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MAURICIO ROCHA MENDES

POLITICAL NEWS AND THE BRAZILIAN SWAP MARKETS

Porto Alegre

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Trabalho de conclusão submetido ao Curso de Graduação em Ciências Econômicas da UFRGS, como requisito parcial para obtenção do título de Bacharel em Economia

Orientador: Prof. Dr. Nelson Seixas dos Santos

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Aos meus avós.

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RESUMO

Este trabalho estuda o efeito da divulgação de notícias relacionadas à política brasileira nos quatro contratos de *swap* mais negociados na bolsa de valores brasileira. Foram coletadas manchetes de notícias relacionadas a eventos políticos do site *g1.com.br*, e as taxas de referência dos preços dos contratos swap negociados do site b3.com.br para os swaps DI x Pre, Dollar x Pre, DI x DOllar e DI x IPCA. O período analisado é de 1º de Fevereiro de 2017 a 2 de Outubro de 2020. As notícias foram coletadas por *web scraping* e filtradas para eventos políticos com o uso de palavras-chave. Foi aplicado um modelo GARCH nos dados coletados das taxas referenciais dos contratos de maturidades 30, 60, 90 e 180 dias para estimar a volatilidade condicional e checar os movimentos de volatilidade anormal utilizando análises paramétrica e não paramétrica. Resultados indicaram que os contratos de 60, 90 e 180 dias dos três contratos mais negociados foram altamente afetados pela divulgação da gravação do áudio do presidente Temer em Maio de 2017, e dois dos contratos mostraram movimentos anormais em dias de divulgação de novas repercussões dessas investigações, em dias de expecativa de eleições e dias próximos ao primeiro turno de eleições, em Setembro e Outubro de 2018, e em dias de expectativas sobre a aprovação de reforma tributária e reforma da previdência. Estresse político também teve efeito nos três principais contratos em 2020, como no rompimento entre o Ministro Sérgio Moro e o presidente Bolsonaro.

Classificação JEL: C58, G14.
Palavras-chave: Mercado financeiro. Informação política. Notícias. Mercados eficientes.

ABSTRACT

This study checks the effect of political related news on the four most negotiated swap contracts of the brazilian stock exchange. We collect news headlines related to political events from "G1" website, and reference rates for swap contracts prices from the brazilian stock exchange, "B3", website for the swap contracts "DI x Pre", "Dollar x Pre", "DI x Dollar" and "DIx IPCA". The time range is February 1st, 2017 to October 2nd 2020. We collect the headlines by web scraping and filter them for political events with the use of keywords. We use a GARCH model on swap contracts data of 30, 60, 90 and 180 days maturities to estimate conditional volatility to check for abnormal movements using both parametric and non-parametric analysis. Results indicate that 60, 90 and 180 days maturities of the three most negotiated contracts were highly affected by the disclosure of President Temer audio recording in May 2017, with two of the contracts showing abnormal movements during new repercussions of investigations, during the expectations and the days prior and just after first round of elections in September and October 2018, and during days of expectations of approval of political measures like pension and tax reforms. Political stress also had an effect on the contracts in 2020, when Minister of Justice Sergio Moro left the government.

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LIST OF ABBREVIATIONS AND ACRONYMS

B3	Commodities and Futures Exchange
CMN	Monetarary National Council
CVM	Securities Comission
CSD	Conditional Standard Deviation
COPOM	Monetary Policy Committee
DI	Interbank Deposit
DI-Over	Interbank Deposit Overnight Rate
GARCH	Generalized autoregressive conditional heteroskedasticity
IGPM	General Market Prices Index
IPCA	Extended National Consumer Price Index
Pre	Prefixed rate
Selic	Special Settlement and Custody System Rate

CONTENTS

1 INTRODUCTION

Brazilian politics has been going through moments of instability during the last years. Impeachment of a president, death of a presidential candidate, murder attempt of another, victory of unorthodox candidates, to mention a few. Easy access to information and the spread of fake news, that can affect even an election outcome, have given even more relevance to the media. It is not unfrequent that financial market movements are associated by the media to news broadcast, or even to social media posts from a public figure. There are studies in several coutries checking for correlation between a new information disclosure and markets fluctuation such as inflation and stocks and commodities prices. In Brazil, there is still little study on this matter.

The main objective of this paper is to test semi-strong form Market Efficiency Hypothesys (FAMA, 1970) by checking the effect of political related news on the four most negotiated swap contracts of the brazilian stock exchange, DI x Pre, Dollar x Pre, DI x Dollar and DI x IPCA. A secondary goal is to verify how much each of them are affected and which types of news are most related to price variations.

For that, we follow Marques e Santos (2016) methods, by applying a GARCH (BOLLER-SLEV, 1986) filter on data collected from B3, "Brasil Bolsa Balcão", Brazil's stock exchange, website to find the periods of abnormal volatility in both a parametric and non-parametric analy-sis. We also collected news headlines from a 40-month period by web scraping one of the main news websites, and filtered the results by using selected keywords. Finally, we compare the days of abnormal volatility with the headlines, to check if moments of high volatility are related to political events.

This paper is organized as follows: Chapter 2 gives a brief introduction of the Brazilian Financial System, brazilian interest rates and the swap contracts definitions. Chapter 3 is a review of literature related to market efficiency, effect of announcements on markets, and studies that relate swap contracts to the brazilian yield curve. Chapter 4 describes the methods of data collection and application of the models. Chapter 5 shows the results and Chapter 6 some concluding remarks.

2 BRAZILIAN MARKETS AND THE INTEREST RATE

2.1 BRAZILIAN FINANCIAL SYSTEM

Cavalcante (2002) defined the brazilian financial system as a set of institutions that intermediates transfers between buyers and sellers and creates the conditions for market liquidity. Since the banking sector reform in 1964, the brazilian banking laws have been improved, after the creation of two new monetary institutions, the National Monetary Council and the Central Bank of Brazil, and the establishment of new forms of organization and hierarchy of public and private financial institutions. (SILVA *et al.*, 2016).

According to Berquó (2006), The National Monetary Council (CMN) is a regulative organization responsible for defining general guidelines in the financial sector, supervise and discipline financial institutions, and altering monetary and exchange rates policies. The Central Bank of Brazil follows the standards of other central banks, is the executive organization that executes the council regulations, and is the only responsible for the printing of money. Since 2019, the National Monetary Council members are the Minister of the Economy, the president of Central Bank of Brazil, and the Special Secretary of Treasury.

The current composition of the financial system consists of the regulatory subsystem, CMN, Central Bank and the Securities Commission, and the financial intermediation subsystem, which is divided by banking institutions, such as commercial banks, and non-banking institutions, such as development banks, investment banks, credit and finance societies, and the stock market institutions, among others.(BERQUÓ, 2006)

Table 1 – National Financial System

	Currency, Credit, Capital, Currency Exchange		Private Insurance	Closed Pension
Regulating Entities	National Monetary Council		National Private Insurance Council	National Supplementary Pension Council
Supervising Entities	Central Bank of Brazil	Securities Commission	Superintendence of Private Insurance	National Superintendence of Supplementary Pension
Operators	Banks, saving banks, credit cooperatives, payment institutions, other non banking institutions	Stocks, commodities and futures exchanges	Insurance companies, open pension entities, capitalization companies	Closed entities of supplementary pension

Source – Author, based on (Central Bank of Brazil, 2020)

In 1976 was created the Securities Commission, responsible for the stock market and its institutions, and in 1996 the Economic Policy Committee (COPOM), that provides the guidelines of behavior for the interest rates in the monetary market, setting targets compatible with the economic policies.

2.2 INTEREST RATES AND ITS DERIVATIVES

Since 1999, Brazil is under an inflation targeting regimen, a policy widely accepted by many theoretical macroeconomists and adopted by many countries, including the United States, in 2012. In Brazil, the National Monetary Council sets the inflation target two years in advance.

The interest rate is one of the most important policies used by the monetary authorities to control inflation and hit inflation targets. In Brazil, the main rate is the banking reserves market interest rate, the Selic Rate, which is a short term nominal rate that strongly influences the behavior of the price levels and economic activity, and is used to determine the other rates (MENDONÇA; DEZORDI; CURADO, 2005). Since its creation, the Economic Policy Committee is responsible for the Selic Rate, and after 1999 its main goal is to maintain inflation under control, inside the target levels defined by CMN. COPOM meetings happen every 45 days and its decisions and announcements are closely watched by several institutions, financial analysts and academics trying to understand and foresee possible future movements of the interest rates (CAETANO; JR; CORRÊA, 2011). Studies and predictions like those allow the existence of a futures market for the interest rates, on the premise that the cost of money can be treated like any other commodity (BESSADA, 1995).

As mentioned, Selic Rate is used to determine other interest rates. One of those is the DI-over rate, the base rate of the private bonds issued between banks in order to raise funds and resources among them, similar to the effective federal funds rate of the United States. These lending and borrowing are the interbank deposits, or DI. DI-over represents the interest for very short term loans between banks. The Brazilian stock exchange, B3, manages several futures markets, including DI Futures, which offers hedge against the interest rates risks.

In addition to the short term interbank deposits, there are the swaps contracts, which are risk exchange contracts with no need of principal transfers, and the only cash flow is the difference of profitability between the two products. Some of the main swap contracts in Brazil are the DI x Pre (DI by Pre), a derivative with a prefixed interest rate for a certain period discounted by the DI profitability, DI X Dollar and Pre x Dollar, to hedge interests against an exchange rate variation, DI x IPCA, a price index for monetary correction, among others.

2.3 SWAP CONTRACTS

(HULL, 2015) reports statistics produced by the Bank for International Settlements show that over 60% of all over-the-counter derivatives are interest rate swaps and currency swaps. As stated by Hull:

> A swap is an over-the-counter agreement between two companies to exchange cash flows in the future. The agreement defines the dates when the cash flows are to be paid and the way in which they are to be calculated. Usually the calculation of the cash flows involves the future value of an interest rate, an exchange rate, or other market variable. (Hull, 2015, p. 152)

In addition, (HULL, 2015) puts a risk-free discount rate for cash flows is required to valuate swap contracts. In Brazil, the traditional risk-free discount rate is the DI-Over, the interbank deposits rate. Regarding interest rate swaps, Hull states:

> In an interest rate swap, one company agrees to pay to another company cash flows equal to interest at a predetermined fixed rate on a notional principal for a predetermined number of years. In return, it receives interest at a floating rate on the same notional principal for the same period of time from the other company. (Hull, 2015, p.153)

In Brazil, futures are negotiated at B3, former BM&F Bovespa. B3 offers several products of fixed and variable income, like stocks, commodities, interest rate coupons, exchanges and swaps, among others.

