

**UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL
FACULDADE DE CIÊNCIAS ECONÔMICAS
PROGRAMA DE PÓS-GRADUAÇÃO PROFISSIONAL EM ECONOMIA**

BERNARDO HILLESHEIM PAULSEN

**POLITICS AND INFORMATIONAL EFFICIENCY:
BRAZILIAN TERM STRUCTURE**

Porto Alegre

2024

BERNARDO HILLESHEIM PAULSEN

**POLITICS AND INFORMATIONAL EFFICIENCY:
BRAZILIAN TERM STRUCTURE**

Dissertation submitted to the Programa de Pós-Graduação em Economia of Faculdade de Ciências Econômicas at UFRGS, as a partial requirement for the degree of Mestre em Economia, professional modality, concentration area: Economia do Desenvolvimento.

Advisor: Professor Ph.D. Nelson Seixas dos Santos

Porto Alegre

2024

CIP - Catalogação na Publicação

Paulsen, Bernardo Hillesheim
Politics and informational efficiency: Brazilian
term structure / Bernardo Hillesheim Paulsen. --
2024.
28 f.
Orientador: Nelson Seixas dos Santos.

Dissertação (Mestrado Profissional) -- Universidade
Federal do Rio Grande do Sul, Faculdade de Ciências
Econômicas, Programa de Pós-Graduação em Economia,
Porto Alegre, BR-RS, 2024.

1. Mercados eficientes. 2. Política. 3. Estrutura a
termo das taxas de juros. 4. Ciência de dados. I.
Santos, Nelson Seixas dos, orient. II. Título.

BERNARDO HILLESHEIM PAULSEN

**POLITICS AND INFORMATIONAL EFFICIENCY:
BRAZILIAN TERM STRUCTURE**

Dissertation submitted to the Programa de Pós-Graduação em Economia of Faculdade de Ciências Econômicas at UFRGS, as a partial requirement for the degree of Mestre em Economia, professional modality, concentration area: Economia do Desenvolvimento.

Accepted on: Porto Alegre, January 18, 2023.

EXAMINATION COMMITTEE:

Professor Ph.D. Nelson Seixas dos Santos – Advisor
UFRGS

Professor Ph.D. Fernando Augusto Boeira Sabino da Silva
UFRGS

Professor Ph.D. Sabino da Silva Pôrto Júnior
UFRGS

ABSTRACT

Economic policy, as it affects the state of the economy, has a major impact on financial returns. The continuation or change in economic policy, however, does not occur without context, and is always a result of the continuous day-to-day political process. In this context, the problem we address in this research is whether daily politics affects the dynamics of the term structure of interest rates. We use web-scraping to collect political news from major Brazilian news portals. We consider the term structure of the one day inter-bank deposits rate, which is closely related to Brazilian monetary policy, and we estimate the term structure with data on the actual interest rate and its future contracts. We finally test whether the daily volume of political news causes volatility in the term structure. We find that politics does affect the term structure of interest rates. For specific maturities and with limited lags, our results show significant causality between political news and the term structure. The major implications of our findings relate to the management of risk in investment portfolios. Day-to-day politics is found to be a valuable source of information for the prediction of term structure risk, and thus the data on events of the continuous political process may be added to the set of information used by investors in the portfolio management process.

Keywords: Efficient markets. Politics. Term structure of interest rates. Data science.

RESUMO

A política econômica, como afeta o estado da economia, tem um grande impacto nos retornos de ativos financeiros. A continuidade ou mudança na política econômica, entretanto, não ocorre sem contexto, sendo sempre resultado do contínuo processo político do dia a dia. Nesse contexto, o problema abordado nesta pesquisa é se a política diária afeta a dinâmica da estrutura a termo das taxas de juros. Utilizamos a técnica de *web-scraping* para coletar notícias políticas dos principais portais de notícias brasileiros. Consideramos a estrutura a termo da taxa de depósitos interbancários de um dia, que está intimamente relacionada à política monetária brasileira, e estimamos a estrutura a termo com dados sobre a taxa de juros atual e seus contratos futuros. Por fim, testamos se o volume diário de notícias políticas causa volatilidade na estrutura a termo das taxas de juros. Descobrimos que a política afeta a estrutura a termo das taxas de juros. Para vencimentos específicos e com defasagens limitadas, nossos resultados mostram causalidade significativa entre notícias políticas e a estrutura a termo. As principais implicações de nossas descobertas estão relacionadas ao gerenciamento de risco em carteiras de investimento. A política do dia a dia mostra-se uma valiosa fonte de informação para a previsão do risco da estrutura a termo, e assim os dados sobre os eventos do processo político contínuo podem ser adicionados ao conjunto de informações utilizadas pelos investidores no processo de gestão de carteiras.

Palavras-chave: Mercados eficientes. Política. Estrutura a termo das taxas de juros. Ciência de dados.

CONTENTS

1	INTRODUCTION	6
2	THEORY OF MARKET EFFICIENCY.....	8
3	POLITICAL INFORMATION AND THE MARKET	10
4	EMPIRICAL STRATEGY	11
4.1	INSTITUTIONAL ENVIRONMENT.....	12
4.2	POLITICAL INFORMATION	12
4.3	INTEREST RATES.....	15
4.4	TERM STRUCTURE MODEL.....	17
4.5	VOLATILITY MODEL	20
5	RESULTS AND DISCUSSION	22
6	CONCLUDING REMARKS	24
	REFERENCES	26

1 INTRODUCTION

The semi-strong market efficiency as defined in Fama (1970) states all information about future prices is embedded in actual market prices so that public available news should not serve as a predictor to market prices. This means prices absorb information immediately, leaving aside any arbitrage opportunity.

That result is particularly interesting to economic policy since it guarantees its effects will take place as soon as possible. Economic policy though isn't the only policy made by governments, and other policies may as well affect the economy. Actually any policy whatsoever may impact financial returns since the latter are affected by the state of the economy as supposed by any asset pricing model like, for instance, Merton (1973), Lucas Jr (1978) or Harrison and Kreps (1979). Moreover, models like Kydland and Prescott (1982) suggest it takes time for the impact of economic measures to fully reflect on real variables, and it may be the case that financial returns also respond to policies with a delay.

In democratic countries, there is alternation of power between different political parties, and each one will defend a different economic policy. Elections, then, are events that define economic policy expectations. Uncertainty about the outcome of an election may raise uncertainty about economic policy, and as a consequence market volatility may increase. This behavior is actually reported in Li and Born (2006), Goodell and VähäMaa (2013) and Smales (2015).

Moreover, day-to-day political events also affect the various policies of a government – including the economic – since they define the division of power between the different parties of the legislative power and even between the different branches of government. These events are generally of less importance than elections, and we should therefore expect from them a lesser impact on the financial markets than the one we observe on elections. This expectation is confirmed in Marques and Santos (2016), which report that stocks respond to few political events while the interest rate responds to none, and Paulsen (2019), which reports the exchange coupon responds to few political events.

Among financial assets, 'sovereign bonds are the asset most directly associated with government policy' (Mcmenamin; Breen; Muñoz-Portillo, 2016, p.3). Thus it can be expected that political events will change the expectations for government policy and consequently also bonds' prices, affecting the term structure of interest rates.

