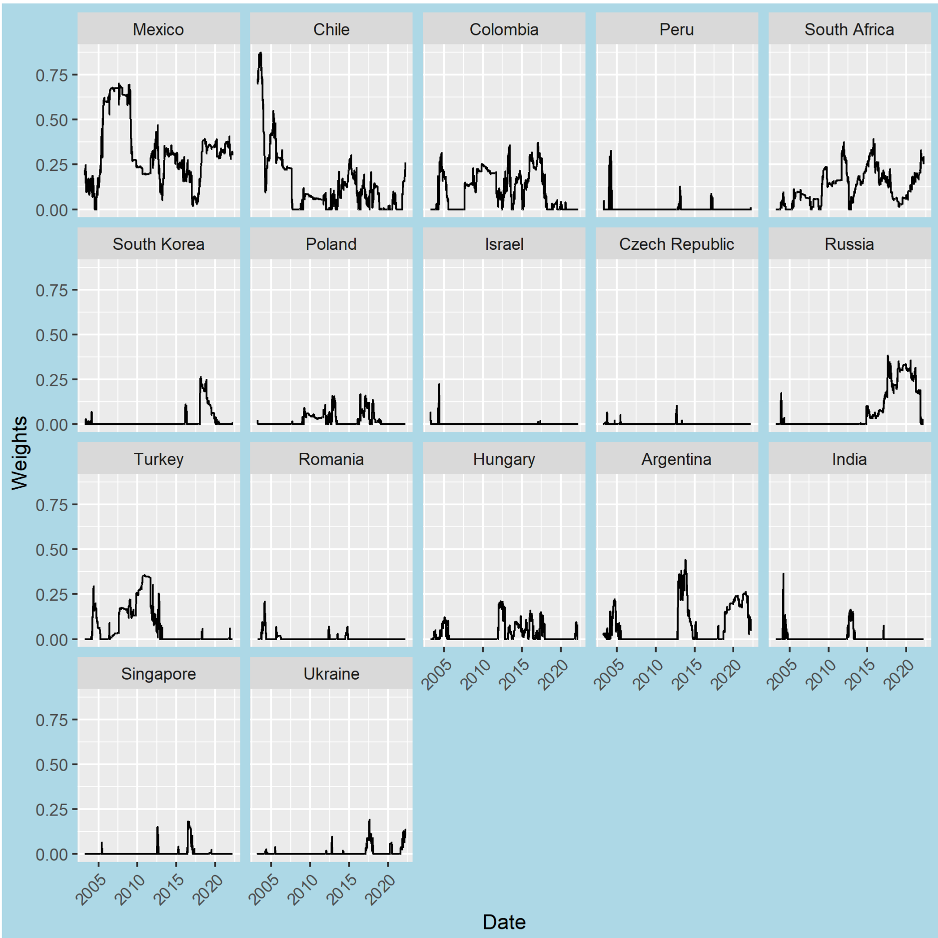

Figure 4.4: Evolution of weights of countries composing the exchange rate synthetic.

[4]Counterfactuals for the Brazilian currency have recently been explored in the empirical literature by Chamon et al. (2017) and Doine (2020) in the context of exchange rate interventions and foreign reserve management, with different methodologies to the one we use.

Year	First	Second	Third	Fourth	Fifth
2003	Chile	Mexico	Argentina	Russia	Romania
2004	Chile	Colombia	Turkey	Argentina	Mexico
2005	Mexico	Chile	Colombia	South Africa	Hungary
2006	Mexico	Chile	South Africa	Turkey	Romania
2007	Mexico	Chile	Turkey	Colombia	South Africa
2008	Mexico	Turkey	Colombia	South Africa	Chile
2009	Mexico	Colombia	South Africa	Turkey	Chile
2010	Turkey	Colombia	Mexico	South Africa	Chile
2011	Turkey	Mexico	South Africa	Colombia	Chile
2012	Mexico	South Africa	Hungary	Turkey	Colombia
2013	Argentina	Mexico	Colombia	South Africa	Chile
2014	Mexico	South Africa	Colombia	Chile	Argentina
2015	South Africa	Mexico	Chile	Colombia	Russia
2016	Colombia	South Africa	Mexico	Chile	Singapore
2017	Colombia	Russia	South Africa	Poland	Chile
2018	Mexico	Russia	South Korea	Chile	South Africa
2019	Mexico	Russia	Argentina	South Korea	South Africa
2020	Mexico	Russia	Argentina	South Africa	Chile
2021	Mexico	Argentina	South Africa	Russia	Chile
2022	Mexico	South Africa	Chile	Argentina	Ukraine

Figure 4.5: Top 5 countries composing exchange rate synthetic according to their average weights per year.

4.0.5 Fiscal and Political Turmoil

We collect close to 1 million news articles published by *Estadão*, a large Brazilian news outlet. The collection process as well as preprocessing of the corpus is discussed in the appendix. We select all news articles belonging to the economics, politics, international and general editorials between January 2002 and March 2022. We eliminate articles which we don't consider relevant, such as blog commentaries and other articles that were periodically released that were not news per se, such as propaganda pieces.

Our goal is to use NLP techniques over this corpus to select dates containing relevant news articles on fiscal and political turmoil to which asset prices may react. We use articles considered benchmark in our sample as priors for the selection, through the Latent Dirichlet Allocation model, of the news articles that relate to this subject, as well as a narrative approach that further restrict news according to vocabulary requirements. Given the complexity associated with this dataset and our goal to extract dates consistent with what we consider fiscal and political turmoil, we apply the LDA model, being a natural choice given its topic discovery role and intuitive statistical foundation. Dummies are imposed at the dates associated with these news articles, and are used in the event study. All details associated with this variable and its construction, as well as the description of the LDA model, are left to the appendix.

4.0.6 Dependent Variables

We use daily returns of the *Ibovespa* stock market index, which is the main performance indicator of the stocks traded in the Brazilian stock exchange and lists major companies in the Brazilian capital market; Daily returns of the spot exchange rate, where an increase is interpreted as a depreciation of the *Real* with respect to the US dollar, and daily differences of the interest curve yields, using multiple maturities of the Brazilian Swap DI × Pré curve, from 2 months up to 10 years.[5] Data on the interest rate curve is available from Bloomberg, while for the other asset prices we use data from Thomson Reuters.

We present descriptive statistics below. We also add a table with descriptive statistics on the asset prices whose responses we assess, however conditioning on the benchmark dates related to fiscal and political turmoil. The average exchange rate and stock market depreciations when we restrict responses to these dates are larger than the averages over the entire sample. The steepening of the yield curve is larger on average for these dates than it is for the entire sample. We also show a table containing responses following

[5] One caveat is that the liquidity of the underlying contracts used for the curve's construction has increased, in particular for longer maturities, over the period covered by our sample.

Joesley day.

Table 4.1: Descriptive statistics on asset prices reactions conditional on the five benchmark dates of news articles used to select the complete set of articles used.

Asset price	n	**Min**	Median	Mean	**Max**	S.d
Δe	5	0.1	1.5	1.4	2.8	1.0
$\Delta Ibov.$	5	-2.4	0.6	0.0	1.4	1.5
Δy^{2m}	5	-4.1	-0.5	0.0	2.9	2.8
Δy^{3m}	5	-4.5	-2.4	-0.5	4.5	4.0
Δy^{4m}	5	-6.0	-2.8	-0.2	8.2	5.7
Δy^{6m}	5	-8.8	-2.2	1.6	16.2	10.0
Δy^{1yr}	5	-16.4	-0.1	4.8	25.6	16.7
Δy^{2yr}	5	-20.2	9.2	9.4	30.5	20.8
Δy^{3yr}	5	-18.2	13.3	12.1	31.5	20.6
Δy^{4yr}	5	-10.1	15.7	15.7	34.5	17.9
Δy^{5yr}	5	-8.5	20.2	17.6	40.0	19.0
Δy^{10yr}	5	-4.4	20.1	18.7	42.1	18.2

.Exchange rate and stock market returns are expressed in percent.

.Yield changes are expressed in basis points.

.Dates are 09/01/2016, 12/02/2016, 06/18/2020, 09/28/2020 and 08/05/2021.

Table 4.2: Asset prices responses on the day following *Joesley day* (05/17/2017), referring to a political scandal that is commonly associated with large reactions of asset prices in the Brazilian market.

Asset price	
Δe	7.0
$\Delta Ibov.$	-9.2
Δy^{2m}	39.4
Δy^{3m}	49.8
Δy^{4m}	78.2
Δy^{6m}	102.7
Δy^{1yr}	136.4
Δy^{2yr}	160.2
Δy^{3yr}	171.4
Δy^{4yr}	179.9
Δy^{5yr}	179.6
Δy^{10yr}	179.7

Table 4.3: Descriptive statistics on asset prices reactions for the complete sample.

Asset price	**n**	**Min**	**Median**	**Mean**	**Max**	**S.d**
Δe	4703	-8.3	0.0	0.0	7.1	1.1
$\Delta Ibov.$	4703	-16.0	0.1	0.1	13.7	1.7
Δy^{2m}	4703	-108.9	-0.1	-0.3	112.5	5.1
Δy^{3m}	4703	-112.1	-0.2	-0.3	115.4	6.0
Δy^{4m}	4703	-110.1	-0.2	-0.3	113.2	7.0
Δy^{6m}	4703	-99.0	-0.4	-0.3	107.4	8.7
Δy^{1yr}	4703	-118.9	-0.5	-0.3	153.2	12.0
Δy^{2yr}	4703	-128.2	-0.7	-0.3	198.4	15.2
Δy^{3yr}	4703	-148.4	-0.7	-0.4	227.0	16.8
Δy^{4yr}	4703	-158.5	-0.6	-0.4	240.2	17.2
Δy^{5yr}	4703	-168.6	-0.5	-0.4	232.4	17.3
Δy^{10yr}	4703	-264.7	-0.1	-0.5	254.2	19.5

Table 4.4: Descriptive statistics on independent variables for the complete sample.

Asset price	n	**Min**	Median	Mean	**Max**	S.d
$\varepsilon^{i-Kuttner}$	4703	-0.9	0.0	0.0	0.4	0.0
$\varepsilon^{i-FOCUS}$	4703	-1.0	0.0	0.0	0.2	0.0
ε^{g}	4703	-1.2	0.0	0.0	0.9	0.1
$\varepsilon^{Industry}$	4703	-0.8	0.0	0.0	1.1	0.0
ε^{IGP-M}	4703	-1.9	0.0	0.0	2.0	0.1
ε^{IPCA}	4703	-0.6	0.0	0.0	1.1	0.1
ε^{GDP}	4703	-0.6	0.0	0.0	0.3	0.0
Synthetic *Real*	4703	-4.7	0.0	0.0	5.4	0.6
Synthetic *Ibov.*	4703	-12.4	0.1	0.1	8.4	1.1
ΔVIX	4703	-43.7	-0.4	0.0	76.8	7.4
$\Delta Commod.$	4703	-6.4	0.0	0.0	8.3	1.0
Swaps	4703	0.0	0.0	10644.7	371400.0	23514.4
Rev. Swaps	4703	0.0	0.0	1951.9	538700.0	16547.5
Spot Net Interv.	4703	-965.0	0.0	38.9	983.0	161.6
Repos	4703	-900.0	0.0	-3.5	0.0	43.7
Forex. Loans	4703	-990.0	0.0	-1.2	0.0	31.6

5
Asset Prices Responses to the Monetary Surprise

Our event study considers all business days in the period from April 1, 2003 to March 31, 2022. By not restricting the analysis to trading days following monetary announcements we are able to more precisely estimate responses of asset prices to other domestic and foreign factors.

In order to estimate the effect β of the monetary surprise, our baseline specification is:

$$\Delta y_t = \beta_0 + \beta_{br} X_{br} + \beta_{int} X_{int} + \beta \varepsilon^i + \mu \quad (5\text{-}1)$$

Δy_t is the daily return of the asset price under consideration, and X_{br} is the vector stacking the domestic macroeconomic surprises, exchange rate interventions (when considering the response of the exchange rate) and dummy series capturing fiscal and political turmoil. X_{int} contains the VIX and, when studying the exchange rate response, we include the synthetic exchange rate change as well as the commodity index. When studying the stock market response, we use the synthetic for the stock market change. ε^i is the monetary surprise variable, which in our baseline model is measured using changes in one month interest rate future prices. For robustness we include in the appendix results obtained by using the alternative, survey based surprise measure, available through the *Focus* report.