B3 (2020a) describes its swap contracts as operations that realize cash flow swaps based on comparison of profitability between two indexes, where the market agents enter a buying position and a selling position. The value of the operation can be adjusted by several indexes, such as inflation indexes (IPCA and IGP-M); stock indexes such as Ibovespa; interest rate indexes like DI, Selic, Prefixed; or exchange rate (Dollar, Euro, Iene).

According to B3 (2020b), the swap contracts with higher liquidity and higher number of open contracts are: Dollar x Pre (Exchange rate variation by the prefixed interest rate), DI x Pre (interbank deposits by a prefixed interest rate), DI x Dollar, and DI x IPCA (interbank deposits by the broad consumer price index).

The maturity of a swap contract is freely defined by the parts, and its range can vary from one day to over thirty years, with higher liquidity on medium terms like 1 month, 3 months, 6 months, and one year. Each parameter of the contract has its own value updating formula, according to B3 (2020c) Formula Notebook. DI is a function of the DI-Over rate for the period, Pre is a function of a preset interest rate, Dollar uses the variation of the exchange rate US Dollar to brazilian Real, and IPCA uses the variation of the main price index used to measure the country's inflation. All of them also affected by an interest rate.

3 LITERATURE REVIEW

3.1 EFFICIENT MARKETS HYPOTHESIS

Eugene Fama (1965) addressed the recurring issue of market efficiency on the stock markets. Fama compared technical analysis theories - which assume that past price behavior of a security is a relevant information for its future price and that former movement patterns have effects on future movements - with random walk theories, that suggest that future prices are as predictable as a series of random numbers, and successive price variations are independent from each other. His empirical results are favorable to the latter, and prices would not carry "memory" from past values. The random walk independence presumption is based on the following: if new pieces of information appear independently through time, and the noise and uncertainty of these new information do not follow a consistent pattern, the prices would also be independent. Fama suggests that even if a set of new information is dependent of another, and that even if some of the news agents are opinion leaders, the more sophisticated market agents are able to adjust and react correctly to these noises.

In theoretical terms, Samuelson (1965) demonstrates asset prices goes as a random walk. Samuelson focused on commodities and futures markets, and reproduces some examples in favor and against the model, such as the long uptrend in the stock market, and seasonal prices of commodities, but, on the other hand, several price series behave like random walks. There would exist so many sources of really low importance that the result would be similar to a random walk. He concludes by suggesting a stochastic model for price behavior, aiming to deduce a theorem that demonstrates that price fluctuation between two time periods is not correlated with the fluctuation of two previous time periods.

Fama *et al.* (1969) extended his studies by examining the process of how securities prices adjust to specific kinds of new information, and the speed these changes would occur, on the premise that asset prices reflect all available information. Fama evaluated if different stock splits of different companies caused similar reaction on prices, and concluded that markets would be efficient and adjust very quickly to the respective split announcement, even though price fluctuations were of relatively low intensity and not sufficient to increase returns, except on privileged information cases. The following year, Fama (1970) reviewed a series of theoretical and empirical papers related to the efficient market hypotheses. In general terms, the prices would be all the information needed for an asset allocation decision, since an efficient market is a market where prices reflect all available information. Fama divides market efficiency into three subsets: weak form efficiency, where the only information is the historical price, semi-strong form, where the information set is all the information available for the public, and strong form efficiency, where all information is available for everyone, including private information.

One of Fama's study objects was Waud (1970). Waud studied the psychological effect of the impact of announcements on the future of the economy, in an attempt to identify how much these announcements affect the expectations of companies, financial institutions and other agents. On the premise that future changes on the company cash flows would be affected by expectations on future economic conditions, and this would influence present stock prices. His analysis suggests that there is an "announcement effect" on future expectations associated to Federal Reserve Board announces of changes in the base interest rate, and markets reflect with "anxiety" during the days that precede the announcement of a reduction of the base interest rate.

3.2 EFFECTS OF NEWS AND ANNOUNCEMENTS ON MARKETS

There is a vast and relevant literature analyzing effects of news announcements on different markets. Pearce e Roley (1984) accompanied Fama and Waud on stock prices and information incorporation to prices, exploring the effect that announcements regarding interest rates, money supply, and inflation rates have on the stock market. Using data from S&P500 index and Federal Reserve pronouncements, their empirical studies and field research indicated that only really unexpected news had effects on returns, and even then, it would only be relevant on the day of the announcement, with a very weak correlation on subsequent days market behavior.

Interest rates and market reaction were also explored by Jovanovic e Zimmermann (2008), who investigated monetary policies in moments of market uncertainty. Using historical data of american interest rates, they applied gaussian models and GARCH models estimations to demonstrate that Federal Reserve interest rates should be significantly lower at moments of uncertainty in the stock market, if compared to stable moments. Smales (2015) measured market volatility in moments of electoral uncertainty in the australian financial markets, and according to his results, when economic agents cannot predict a winner with relative conviction, market volatility increases. According to Moussa, Delhoumi e Ouda (2017), alterations on supply and demand for information about a certain company also have an impact on the company's stock volatility, although it does not really have an effect on that stock's returns, and results may vary according to market characteristics, available information, and risk aversion.

McQueen e Roley (1993) checked how much the state of the economy is affects the effect of an announcement on stock prices, interest rates and expected cash flows. Using S&P500 data and industrial production index, his conclusions are similar to other works, that the announcement has to be unexpected to have a real effect. Also, when the economy is strong, the market reacts negatively to reports of increases in economic activity, because expected increases on cash flows would increase interest rates. In contrast, in a weak economy, an optimistic announcement would increase the stock price.

Macroeconomic news and commodities returns were the objects of study of Caporale, Spagnolo e Spagnolo (2017), where they checked the existence of a correlation between macroeconomic announcements and anomalous price movements in most commodities, such as

soybeans, oil, wheat, corn. The paper suggests that the 2008 financial crisis strengthened this correlation, and the main exceptions for this correlation were gold and silver.

Also in recent years, Marques e Santos (2016) analyzed the effect of political news on Brazilan stock markets, comparing unusual movements on prices with dates of news related to political events, using parametric and non-parametric methods. The results were in line with previous studies, and demonstrated that electoral uncertainty increases volatility, but only surprising or extremely important news had a pertinent effect on asset prices.

3.3 SWAPS

Mario Pina (2009) defines swap as an exchange of prices, indexes, or rates. If a company borrows money at a certain post-fixed interest rate, it can enter a swap operation to reduce the risk of interest rate variation. According to Pina, the major advantage of a swap is that the only cash flow is the difference of ending prices or rates, and usually the total cash values of the operations are used only as reference values. In addition to this reduced cash flow, the other important aspect of swap contracts that boosted the volume growth of this kind of operation are the possible gains resulting from comparative advantages, by allowing the banks and companies different options of lending and borrowing money, by swapping interest rates between companies.

Ribeiro, Machado e Júnior (2013) studied the effect of swap operations on the value of Brazilian firms, but the importance of swap contracts market goes beyond hedging and comparative advantages. Many Brazilian studies and models about the term structure of interest rates, or yield curve, utilize DI x Pre swaps data. The term structure of interest rates illustrates the behavior of the market supply and demand of short and long term bonds. It represents the relation between different maturities interest rates for a certain moment in time (SHOUSHA, 2008). Fraletti (2004) affirms that implied rates of CDI-Over derivatives should be used to model Brazil's yield curve, because of the low risk associated do this curve. Laurini e Moura (2010), Novy (2000) and Rezende (2008) used swap data to test different existent yield curve models, and swap DI x Pre data was used in Tabata e Tabak (2004) and Nunes, Holland e Silva (2011) models of the yield curve to test the effects of monetary policies, specifically, basic interest rate (Selic) adjustments, on the yield curve.

4 DATA AND METHODOLOGY

In order to analyze the effect of news on swap contracts markets in Brazil, we followed a similar approach to that of Marques e Santos (2016), by developing a web scraping software to navigate one of the main Brazilian news website, G1, and gather the main headlines of each business day. A similar software was developed to collect market data from B3 referential rates of the four main swap contracts (DI x Pre, DI x Dollar, DI x IPCA, Dollar x Pre) negotiated for different maturities. The time period is defined by the availability of news headlines from G1 website, that starts on February 1st, 2017, and ends on October 2nd, 2020. All codes available on https://github.com/mauriciormendes/political-news-and-swap-markets

We then test the collected data for stationarity with an Augmented Dickey-Fuller (ADF) test (DICKEY; FULLER, 1979) and a KPSS test (KWIATKOWSKI *et al.*, 1992). In the stationary data we can apply a GARCH model (BOLLERSLEV, 1986) to collect the standardized residuals and conditional volatility. To confirm that the data is suitable for this model, a Ljung-Box test (LJUNG; BOX, 1978) is applied to the residuals to check if they behave as white noise. In the positive cases, we extract the Conditional Standard Deviation of each time series. We then make both a parametric and a non-parametric analysis to check the moments of abnormal volatility. Finally, we compare the days of abnormal volatility with the political news related to these days.

4.1 DATA

4.1.1 News Source

The source of news selected was G1, the news portal of Grupo Globo, Brazil's biggest media and communications conglomerate. The web scraping was done on G1 *Summary of the day* page, which links to synopsis of important news from each business day. The scraper then access the daily synopsis and stores that day's main headlines in a *csv* archive. This resulted on a sample of headlines from 819 days.

In order to filter the headlines we follow an approach similar to the one taken by Baker, Bloom e Davis (2016), where they developed an index to measure economic policy uncertainty by checking the occurrence of a set of keywords on newspapers articles. We search our headlines for one of the following keywords: "mercado", "economia", "incerteza", related to markets, economy and uncertainty, "dólar", "Selic", "taxa básica de juros", related to the exchange rate and basic interest rate, "presidente", "Bolsonaro", "Temer", current and former presidents, and "Câmara", "Senado", "STF" and "Supremo Tribunal Federal", related to the chamber of deputies, senate and the supreme court. With this filter we ended with headlines from 581 days.

Table 2 – News Sample

	Date	Headline
	Date	Headline
1	2020-10-02	Após meses minimizando os riscos da Covid, Trump anuncia que está com o novo...
2	2020-10-01	Bolsonaro escolhe o desembargador Kassio Nunes Marques para a vaga no STF...
3	2020-09-30	Guedes diz agora que o governo não vai usar o dinheiro do pagamento de dívidas para...
[...]		
817	2017-05-04	No mesmo dia em que um governador teve sua cassação mantida, o STF entendeu...
818	2017-05-03	José Dirceu foi solto. Após colocar a tornozeleira eletrônica, o ex-ministro da Casa...
819	2017-04-28	A sexta foi praticamente tomada no país pelas paralisações e protestos contra as reformas...

Source – Author

4.1.2 Swap Reference Rates

Swap rates historical data was collected from B3 (2020d) Reference Rates website. Since the available data informs only one day of reference rates for one of the swap products at a time, another software was developed to navigate through the pages, and collect and store data in a format that allowed it to be handled correctly.