Furthermore, these events may influence market volatility as an increasing in trading volume occurs while investors 'rebalance their portfolios in light of the news' (Smales, 2013).

In that scenario, the term structure of interest rates seems to be of paramount importance in the assessment of the effects of politics in the financial markets, since it captures each day the whole dynamics of the cost of money for years to come. The term structure of interest rates is thus the framework we will use to measure what we want to, that is, how long does it take to political events affect forward interest rates if it affects at all? More specifically, we will test the following hypothesis: does the volume of political news in Brazilian newspapers causes volatility – in the sense of Granger (1969) - in the term structure of the inter-bank deposits interest rate?

We apply web-scraping in the main Brazilian news portals to collect information on political news articles, with which we calculate the overall daily volume of published articles on politics. The term structure of interest rates is built with the Vasicek (1977) model, using data on the inter bank deposits rate and its future contracts. The Bollerslev (1986) model is used to estimate the volatility of various maturities of the term structure. Finally, we test if the volume of political news Granger (1969) causes volatility in the term structure.

This paper contributes to the literature in the following ways. First, we shed light on the interconnections between politics and financial assets in Brazil, where the structure and power of government differ from the countries generally considered in the literature. Second, we focus on political events in general, even the ones that have taken place when the party in power is not changing – unlike previous research which mainly focus on specific events of arguably great importance, such as elections. Third, we analyze the impact of politics in the whole term structure – which gives information on the value of money for years to come – and thus reveals market expectations for that same period, which ranges from a single day to several years into the future. Finally, we test not only the existence but also the timing of the impact of political information, therefore we shed light on the process of absorption of information by the financial markets.

The organization of paper goes as follows. Section (2) presents the theory of market efficiency about the behavior of market prices. Section (4) explains the procedure we follow to answer the question we posed. Section (5) show the results we find and compare them with the literature we disclosed. Finally, section (6) closes the paper and gives a hint around the continuation of the research.

2 THEORY OF MARKET EFFICIENCY

Market efficiency is the most influential theory of the asset pricing literature since it was popularized in Fama (1970). Other theories developed since were presented as an alternative to the market efficiency theory and their struggle was to account for the market anomalies, namely empirical findings which are considered counter-evidence to market efficiency.

Malkiel (1987, p. 1) defines market efficiency as follows:

[...] the market is said to be efficient with respect to some information set, Φ , if security prices would be unaffected by revealing that information to all participants. Moreover, efficiency with respect to an information set, Φ , implies that it is impossible to make economic profits by trading on the basis of Φ .

Formally, following Fama (1970), the theory states

$$E[p_{j,t+1}|\Phi_t] = (1 + E[r_{j,t+1}|\Phi_t])p_{j,t} \quad (2.1)$$

where $p_{j,t}$ is the price of asset j at time t , Φ_t is the information set at time t , and $r_{j,t}$ is the net return of asset j at time t .

The three classical categories for the information set, as posed by Fama (1970) are: weak form, where Φ is past prices; semi-strong form, where Φ is all publicly available information (including past prices); strong form, where Φ is all information, including private (and all publicly available information).

One can ask if hypothetical trading based on a specific Φ would earn economic profits as a test for market efficiency related to Φ . Nevertheless, this requires a specific model that “specifies the nature of market equilibrium when prices ‘fully reflect’ available information” (FAMA, 1970, p. 414).

In this approach, one must first choose Φ , then specify a model of “normal” returns, and finally compute the abnormal returns as the difference between the return on a security and its normal return, using Φ (Campbell; Lo; Mackinlay, 1997). “If the abnormal security return is unforecastable, [...] then the hypothesis of market efficiency is not rejected” (Campbell; Lo; Mackinlay, 1997, p. 22).

As Fama (1991, p. 1575), referring to Fama (1970), states “market efficiency per se is not testable”. Anomalous evidence can refer to efficiency or the asset pricing modeling, the split being ambiguous in accordance with Roll (1977).

Fama (1970) concludes weak-form tests are strongly in support of the market efficiency

hypothesis, and semi-strong form tests also support the hypothesis. Two decades later, Fama (1991) concludes controversy about market efficiency lies mostly on return predictability tests.

3 POLITICAL INFORMATION AND THE MARKET

The research on the direct relationship between political information and financial markets has focused mainly in election-related event studies, eventually involving other types of political events of great repercussion in the public discussion. In this section we discuss some findings of that research and of our own recent research on the topic – where we considered day-to-day political information.

As of the periods leading to elections, Li and Born (2006), Goodell and Vähämaa (2013), and Smales (2015) report that political uncertainty – the uncertainty about the outcome of an election – drives up market uncertainty. Li and Born (2006) and Smales (2015) use public polls data to measure political uncertainty, and Goodell and Vähämaa (2013) use the prices of contracts in which the payoff is based on the election outcome. Additionally, Smales (2015) reports that the probability of the current ruling party remaining in power drives down market uncertainty.

As of the election outcomes, Eichler and Plaga (2020) report a positive impact on the cumulative abnormal returns of sovereign bonds in the case of alternation of power when the government showed a low primary fiscal balance during the mandate of the current ruling party. This result holds only for emerging markets though, as they found no evidence of the previous behavior when developed countries were considered.

Considering not only elections but also global summits, Kelly, Pástor and Veronesi (2016) report that political uncertainty is priced in the option market. When testing the predictions of a theoretical model of government policy choice, they find that the protection given by options is more valuable when major political events happen during their life-time, this being increased as the economy is weaker and as political uncertainty is higher. When day-to-day political events are considered, as they were in Marques and Santos (2016) and Paulsen (2019), results show little to no impact of politics on the financial markets. Both papers relate moments of abnormal volatility in financial assets to political events reported in the news, although they consider different financial assets. Marques and Santos (2016) report no impact of political events in the bond market, and rare impacts in the stock market. Paulsen (2019) considers the exchange coupon, and reports results similar to the ones on the stock market in the previous paper, that means the existence of impact from political events is rare.

4 EMPIRICAL STRATEGY

The hypothesis we test in this study is whether the arrival of political information causes volatility in the term structure of interest rates. The hypothesis is tested specifically for the case of Brazil.

The political information we consider are Brazilian news articles on the subject of politics, and we calculate the total daily volume of these news. The information about the bond market that we consider are: the daily value of the one-day inter-bank deposit rate; the daily value of futures contracts that have the one-day inter-bank deposit rate as the underlying asset. We use this information in order to estimate the daily volatility for each maturity of the yield curve. First, we build the term structure of interest rates according to the Vasicek (1977) model, then we estimate the volatility process for the prices of each maturity with the Bollerslev (1986) model. In order to evaluate the impact of the political information on the term structure of interest rates, we apply Granger (1969) causality tests on the total daily volume of news and the daily volatility for each maturity of the yield curve.

Each one of those steps are carried out using the programming language described in Langa (2022). Python was chosen as it provides numerous mature libraries which can be used to execute, with minimal effort, each step of the empirical strategy. Also, as it is one of the most popular programming languages right now, the community is large and welcoming, making possible an efficient development process as information is found also with minimal effort.