The second specification only differs from the above in that it conditions the response of the asset prices on whether the fiscal and monetary surprise measures are positive or negative:

$$\Delta y_t = \beta_0 + \beta_{br} X_{br} + \beta_{int} X_{int} + \beta^i_+ \varepsilon^i_+ + \beta^i_- \varepsilon^i_- + \beta^g_+ \varepsilon^g_+ + \beta^g_- \varepsilon^g_- + \mu \quad (5\text{-}2)$$

where $\varepsilon^i_+ = \varepsilon^i$ if $\varepsilon^i \geq 0$ and 0 otherwise, and similarly for negative shocks and also the fiscal shocks.

The third and fourth specifications eliminate controls, only considering the monetary and fiscal policy surprises, respectively.

In order to assess if, as widely discussed in the case of Brazil, sovereign risk is a relevant variable, such that it can generate regimes with different responses of the exchange rate to monetary and fiscal surprises, we estimate a Markov-switching model, similar to the one in Alberola et al. (2021). It is assumed that $\alpha_t = \alpha(s_t)$, $\beta_t = \beta(s_t)$ and $\beta^g_t = \beta^g(s_t)$, where $s_t \in \{1, 2\}$ is the state of the system, that changes according to a Markov chain with constant transition matrix $\mathbf{P}$. Here we use β to refer to the effect of the monetary surprise, and β^g to that of the fiscal surprise. We also allow the volatility of the residual to differ between regimes, as well as the intercept, so possible changes in trend depreciation can be captured. While in principal there are different ways to model non-linear responses, the Markov-switching model offers a more agnostic choice, as the dates in which each regime is most likely are jointly estimated along with other parameters. This strategy resonates with modelling assumptions found in a large body of theoretical work on sovereign debt, which imply that the probability of sovereign default (corresponding to risk premium in this literature) is dependent on realized values of shocks or regimes.[1]

[1]Recent literature includes, among others, Bi (2012) and Bocola (2016). In the former, government transfers follow a Markov-switching process, with regimes having pronounced impact on risk premium, while in the latter sovereign default occurs according to a standard logistic distribution.

6
Results

Consistent with several of the articles reviewed earlier, the response of the yield curve to the monetary surprise, present in table 6.1, is hump-shaped. One p.p. positive monetary surprise is associated with nearly one-to-one responses of yields (here measured in basis points), reaching a maximum of 115 b.p. at 6 months and decreasing monotonically for longer maturities. We do not observe long rates pricing in reversal of interest rate surprises, although their responses, as expected, are weaker than those of shorter maturity yields. Up to yields of two year maturity, the shock corresponding to the industrial output indicator positively affects yields, and this effect increases with maturity. The effect of the IPCA shock over the spectrum of yields is similar to the effect of the monetary shock, and the GDP shock positively affects yields up to one year, with this effect also increasing with maturity. Neither the IGP-M nor deficit shocks have statistically significant effects on yields. Changes in global sentiment proxied by the VIX are positively correlated with yields, and we find that the slope of the yield curve increases on dates associates with fiscal and political turmoil, and this effect is statistically significant over all maturities.

The response of the yield curve to the monetary surprise in the absence of controls does not change significantly with respect to the previous specification, while for the fiscal shock, no yields respond to it significantly.

In table 6.2 responses are conditional on the different signs of shocks. Both positive and negative monetary shocks have hump-shaped effects on the spectrum of maturities, and the effects of negative shocks are smaller in magnitude. These are statistically significant for all maturities, while the positive shock's significance disappears for the 10 year yield.

While current fiscal deficits have no effects on the yield curve, the release of news perceived as characterising political and/or fiscal turmoil is associated with a larger yield curve slope. Intuitively, this can be caused by the dominance of political and fiscal events perceived negatively by the market, related to fiscal indiscipline and political instability. Inflation expectations could increase due to future spending or foreign currency outflows, in turn raising expectations of future contractionary policies by the monetary authority.

Table 6.1: Responses of the interest rate curve yields to monetary and fiscal policy shocks.

	$\Delta y^{2\text{ mo.}}$	$\Delta y^{3\text{ mo.}}$	$\Delta y^{4\text{ mo.}}$	$\Delta y^{6\text{ mo.}}$	$\Delta y^{1\text{ yr.}}$	$\Delta y^{2\text{ yr.}}$	$\Delta y^{3\text{ yr.}}$	$\Delta y^{5\text{ yr.}}$	$\Delta y^{10\text{ yr.}}$
ε^i	100.29	107.01	110.76	114.87	109.66	89.67	78.05	43.77	25.57
	(3.03)***	(5.50)***	(8.26)***	(10.00)***	(9.28)***	(10.17)***	(12.25)***	(10.62)***	(10.79)**
Fisc. and Pol. Turm.	1.02	1.12	1.15	1.28	1.30	1.45	1.39	1.54	1.86
	(0.24)***	(0.27)***	(0.30)***	(0.34)***	(0.47)***	(0.58)**	(0.63)**	(0.65)**	(0.73)**
Adjusted R^2	0.23	0.19	0.15	0.12	0.07	0.05	0.04	0.03	0.03
ε^i	101.19	107.94	112.03	116.53	112.31	92.52	80.94	47.60	28.34
	(2.55)***	(4.78)***	(7.41)***	(9.22)***	(9.30)***	(10.98)***	(13.05)***	(11.26)***	(11.46)**
Adjusted R^2	0.95	0.86	0.78	0.69	0.47	0.31	0.24	0.09	0.03
ε^g	0.48	0.74	1.47	2.19	3.53	4.42	3.55	4.59	3.44
	(0.97)	(1.06)	(1.25)	(1.64)	(2.78)	(4.15)	(4.57)	(4.60)	(5.44)
Adjusted R^2	−0.004	−0.004	−0.003	−0.001	0.003	0.003	−0.001	0.0003	−0.003

.Robust standard errors are used, and superscripts *,** and *** denote statistical significance at, respectively, 10%, 5% and 1% levels.

.The monetary shock is expressed in percentage points, while yields are in basis points. Macroeconomic surprises are expressed as standard deviations.

Table 6.2: Responses of the interest rate curve yields to monetary and fiscal policy shocks, conditional on their different signs.

	$\Delta y^{2\,mo.}$	$\Delta y^{3\,mo.}$	$\Delta y^{4\,mo.}$	$\Delta y^{6\,mo.}$	$\Delta y^{1\,yr.}$	$\Delta y^{2\,yr.}$	$\Delta y^{3\,yr.}$	$\Delta y^{5\,yr.}$	$\Delta y^{10\,yr.}$
ΔVIX	0.02	0.03	0.05	0.08	0.17	0.29	0.36	0.39	0.44
	(0.01)***	(0.01)***	(0.01)***	(0.02)***	(0.03)***	(0.04)***	(0.05)***	(0.05)***	(0.05)***
ε^{IGP-M}	0.43	0.74	1.66	1.53	1.45	−0.13	−0.78	−1.94	−4.84
	(0.61)	(0.82)	(0.88)*	(1.26)	(2.08)	(2.64)	(2.78)	(2.63)	(3.87)
$\varepsilon^{Industry}$	3.94	5.36	6.57	7.43	8.57	8.80	6.90	5.86	8.50
	(1.60)**	(2.03)***	(2.50)***	(3.11)**	(3.92)**	(5.20)*	(5.58)	(5.47)	(5.63)
ε^{IPCA}	6.71	10.67	13.49	17.68	23.34	25.91	24.80	16.58	8.26
	(1.83)***	(2.37)***	(2.81)***	(3.94)***	(3.77)***	(4.97)***	(6.30)***	(4.02)***	(6.30)
ε^{GDP}	8.33	8.92	9.73	10.53	19.37	15.31	2.91	18.63	19.73
	(2.74)***	(3.53)**	(4.34)**	(5.32)**	(8.01)**	(14.55)	(22.03)	(14.65)	(13.20)
ε^{i}_{+}	114.90	126.71	137.31	145.93	133.91	96.33	78.89	67.09	42.74
	(4.72)***	(9.43)***	(13.48)***	(17.25)***	(28.54)***	(33.11)***	(33.71)**	(36.81)*	(35.98)
ε^{i}_{-}	95.09	100.00	101.32	103.82	101.00	87.21	77.71	35.45	19.56
	(1.59)***	(4.10)***	(6.89)***	(8.38)***	(6.53)***	(7.93)***	(11.69)***	(8.16)***	(8.54)**
ε^{g}_{+}	0.89	0.95	1.54	2.94	4.99	6.87	3.60	4.24	−1.97
	(1.14)	(1.15)	(1.21)	(1.51)*	(2.35)**	(4.06)*	(4.44)	(5.19)	(6.10)
ε^{g}_{-}	0.14	0.45	1.31	1.20	1.77	0.75	0.84	1.87	3.69
	(1.32)	(1.47)	(1.81)	(2.22)	(3.93)	(5.69)	(6.06)	(5.69)	(7.34)
Fisc. and Pol. Turm.	1.02	1.12	1.15	1.28	1.29	1.43	1.38	1.54	1.87
	(0.25)***	(0.27)***	(0.30)***	(0.34)***	(0.47)***	(0.58)**	(0.63)**	(0.64)**	(0.73)**
Adjusted R^2	0.23	0.19	0.16	0.12	0.07	0.05	0.04	0.03	0.03

.Robust standard errors are used, and superscripts *,** and *** denote statistical significance at, respectively, 10%, 5% and 1% levels.

.The monetary shock is expressed in percentage points, while yields are in basis points. Macroeconomic surprises are expressed as standard deviations.

Table 6.4 summarises the main results for the exchange rate and stock market index. For the exchange rate, the first column presents the complete model, where we find that a monetary surprise of one p.p. leads to an appreciation of 1.31%.[1] Apart from monetary policy, no domestic indicator has its unexpected component significantly affecting the exchange rate.[2]

As expected, positive changes in commodity prices appreciate the exchange rate, while positive changes in the VIX depreciate it, but these effects are small. The synthetic *Real* we construct is highly correlated with the exchange rate, and because currencies used in its construction are also sensitive to changes in the VIX and commodity prices, we indirectly also capture effects of these variables through this synthetic.[3] While it is common for papers within the literature to incorporate controls for external conditions in event studies, it is noteworthy that the inclusion of such controls seems to be an important contribution for the significance of the effect of the monetary surprise to the exchange rate. While this effect was estimated to be negative in the absence of controls, it was statistically insignificant, and tests showed that accounting for foreign conditions strongly increased the statistical significance of this effect.

Caveats were mentioned concerning the simultaneity bias related to the intervention effects. The only interventions with statistically significant effects at our daily frequency event study are reverse swaps (with the increase in the number of announced contracts depreciating the exchange rate) and spot net interventions. For this last intervention instrument, there actually is an effect

[1] The result is similar when we identify the monetary surprise using the *Focus* survey, and is displayed in table 9.3 in the appendix. A one p.p. monetary surprise leads to an appreciation of the exchange rate in 0.94%.

[2] While surprise deficits are shown to depreciate the *Real*, their effects are statistically insignificant. At a previous version of the paper, with the sample ending in September 2020 instead of March 2021, the fiscal's surprise effect was statistically significant at the 5% level, being the only domestic surprise apart from the monetary decisions that, despite with a reduced statistical significance, did affect the exchange rate.

[3] Conditional on the synthetic, the omission of the VIX and commodity prices generates insignificant changes in the responses of the exchange rate to the other variables. As previously stated, given that the commodity price index could reflect domestic monetary decisions of exporting economies, such as Brazil, the advantage of the use of the synthetic is that the impact of domestic monetary decisions on the commodity price should be mitigated, and the commodity price be omitted.

opposite to what would be expected in case the intervention were to succeed, which can be rationalized through the "leaning against the wind" behaviour by the central bank that introduces a simultaneity bias. While an increase in spot net interventions (interpreted here as purchase of dollars by the central bank) should be expected to depreciate the exchange rate, what we find is an appreciation.