The four products with higher volatility were selected: *DI x Pre, Dollar x Pre, DI x Dollar, and DI x IPCA*. The time period covered is the same as the news available, from February 1st, 2017, to October 2nd, 2020. We selected the maturities used by Tabata e Tabak (2004) and Nunes, Holland e Silva (2011) for each product, 1, 2, 3, 6 and 12 months, since the liquidity is reduced for longer terms.

4.1.2.1 DI x Pre

Figure 1 shows B3 daily reference rates historical data for DI x Pre swaps for 1, 2, 3, 6 and 12 months, in the aforementioned period, February 2017 to October 2020. The behavior is similar in all maturities, showing a downtrend that closely resembles Brazil's basic interest rate, Selic, historical data for the same period, seen in Figure 2.

Figure 1 – DI x Pre swaps reference rates for different maturities
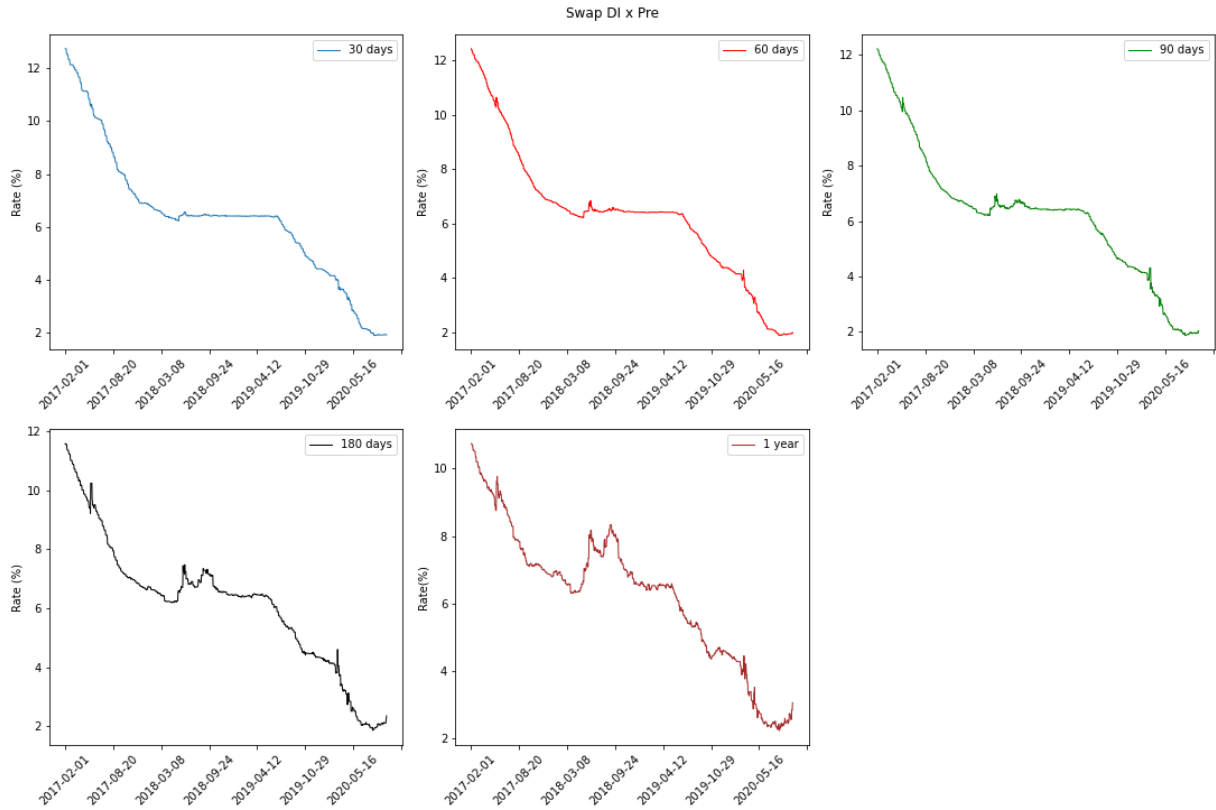
Source: Author

Table 3 – Descriptive Statistics for Swap DI x Pre

Maturity	Mean	Standard Deviation	Minimum Value	Maximum Value
30 days	6.344	2.457	1.89	12.43
60 days	6.259	2.395	1.88	12.43
90 days	6.202	2.340	1.87	12.23
180 days	6.114	2.201	1.86	11.57
360 days	6.227	2.046	2.23	10.74

Since the series clearly shows a deterministic trend, we will use its daily variation. Figure 3 shows the behavior of the daily variation.

The movements are very similar and appear to show stationary forms. We applied both an Augmented Dickey-Fuller (ADF) test (DICKEY; FULLER, 1979) and a Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test (KWIATKOWSKI *et al.*, 1992) to confirm this hypothesis. ADF-Test suggests stationarity in all of them. Results on Table 4 and Table 5.

Figure 2 – Selic Rate
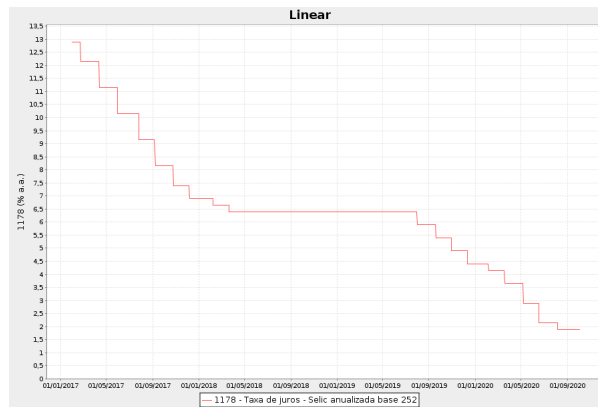
Source: Banco Central do Brasil

Figure 3 – DI x Pre daily variation
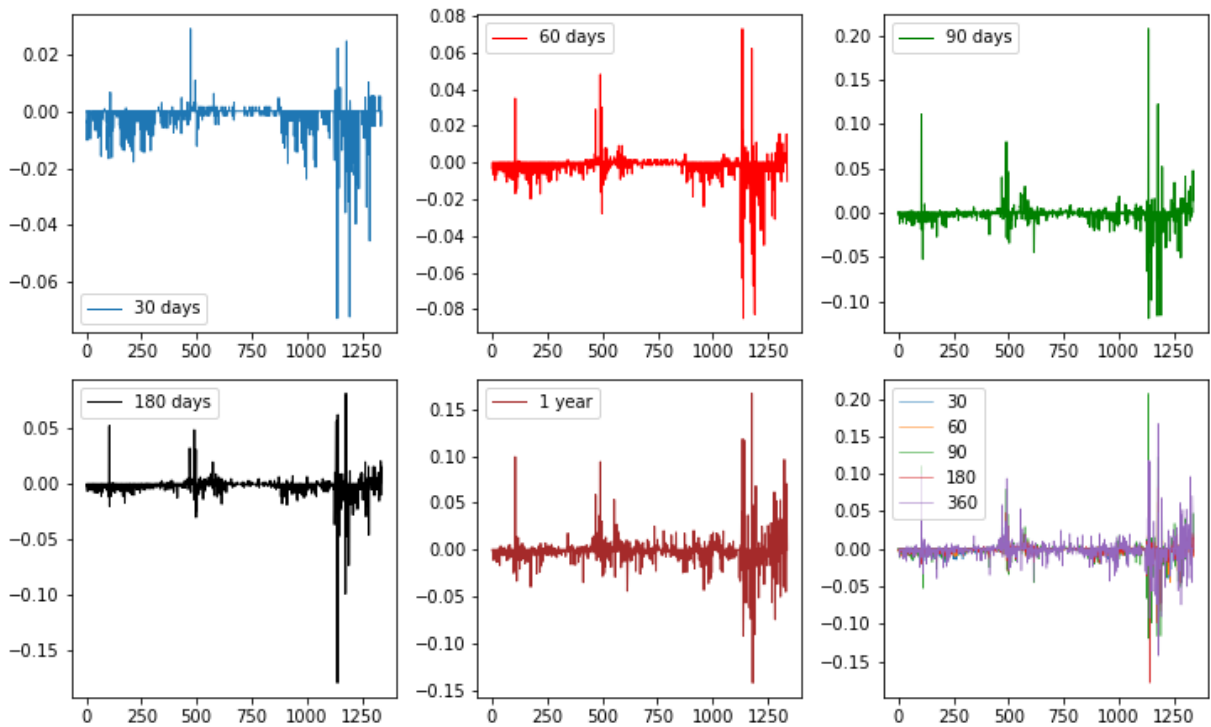
Source: Author

Table 4 – ADF test for DI x Pre Variation data

Maturity	ADF statistic	p-value	Critical Values	H0 Result
30 days	-4.686540	0.000089		Rejected
60 days	-4.083119	0.001033	1%: -3.435	Rejected
90 days	-5.667589	0.000001	5%: -2.864	Rejected
180 days	-5.325151	0.000005	10%: -2.568	Rejected
360 days	-24.90912	0.000000		Rejected

Table 5 – KPSS test for DI x Pre Variation data

Maturity	KPSS statistic	p-value	Critical Values	H0 Result
30 days	0.88354	0.01	10%: 0.347	Not Rejected
60 days	0.77666	0.01	5%: 0.463	Not Rejected
90 days	0.30608	0.1	2.5% : 0.574	Rejected
180 days	0.60815	0.02	1%: 0.739	Rejected
360 days	0.14267	0.1		Rejected

4.1.2.2   Dollar x Pre

Figure 4 shows B3 reference rates for Dollar x Pre swaps:

Figure 4 – Dollar x Pre swaps reference rates for different maturities
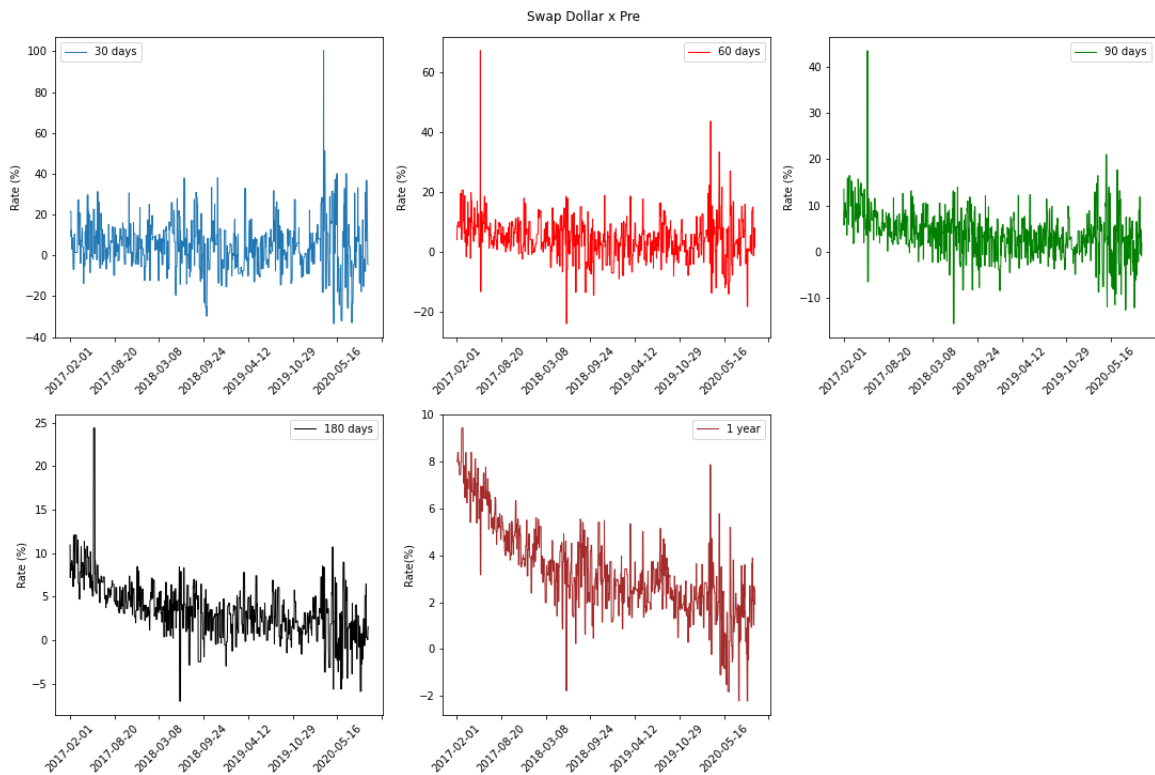
Source: Author

Table 6 – Descriptive Statistics for Swap Dollar x Pre

Maturity	Mean	Standard Deviation	Minimum Value	Maximum Value
30 days	4.207	43.024	-33.37	100.34
60 days	4.271	7.301	-24.02	67.38
90 days	3.535	5.077	-15.55	43.53
180 days	3.403	3.341	-7.00	24.38
360 days	3.332	2.014	-2.22	9.43

The rates for shorter terms appear to show stationary forms. We applied both an Augmented Dickey-Fuller (ADF) test and a Kwiatkowski-Phillips-Schmidt-Shin (KPSS) to confirm this hypothesis. Results in Table 7 and Table 8:

Table 7 – ADF test for Dollar x Pre swap data

Maturity	ADF statistic	p-value	Critical Values	H0 Result
30 days	-10.271773	0.000000		Rejected
60 days	-10.120096	0.000000	1%: -3.435	Rejected
90 days	-8.134470	0.000000	5%: -2.864	Rejected
180 days	-4.658551	0.000101	10%: -2.568	Rejected
360 days	-2.721334	0.070419		Not Rejected

Table 8 – KPSS test for Dollar x Pre swap data

Maturity	KPSS statistic	p-value	Critical Values	H0 Result
30 days	0.28072	0.1	10%: 0.347	Not Rejected
60 days	1.09527	0.01	5%: 0.463	Rejected
90 days	2.65402	0.01	2.5% : 0.574	Rejected
180 days	3.45682	0.01	1%: 0.739	Rejected
360 days	4.42232	0.01		Rejected

The ADF test rejected the Null Hypothesis of unit root's existence for most maturities, which suggests stationarity except for the 1 year swaps. In the KPSS test, the rejection of the Null Hypothesis suggests that the series is non stationary, and the results show that the only stationary series would be the 30 days one.

4.1.2.3 DI x Dollar

Figure 5 shows DI x Dollar data. The rates also appear stationary and the same tests were applied. Table 10 and Table 11 show that the results are similar with the ones from Dollar x Pre swaps, ADF suggests that the only non stationary is the 1 year series, KPSS suggests the only stationary is the 30 days series.

Figure 5 – DI x Dollar swaps reference rates for different maturities
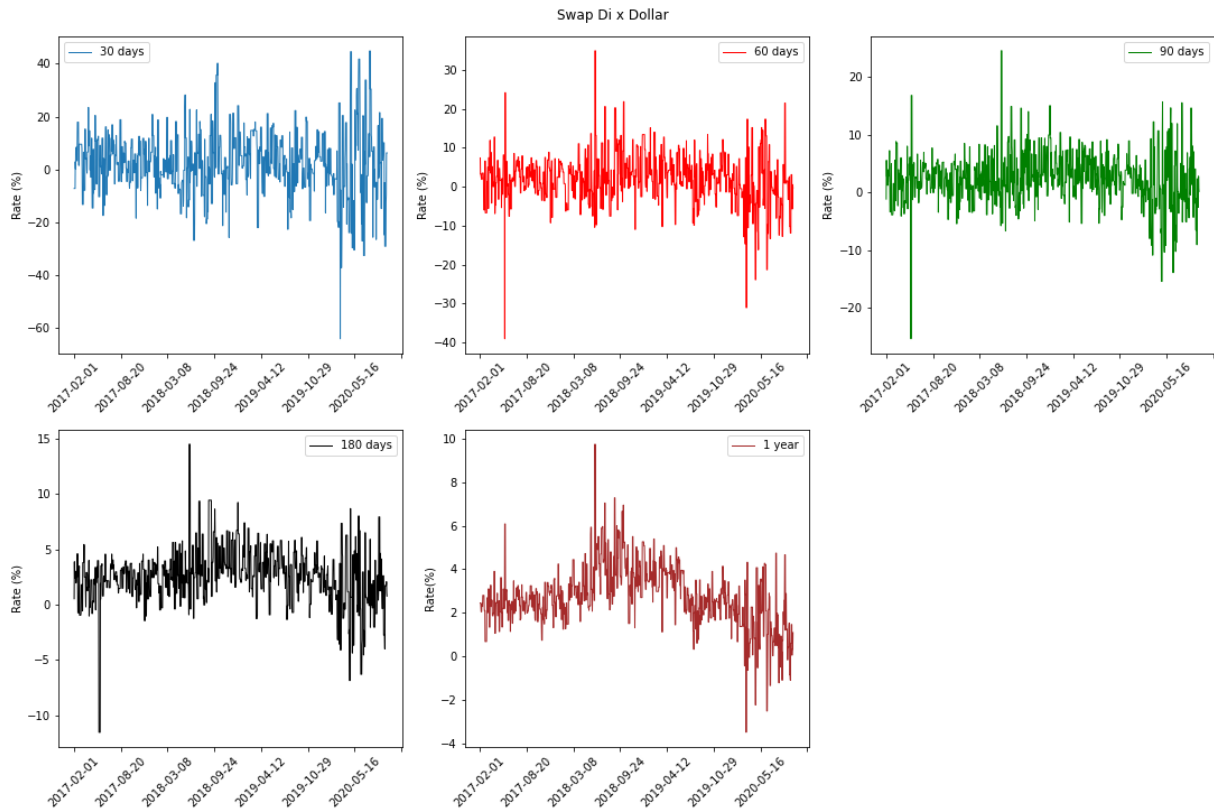
Source: Author

Table 9 – Descriptive Statistics for Swap DI x Dollar

Maturity	Mean	Standard Deviation	Minimum Value	Maximum Value
30 days	2.845	12.519	-64.08	44.94
60 days	2.097	6.713	-39.08	34.89
90 days	2.609	4.571	-25.34	24.59
180 days	2.592	2.648	-11.54	14.51
360 days	2.757	1.399	-3.49	9.74

Table 10 – ADF test for DI x Dollar swap data

Maturity	ADF statistic	p-value	Critical Values	H0 Result
30 days	-10.09908	0.000000		Rejected
60 days	-10.53602	0.000000	1%: -3.435	Rejected
90 days	-10.52686	0.000000	5%: -2.864	Rejected
180 days	-8.59831	0.000000	10%: -2.568	Rejected
360 days	-3.036820	0.0031596		Not Rejected

Table 11 – KPSS test for DI x Dollar swap data

Maturity	KPSS statistic	p-value	Critical Values	H0 Result
30 days	0.13049	0.1	10%: 0.347	Not Rejected
60 days	0.78092	0.01	5%: 0.463	Rejected
90 days	0.73601	0.01	2.5% : 0.574	Rejected
180 days	0.88959	0.01	1%: 0.739	Rejected
360 days	1.40775	0.01		Rejected

4.1.2.4 DI x IPCA

Finally, Figure 6 shows DI x IPCA data, which shows a gradually more visible and less volatile downtrend as the maturities are increased. ADF suggests 30 days is stationary.

Figure 6 – DI x IPCA swaps reference rates for different maturities
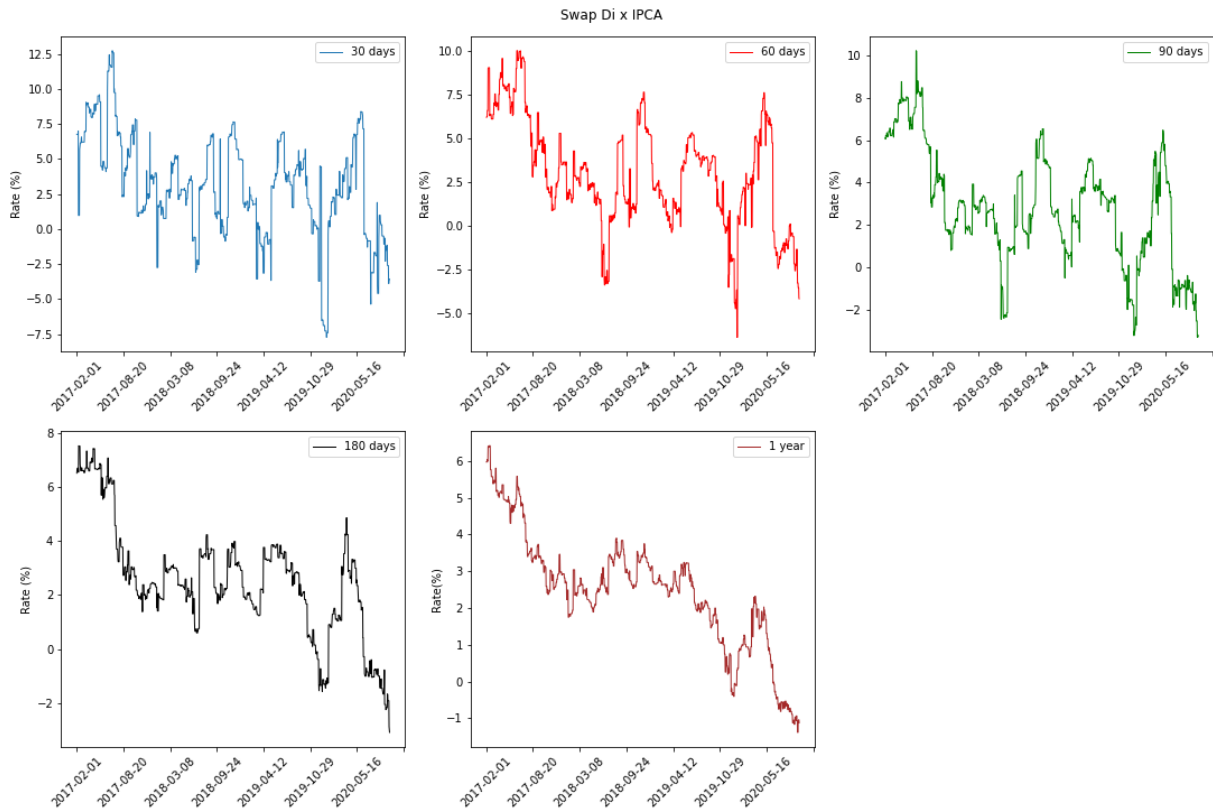
Source: Author