The execution of each method required the use of specific packages, which we will mention as we follow the empirical strategy. Two packages were used through the strategy, which are: McKinney (2010), with which we managed and described the data; Hunter (2007), with which we generated all plots. When there was need to process date and time data taking weekends and holidays into consideration, we used the Bord (2022) package.

The section goes as follows. Subsection 4.1 describes the institutional environment in Brazil, with focus on the national financial system. The two subsections that follow discuss both the data on political information (Subsection 4.2) and on interest rates (Subsection 4.3). The final subsections discuss the financial and econometric models, Subsection 4.4 discusses the Vasicek (1977) model while Subsection 4.5 discusses the Bollerslev (1986) model.

4.1 INSTITUTIONAL ENVIRONMENT

First, we shall describe the institutional environment of Brazil, which defines not only the nature of the political system but also the nature of the monetary and financial systems, which ultimately define the nature of the generating process of all financial variables. As a consequence, understanding the institutional environment is of paramount importance for the understanding of our data.

Brazilian institutions are designed as a typical western democratic state ruled by civil law (Brasil, Constituição 1988). Accordingly, Brazilian Financial System was instituted in Law No. 4595, December 31, 1964 (Brasil, 1964), which established the National Monetary Council as the major normative institution and the Central Bank as the major executive institution. The Monetary Council defines – monetary and exchange – policy guidelines, which are executed by the Central Bank – that has the monopoly of currency and executes its policies through operations with public debt securities (issued by the National Treasury). Recently, the Central Bank was made independent from the Ministry of Economy - Complementary Law No. 179, February 24, 2021 (Brasil, 2021) - our sample period lies before this event however. The Securities and Exchange Commission of Brazil was established in Law No. 6.385, of December 7, 1976 (Brasil, 1976), and disciplines and supervises the transferable securities market. The only securities exchange in Brazil, B3, acts in all branches of the transferable securities market.

Besides, the so-called Economic Tripod, which is a set of rules that determines specific regimes for fiscal, monetary and exchange policies, was established in 1999 in Decree No. 3088, of June 21, 1999 (Brasil, 1999). The monetary policy would follow an inflation targeting regime. The target for the inflation rate would be defined by the Monetary Council, the target for the short-term interest rate would be defined – every 45 days – by the Monetary Policy Committee, and the Central Bank would pursue that interest rate.

4.2 POLITICAL INFORMATION

The political information we are going to consider is that disseminated through news articles coming from open access online news portals with national coverage. The decision to use open access online news portals was made considering the availability of the data, and we chose to include only news portals with national coverage since we consider the national term structure of interest rates. The information we extract from the data on political news is the daily

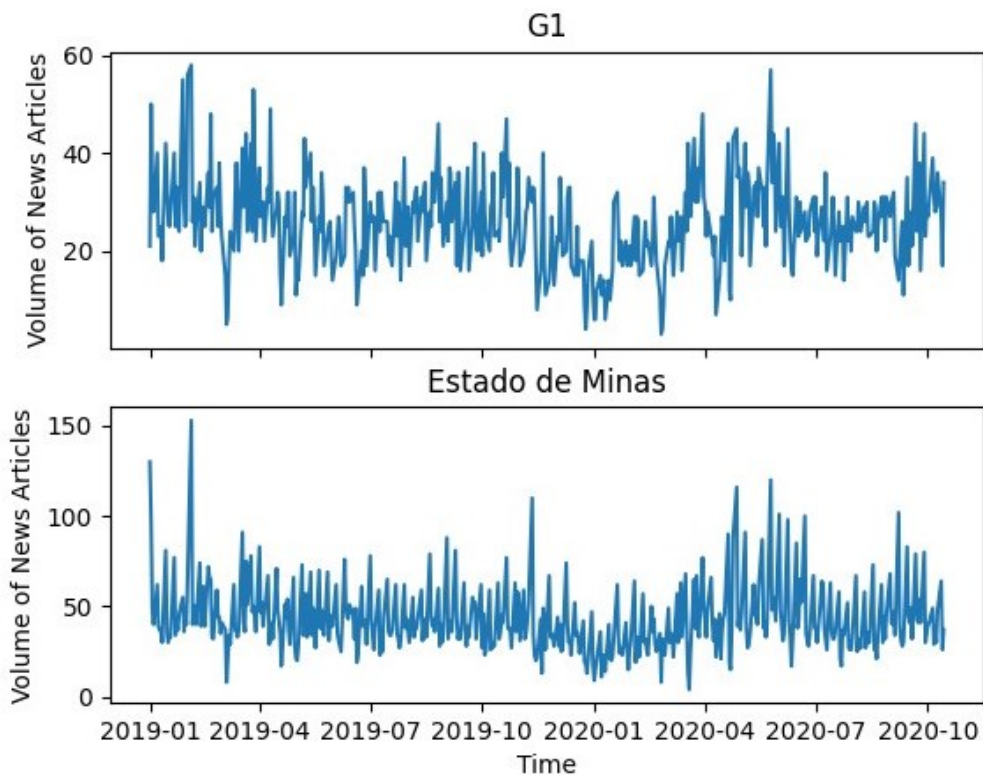
volume of news articles.

We collect data from news portals via web scraping, using Python package Zyte (2022) to scrape static web pages, and a combination of Python packages, Selenium (2022) and Richardson (2007) to scrape dynamic web pages. The data we collected about each article was only its main information (date and time, title, and link).

At first, the news portals considered were 'G1', 'Estado de Minas', 'Universo Online' (UOL) and 'iG'. From this sample, we chose the portals which had at least 2 years of data. The portals 'G1' and 'Estado de Minas' remained. To calculate the daily volume of news, we considered, for each date in which the spot and futures markets opened, all news from the closing time of the markets at the previous date until the closing time of the markets at the current date.

The volume of news for each portal is shown in Figure 1, and the total daily volume of news from both portals are shown in Figure 2. Descriptive statistics are shown in Table 1.