A recent paper exploring intraday swap intervention effects on the exchange rate is Santos (2021), who finds that the exchange rate appreciates up to 0.29% for each USD 1 billion discretionary intervention, with the impact being significant up to the following day of the intervention. The impact on the intervention day is 0.18%. When we transform our variables for swaps and reverse swaps (maximum number of contracts announced in communiques that are to be offered in the upcoming auction) into USD[4] to obtain a coefficient comparable in unit, we find that a USD 1 billion intervention appreciates the *Real* in 0.022% in the case of swaps, and depreciates it in 0.030% in the case of reverse swaps, with only the latter effect being statistically significant. These effects are approximately 15% of the one obtained by Santos (2021), and are generated at a lower (daily) frequency. Under this lower frequency, an initial *Real* depreciation, for example, at the market‘s opening, that triggers an intervention which reestablishes the exchange rate to a level similar to its previous day’s closing value, leads us to associate a certain intervention volume to a near zero exchange rate change for that day. This simple example can shed light on the "leaning against the wind" behaviour by the central bank that, being a feature of our data, is likely to generate smaller reactions to those found in intraday studies. We are not able to capture what in this example is the reestablishment of the exchange rate to its previous day’s closing value in response to the intervention, which is its actual effect and should be similar to what higher frequency studies such as Santos (2021) found.

Finally, on dates associated with fiscal and political turmoil captured

[4]One swap contract is worth 50,000 USD when it expires.

through the NLP methods previously discussed, the exchange rate‘s depreciation is 0.9% larger than on dates not associated with it, and this difference is statistically significant at the 1% level.

On the second column we condition responses of the exchange rate on positive and negative monetary and fiscal surprises, finding that only the negative monetary surprises are significant. Moreover, qualitatively, both negative and positive surprises are similar, there being no relevant asymmetries between them. In the third and fourth columns, in the absence of controls, the response of the exchange rate to monetary and fiscal surprises is qualitatively the same as in the complete model, but it is not statistically significant.

For the stock market, a one p.p. interest rate surprise is associated with a statistically significant decrease of 3.25%. A one standard deviation deficit surprise is associated with an increase of 0.67% in stock prices, which is only significant at the 10% level. Except for the IPCA price index surprise, which is negatively associated with stock market changes but with little significance, all other macroeconomic surprises do not have significant effects on stock prices. One can expect, due to the forward looking nature of the stock market index, its reactions to be stronger to changes in expected values of these macroeconomic indicators in the near future than to their current surprises, although the former are likely to be, at least to some degree, affected by the latter. On dates associated with fiscal and political turmoil, the stock market‘s depreciation is 0.9% larger than on dates not associated with it.

On the second column for the stock market index, we see that both positive and negative monetary surprises are associated with stock market depreciation, with positive monetary surprises associated with a larger depreciation. In the absence of controls, only the monetary surprise has a strong and negative effect on stocks.

In spite of several instances of increased perception of fiscal and political turmoil, our results do not support the hypothesis that such instances, often occurring in a state of an already large debt burden, prevent the surprise component of monetary policy decisions from negatively affecting the exchange rate.

One possibility would be to interact the monetary policy surprise with the turmoil variable, as this could be somewhat similar to the idea of a regime. However, and especially given that we are not differentiating between positive and negative news, it could be the case that both of them occur during periods associated with "Ricardian" and "Non-Ricardian" regimes. During an overall period of increased sovereign risk, consistent with a non-Ricardian regime, there can still be news associated with particularly positive fiscal consolidation projects being approved. Not differentiating between positive and negative news articles make the task of explicitly associating news articles with a particular regime harder and more subjective.

Table 6.3: Responses of the exchange rate and stock market returns to monetary and fiscal policy shocks.

	Exchange rate				**Stock market index**			
	Complete	Diff. signs	Mon.	Fisc.	Complete	Diff. signs	Mon.	Fisc.
ε^i	−1.31		−0.60		−3.25		−3.20	
	(0.56)**		(0.64)		(0.79)***		(0.79)***	
ε^g	0.46			0.50	0.67			0.42
	(0.33)			(0.51)	(0.36)*			(0.51)
ε^i_+		−1.54				−4.23		
		(1.13)				(1.68)**		
ε^i_-		−1.24				−2.79		
		(0.63)**				(0.90)***		
ε^g_+		0.59				1.14		
		(0.59)				(0.66)*		
ε^g_-		0.37				0.36		
		(0.38)				(0.41)		
Fisc. and Pol. Turm.	0.09	0.09			−0.09	−0.09		
	(0.03)***	(0.03)***			(0.04)**	(0.04)**		
Adjusted R^2	0.41	0.41	−0.002	0.005	0.54	0.54	0.05	−0.001

.Robust standard errors are used, and superscripts *,** and *** denote statistical significance at, respectively, 10%, 5% and 1% levels.

Table 6.4: Responses of the exchange rate and stock market returns to other shocks.

	Exchange rate				**Stock market index**			
	Complete	Diff. signs	Mon.	Fisc.	Complete	Diff. signs	Mon.	Fisc.
Synthetic *Real*	0.98	0.98						
	(0.04)***	(0.04)***						
Synthetic *Ibov.*					0.97	0.94		
					(0.04)***	(0.05)***		
$\Delta Commod.$	−0.08	−0.08						
	(0.02)***	(0.02)***						
ΔVIX	0.01	0.01			−0.04	−0.04		
	(0.002)***	(0.002)***			(0.004)***	(0.004)***		
ε^{IGP-M}	−0.18	−0.18			0.32	0.33		
	(0.19)	(0.19)			(0.20)	(0.20)*		
$\varepsilon^{Industry}$	−0.44	−0.44			−0.03	0.003		
	(0.35)	(0.35)			(0.40)	(0.40)		
ε^{IPCA}	−0.42	−0.42			−0.53	−0.55		
	(0.32)	(0.32)			(0.33)	(0.33)*		
ε^{GDP}	−0.95	−0.94			0.45	0.51		
	(0.58)	(0.59)			(0.86)	(0.87)		
Swaps	−0.0000	−0.0000						
	(0.0000)	(0.0000)						
Rev. Swaps	0.0000	0.0000						
	(0.0000)**	(0.0000)**						
Spot Net Interv.	−0.0002	−0.0002						
	(0.0001)**	(0.0001)**						
Repos	0.0001	0.0001						
	(0.001)	(0.001)						
Forex. Loans	−0.0004	−0.0004						
	(0.0004)	(0.0004)						
Adjusted R^2	0.41	0.41	−0.002	0.005	0.54	0.54	0.05	−0.001

.Robust standard errors are used, and superscripts *,** and *** denote statistical significance at, respectively, 10%, 5% and 1% levels.

In another specification we do not use filters to construct the series for dates associated with fiscal and political turmoil, only requiring the ranking topics of articles to be matched with those of the benchmark in order to select them and their dates. This approach‘s advantage is the reduced subjectivity that is intrinsic to NLP methods based on word counts or presence. Tables 9.5 and 9.6 present the results. While results for the effects of dates associated with fiscal and political turmoil on all asset prices remain similar to the original specification, the effect on the exchange rate is not statistically significant.

When the set of filters related to fiscal and political turmoil vocabulary reduces, results remain qualitatively the same (they are displayed in tables 9.7 and 9.8). However, the magnitudes of the effects increase (effects of fiscal and political turmoil dates on longer term yields double with respect to the effects in our benchmark specification, and effects on stock and exchange rate returns increase by 50%). While with the original set of filters 880 dates were selected, the reduced set of filters leads to the selection of only 333 dates, out of 4703 business days. Increased effects found in the second version could suggest dates selected reflect information flows that were less anticipated by markets, or a stronger dominance of events perceived as negative over events perceived as positive, or both. This robustness exercise also highlights the sensitivity of estimated effects to the choice of filters, albeit qualitatively, results are shown to be robust to this change of filters.

While overall responses of the stock market and yield curve to the monetary surprise are in line with what has been found in previous literature, it is the exchange rate‘s response estimated in our model that diverges from most of the literature. Only Vicente et al. (2021) found an appreciation of the *Real* to the monetary surprise, while previous papers either found depreciation or an insignificant response.

Our sample is the longest among papers studying the Brazilian currency‘s response, and it does include periods associated with a larger perception of fiscal indiscipline by the government (which is the main cause cited in previous papers on Brazil for a lack of negative association between interest rates and the Brazilian currency), such as the beginning of Lula‘s government in 2003, the years of 2014-2016 in which public discussions of fiscal consolidation were very predominant, with a spending cap eventually approved in 2016, and a large increase of public expenditure during the COVID pandemic. However, we still find close to a 1% appreciation of the *Real* in response to a one percentage point surprise increase in the target interest rate.

In the appendix we show graphs for rolling window estimations of the exchange rate regression. The estimations are made for windows of 6, 10 and 15 years. Except for some of the 6 year windows, we find, consistent with our baseline model, appreciations of the exchange rate to the positive monetary surprise. Moreover, the responses, for the three window lengths, generally increase overtime in absolute value. For the 6 year windows (which was the length of the sample used in Guimarães and Gonçalves (2011)), we find a depreciation of the exchange rate in response to the monetary tightening in the period between 2003 and 2006, but most of these associations are not statistically significant. For windows beginning after 2006, the *Real* appreciates in response to such a tightening, and this reaction increases over time, being statistically significant for approximately half of the windows. For windows of 10 years, appreciation responses are significant at the 5% level (or less) only for windows not covering the period prior to 2006. As we increase the window length to 15 years, a larger share of them present statistically significant responses, including those covering the period prior to 2006. The increased appreciation of the *Real* to the positive monetary surprise around and after 2006, more noticeable in the 6 and 10 year windows, are consistent with estimates found in Vicente et al. (2021), whose sample spans the period from 2006 to 2020. There seems to be a relevant source of variation in the early part of our sample that reduces the magnitude of the response of the *Real* to the monetary surprise, without, however, making this response one of depreciation or statistically insignificant appreciation.

As for the Markov-switching model, our exercise is similar to the one performed by Alberola et al. (2021), in which they assess if two different regimes, described by them as Ricardian and non-Ricardian, can have different effects of monetary surprises on the exchange rate. We impose that two regimes exist, in which the effects of monetary and fiscal shocks, as well as the intercept and residual volatility, are allowed to differ between both regimes. We allow the fiscal shock's effect to change due to recent work pointing to the state dependence of fiscal multipliers and non-linear effects fiscal shocks may have on risk premium depending on the amount of fiscal stress in the economy. For other variables we impose a constant effect across both regimes. In the first regime we find a statistically insignificant appreciation of 3.11% of the exchange rate in response to a positive monetary surprise, while in the second regime, the exchange rate's appreciation of 1.04% is statistically significant. The first difference with respect to Alberola et al. (2021) is that they found opposite and statistically significant effects of monetary policy shocks on the exchange rate between regimes, while only our second regime obtained a significant appreciation.

In figure 6.1 we plot the implied probability of the economy finding itself in this second regime on the business days following monetary policy announcements. This regime contains an exchange rate‘s response qualitatively similar to the one we found in our original event study.

One particular difference between our result and that of Alberola et al. (2021) is that we find, at the end of 2008, an instance in which the economy, with a probability of one, is in the first regime, where the exchange rate does not respond to monetary surprises, while they found an appreciation, making the point that external conditions, which were extremely adverse in 2008, would thus likely not be the underlying cause behind this regime, resorting to a domestic (possibly fiscal) reason. Our results suggest that causes for this regime in which the exchange rate does not respond to the monetary surprise could be external, such as the financial crisis that was taking place in 2008 and the COVID pandemic that increased risk aversion, and also lead to consequences concerning sovereign risk, as the debt burden of several economies increased significantly.

We also note that the majority of years in our sample, except 2007, 2009-2011 and 2019, contained at least one monetary policy decision during which the economy most likely found itself in the first regime (which observes a statistically insignificant response of the exchange rate to the monetary surprise). Moreover, there were instances in which the probability of being in this regime was one, namely in early 2003, the end of 2008, 2014, 2016-2017 and 2020-2021. The last two periods were characterised, as previously mentioned, by an increased discussion and public perception of fiscal indiscipline. But, as we first pointed out, almost every year in our sample saw at least one instance of increased likelihood of being in this regime. There are also swift regime changes, in part probably caused by the high-frequency nature of our data, often being the case that the second regime was the most likely following an announcement, while for the previous announcement the first regime (where, again, the exchange rate is irresponsive) was clearly dominant. Both at the beginning of 2003 and at the end of 2016, the first regime dominated, and the exchange rate was slightly above 3 BRL/USD and going through local appreciation processes, which would not seem likely if the amount of sovereign risk was large enough so as to keep the economy in a non-Ricardian regime. Thus, while on one hand there is some appeal to qualify the cause behind these regimes as fiscal, due to a common perception of worsening debt sustainability during some periods in which the first regime was more likely, on the other hand the swift regime changes and coexistence between this regime and moments of currency appreciation reduce such appeal. This is not to say sovereign risk does not generate non-linear effects of monetary policy to the exchange rate, but if such effects exist, the current exercise does not make them evident.