Table 12 – Descriptive Statistics for Swap DI x IPCA

Maturity	Mean	Standard Deviation	Minimum Value	Maximum Value
30 days	3.060	3.616	-7.73	12.72
60 days	2.972	3.080	-6.37	10.00
90 days	2.807	2.677	-3.31	10.22
180 days	2.545	2.099	-3.08	7.52
360 days	2.448	1.578	-1.38	6.41

Table 13 – ADF test for DI x IPCA variation data

Maturity	ADF statistic	p-value	Critical Values	H0 Result
30 days	-4.376761	0.000326		Rejected
60 days	-2.397258	0.142512	1%: -3.435	Not Rejected
90 days	-1.979176	0.295778	5%: -2.864	Not Rejected
180 days	-1.47994	0.543408	10%: -2.568	Not Rejected
360 days	-1.256317	0.648913		Not Rejected

Table 14 – KPSS test for DI x IPCA swap data

Maturity	KPSS statistic	p-value	Critical Values	H0 Result
30 days	1.54021	0.01	10%: 0.347	Rejected
60 days	1.68419	0.01	5%: 0.463	Rejected
90 days	1.96193	0.01	2.5% : 0.574	Rejected
180 days	2.86367	0.01	1%: 0.739	Rejected
360 days	4.04005	0.01		Rejected

4.2 METHODOLOGY

We use a GARCH (BOLLERSLEV, 1986) model on the selected series to estimate normal and abnormal volatility by using the Conditional Standard Deviation (CSD) extracted from the GARCH. For this model to be suitable, the series residuals must behave like white noise. A Ljung-Box test (LJUNG; BOX, 1978) is applied to check the characteristics of the data series.

Next, we make both a parametric and a non-parametric analysis. In the parametric, we utilize a Shapiro-Wilk test (SHAPIRO; WILK, 1965) to test the residuals for normality, then we can find parametric limits for these residuals, that will show abnormal volatility. In the non-parametric approach, we will examine the CSD percentiles to find possible abnormal volatility points.

Finally, we find the dates of those abnormal movements and check the relevant news of the days before this movement.

4.2.1 Estimations

We apply a GARCH model to all stationary series for each maturity. Figure 7 shows GARCH results for the 30 days series of DI x Pre variations, Dollar x Pre, DI x Dollar and Dollar x IPCA.

Figure 7 – GARCH for 30 days series
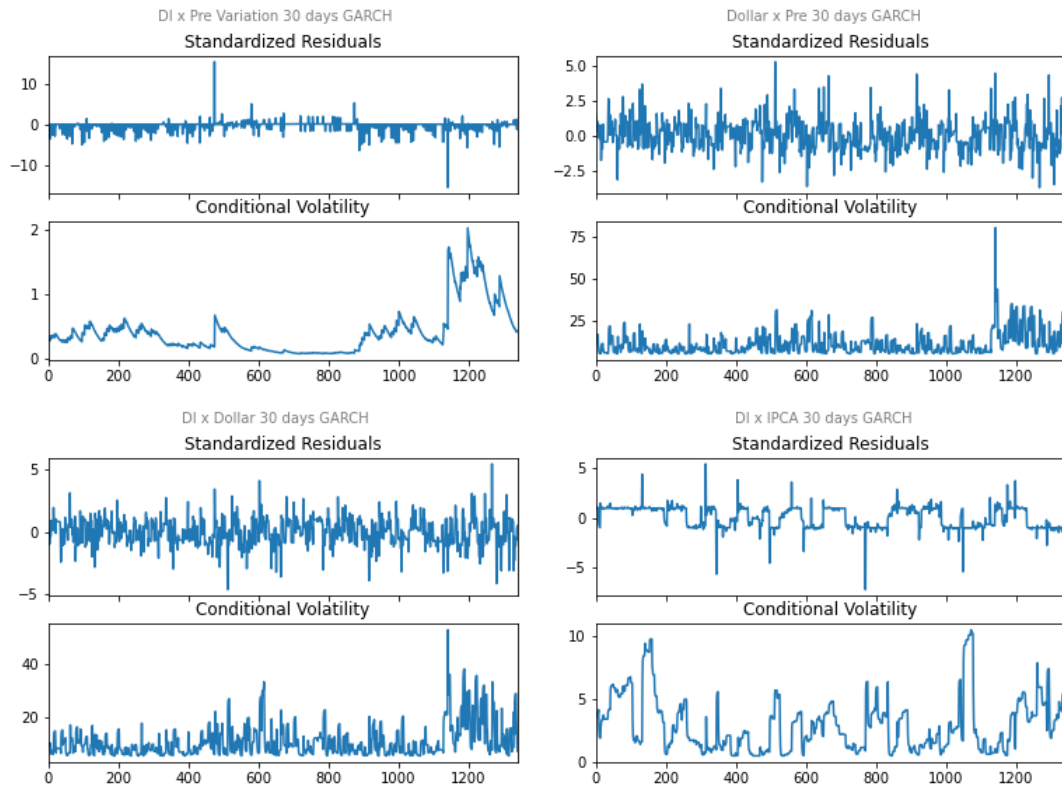
Source: Author

For 60, 90 and 180 days we will not check DI x IPCA since it did not behave as stationary. Figure 8, Figure 9 and Figure 10 shows GARCH results for 60, 90 and 180 days.

We then apply a Ljung-Box test on the residuals to check if it behaves as white noise. Results in Table 15.

Table 15 – Ljung-Box p-values

	DI x Pre Variation	Dollar x Pre	DI x Dollar	DI x IPCA
30 days	6.39E-05	4.01E-139	6.68E-148	6.07E-274
60 days	4.94E-08	1.99E-116	6.04E-122	
90 days	4.80E-06	1.02E-144	3.29E-102	
180 days	1.05E-03	1.23E-200	1.81E-166	
360 days	0.525			

Figure 8 – GARCH for 60 days series
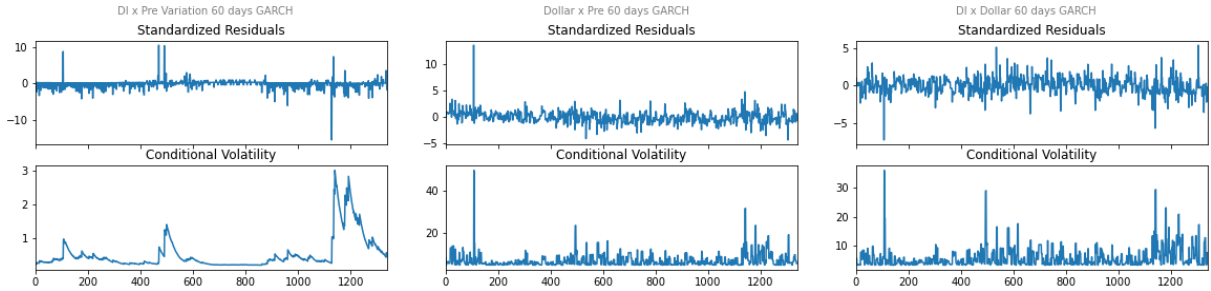
Source: Author

Figure 9 – GARCH for 90 days series
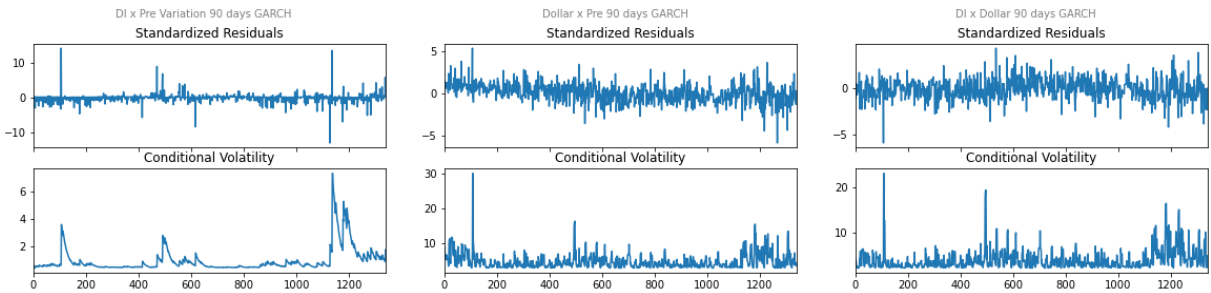
Source: Author

Figure 10 – GARCH for 180 days series
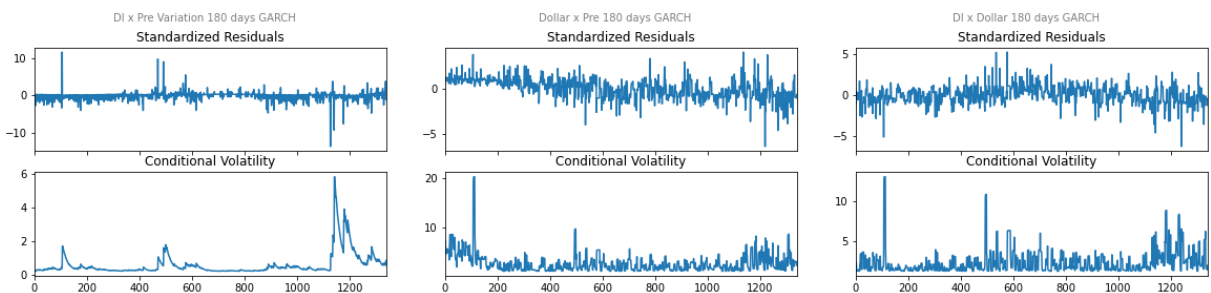
Source: Author

All series accepted so far except the DI x Pre Variation 360 days series reject the null hypothesis and can therefore be assumed as white noise behavior. The Shapiro-Wilk test rejected the hypothesis of normality for all series.