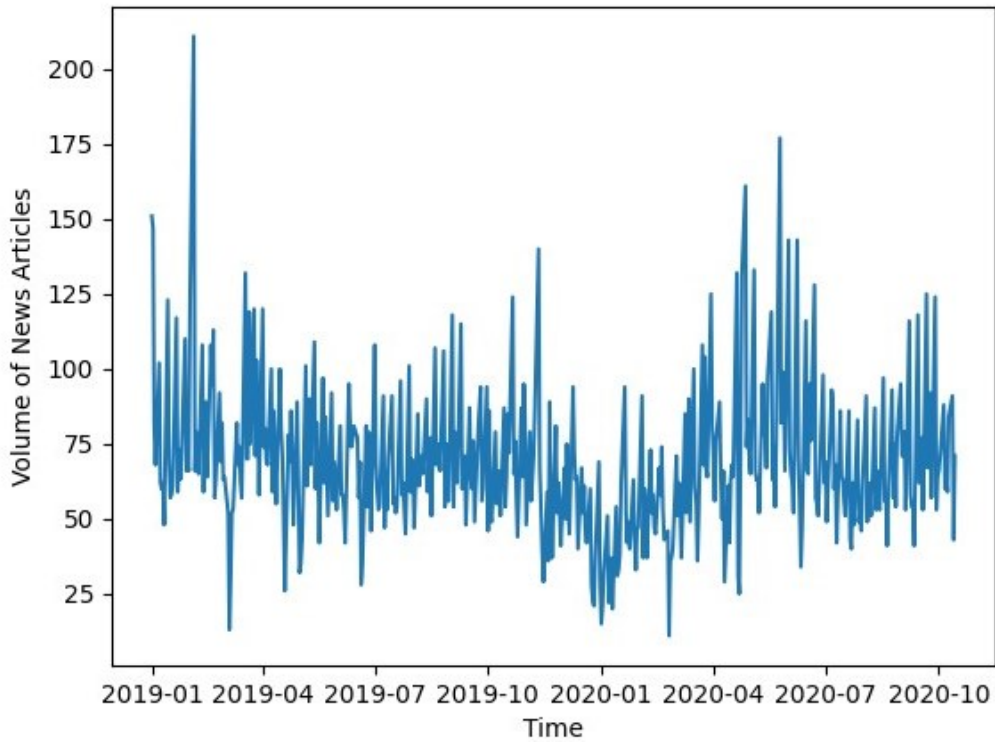
Figure 1 - News Volume for Each Portal



Source: proprietary development based on data collected by proprietary application.

As we see in Figure 1 the daily volume of news of each portal varies from day-to-day, but remains close to its mean thorough the sample. This behavior is also exhibited by the total news volume from both portals, as we see in Figure 2. As Table 1 shows, 'Estado de Minas' has overall greater volume of news and variance in the daily volume than 'G1'.

Figure 2 - Total News Volume



Source: ptopietary development based on data collected by proprietary application.

Table 1 - Descriptive Statistics on News Volume

	G1	Estado de Minas	Total
Mean	26.194861	42.171306	68.366167
Standard Deviation	8.992995	19.047394	25.090411
Minimum	3	4	11
Maximum	58	153	211

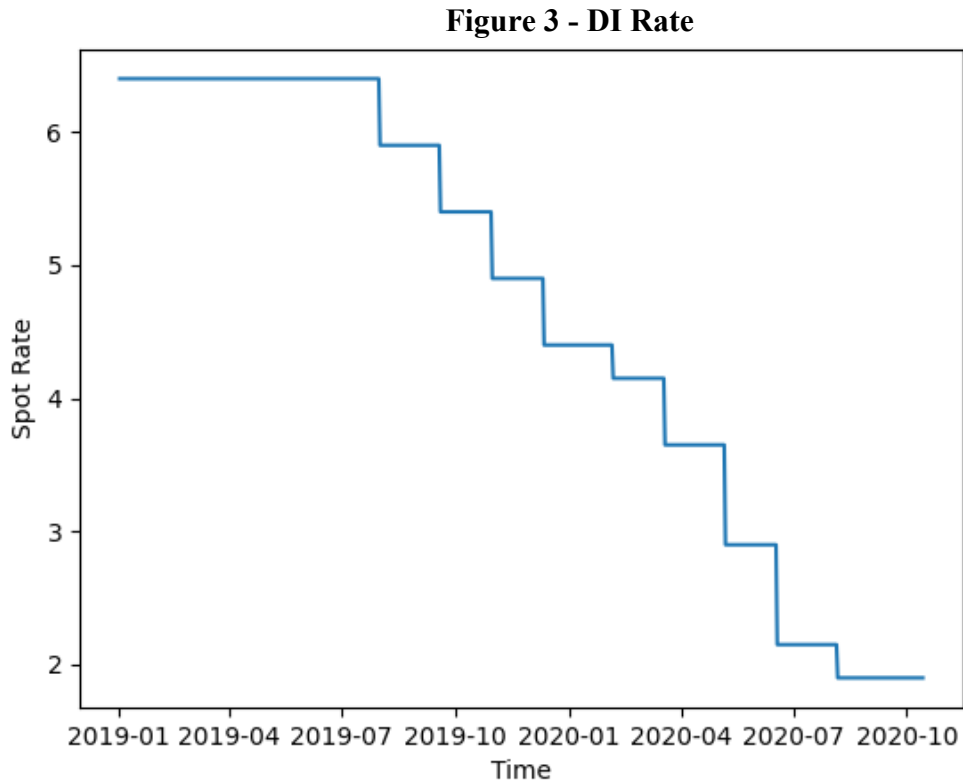
Source: ptopietary development based on data collected by proprietary application.

4.3 INTEREST RATES

The interest rate considered in this study is the one day inter-bank deposits rate (DI rate). We use daily data on both the DI rate and the futures contracts that have the DI rate as underlying asset. We choose this specific interest rate as it is backed by public titles and defined by competition across banks as they lend from and borrow to each other with the intention of not closing with negative cash. This rate also is the asset behind a lot of post-fixed income contracts.

The spot rate was collected from the Time Series Management System of Central Bank of Brazil. The System is an open access source of data for many Brazilian economic variables. The prices of futures contracts were collected from Economática, a paid service that our university subscribes to and makes available to its academic community.

In Figure 3 we show the DI spot rate data, and in Figure 4 we show prices of future contracts for six equally spaced dates during the same time period. Table 2 contains descriptive statistics on the DI spot rate.



Source: proprietary development based on data from ECONOMATICA.

Table 2 - Descriptive Statistics of the DI Rate

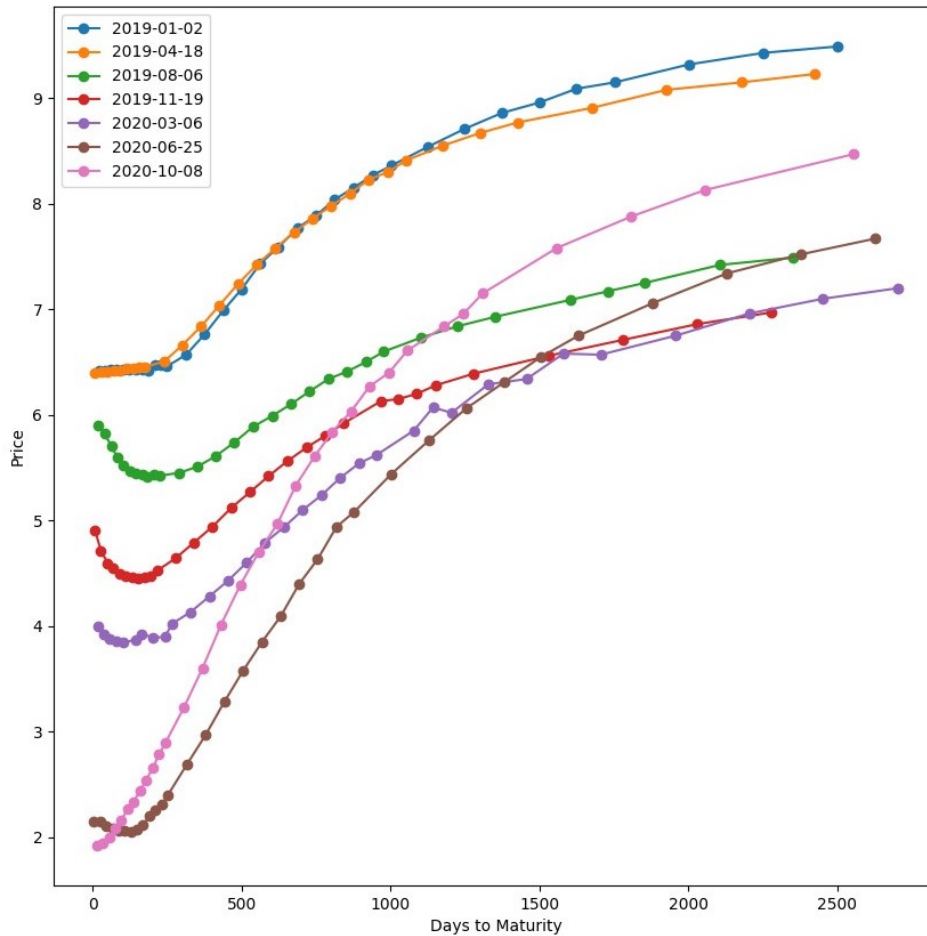
Mean	4.657222
Standard Deviation	1.656743
Minimum	1.9
Maximum	6.4