The effects of fiscal shocks on the exchange rate in both regimes are not statistically significant. When conditioning on the signs of fiscal shocks across regimes, we find that negative fiscal shocks (public surpluses) are associated with an exchange rate depreciation (significant at the 10% level) in the regime where the monetary policy shock has no significant effect on the exchange rate. In the regime where the monetary shock significantly affects the exchange rate in the "expected" direction, the negative fiscal shock does not affect the exchange rate. If increased sovereign risk depreciates the exchange rate and the cause behind regimes were fiscal, then a stronger non-linear effect of the negative fiscal shock on the exchange rate depending on the amount of fiscal stress could be expected, considering the results in Born et al. (2020), where negative fiscal shocks were found to increase sovereign risk if fiscal stress were severe, and reduce it otherwise.[5]

[5] This paper combines a panel model with local projections to assess the impact of fiscal shocks on sovereign risk for 38 countries, including Brazil. The main intuition of their result is that in times of recession and fiscal stress, negative fiscal shocks caused by an increase in distortionary taxes amplify recessions because higher taxes reduce the incentive to work, and this results in an increase of the default premium. In times where economic conditions are benign, negative fiscal shocks reduce the default premium.

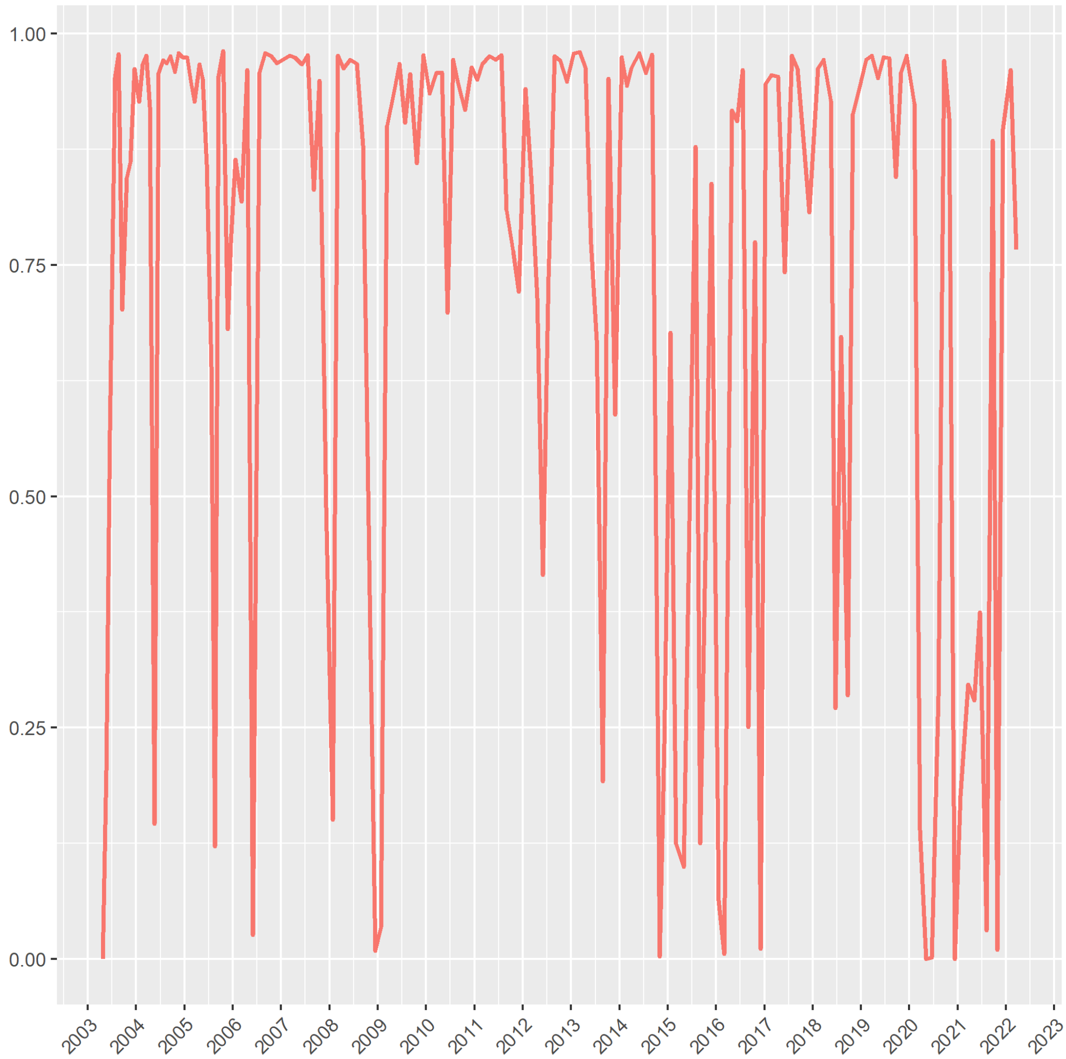

Figure 6.1: Evolution of the smoothed unconditional probability of the second regime estimated in the Markov-switching model.

One subtle difference between our empirical model and that in Vicente et al. (2021), which is the only apart from ours to find an appreciation of the *Real* in response to a surprise monetary contraction, is the inclusion of the return of the five-year CDS Brazil as control for country risk in their model. If, as has often been speculated in the literature for emerging economies and Brazil in particular, sovereign risk is a channel through which the surprise monetary contraction depreciates the domestic exchange rate, then the fact that sovereign risk is an outcome of the monetary policy surprise qualifies it as a bad control.[6] Moreover, the extent to which the return of the CDS

[6]In this case, following the terminology in Cinelli et al. (2020), sovereign risk would be

captures sovereign risk is limited. While the CDS premium proxies for the risk of default on the external federal debt (its foreign currency component), such component represented, in February 2022, 4.2% of the federal debt in Brazil, and has continuously decreased since the early 2000s.[7] In 2006, this share was also small, at 14%. In spite of this, Kohlscheen (2014) regresses changes of the CDS against the monetary surprise to test for fiscal dominance, while Alberola et al. (2021) use the level of the CDS to give Ricardian versus non-Ricardian interpretation to regimes in which different reactions of the exchange rate to monetary shocks occur, and Vicente et al. (2021) use it as a control in their event study.

considered a mediator in the causal effect of the monetary contraction on the exchange rate, such that conditioning on sovereign risk blocks this effect and possibly leads to an exchange rate appreciation response.

[7]Source: https://sisweb.tesouro.gov.br/apex/f?p=2501:9::::9:P9_ID_PUBLICACAO:43139.

7
Concluding Remarks

In this paper we assess how a class of important asset prices in the Brazilian economy respond to monetary policy surprises using an event study approach. Due to institutional factors, our method deviates from the common approach found for other central bank announcements in which windows of a few minutes identify these responses through the covariance between the identified shock and asset prices responses, such that we control for both domestic factors, namely macroeconomic indicator surprises, as well as foreign factors. Predictions found can be useful to guide, for example, those of models that incorporate asset prices for Brazil, and methods employed may be extended to other event studies applied to data available at a lower frequency than that commonly seen in empirical work for the US economy or the Eurozone.

Another contribution we make is to the increasing literature that uses natural language processing techniques in applied economics. We exemplified several episodes of political and fiscal turmoil in Brazil that affected financial markets. As newspaper articles reflect information flows associated with these episodes, we are able to systematically select dates related to these episodes combining a topic discovery model, LDA, and a narrative approach based on the application of filters. One avenue for future research is the application of sentiment analysis, which would allow us to discriminate between news perceived as positive and negative by market participants and see if they have different effects on asset prices, as well as allow for better quantification of the content in these news articles. Another possibility would be to use dictionaries to filter for news articles capturing information flows which were less anticipated by markets than others, possibly leading to stronger asset prices reactions. These tasks are made easier with sources in the English language, which also include other data collections, such as transcripts from earnings calls and content from social media.[1]

Our main result consists of the appreciation of the Brazilian *Real* in response to a surprise monetary tightening. As extensively reviewed, the majority of the work analysing exchange rate reactions for Brazil and emerging economies points to an insignificant or a depreciation response of the exchange rate to monetary surprises, and arguments in line with fiscal dominance are predominant to rationalize such a finding. Puzzling reactions of the exchange rate have also been rationalized in the recent literature by a combination of arguments considering informational effects of monetary policy, liquidity demand and output channels, as well as sovereign risk. The response of the yield curve to the monetary policy surprise is positive and hump-shaped, and the stock market is negatively associated with it.

[1] See Ehrmann and Wabitsch (2022) for an application of NLP on tweets to study central bank communication with non experts.

8
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9
Appendix

9.0.1
Components of the Stock Market Synthetic

Below is a list of each country and the stock market index used for it. Except for Colombia‘s MSCI, which was extracted from Bloomberg, all others are from Thompson Reuters.

Argentina: S&P MERVAL INDEX

Chile: S&P/CLX IPSA INDEX

Colombia: MSCI Colombia

Czech Republic: PX PRAGUE SE INDEX

Hungary: BUDAPEST SE INDEX

India: S&P BSE SENSEX INDEX

Indonesia: JAKARTA SE COMPOSITE INDEX

Mexico: S&P/BMV IPC

Peru: S&P/BVL PERU GENERAL INDEX

Poland: WARSAW SE WIG POLAND INDEX

Romania: BUCHAREST SE BET INDEX

Russia: MOEX RUSSIA INDEX

Singapore: FTSE STRAITS TIMES INDEX

South Africa: FTSE/JSE SA ALL SHARE INDEX

South Korea: KOREA SE KOSPI INDEX

Taiwan: TAIEX - TAIWAN WEIGHTED INDEX

Turkey: Istanbul ISE BIST 100

Ukraine: PFTS INDEX

9.0.2 Exchange Rate Interventions

For swaps and reverse swaps data is available on the announcement, intervention and settlement dates. The central bank publishes monthly data in `www.bcb.gov.br/estatisticas/historicomercadoaberto` on swap interventions containing these three dates associated with each intervention communiqué, as well as the maximum number of contracts informed on the communiqué to be negotiated in the upcoming auction, this being the quantity we associate to each swap intervention. By scraping the time of each swap communique in `https://www.bcb.gov.br/estabilidadefinanceira/buscanormas`, we are able to make the necessary adjustments on critical dates, as the communique may have been released after trading hours.

Swap contracts offered at a certain date are worth 50,000 USD by the time they expire, and the central bank often announces that on a certain auction it will offer contracts of different maturities. Moreover, it is common to see the central bank rolling over contracts due to expire so as to avoid pressure on the exchange rate, such that on several dates, swap operations consisted solely on the rollover of swaps previously offered. Even when eliminating rollover operations from our sample, given that several of them were expected by market participants, results remain similar.

Spot interventions include spot net interventions, forwards, foreign currency loans/foreign currency repos and repo lines of credit, and are available in `https://www3.bcb.gov.br/sgspub/localizarseries/localizarSeries.do?method=prepararTelaLocalizarSeries` by searching series of numbers 17843, 24425, 24427 and 24448. Only settlement dates are available, which we use to recover intervention dates given standard time intervals between them. We do not use forwards, as we are not able to recover the dates of these interventions simply from the settlement dates. Moreover, only eleven dates between 2011 and 2012 saw settlements associated with forward interventions, this being the least used instrument.

Spot net interventions occur two business days before their settlement, considering the calendars of both Brazil and the US. For repo lines of credit, the interval between the settlement and interventions in which currency is sold to the market is two business days considering the Brazilian calendar, while no pattern exists for the interval between settlement and repurchase intervention. We thus restrict the analysis to sales interventions by the central bank, another reason being that the repurchase operation and its date is previously defined and anticipated when the sale occurs, such that no relevant effect for it is expected. For foreign currency loans/foreign currency repos we use the same procedure as for repo lines of credit.