We can then extract the Conditional Standard Deviation (CSD) for the series that behave like white noise. CSD will be used as an estimate for the standard deviation of each period.

Table 16 – Shapiro-Wilk Results

	DI x Pre Variation		Dollar x Pre		DI x Dollar		DI x IPCA	
	statistic	p-value	statistic	p-value	statistic	p-value	statistic	p-value
30 days	0.912	3.781e-27	0.855	2.431e-33	0.854	1.883e-33	0.958	4.923e-19
60 days	0.758	1.834e-40	0.758	2.021e-40	0.798	7.785e-38		
90 days	0.707	2.77e-43	0.840	1.297e-34	0.822	4.344e-36		
180 days	0.708	3.23e-43	0.854	2.053e-33	0.803	1.625e-37		

Figures 11 to 14 show CSD for each series for 30, 60, 90 and 180 days.

Figure 11 – CSD for 30 days series
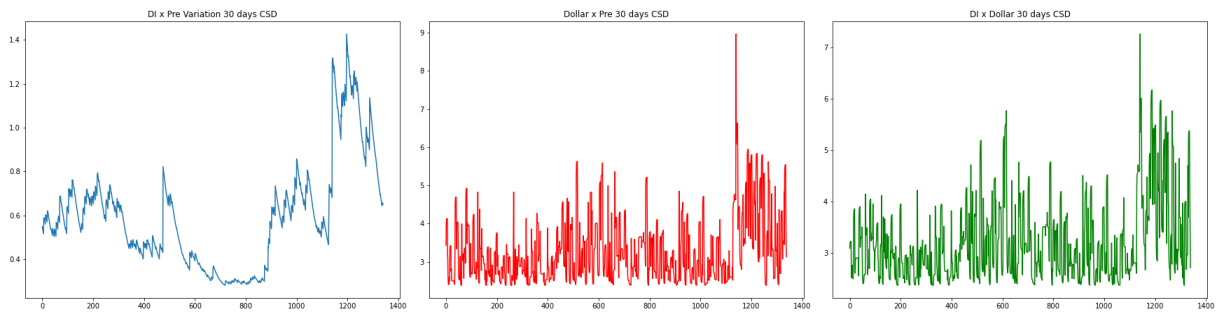
Source: Author

Table 17 – Descriptive Statistics for 30 days CSD

Series	Mean	Standard Deviation	Min Value	Max Value
DI x Pre Variation	0.5988	0.2429	0.2826	1.4261
Dollar x Pre	3.2728	0.8639	2.3809	8.9683
DI x Dollar	3.2147	0.7972	2.3682	7.2623
DI x IPCA	1.6009	0.6109	0.7023	3.2411

Figure 12 – CSD for 60 days series
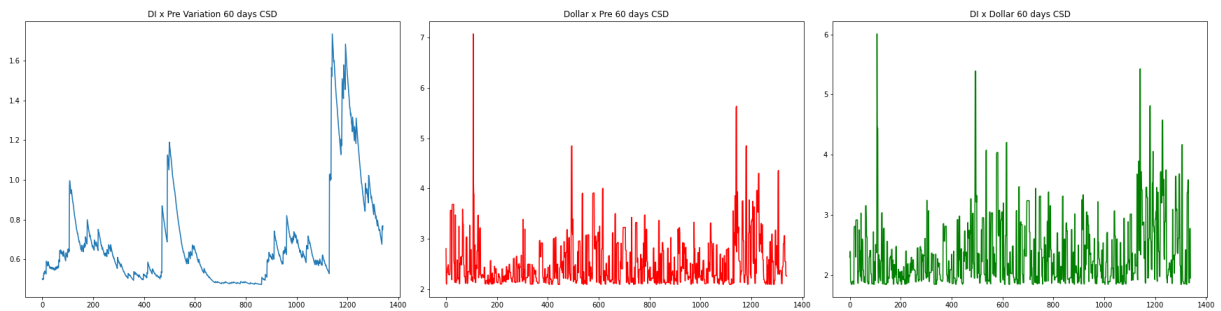
Source: Author

Table 18 – Descriptive Statistics for 60 days CSD

Series	Mean	Standard Deviation	Min Value	Max Value
DI x Pre Variation	0.6925	0.2524	0.4735	1.7342
Dollar x Pre	2.5119	0.5104	2.0922	7.0719
DI x Dollar	2.3551	0.5821	1.8446	6.0098

Figure 13 – CSD for 90 days series
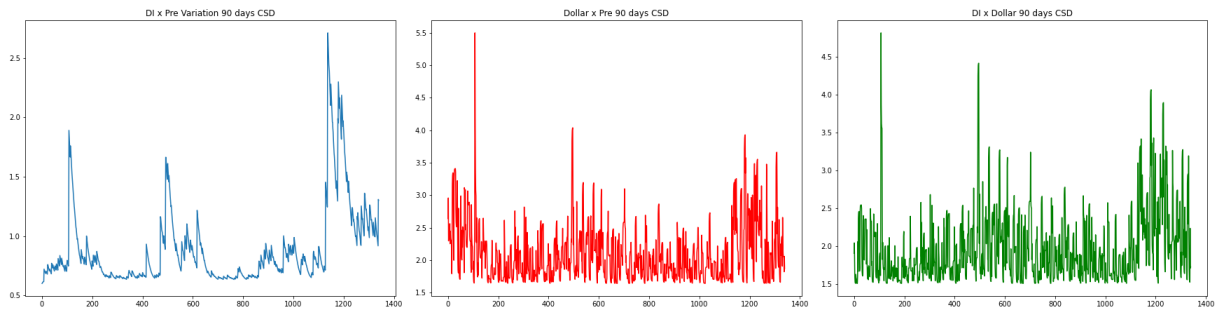
Source: Author

Table 19 – Descriptive Statistics for 90 days CSD

Series	Mean	Standard Deviation	Min Value	Max Value
DI x Pre Variation	0.8911	0.3407	0.6003	2.7132
Dollar x Pre	2.0955	0.4507	1.6405	5.5002
DI x Dollar	1.9666	0.4679	1.5089	4.8116

Figure 14 – CSD for 180 days series
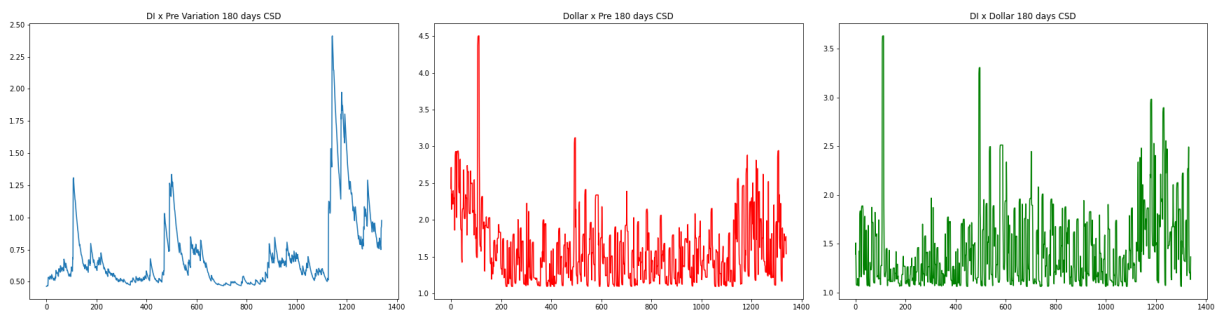
Source: Author

Table 20 – Descriptive Statistics for 180 days CSD

Series	Mean	Standard Deviation	Min Value	Max Value
DI x Pre Variation	0.7078	0.3019	0.4637	2.4122
Dollar x Pre	1.5958	0.4794	1.0939	4.5037
DI x Dollar	1.4326	0.4071	1.0614	3.6316

4.2.2 Parametric

For the parametric analysis, we assumed abnormal volatility as any value over or under two standard deviations:

$$UpperLimit = mean + 2*(StandardDeviation)$$

$$LowerLimit = mean - 2*(StandardDeviation)$$

Horizontal lines on Figure 15 show the mean and upper and lower limits for DI x Pre variation CSD. Table 21 describes those limits and the number of occurrences outside the interval:

Figure 15 – Parametric limits for DI x Pre Variation CSD
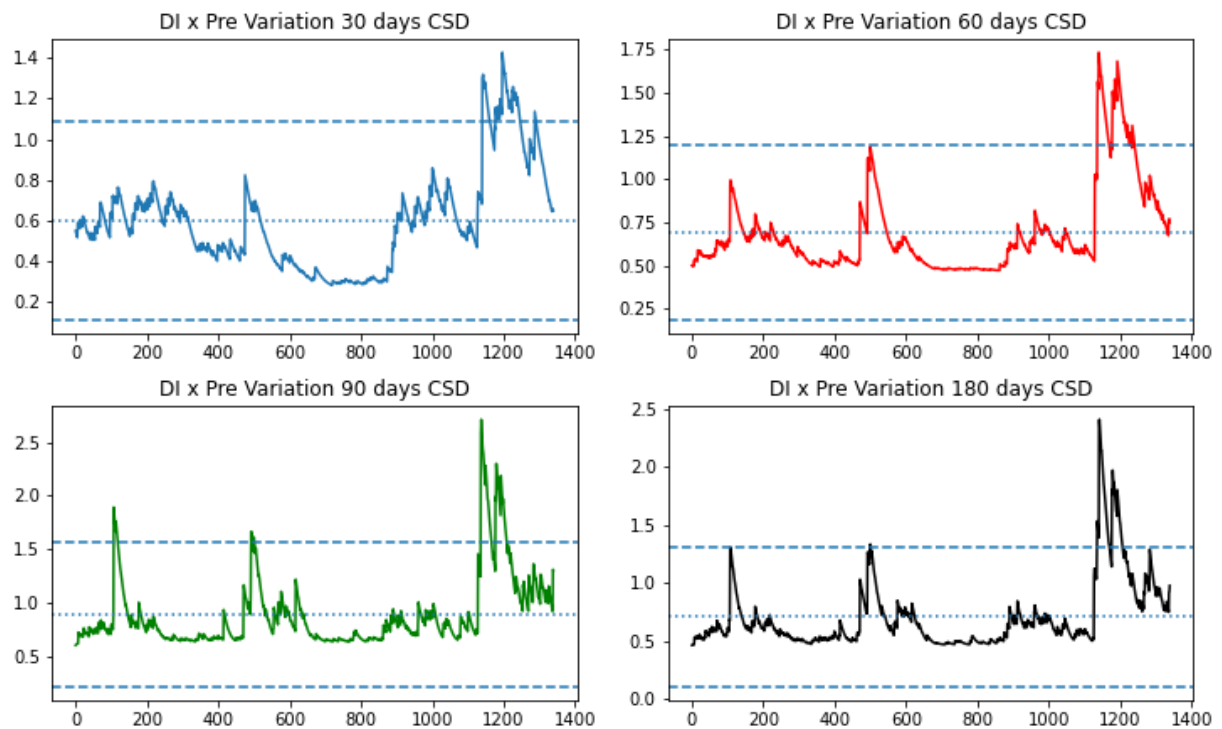
Source: Author

Table 21 – Limits for DI x Pre Variation CSD

	Upper	Lower	Occurrences out of interval
30 days	1.0846	0.1129	96
60 days	1.1972	0.1879	96
90 days	1.5725	0.2097	79
180 days	1.3118	0.1038	66

Swap DI x Pre Variation for 30 and 60 days maturities have two clear periods of abnormal volatility, March 17 to April 7 and April 23 to August 14, all in 2020. The longer maturities show, besides the aforementioned time frames, abnormal volatility in two other moments, May

17 to May 29 in 2017, June 08 to June 16 in 2018. The four maturities share 56 days of abnormal volatility.