Source: proprietary development based on data from ECONOMATICA.

As we can see in Figure 3, in the sample period the DI rate was non-increasing, actually it decreased after almost every meeting of the Monetary Policy Committee. In this period, inflation was also decreasing. The year of 2019 showed an increase in GDP, whereas the year of 2020 – the first year of economic restrictions motivated by the COVID- 19 pandemic – showed great decrease in GDP.

The sample period matches the beginning of the presidency of President Jair Messias Bolsonaro from Social Liberal Party, the first elected president who was not from the Labour Party since 2002 – although the impeachment of President Dilma Roussef in 2016 caused her vice president, Michel Temer from the Brazilian Democratic Movement Party, to occupy the presidency for the last two years of the mandate of their badge.

Figure 4 - Price of Future Contracts



Source: proprietary development based on data from ECONOMATICA.

As briefly shown in Figure 4, the Brazilian term structure was mostly upward sloping during the sample period. The term structure varied greatly in level nevertheless, following the behavior of the spot rate. The difference between the short and long maturities was also great in occasions, as in June 25, 2020, when the difference between the shortest and longest maturity was above 5 percentage points.

4.4 TERM STRUCTURE MODEL

In this study we consider the Vasicek (1977) model of the term structure of interest rates. We chose this model as it has few assumptions, one being the efficiency of the financial markets, and is widely used both in academia and in the financial industry.

The Vasicek model is a one factor continuous affine model based on an arbitrage

argument. Three assumptions are made:

- a) the spot rate follows a diffusion process,
- b) the price of a discount bond depends only on the spot rate over its term,
- c) the market is efficient.

From these assumptions it follows that the spot rate is the only state variable of the term structure, and the only source of risk. Adding two more assumptions – the market price of risk is a constant and the spot rate follows a Ornstein-Uhlenbeck process – we arrive at a specific case of the model, which will be the one considered in this research, and which main results are the following:

the spot rate follows the process

$$dr = \alpha(r - r)dt + \sigma dz \quad (4.1)$$

where r is the spot rate and z is a Wiener process, and the term structure takes the form

$$R(t, T) = R(t) + (r(t) - R(t)) e^{-\alpha(T-t)} + \frac{\sigma^2}{4\alpha^3} (1 - e^{-\alpha(T-t)})^2 \quad (4.2)$$

where

$$R(t) = \frac{1}{T-t} \left[\int_t^T R(t, s) ds + \frac{1}{2} \sigma^2 (T-t) \right] \quad (4.3)$$

where $R(t, T)$ is the internal rate of return at time t on a bond with maturity date

$$T = t + s.$$

We build the term structure from the spot rate and futures contracts data. For each date, we adjust the Vasicek (1977) model to the spot and futures data of that date, from which we extract a continuous term structure. We chose specific maturities for which we calculate the value of the term structure at each date so we have data on the daily interest rate for each maturity.

We use the Virtanen et al. (2020) library to adjust the Vasicek model to the data. We calculate the interest rates for all daily maturities from 0 days to 8 years. The term structure is shown in Figure 5, and in Table 3 the descriptive statistics for 6 different maturities as shown.

Figure 5 - Term Structure

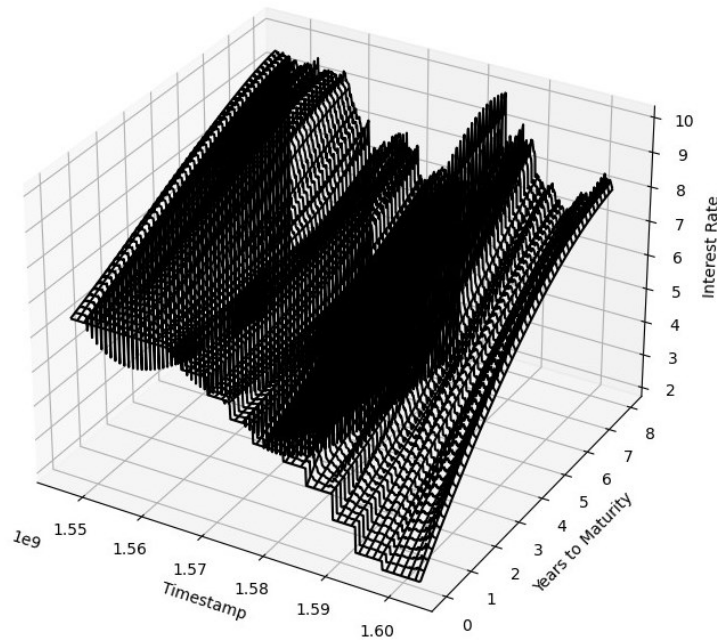


Table 3 - Descriptive Statistics on Term Structure

Maturity	0.004	1.587	3.171	4.754	6.337	7.921
Mean	4.653178	5.265556	5.922419	6.607123	7.285843	7.845636
Std. Dev.	1.653271	1.365466	1.205820	1.151001	1.145621	1.136792
Minimum	1.902698	3.009608	2.448617	2.156445	1.996108	1.897540
Maximum	6.402318	7.305787	8.140233	8.855964	9.887988	10.034740

Source: ptopietary development based on data from ECONMATICA.

As previously indicated by the DI rate and future contracts data, the term structure was mostly upward sloping during the sample period, also the shortest maturities showed a clear downward trend.

4.5 VOLATILITY MODEL

We measure the spot rate volatility with the Bollerslev (1986) model, namely the Generalized AutoRegressive Conditional Heteroskedasticity (GARCH) model. We chose this model as it was created specifically for economic time series and is widely used in academia and in the financial industry – as is the case of the Vasicek (1977) model.