We do not have access to the entire set of communiques by the central bank on spot interventions, while we do so for swaps. However, the majority of announcements for spot interventions were made in a very short interval before the interventions. We thus consider, for spot interventions, critical dates as being those of the interventions themselves (which for most cases coincide with the announcements) and for swap interventions we consider the dates of the announcements. Spot interventions are in millions of USD.

9.0.3 Measuring the Monetary Surprise through the *Focus* Report

Table 9.1: Responses of the interest rate curve yields to monetary and fiscal policy shocks.

	$\Delta y^{2\,mo.}$	$\Delta y^{3\,mo.}$	$\Delta y^{4\,mo.}$	$\Delta y^{6\,mo.}$	$\Delta y^{1\,yr.}$	$\Delta y^{2\,yr.}$	$\Delta y^{3\,yr.}$	$\Delta y^{5\,yr.}$	$\Delta y^{10\,yr.}$
ΔVIX	0.02	0.03	0.05	0.08	0.16	0.29	0.36	0.39	0.44
	(0.01)***	(0.01)***	(0.01)***	(0.02)***	(0.03)***	(0.04)***	(0.05)***	(0.05)***	(0.05)***
ε^{IGP-M}	0.27	0.57	1.48	1.35	1.27	−0.30	−0.93	−1.98	−4.86
	(0.69)	(0.89)	(0.88)*	(1.17)	(1.92)	(2.55)	(2.70)	(2.61)	(3.86)
$\varepsilon^{Industry}$	3.97	5.39	6.60	7.45	8.58	8.81	6.92	5.85	8.52
	(1.60)**	(2.04)***	(2.50)***	(3.12)**	(3.92)**	(5.20)*	(5.58)	(5.47)	(5.62)
ε^{IPCA}	6.73	10.68	13.50	17.69	23.36	25.92	24.81	16.58	8.26
	(1.83)***	(2.36)***	(2.80)***	(3.94)***	(3.77)***	(4.97)***	(6.30)***	(4.02)***	(6.29)
ε^{GDP}	9.33	9.98	10.77	11.49	20.23	15.98	3.64	18.87	20.13
	(2.69)***	(3.49)***	(4.33)**	(5.37)**	(8.09)**	(14.58)	(22.08)	(14.64)	(13.22)
ε^{i}	61.74	65.23	67.81	71.64	70.66	59.41	50.89	26.50	12.13
	(7.90)***	(8.27)***	(8.76)***	(9.48)***	(11.58)***	(13.23)***	(15.47)***	(11.82)**	(11.42)
ε^{g}	0.68	0.93	1.71	2.22	3.34	3.37	2.08	2.99	1.56
	(0.95)	(1.03)	(1.21)	(1.54)	(2.64)	(3.95)	(4.10)	(4.01)	(4.91)
Fisc. and Pol. Turm.	1.04	1.14	1.17	1.30	1.32	1.46	1.40	1.55	1.86
	(0.25)***	(0.28)***	(0.31)***	(0.34)***	(0.48)***	(0.58)**	(0.63)**	(0.65)**	(0.73)**
Adjusted R^2	0.13	0.11	0.09	0.08	0.05	0.04	0.04	0.03	0.03
ε^{i}	62.21	65.72	68.61	72.79	72.79	62.02	53.71	30.14	15.00
	(7.94)***	(8.28)***	(8.57)***	(9.10)***	(11.65)***	(13.41)***	(15.61)***	(11.85)**	(11.35)
Adjusted R^2	0.53	0.47	0.43	0.40	0.29	0.21	0.16	0.05	0.01
ε^{g}	0.48	0.74	1.47	2.19	3.53	4.42	3.55	4.59	3.44
	(0.97)	(1.06)	(1.25)	(1.64)	(2.78)	(4.15)	(4.57)	(4.60)	(5.44)
Adjusted R^2	−0.004	−0.004	−0.003	−0.001	0.003	0.003	−0.001	0.0003	−0.003

.Robust standard errors are used, and superscripts *,** and *** denote statistical significance at, respectively, 10%, 5% and 1% levels.

.The monetary shock is expressed in percentage points, and macroeconomic surprises are expressed as standard deviations.

Table 9.2: Responses of the interest rate curve yields to monetary and fiscal policy shocks, conditional on their different signs.

	$\Delta y^{2\,mo.}$	$\Delta y^{3\,mo.}$	$\Delta y^{4\,mo.}$	$\Delta y^{6\,mo.}$	$\Delta y^{1\,yr.}$	$\Delta y^{2\,yr.}$	$\Delta y^{3\,yr.}$	$\Delta y^{5\,yr.}$	$\Delta y^{10\,yr.}$
ΔVIX	0.02	0.03	0.05	0.08	0.16	0.29	0.36	0.39	0.44
	(0.01)***	(0.01)***	(0.01)***	(0.02)***	(0.03)***	(0.04)***	(0.05)***	(0.05)***	(0.05)***
ε^{IGP-M}	0.36	0.65	1.52	1.33	1.18	−0.31	−0.91	−2.08	−4.93
	(0.66)	(0.87)	(0.89)*	(1.17)	(1.85)	(2.50)	(2.68)	(2.55)	(3.85)
$\varepsilon^{Industry}$	3.98	5.40	6.60	7.45	8.60	8.84	6.94	5.85	8.50
	(1.61)**	(2.04)***	(2.50)***	(3.12)**	(3.92)**	(5.20)*	(5.58)	(5.47)	(5.63)
ε^{IPCA}	6.72	10.68	13.50	17.69	23.36	25.93	24.81	16.58	8.26
	(1.83)***	(2.36)***	(2.80)***	(3.94)***	(3.77)***	(4.97)***	(6.30)***	(4.02)***	(6.30)
ε^{GDP}	9.24	9.90	10.75	11.58	20.43	16.16	3.68	19.06	20.08
	(2.70)***	(3.50)***	(4.34)**	(5.38)**	(8.12)**	(14.62)	(22.11)	(14.67)	(13.23)
ε^{i}_{+}	48.44	53.84	63.28	75.01	82.19	59.28	46.06	39.85	23.48
	(13.01)***	(17.61)***	(21.46)***	(24.63)***	(33.25)**	(35.88)*	(36.31)	(35.50)	(33.35)
ε^{i}_{-}	66.16	69.02	69.32	70.49	66.78	59.38	52.46	22.03	8.41
	(8.59)***	(8.57)***	(9.06)***	(9.68)***	(11.37)***	(13.00)***	(16.31)***	(11.04)**	(11.02)
ε^{g}_{+}	1.42	1.52	2.13	3.53	5.48	7.25	3.94	4.48	−1.80
	(1.22)	(1.25)	(1.31)	(1.62)**	(2.47)**	(4.11)*	(4.48)	(5.23)	(6.09)
ε^{g}_{-}	0.27	0.60	1.46	1.33	1.85	0.80	0.88	1.92	3.72
	(1.33)	(1.48)	(1.82)	(2.24)	(3.93)	(5.69)	(6.06)	(5.69)	(7.35)
Fisc. and Pol. Turm.	1.04	1.15	1.17	1.30	1.30	1.45	1.40	1.54	1.87
	(0.25)***	(0.28)***	(0.31)***	(0.35)***	(0.48)***	(0.58)**	(0.63)**	(0.64)**	(0.73)**
Adjusted R^2	0.13	0.11	0.09	0.07	0.05	0.04	0.04	0.03	0.03

.Robust standard errors are used, and superscripts *,** and *** denote statistical significance at, respectively, 10%, 5% and 1% levels.

.The monetary shock is expressed in percentage points, while yields are in basis points. Macroeconomic surprises are expressed as standard deviations.

Table 9.3: Responses of the exchange rate and stock market returns to monetary and fiscal policy shocks.

	Exchange rate				**Stock market index**			
	Complete	Diff. signs	Mon	Fisc	Complete	Diff. signs	Mon	Fisc
Synthetic *Real*	0.98	0.98						
	(0.04)***	(0.04)***						
synthetic *Ibov.*					0.97	0.97		
					(0.04)***	(0.04)***		
$\Delta Commod.$	−0.08	−0.08						
	(0.02)***	(0.02)***						
ΔVIX	0.01	0.01			−0.04	−0.04		
	(0.002)***	(0.002)***			(0.004)***	(0.004)***		
ε^{IGP-M}	−0.18	−0.19			0.32	0.33		
	(0.19)	(0.19)			(0.20)	(0.20)*		
$\varepsilon^{Industry}$	−0.44	−0.44			−0.03	−0.03		
	(0.35)	(0.35)			(0.40)	(0.40)		
ε^{IPCA}	−0.42	−0.42			−0.53	−0.53		
	(0.32)	(0.32)			(0.33)	(0.33)		
ε^{GDP}	−0.96	−0.95			0.41	0.42		
	(0.58)	(0.59)			(0.87)	(0.87)		
ε^{i}	−0.94		0.05		−2.00		−3.15	
	(0.50)*		(0.60)		(0.89)**		(0.79)***	
ε^{g}	0.46			0.50	0.67			0.42
	(0.33)			(0.51)	(0.36)*			(0.51)
ε^{i}_{+}		−0.21				−3.06		
		(1.13)				(1.44)**		
ε^{i}_{-}		−1.18				−1.65		
		(0.56)**				(1.09)		
ε^{g}_{+}		0.58				1.16		
		(0.59)				(0.64)*		
ε^{g}_{-}		0.37				0.35		
		(0.38)				(0.42)		
Swaps	−0.0000	−0.0000						
	(0.0000)	(0.0000)						
Rev. Swaps	0.0000	0.0000						
	(0.0000)**	(0.0000)**						
Spot Net Interv.	−0.0002	−0.0002						
	(0.0001)**	(0.0001)**						
Repos	0.0001	0.0001						
	(0.001)	(0.001)						
FOREX. Loans	−0.0004	−0.0004						
	(0.0004)	(0.0004)						
Fisc. and Pol. Turm.	0.09	0.09			−0.09	−0.09		
	(0.03)***	(0.03)***			(0.04)**	(0.04)**		
Adjusted R^2	0.41	0.41	−0.01	0.005	0.54	0.54	0.07	−0.001

9.0.4
Rolling Window Estimation for the Exchange Rate

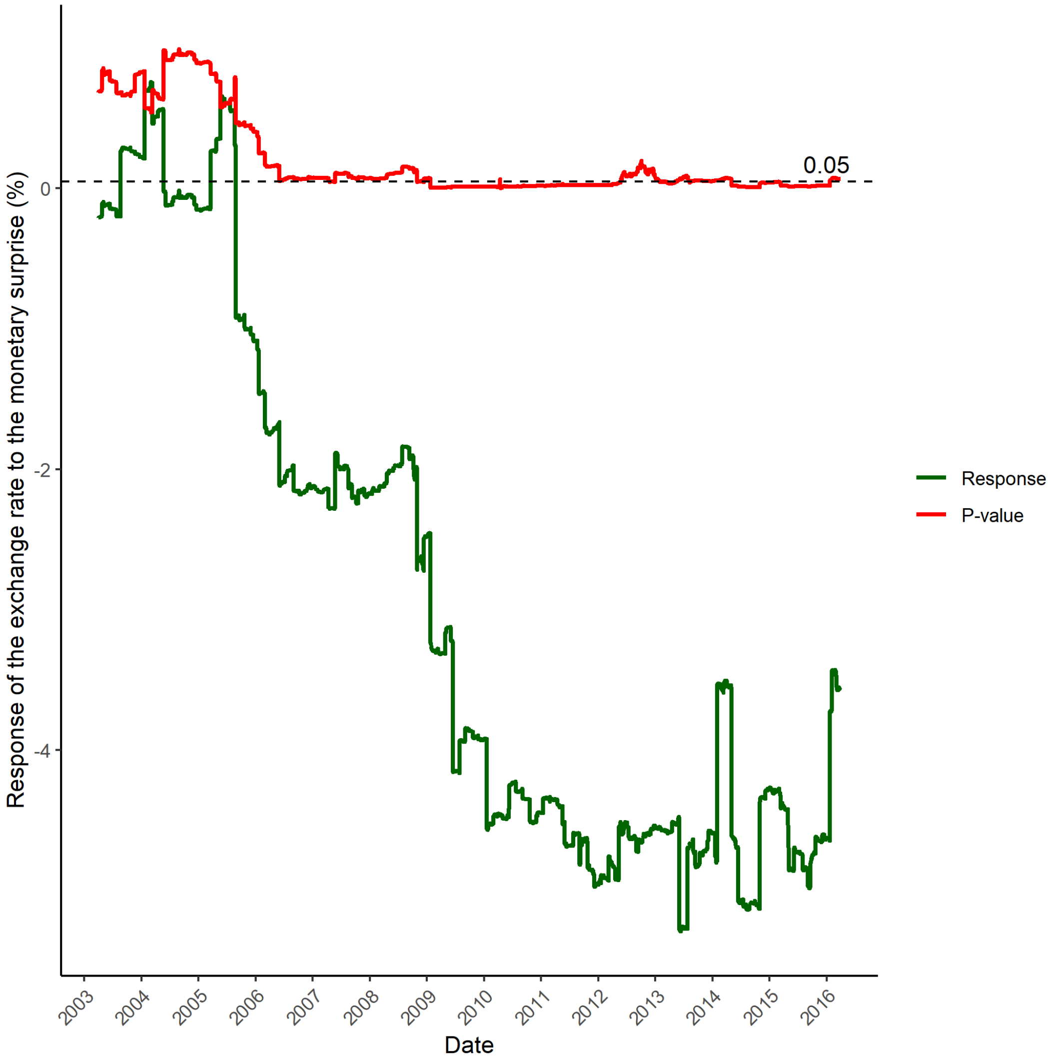

Figure 9.1: Rolling window (of 6 years) responses of the exchange rate to the monetary surprise.