The same is applied to Dollar x Pre CSD and DI x Dollar CSD, on Figure 16 and Figure 17, and Table 22 , and Table 23. Dollar x Pre and DI x Dollar share 9 and 10 days of abnormal volatility in all four maturities, respectively, all in 2020.

Figure 16 – Parametric limits for Dollar x Pre CSD
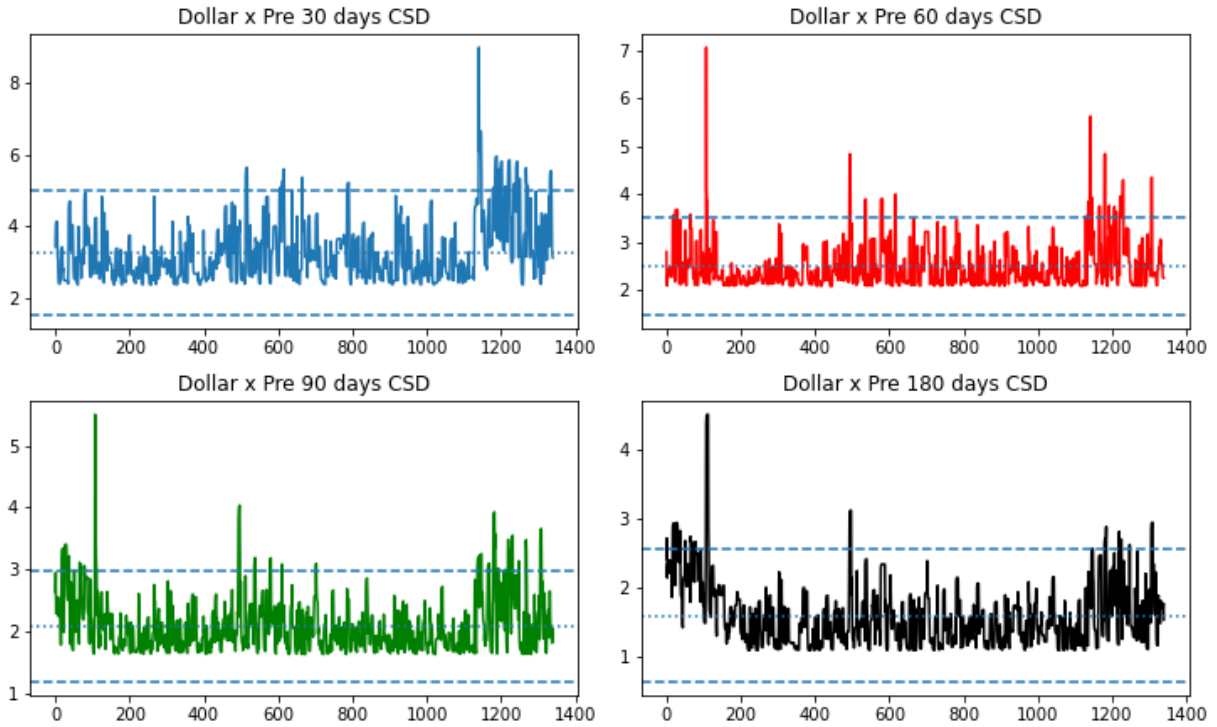
Source: Author

Table 22 – Limits for Dollar x Pre CSD

	Upper	Lower	Occurrences out of interval
30 days	5.0007	0.2097	83
60 days	3.5326	1.4911	63
90 days	2.9968	1.1941	78
90 days	2.5545	0.6369	57

Table 23 – Limits for DI x Dollar CSD

	Upper	Lower	Occurrences out of interval
30 days	4.8092	1.6203	80
60 days	3.5192	1.1909	56
90 days	2.9024	1.0309	63
180 days	2.2468	0.6185	59

Figure 17 – Parametric limits for DI x Dollar CSD
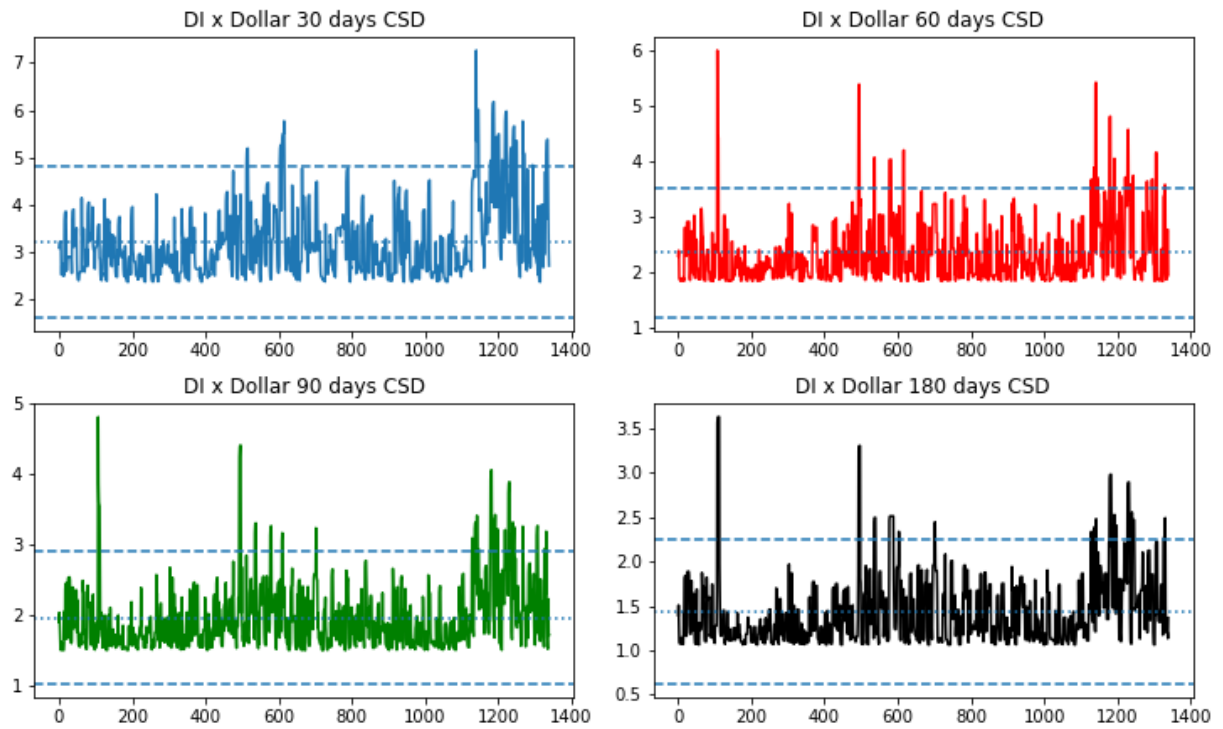
Source: Author

Figure 18 – Parametric limits for DI x IPCA CSD
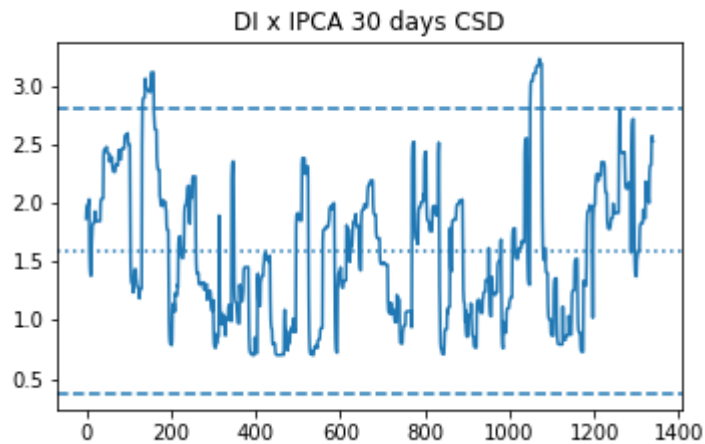
Source: Author

Table 24 – Limits for DI x IPCA CSD

	Upper	Lower	Occurrences out of interval
30 days	2.8228	0.3790	63

Figure 16 shows Dollar x Pre, where it shows short peaks of volatility that started on April 7 2017, May 19 2017, March 29 2019, and other periods that are shared with DI x Dollar moments of abnormal volatility, as seen on Table 25. Also, 60, 90 and 180 maturities had similar behavior among them.

Table 25 – Abnormal volatility periods in Dollar x Pre and DI x Dollar

30 days	60, 90 and 180 days
2018/06/28 to 2018/07/02	2017/02/20 to 2017/03/03 (dol x pre)
2018/09/28 to 2018/10/09	2017/04/07 to 2017/04/12 (dol x pre)
2018/11/27	2017/05/09 to 2017/05/24
2019/03/29 to 2019/04/2	2018/06/09 to 2018/07/23
2020/03/17 to 2020/24/03	2018/09/01 to 2018/10/11
2020/04/24 to 2020/05/14	2020/03/16 to 2020/09/02
2020/05/27	
2020/06/03 to 2020/09/28	

DI x IPCA on Figure 18 shows two periods of abnormal volatility, June 14 2017 to July 10 2017 and December 16 2019 to March 01 2020.

4.2.3   Non-Parametric

For the Non-Parametric approach, we will consider abnormal volatility everything above the 95th percentile of the Conditional Standard Deviation of each series. This gives us 67 days of abnormal volatility for each maturity of each contract.

Figure 19 shows the upper limits for DI x Pre Variation CSD. DI x Pre variation for 30 and 60 days shows abnormal volatility from March 13 2020 to April 08 2020 and from April 24 2020 to June 26 2020. For 90 and 180 days there is abnormal volatility from May 19 2017 to May 27 2017, June 08 2018, March 13 2020 to April 15 2020 and April 24 2020 to May 23 2020.