The GARCH model is a parametric model, where the conditional variance is specified as a linear function of lagged sample and conditional variances. The model is given by the following equations:

$$r_t | f_{t-1} \sim N(0, h_t) \tag{4.4}$$

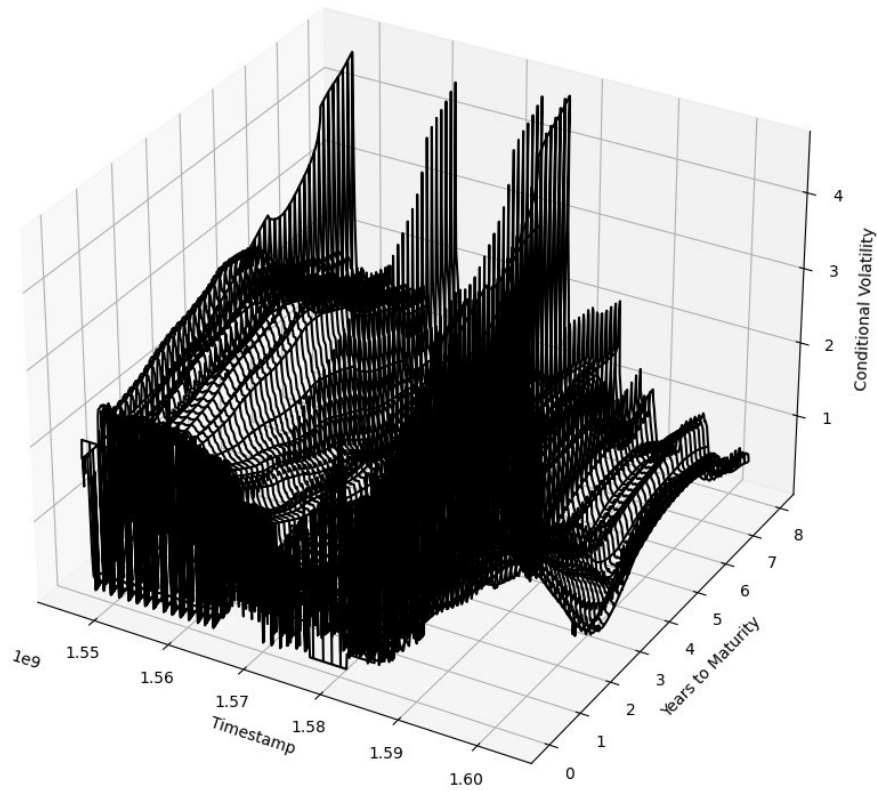
and

$$h_t = \omega + \sum_{i=1}^q \alpha_i r_{t-i}^2 + \sum_{i=1}^p \beta_i h_{t-i} \tag{4.5}$$

where r_t is the real-valued discrete time process and f_t is the information set of all information through time t .

The conditional volatility from the GARCH model was estimated with the (SHEP-PARD, 2022) library. All volatility series are shown in Figure 6, and the descriptive statistics for 6 different maturities are shown in Table 4.

Figure 6 - Term Structure Volatility



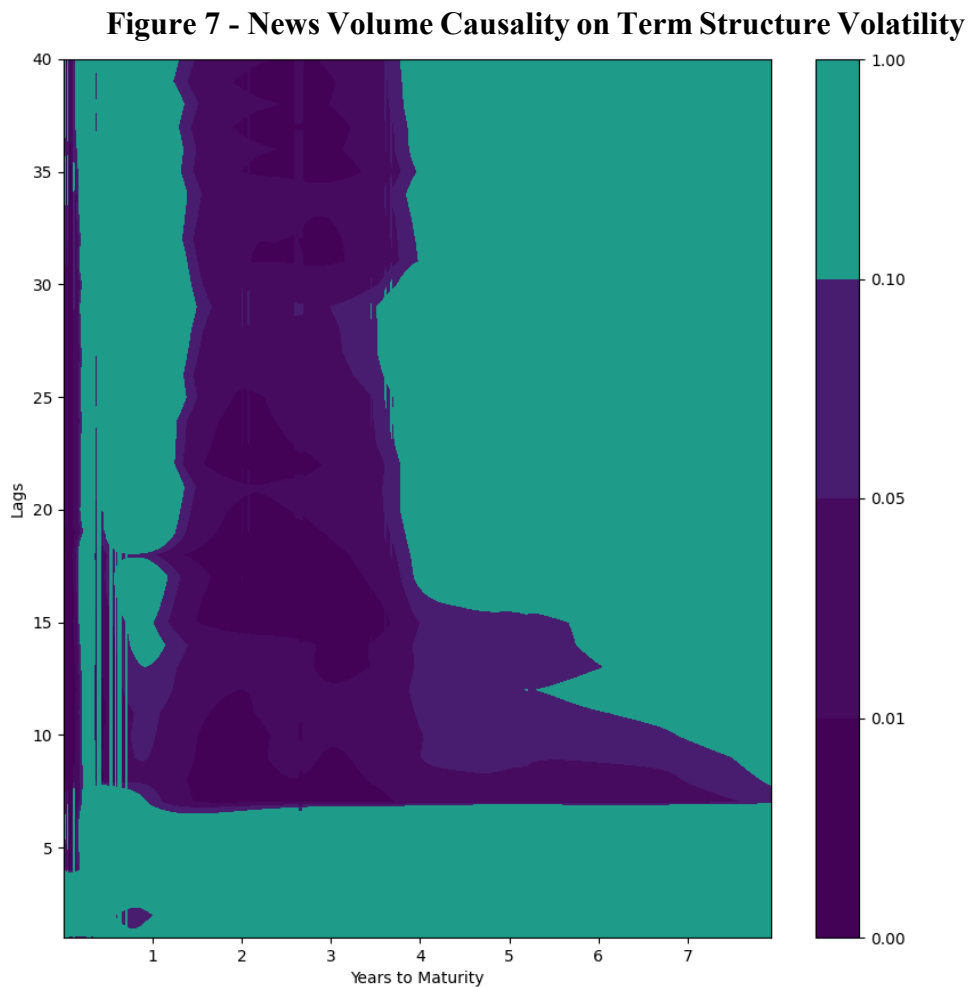
Source: proprietary development based on data built by proprietary application

Table 4 - Descriptive Statistics on the Volatility of the Term Structure

Maturity	0.004	1.587	3.171	4.754	6.337	7.921
Mean	1.470860	1.232396	1.117300	1.113322	1.078002	0.954672
Std. Dev.	0.791553	0.714202	0.818483	0.925470	0.611128	0.671146
Minimum	0.039481	0.039095	0.226883	0.266817	0.582090	0.244832
Maximum	2.492270	2.337352	2.726379	3.049969	3.386658	4.697934

5 RESULTS AND DISCUSSION

We measure causality between the volume of political news and the volatility of the term structure with the GRANGER (1969) test. Granger causality is estimated with the SEABOLD; PERKTOLD (2010) library. We test causality for all maturities of the term structure, using lags from 1 to 40. The p-value of each test is shown in Figure 7.



Source: proprietary development based on data from ECONOMATICA.

As we see above, the existence of causality is limited, but exists. At the shortest maturities, from a day until about a month, there is causality from the 4th lag until the 40th. In regards to the shorter lags, there is causality at the first 2 lags for maturities close to 1 year. There is also causality from about 2 to about 4 years of maturity, from the 5th lag to the 40th.