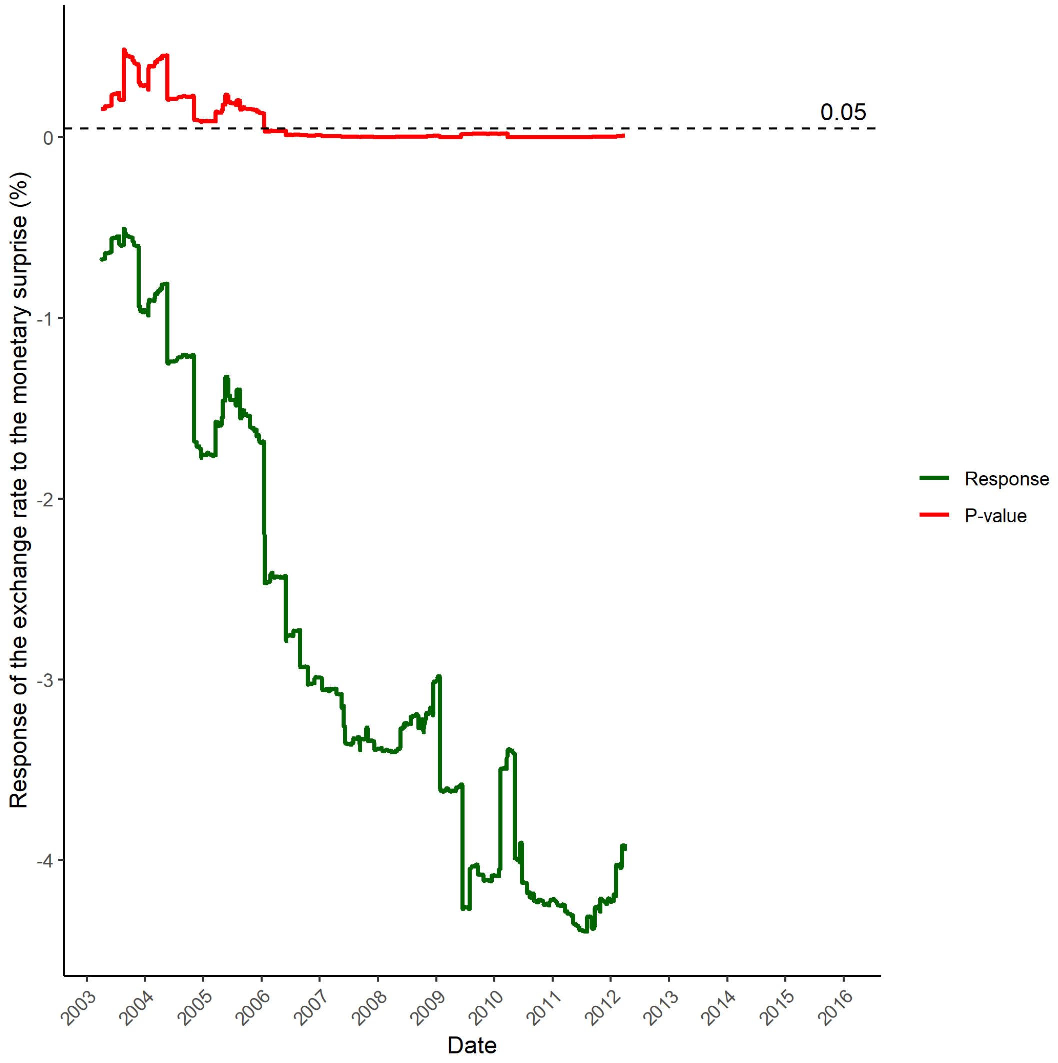

Figure 9.2: Rolling window (of 10 years) responses of the exchange rate to the monetary surprise.

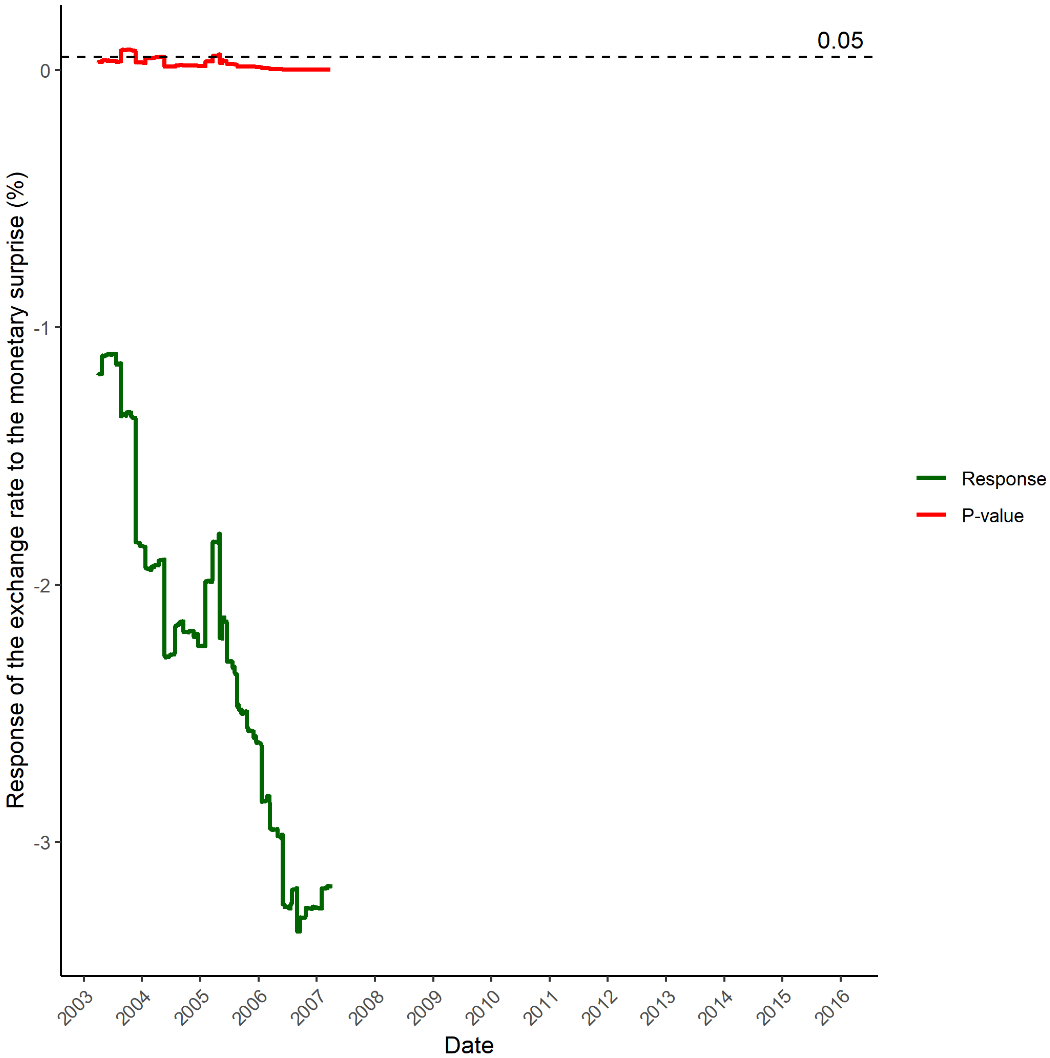

Figure 9.3: Rolling window (of 15 years) responses of the exchange rate to the monetary surprise.

9.0.5 News and Natural Language Processing Techniques

The LDA model yields, for each article, a probability distribution of topics, with the number of topics chosen by the researcher. Also, for each topic, the model generates a probability distribution of the vocabulary in the corpus.[1] While the main hyparameter of the model is the number of topics, with the literature pointing to both statistical criteria, such as coherence or perplexity measures, or interpretability of topics as being valid ways to choose

[1]This vocabulary is a subset of all words present in the articles collected, the reduction being carried out in the preprocessing steps.

them, other hyperparameters describe priors of the topic distribution for each article and of the distribution of words for each topic, which we set using standard values also used in Hansen et al. (2017).

We initially explore the topic distribution of news articles we consider benchmark representatives of fiscal and political turmoil. In particular, we analyse their most likely topics. These news articles were released across our sample period, and we summarise each of them here.

June 21, 2002: Concerns due to the possibility of a downgrade of Moody‘s ratings on Brazil, as surveys with voters before the upcoming elections suggested increased likelihood of Lula winning. One concern vocally noted by the opposition and market participants was the perception that debt would become less sustainable under Lula. The article mentions an increase of Brazil‘s fiscal risk, as measured by the sovereign CDS.

September 1, 2016: The article reports on the uncertainty surrounding the beginning of the presidency under Michel Temer, who on this day replaced Dilma Roussef following her impeachment, and his ability to gather political support for the approval of his fiscal consolidation proposals in the legislative power.

December 2, 2016: Political uncertainty related to the investigation of the corruption scandal involving Odebrecht, a large Brazilian construction company which had taken part in several corruption schemes. In particular, the article notes that on the following week, a new phase of the investigation would begin with several of the accused making statements as part of their plea bargains, which worried market participants due to the possible political repercussions. The article also notes that negative reactions occurred in the domestic market in spite of the approval of a major fiscal change in which new rules were set to limit the increase in spending by the government. Another fact reported was on the trial in the supreme court that charged Renan Calheiros, a member of the senate who had led it in 2013-2014, with embezzlement, which added to the political tension.

June 18, 2020: On this day, several politically sensitive episodes were reported, most important of which was the arrest of Fabrício Queiroz, which was described previously. The firing of the education minister and his new assignment as director in the World Bank was also pointed out in the article.

September 28, 2020: The *Renda-Cidadã* project was announced, and the major spending increase caused by it, as well as doubts on its funding sources, led to negative reactions by the market. The article points to the increased perception that, given presidential elections on the following year, president Bolsonaro would make an effort to have fiscal policy become more expansionary.

August 5, 2021: Increased perception of fiscal risk, as the senate was discussing the introduction of a new program that would increase flexibility of the payment of tax debts held by companies, which would lead to a fall in government revenue.

When analysing table 4.1, which displays descriptive statistics for asset prices reactions on these dates (except for the first, which we use in our article selection based on topic distributions but is not included in the time horizon of our sample), we see an increasing slope of the interest rate curve, as well as a larger depreciation of the exchange rate. Such reactions were not, however, as significant as those following *Joesley day*, which we plot in table 4.2 and show a significant fall in the stock market, the Brazilian *Real* and a large increase of the slope of the interest rate curve.

When running a regression for each asset price against the monetary policy shock, a dummy series for these five dates and the other control variables, results in table 9.4 show a statistically significant increase of the exchange rate, as well as significant increases on longer maturity yields of the interest rate curve.

While these five dates naturally do not capture the whole set of dates associated with fiscal and political turmoil, this first regression suggest the content on news reflected by these articles may be relevant for asset prices, which can also be seen by their mean responses conditional on the five benchmark dates covered by the sample.