Our results show that the impact of political news are not immediate, and they actually last

for weeks. That suggests that the market adapts slowly to political information, and the market is thus not efficient in regards to this type of information. Moreover, there is significant impact in the short to mid-term maturities, what suggests that the political information released today may impact the economy and the financial markets mostly only a couple of years into the future.

In regards to the literature on elections, as Li and Born (2006), Goodell and Vähämaa, (2013), Smales (2015) and Eichler and Plaga (2020), our results show that political information impacts market uncertainty not only in the election periods but in an ongoing manner. While elections are arguably the event which most changes investors' expectations, the day-to-day politics also have this effect.

Previously, Marques and Santos (2016) found little to no effect of the day-to-day politics on the financial markets, results which were found also in Paulsen (2019). These studies have not used data on derivatives however, and, specially in the case of the inter-bank rate, the current value of the variable is much more influenced by the current economic policy than by the expectation of future economic policies. In our case, as we use data on the whole term structure of interest rates, we are able to measure market expectations clearly, and thus find the impact of political information on the financial markets.

6 CONCLUDING REMARKS

This research sheds light on the relationship between political information and the financial markets. More specifically, we test when the release of political information affects the volatility of the term structure, if it does at all. Since our approach is new – not only we use data on the whole term structure and daily political news, but we test for existence and timing of causality between them - the methods we chose to use are all very well established and widely used in academia and in the financial industry.

As shown in Section 5, our results show that, for specific maturities of the term structure and for specific lags – mainly the short-to-medium term maturities and lags greater than 5 days – there is causality between political information and the term structure indeed. That is, not only daily political information does affect the term structure of interest rates, but the latter responds to the first in a delayed manner.

The results mean the market is not efficient in regards to this set of information, as prices take time to absorb the release of new information in news articles. Furthermore, this means there is opportunity to make economic profit with political information, as it is useful information for the prediction of term structure volatility, a variable closely related to the prices of many derivatives.

Although politics is of great importance in the economy, and a broad field of study in economics, it seems both the academic literature and financial investors are missing on the importance of day-to-day political information in regards to market returns. Our results show that the overall, continuous political process is a meaningful source of information about the future paths the economy can follow, as market returns are directly related to investors expectations about the future of the economy.

A political event may mean instantaneous change in government policy, but can also be informative about a policy change which may happen only in the future. Also, a policy change may be the result of many political events which build up to the change. That is, political information may change expectations about future government policy without changing the expectations for current policy. Our results, as they encompass the whole term structure of interest rates, shed light on this fact, as most causality between political information and term structure volatility lies in the short-to-medium term maturities.

Investors may use political information for the sake of economic profit, but politicians can also benefit from the knowledge on how the information generated by their activity affects

the financial markets. The results of government policy are, to a great extent, dependent on how investors understand, evaluate and react to given policy.

As of future research, it would be very informative to see tests using high frequency data. In a world where high frequency trading is increasing, and where a great portion of trades are made by high frequency trading algorithms, the discovering of new sources of information for high frequency trading strategies is of great use for investors who search for economic profit and risk control.

Moreover, the growing field of natural language processing may be of great use in the process of extracting information from political news. In this study we do not consider the textual content of the political news we collected. This textual content is, however, a possible source of useful information for trading. Techniques like sentiment analysis can be used to address this question.

At last, the sole information on the relationship between a set of information and market prices is not enough to make economic profit. Taking this into consideration, future research could also engage with the problem of creating profitable trading strategies which benefit from daily political information.

REFERENCES

- BOLLERSLEV, T. Generalized autoregressive conditional heteroskedasticity. **Journal of Econometrics**, Amsterdam, v. 31, n. 3, p. 307–327, 1986. Available at: [https://doi.org/10.1016/0304-4076\(86\)90063-1](https://doi.org/10.1016/0304-4076(86)90063-1). Accessed on: Jan. 18, 2023.
- BORD, B. **Workalendar Documentation**. 2022. Available at: <https://workalendar.github.io/workalendar/>. Accessed on: Jan. 18, 2023.
- BRASIL. **Constituição da República Federativa do Brasil de 1988**. Brasília, DF, 1988. Available at: http://www.planalto.gov.br/ccivil_03/constituicao/constituicao.htm. Accessed on: Jan. 18, 2023.
- BRASIL. **Decreto no 3.088, de 21 de junho de 1999**. Estabelece a sistemática de "metas para a inflação" como diretriz para fixação do regime de política monetária e dá outras providências. Brasília, DF, 1999. Available from : http://www.planalto.gov.br/ccivil_03/decreto/d3088.htm. Accessed on: Jan. 18, 2023.
- BRASIL. **Lei complementar nº 179, de 24 de fevereiro de 2021**. Define os objetivos do Banco Central do Brasil e dispõe sobre sua autonomia e sobre a nomeação e a exoneração de seu Presidente e de seus Diretores; e altera artigo da Lei nº 4.595, de 31 de dezembro de 1964. Brasília, DF, 2021. Available at: http://www.planalto.gov.br/ccivil_03/leis/LCP/Lcp179.htm. Accessed on: Jan. 18, 2023.
- BRASIL. **Lei no 4.595, de 31 de dezembro de 1964**. Dispõe sobre a Política e as Instituições Monetárias, Bancárias e Creditícias, Cria o Conselho Monetário Nacional e dá outras providências. Brasília, DF, 1964. Available at: http://www.planalto.gov.br/ccivil_03/leis/l4595.htm. Accessed on: Jan. 18, 2023.
- BRASIL. **Lei no 6.385, de 7 de dezembro de 1976**. Dispõe sobre o mercado de valores mobiliários e cria a Comissão de Valores Mobiliários. Brasília, DF, 1976. Available at: http://www.planalto.gov.br/ccivil_03/constituicao/constituicao.htm. Accessed on: Jan. 18, 2023.
- CAMPBELL, J. Y.; LO, A. W.; MACKINLAY, A. **The econometrics of financial markets**. Princeton: Princeton University Press, 1997. Available from: <http://www.jstor.org/stable/j.ctt7skm5.6>. Accessed on: Jan. 18, 2023.
- EICHLER, S.; PLAGA, T. The economic record of the government and sovereign bond and stock returns around national elections. **Journal of Banking & Finance**, Amsterdam, v. 118, p. 105832, 2020. Available at: <https://doi.org/10.1016/j.jbankfin.2020.105832>. Accessed on: Jan. 18, 2023.
- FAMA, E. F. Efficient capital markets: A review of theory and empirical work. **The Journal of Finance**, New York, v. 25, n. 2, p. 383–417, 1970. 15406261. Available at: <https://www.jstor.org/stable/2325486>. Accessed on: Jan 18, 2023.
- FAMA, E. F. Efficient capital markets: II. **The Journal of Finance**, New York, v. 46, n. 5, p. 1575–1617, 1991. Available at: <https://doi.org/10.2307/2328565>. Accessed on: Jan. 18, 2023.
- GOODELL, J. W.; VãHãMAA, S. Us presidential elections and implied volatility: The role of