When running several LDA models with different topic numbers between them,[2] most of them show that the benchmark news articles are described by the same most likely topic, which also provides a data-driven reason to select them as benchmark. However, the topic distribution of one model, that with 90 topics, is particularly interesting, as not only benchmark news articles share the most likely topic, but the four benchmark articles related to fiscal turmoil (which are the ones described above except for those on December 2, 2016 and June 18, 2020, which concern political turmoil) also share the second most likely topic. Thus, we choose this model, due to the interpretable distribution of ranking topics amongst benchmark articles, to be used in the process to select other dates associated with news on fiscal and political turmoil.

Given this model, we obtain all other articles such that their most likely topic coincided with the most likely topic of the benchmark, and that their second most likely topic was also that in at least one of the benchmark articles.

In a basic sanity test we check and find that this approach selects the article released describing the *Joesley day* events on may 18, 2017. This event was not considered a benchmark because of its tail nature, given the extremely

[2]We run 20 models with topic numbers spanning the 10 topic interval grid between 10 and 200 topics, with other hyperparameters held constant.

negative political perception surrounding it that led to record breaking market reactions, as shown in table 4.2.

The next step is based on the application of filters, which are certain expressions common in the "fiscal and political turmoil vocabulary" in Brazil, that we require news articles captured in the previous step to contain for their final selection. While more applications are using data-driven and probabilistic models to construct text measures, this method based on filters to qualitatively and quantitatively describe certain events has been very popular since Baker et al. (2016). However, some limitations exist for these methods, such as the subjectivity associated with the choice of words or expressions to be used as filters, as well as overfitting that usually results from the application of non-probabilistic models, including Latent Semantic Analysis, Cosine Similarity and others. In the results section we comment on this last step and compare results when dates are selected solely based on underlying news topic distribution, and when this last step is also applied to restrict even more the set of articles and dates.

We also show results that arise when we use a reduced set of filters, that is, a subset of the benchmark set of filters used to generate the main results. This second version is more restrictive, as now articles selected are those containing at least one word from a smaller set. Results are qualitatively the same for both sets of filters used.

Table 9.4: Responses of asset prices when dummies are imposed on the five benchmark dates.

	Δe	$\Delta Ibov$	Δy^{2m}	Δy^{3m}	Δy^{4m}	Δy^{6m}	Δy^{1yr}	Δy^{2yr}	Δy^{3yr}	Δy^{4yr}	Δy^{5yr}	Δy^{10yr}
Benchmark	1.34	0.15	0.92	0.49	0.82	2.68	6.01	10.70	13.41	16.95	18.82	19.96
	(0.23)***	(0.78)	(0.77)	(1.56)	(2.07)	(3.41)	(6.36)	(8.36)	(8.36)	(7.29)**	(7.78)**	(7.44)***

.Robust standard errors are used, and superscripts *,** and *** denote statistical significance at, respectively, 10%, 5% and 1% levels.

.Coefficients of other variables were omitted and will be shown in the results section.

.Yield changes are expressed in basis points, while the exchange rate and stock market returns are in percentage points.

While we use the 90 topic model in our benchmark specification, we point to the fact that the model with 100 topics also contains an attractive structure for ranking topics, with all 6 benchmark articles sharing the first and second most likely topics. The 90 and 100 topic LDA models display the largest similarity between benchmark articles, when considering their ranking topics, and this is reflected in results of econometric exercises for both of these models, which are quantitatively and qualitatively very similar.

We note that, in principle, the article selection process based on topics may also select news associated with, for example, fiscal consolidation episodes that are perceived as positive by markets. One case includes the benchmark article from December 2, 2016, where, although a negative perception on the political scenario is described, there is mention of the approval of a government spending cap that was perceived positively by market institutions. Overall, fiscal turmoil could designate both positive and negative episodes, although episodes perceived as negative are likely more spoken of. Our method, thus, does not explicitly differentiate between positive and negative fiscal and political turmoil (this would require sentiment analysis, which we opt not to perform due to the relative complexity of Portuguese that makes this task harder and more subjective). Filters we choose, including, for example (and here we already made translations into English), "fiscal uncertainty", "spending increase", "sovereign risk" or "institutional crisis", can also be seen in articles pointing to events perceived as positive, such as those commenting on how fiscal consolidation programs prevented spending increases that amplify the perception of sovereign risk by markets. Our goal is to select news articles concerning volatility, or turmoil, in the fiscal and political realities, so estimated effects for the variable that reflects this turmoil should be interpreted as the average affect considering positive and negative events. As will be mentioned in detail in the results section, the sign of the estimated effect is, for all asset prices, consistent with the expected sign for the prices‘ reactions to events perceived as negative.[3]

9.0.5.1 LDA

LDA is a generative statistical model that assumes a latent structure of associations between words and documents (in our case, news articles) in a corpus. It is an unsupervised learning algorithm in that no training of the model or labelling of documents occurs before the classification of these documents.

Each document is constructed through the combination of a given number of topics, that is, a random mixture of all topics, and each topic is a probability distribution over a given vocabulary (which results from the preprocessing steps applied over the raw set of articles). What follows is the intuition for the LDA model with K topics. Consider the t^{th} document with N_t total words. How does the model "write" the j^{th} term in the document?

1. It draws a topic at random from the list of all topics, where the probabilities of drawing each topic are given by the $K \times 1$ vector θ_t.

[3] One concern that is common in some empirical exercises using news articles is that of media bias. Some news outlets could report more frequently on events characterising, for example, increased fiscal risk, such that the method used here would likely capture more news articles reflecting these events than those describing episodes perceived as positive, and this would strengthen the association between turmoil dates and the exchange rate and stock market depreciation, as well as steepening of the yield curve.

2. Suppose we happened to draw topic k for the j^{th} term's topic. To then draw the j^{th} term itself, we randomly choose from the vocabulary of all terms, where the probability of drawing any given term is given by the $V \times 1$ vector ϕ_k, which is the topic-specific term probability distribution.

By iterating the first and second steps over the set of D documents and their corresponding given word counts, the collection of documents is generated. The LDA algorithm proposed in Blei et al. (2003) differs from the related probabilistic Latent Semantic Indexing in Hofmann (2013) in that it imposes prior (Dirichlet) distributions to the parameters of interest, overcoming issues related to overfitting, and smoothing estimation. Specifically, θ_d, the topic distribution for document d, is drawn independently, for $d = 1, \ldots, D$, from a Dirichlet ($\boldsymbol{\alpha}$) with K dimensions, and ϕ_k, the vocabulary distribution for topic k, is also drawn independently, for $k = 1, \ldots, K$, from a Dirichlet ($\boldsymbol{\eta}$) with V dimensions. Hyperparameters α and η are fixed and, the higher they are, the more even the probability mass spread across the dimensions. We follow Griffiths and Steyvers (2004) and use $\alpha = \frac{50}{K}$ and $\eta = \frac{200}{V}$.

The key inferential problem to be solved in LDA is the computation of the posterior distribution of the hidden variables, which is generally intractable to compute, as pointed by Blei et al. (2003). Thus, an approximation is needed for these posterior distributions (over θ_k for every k and over θ_d for every d, given K, α and η). In the implementation of LDA used by us,[4] the algorithm used to approximate the posterior distributions is the Variational Bayes algorithm.[5]

[4] We use the open source Python's Gensim library.
[5] For more details on such algorithms and a comparison between them, see Špeh et al. (2013).

9.0.6
Results when just the Ranking Topics Distribution Selects Dates

Table 9.5: Responses of the interest rate curve yields to monetary and fiscal policy shocks.

	$\Delta y^{2\text{ mo.}}$	$\Delta y^{3\text{ mo.}}$	$\Delta y^{4\text{ mo.}}$	$\Delta y^{6\text{ mo.}}$	$\Delta y^{1\text{ yr.}}$	$\Delta y^{2\text{ yr.}}$	$\Delta y^{3\text{ yr.}}$	$\Delta y^{5\text{ yr.}}$	$\Delta y^{10\text{ yr.}}$
ΔVIX	0.03	0.03	0.05	0.08	0.17	0.29	0.36	0.39	0.44
	(0.01)***	(0.01)***	(0.01)***	(0.02)***	(0.03)***	(0.04)***	(0.05)***	(0.05)***	(0.05)***
ε^{IGP-M}	0.60	0.92	1.85	1.75	1.65	0.06	−0.61	−1.72	−4.66
	(0.59)	(0.79)	(0.87)**	(1.25)	(2.09)	(2.67)	(2.80)	(2.65)	(3.85)
$\varepsilon^{Industry}$	4.07	5.50	6.71	7.57	8.72	8.97	7.09	6.05	8.79
	(1.57)***	(2.01)***	(2.47)***	(3.09)**	(3.90)**	(5.18)*	(5.56)	(5.44)	(5.57)
ε^{IPCA}	6.56	10.50	13.32	17.49	23.16	25.71	24.61	16.36	8.02
	(1.85)***	(2.38)***	(2.82)***	(3.94)***	(3.77)***	(4.96)***	(6.28)***	(4.03)***	(6.34)
ε^{GDP}	8.36	8.93	9.69	10.43	19.29	15.33	3.07	18.62	20.03
	(2.77)***	(3.53)**	(4.32)**	(5.28)**	(7.89)**	(14.40)	(21.88)	(14.51)	(13.05)
ε^{i}	100.61	107.35	111.11	115.28	110.13	90.22	78.60	44.37	26.45
	(3.01)***	(5.45)***	(8.21)***	(9.96)***	(9.28)***	(10.18)***	(12.26)***	(10.59)***	(10.73)**
ε^{g}	0.35	0.57	1.34	1.83	2.93	2.96	1.69	2.63	1.09
	(0.91)	(0.99)	(1.17)	(1.48)	(2.60)	(3.93)	(4.09)	(3.99)	(4.88)
‘Fisc. and Pol. Turm.‘	0.40	0.43	0.45	0.55	0.72	0.85	0.88	0.96	1.58
	(0.14)***	(0.16)***	(0.18)**	(0.24)**	(0.36)**	(0.45)*	(0.50)*	(0.53)*	(0.61)***
Adjusted R^2	0.22	0.18	0.15	0.11	0.07	0.05	0.04	0.03	0.03
ε^{i}	101.70	108.73	112.88	117.30	112.51	92.71	81.20	47.66	28.23
	(2.57)***	(4.87)***	(7.56)***	(9.38)***	(9.29)***	(10.96)***	(13.03)***	(11.37)***	(11.60)**
Adjusted R^2	0.95	0.87	0.80	0.72	0.53	0.34	0.27	0.10	0.03
ε^{g}	0.94	1.02	1.87	3.06	5.16	6.96	6.15	6.75	5.96
	(1.08)	(1.16)	(1.40)	(1.68)*	(2.59)**	(3.70)*	(4.14)	(4.85)	(6.06)
Adjusted R^2	−0.004	−0.004	−0.003	0.001	0.01	0.01	0.005	0.004	0.0000

. Robust standard errors are used, and superscripts *,** and *** denote statistical significance at, respectively, 10%, 5% and 1% levels.

.The monetary shock is expressed in percentage points, while yields are in basis points. Macroeconomic surprises are expressed as standard deviations.

Table 9.6: Responses of the exchange rate and stock market returns to monetary and fiscal policy shocks.