- political uncertainty. **Journal of Banking & Finance**, Amsterdam, v. 37, n. 3, p. 1108–1117, 2013. Available at: <https://doi.org/10.1016/j.jbankfin.2012.12.001>. Accessed on: Jan. 18, 2023.
- GRANGER, C. W. J. Investigating causal relations by econometric models and cross-spectral methods. **Econometrica**, Chicago, v. 37, n. 3, p. 424–438, 1969. ISSN 00129682, 14680262. Available at: <http://www.jstor.org/stable/1912791>. Accessed on: Jan. 18, 2023.
- HARRISON, J.; KREPS, D. M. Martingales and arbitrage in multiperiod securities markets. **Journal of Economic Theory**, San Diego, v. 20, n. 3, p. 381–408, 1979. Available at: [https://doi.org/10.1016/0022-0531\(79\)90043-7](https://doi.org/10.1016/0022-0531(79)90043-7). Accessed on: Jan. 18, 2023.
- HUNTER, J. D. Matplotlib: A 2d graphics environment. **Computing in Science & Engineering**, Los Alamitos, v. 9, n. 3, p. 90–95, 2007. Available at: <https://ieeexplore.ieee.org/document/4160265>. Accessed on: Jan. 18, 2023.
- KELLY, B.; PÁSTOR,.; VERONESI, P. The price of political uncertainty: theory and evidence from the option market. **The Journal of Finance**, New York, v. 71, n. 5, p. 2417–2480, 2016. Available at: <https://www.jstor.org/stable/44155394>. Accessed on: Jan. 18, 2023.
- KYDLAND, F. E.; PRESCOTT, E. C. Time to build and aggregate fluctuations. **Econometrica**, Chicago, v. 50, n. 6, p. 1345–1370, 1982. Available at: <https://doi.org/10.2307/1913386>. Accessed on: Jan. 18, 2023.
- LANGA, Ł. **The Python Language Reference**. 2022. Available at <https://docs.python.org/3.8/reference/index.html>. Accessed on: Jan. 18, 2023.
- LI, J.; BORN, J. A. Presidential election uncertainty and common stock returns in the United States. **Journal of Financial Research**, United States, v. 29, n. 4, p. 609–622, 2006. Available at: <https://doi.org/10.1111/j.1475-6803.2006.00197.x>. Accessed on: Jan. 18, 2023.
- LUCAS JR, R. E. Asset prices in an exchange economy. **Econometrica**, Chicago, p. 1429–1445, 1978. Available at: <https://www.jstor.org/stable/1913837>. Accessed on: Jan. 18, 2023.
- MALKIEL, B. G. Efficient market hypothesis. *In: The New Palgrave Dictionary of Economics*. London: Palgrave Macmillan, 1987. p. 1–7. Available at: https://doi.org/10.1057/978-1-349-95121-5_42-1. Accessed on: Jan. 18, 2023.
- MARQUES, T.; SANTOS, N. dos. Do political news affect financial market returns? evidences from brazil. **International Journal of Management, Accounting and Economics**, Mashhad, v. 3, n. 10, p. 545–571, 2016. Available at: http://www.ijmae.com/article_115521.html. Accessed on: Jan. 18, 2023.
- MCKINNEY Wes. Data Structures for Statistical Computing in Python. *In: PYTHON IN SCIENCE CONFERENCE*, 9., 2010. **Proceedings** [...]. 2010. 2010. p. 56-61.
- MCMENAMIN, I.; BREEN, M.; MUÑOZ-PORTILLO, J. Comparative politics and quasi-rational markets. **New Political Economy**, United States, v. 21, n. 6, p. 587–605, 2016. Available at: <https://doi.org/10.1080/13563467.2016.1183114>. Accessed on: Jan. 18, 2023.
- MERTON, R. C. An intertemporal capital asset pricing model. **Econometrica**, Chicago v. 41, n. 5, p. 867–887, 1973. Available at: <https://doi.org/10.2307/1913811>. Accessed on: Jan. 18, 2023.

PAULSEN, B. H. **Some evidence on political information and exchange coupon in Brazil**. 2019. Trabalho de conclusão (Graduação em Ciências Econômicas) - Universidade Federal do Rio Grande do Sul, Porto Alegre, 2019. Available at: <https://lume.ufrgs.br/handle/10183/198031>. Accessed on: Jan. 18, 2023.

RICHARDSON, L. **Beautiful soup documentation**. 2007. Available at: <https://www.crummy.com/software/BeautifulSoup/bs4/doc/>. Accessed on: Jan. 18, 2023.

ROLL, R. A critique of the asset pricing theory's tests part i: On past and potential testability of the theory. **Journal of Financial Economics**, Lausanne, v. 4, n. 2, p. 129-176, 1977. Available at: [https://doi.org/10.1016/0304-405X\(77\)90009-5](https://doi.org/10.1016/0304-405X(77)90009-5). Accessed on: Jan. 18, 2023.

SEABOLD, S.; PERKTOLD, J. Statsmodels: econometric and statistical modeling with python. *In: PYTHON IN SCIENCE CONFERENCE*, 9., 2010. **Proceedings** [...]. 2010. p. 92-96. Available at: <https://www.doi.org/10.25080/Majora-92bf1922-011>. Accessed on: Jan. 18, 2023.

SELENIUM PROJECT. **Selenium**. 2022. Available at: <https://www.selenium.dev>. Accessed on: Jan. 18, 2023.

SMALES, L. A. Better the devil you know: The influence of political incumbency on Australian financial market uncertainty. **Research in International Business and Finance**, Netherlands, v. 33, n. C, p. 59–74, 2015. Available at: <https://doi.org/10.1016/j.ribaf.2014.06.002>. Accessed on: Jan. 18, 2023.

SMALES, L. A. Impact of macroeconomic announcements on interest rate futures: High-frequency evidence from Australia. **Journal of Financial Research**, United States, v. 36, n. 3, p. 371–388, 2013. Available at: <https://doi.org/10.1111/j.1475-6803.2013.12015.x>. Accessed on: Jan. 18, 2023.

VASICEK, O. An equilibrium characterization of the term structure. **Journal of Financial Economics**, Lausanne, v. 5, n. 2, p. 177–188, 1977. Available at: [https://doi.org/10.1016/0304-405X\(77\)90016-2](https://doi.org/10.1016/0304-405X(77)90016-2). Accessed on: Jan. 18, 2023.

VIRTANEN, P., GOMMERS, R., OLIPHANT, T. E., HABERLAND, M., REDDY, T., COURNAPEAU, D., BUROVSKI, E., PETERSON, P., WECKESSER, W., BRIGHT, J., VAN DER WALT, S. J., BRETT, M., WILSON, J., MILLMAN, K. J., MAYOROV, N., NELSON, A. R. J., JONES, E., KERN, R., LARSON, E., CAREY, C. J. SciPy 1.0: Fundamental Algorithms for Scientific Computing in Python. **Nature Methods**, United States, v. 17, p. 261–272, 2020. Available at: <https://doi.org/10.1038/s41592-019-0686-2>. Accessed on: Jan. 18, 2023.

ZYTE; CONTRIBUTORS, S. **Scrapy 2.7**: documentation. Vienna, 2022. Available at <https://docs.scrapy.org/en/2.7/>. Accessed on: Jan. 18, 2023.