	Exchange rate				**Stock market index**			
	Complete	Diff. signs	Mon.	Fisc.	Complete	Diff. signs	Mon.	Fisc.
Synthetic *Real*	0.98	0.98						
	(0.04)***	(0.04)***						
Synthetic *Ibov.*					0.97	0.94		
					(0.04)***	(0.05)***		
$\Delta Commod.$	-0.08	-0.08						
	(0.02)***	(0.02)***						
ΔVIX	0.01	0.01			-0.04	-0.04		
	(0.002)***	(0.002)***			(0.004)***	(0.004)***		
ε^{IGP-M}	-0.17	-0.17			0.31	0.32		
	(0.19)	(0.19)			(0.20)	(0.19)*		
$\varepsilon^{Industry}$	-0.43	-0.43			-0.05	-0.01		
	(0.34)	(0.34)			(0.40)	(0.40)		
ε^{IPCA}	-0.43	-0.43			-0.52	-0.54		
	(0.32)	(0.32)			(0.33)	(0.33)*		
ε^{GDP}	-0.94	-0.94			0.43	0.49		
	(0.58)	(0.58)			(0.85)	(0.85)		
ε^{i}	-1.29		-0.60		-3.29		-3.20	
	(0.57)**		(0.64)		(0.78)***		(0.79)***	
ε^{g}	0.45			0.50	0.70			0.42
	(0.33)			(0.51)	(0.36)*			(0.51)
ε^{i}_{+}		-1.52				-4.25		
		(1.11)				(1.67)**		
ε^{i}_{-}		-1.21				-2.84		
		(0.64)*				(0.89)***		
ε^{g}_{+}		0.61				1.15		
		(0.59)				(0.65)*		
ε^{g}_{-}		0.34				0.39		
		(0.38)				(0.42)		
Swaps	-0.0000	-0.0000						
	(0.0000)	(0.0000)						
Rev. Swaps	0.0000	0.0000						
	(0.0000)***	(0.0000)***						
Spot Net Interv.	-0.0002	-0.0002						
	(0.0001)***	(0.0001)***						
Repos	0.0001	0.0001						
	(0.001)	(0.001)						
FOREX. Loans	-0.0004	-0.0004						
	(0.0004)	(0.0004)						
Fisc. and Pol. Turm.	0.04	0.04			-0.08	-0.08		
	(0.03)	(0.03)			(0.04)**	(0.04)**		
Adjusted R^2	0.41	0.41	-0.002	0.005	0.54	0.54	0.05	-0.001

9.0.7 Preprocessing of News Articles

1. Given the set of news articles that were extracted from the online version of the *Estadão* newspaper (using mostly python's Selenium and Beautiful Soup libraries), we organize them in a dataframe containing, as columns, the date, title, subtitle, text and link of each article.

2. The title, subtitle and text are joined into a single body of text, for each article.

3. Each article is tokenized, that is, is transformed into a list of unigrams, with spaces used as delimiters.

4. Tokens containing no alphabetic characters are removed.

5. Non-alphanumeric characters in the extremes of tokens are removed (thus, we get rid of punctuation).

6. Non-alphanumerical characters, except for hyphens, are replaced with empty strings (and a token in which such replacement occurs is also tokenized based on the empty string as delimiter).

7. Single letter words are eliminated.

8. Tokens corresponding to stop words are eliminated. To obtain stop words in Portuguese we combine the list provided in the NLTK library with a list made by us.

9. Tokens are transformed into lower-case.

10. Tokens are lemmatized, using the library Spacy. Because the training set used within the library to generate the lemmatization process is not as large for Portuguese as it is for English, in order to assess if an imprecision can generate significant changes in our final results, we perform three lemmatization versions: The first only lemmatizes verbs, the second lemmatizes verbs, adverbs, adjectives, and the third lemmatizes all parts of speech (generating the smallest vocabulary amongst the three versions). Final results do not show sensitivity to such choices, also due to the fact that we opt for a qualitative variable as the Portuguese language is still limited in the NLP applications, including implementation of preprocessing steps and availability of dictionaries for sentiment analysis.

11. The final dataframes consist of a column with each article's date and one for its cleaned version, which corresponds to a dictionary relating each final token with the frequency with which it appears in the clean article (as the order of words do not matter for the methods used, dictionaries allow for more economical storage of the final data).

Some of the steps are applied more than once. Some errors following patterns in headlines or subtitles were also corrected in the preprocessing steps.

Given the dictionary of cleaned words (unigrams) associated with each article, a term document matrix is constructed, with each row corresponding to an article and each column corresponding to each unique term in the vocabulary (which is generated by combining the vocabularies of all articles), and element i, j representing the frequency of word j in article i. An additional step we perform is to eliminate from this matrix columns corresponding to unigrams that appear in less then 0.1% of articles. The matrix is then used as input in the LDA model.

9.0.8 Filters Used

Two sets of words/ expressions were created. For the set of articles that were selected in the first step due to their two top ranking topics being equal to those of at least one of the benchmark articles, we restrict ourselves to those that contain at least one element of each set of expressions defined below. The first set is composed of words or expressions that are part of the "fiscal/political vocabulary" to which the benchmark articles are closely related. The second set‘s goal is to approximate articles that refer to Brazil, as articles can, for example, refer to the Greek fiscal crisis of 2012 and thus not be of our particular interest. Because of the complexity of Portuguese, apart from the words and expressions in both sets listed below, we also considered possible variations (such as plural versus singular or different prepositions that can be used in these expressions, as well as genre variations). The selection based on filters is not case sensitive.

All articles that are filtered based on the presence of expressions below already resemble, to some degree, benchmark articles, because of the previous selection solely based on their ranking topics.

Set 1: {’default da dívida’, ’calote da dívida’, ’risco fiscal’, ’ajuste fiscal’, ’precatório’, ’cenário fiscal’, ’piora fiscal’, ’rombo das contas’, ’teto de gastos’, ’preocupação fiscal’, ’descumprimento do superávit’, ’descumprimento do objetivo do superávit’, ’incerteza fiscal’, ’meta fiscal’, ’meta do superávit’, ’contas públicas’,’gastos públicos’, ’despesas públicas’, ’reforma da previdência’, ’brecha fiscal’,’renda cidadã’, ’aumento descontrolado’, ’descontrole das contas’, ’delação’, ’risco político’, ’crise institucional’, ’cenário político’, ’noticiário político’}

Set 2: {brasil’, ’brasileiro’, ’brasileira’, ’brasileiros’, ’brasileiras’, ’são paulo’, ’ibovespa’, ’bovespa’, ’bolsa’}

9.0.9 Results When Using a Smaller Set of Filters

The difference between this version and the previous one consists of a reduction in the words in set 1. We select only a few words from the original version of set 1 to form this new set, making the selection process more restrictive (articles selected must contain one or more words of set 1, which is now smaller than before).

Reduced version of set 1: {'Preocupação fiscal', 'calote', 'superávit primário', 'Risco fiscal', 'Incerteza fiscal', 'descontrole das contas', 'Rombo das contas', 'crise institucional', 'risco político', 'delação'}

Table 9.7: Responses of the interest rate curve yields to monetary and fiscal policy shocks.

	$\Delta y^{2\text{ mo.}}$	$\Delta y^{3\text{ mo.}}$	$\Delta y^{4\text{ mo.}}$	$\Delta y^{6\text{ mo.}}$	$\Delta y^{1\text{ yr.}}$	$\Delta y^{2\text{ yr.}}$	$\Delta y^{3\text{ yr.}}$	$\Delta y^{5\text{ yr.}}$	$\Delta y^{10\text{ yr.}}$
ΔVIX	0.02	0.03	0.05	0.08	0.17	0.29	0.36	0.39	0.44
	(0.01)***	(0.01)***	(0.01)***	(0.02)***	(0.03)***	(0.04)***	(0.05)***	(0.05)***	(0.05)***
ε^{IGP-M}	0.58	0.91	1.83	1.72	1.61	0.02	−0.66	−1.78	−4.67
	(0.59)	(0.78)	(0.84)**	(1.21)	(2.03)	(2.62)	(2.76)	(2.61)	(3.85)
$\varepsilon^{Industry}$	4.18	5.62	6.85	7.75	8.96	9.24	7.36	6.35	9.13
	(1.57)***	(2.00)***	(2.46)***	(3.08)**	(3.89)**	(5.16)*	(5.55)	(5.43)	(5.55)
ε^{IPCA}	6.51	10.45	13.26	17.42	23.06	25.60	24.50	16.24	7.86
	(1.83)***	(2.36)***	(2.80)***	(3.94)***	(3.78)***	(5.01)***	(6.34)***	(4.07)***	(6.31)
ε^{GDP}	8.24	8.80	9.54	10.24	19.02	15.04	2.77	18.29	19.67
	(2.74)***	(3.51)**	(4.30)**	(5.28)*	(7.96)**	(14.45)	(21.94)	(14.54)	(13.08)
ε^{i}	100.43	107.15	110.90	115.03	109.80	89.83	78.20	43.94	25.77
	(3.04)***	(5.51)***	(8.29)***	(10.05)***	(9.36)***	(10.23)***	(12.26)***	(10.69)***	(10.84)**
ε^{g}	0.42	0.64	1.41	1.91	3.04	3.09	1.82	2.78	1.35
	(0.92)	(1.00)	(1.20)	(1.50)	(2.63)	(3.93)	(4.08)	(3.99)	(4.88)
Fisc. and Pol. Turm.	1.20	1.33	1.57	1.93	2.66	2.92	3.02	3.33	3.83
	(0.35)***	(0.40)***	(0.48)***	(0.64)***	(0.90)***	(1.12)***	(1.15)***	(1.17)***	(1.15)***
Adjusted R^2	0.22	0.18	0.15	0.12	0.07	0.05	0.04	0.04	0.03
ε^{i}	62.21	65.72	68.61	72.79	72.79	62.02	53.71	30.14	15.00
	(7.94)***	(8.28)***	(8.57)***	(9.10)***	(11.65)***	(13.41)***	(15.61)***	(11.85)**	(11.35)
Adjusted R^2	0.53	0.47	0.43	0.40	0.29	0.21	0.16	0.05	0.01
ε^{g}	0.48	0.74	1.47	2.19	3.53	4.42	3.55	4.59	3.44
	(0.97)	(1.06)	(1.25)	(1.64)	(2.78)	(4.15)	(4.57)	(4.60)	(5.44)
Adjusted R^2	−0.004	−0.004	−0.003	−0.001	0.003	0.003	−0.001	0.0003	−0.003

.Robust standard errors are used, and superscripts *,** and *** denote statistical significance at, respectively, 10%, 5% and 1% levels.

.The monetary shock is expressed in percentage points, and macroeconomic surprises are expressed as standard deviations.

Table 9.8: Responses of the exchange rate and stock market returns to monetary and fiscal policy shocks.

	Exchange rate				**Stock market index**			
	Complete	Diff. signs	Mon.	Fisc.	Complete	Diff. signs	Mon.	Fisc.
Synthetic Real	0.98	0.98						
	(0.04)***	(0.04)***						
synthetic Ibov.					0.97	0.97		
					(0.04)***	(0.04)***		
$\Delta Commod.$	−0.08	−0.08						
	(0.02)***	(0.02)***						
ΔVIX	0.01	0.01			−0.04	−0.04		
	(0.002)***	(0.002)***			(0.004)***	(0.004)***		
ε^{IGP-M}	−0.17	−0.18			0.31	0.31		
	(0.19)	(0.19)			(0.20)	(0.20)		
$\varepsilon^{Industry}$	−0.41	−0.41			−0.06	−0.06		
	(0.34)	(0.34)			(0.40)	(0.40)		
ε^{IPCA}	−0.43	−0.43			−0.51	−0.51		
	(0.32)	(0.32)			(0.33)	(0.33)		
ε^{GDP}	−0.95	−0.95			0.45	0.46		
	(0.58)	(0.58)			(0.86)	(0.86)		
ε^{i}	−1.30		−0.66		−3.26		−3.15	
	(0.56)**		(0.65)		(0.79)***		(0.79)***	
ε^{g}	0.45			0.50	0.68			0.42
	(0.33)			(0.51)	(0.36)*			(0.51)
ε^{i}_{+}		−1.55				−4.47		
		(1.12)				(1.64)***		
ε^{i}_{-}		−1.22				−2.85		
		(0.63)*				(0.89)***		
ε^{g}_{+}		0.59				1.17		
		(0.59)				(0.63)*		
ε^{g}_{-}		0.36				0.36		
		(0.38)				(0.42)		
Swaps	−0.0000	−0.0000						
	(0.0000)	(0.0000)						
Rev. Swaps	0.0000	0.0000						
	(0.0000)***	(0.0000)***						
Spot Net Interv.	−0.0002	−0.0002						
	(0.0001)***	(0.0001)***						
Repos	0.0001	0.0001						
	(0.001)	(0.001)						
FOREX. Loans	−0.0004	−0.0004						
	(0.0004)	(0.0004)						
Fisc. and Pol. Turm.	0.15	0.15			−0.15	−0.15		
	(0.05)***	(0.05)***			(0.07)**	(0.07)**		
Adjusted R^2	0.41	0.41	−0.001	0.005	0.54	0.54	0.04	−0.001