Table 26 – Non Parametric Limits for DI x Pre CSD Variation

	Upper Limit
30 days	1.1476
60 days	1.2977
90 days	1.6640
180 days	1.3047

Dollar x Pre and DI x Dollar also share most of its abnormal volatility days. Seen on Figure 20. Also, 60, 90 and 180 maturities have similar behavior among them. Table 30 compiles the time periods of abnormal behavior.

DI x IPCA on Figure 22 shows the following periods of abnormal volatility: June 14 2017 to July 16 2017, December 17 2019 to January 13 2020, July 15 2020 and August 13 2020 to August 17 2020.

Figure 19 – Non Parametric limits for DI x Pre Variation CSD
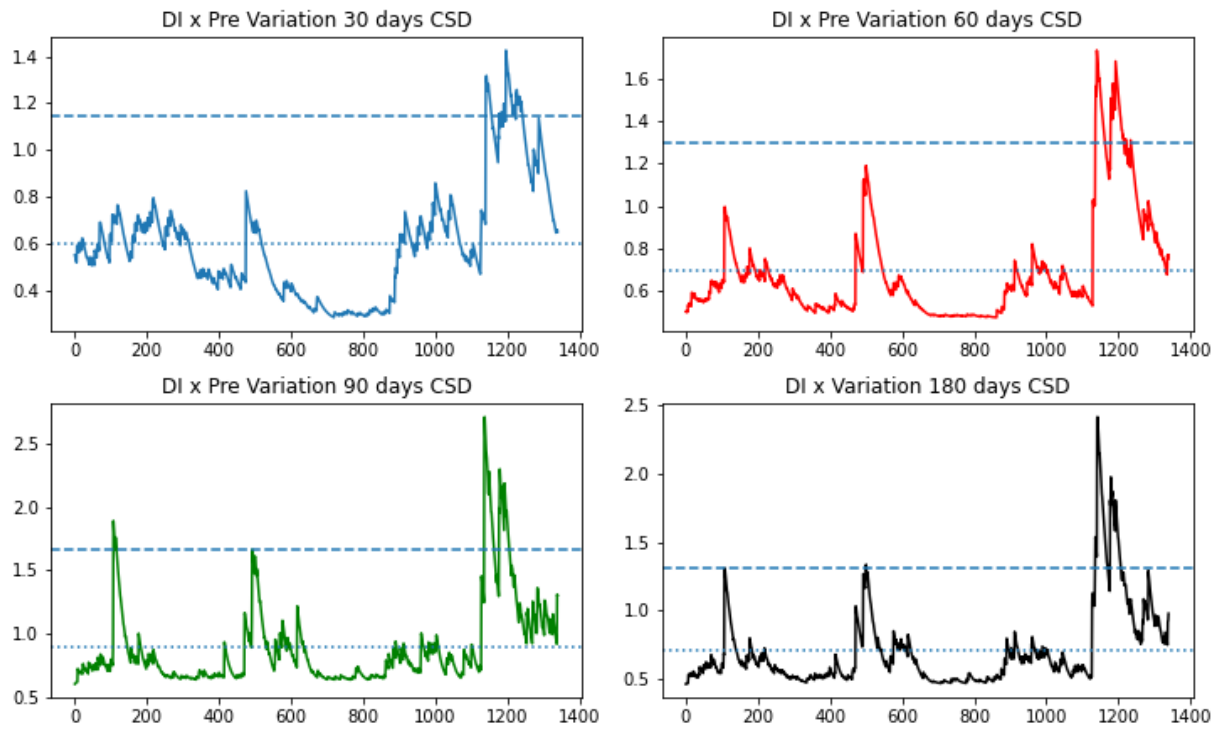
Source: Author

Table 27 – Non Parametric Limits for Dollar x Pre CSD

	Upper Limit
30 days	5.1459
60 days	3.4998
90 days	3.0832
180 days	2.4938

Table 28 – Non Parametric Limits for DI x Dollar CSD

	Upper Limit
30 days	5.068
60 days	3.4157
90 days	2.8909
180 days	2.1879

Table 29 – Non Parametric Limits for DI x IPCA CSD

	Upper
30 days	2.6319

Figure 20 – Non Parametric limits for Dollar x Pre CSD
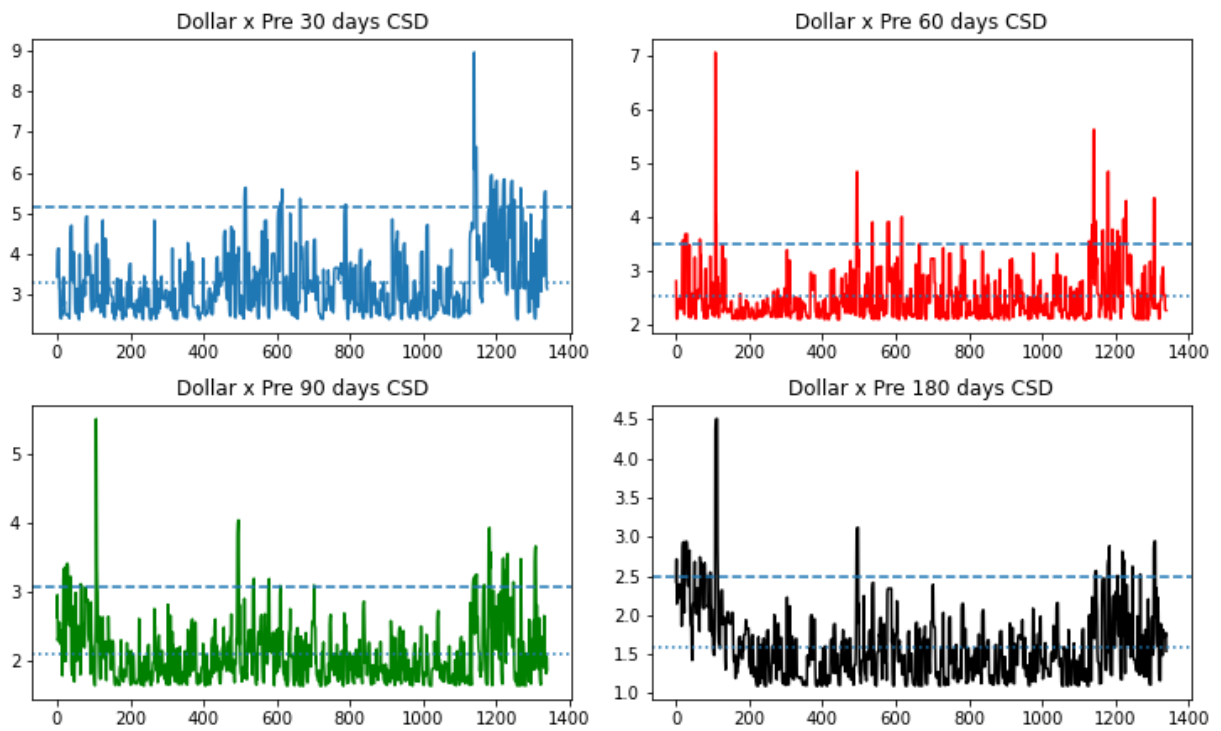
Source: Author

Table 30 – Non Parametric Abnormal volatility DI x Pre and DI x Dollar

30 days	60, 90 and 180 days
2018/06/28 to 2018/07/02	2017/02/20 to 2017/03/03 (Dol x Pre)
2018/10/04 to 2018/10/09	2017/04/07 to 2017/04/12 (Dol x Pre)
2018/11/27	2017/05/09 to 2017/05/25
2019/03/29 to 2019/04/02	2018/06/09 to 2018/06/13
2020/03/17 to 2020/03/24	2018/09/01 to 2018/09/06
2020/04/30 to 2020/05/18	2018/10/09 to 2018/10/10
2020/06/03 to 2020/09/28	2018/11/29
	2020/03/16 to 2020/09/02

Figure 21 – Non Parametric limits for DI x Dollar CSD
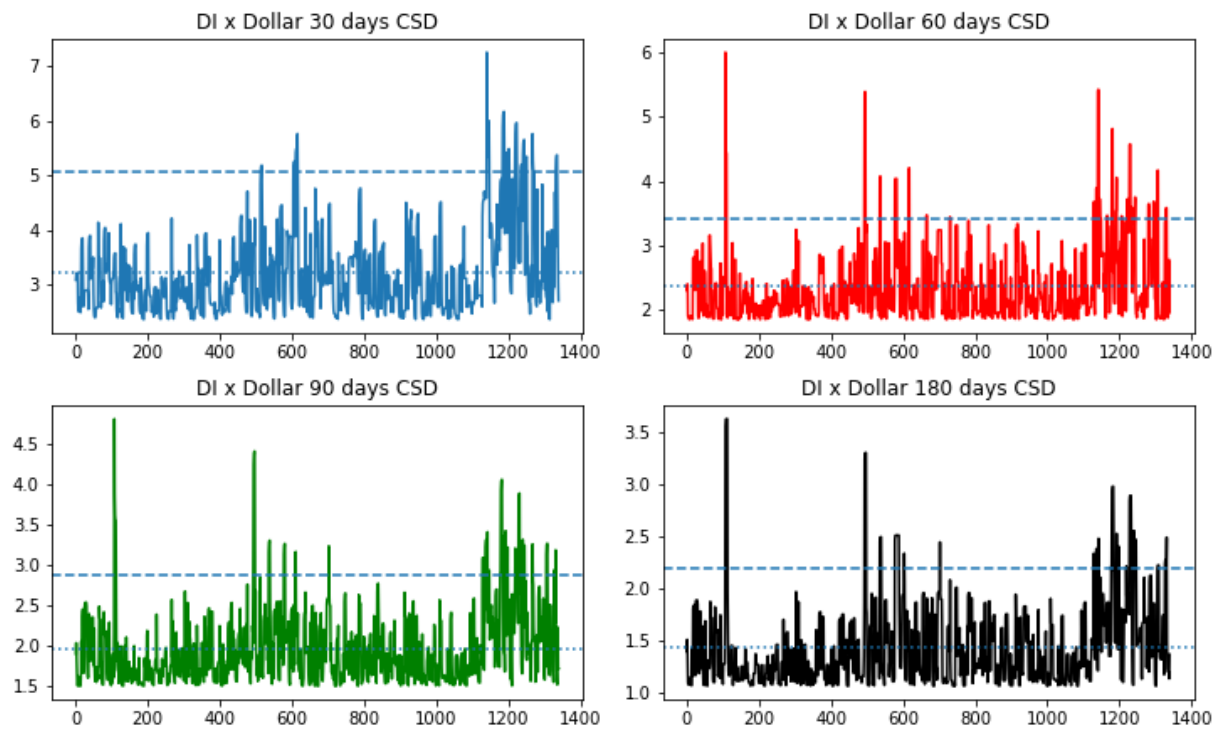
Source: Author

Figure 22 – Non Parametric limits for DI x IPCA CSD
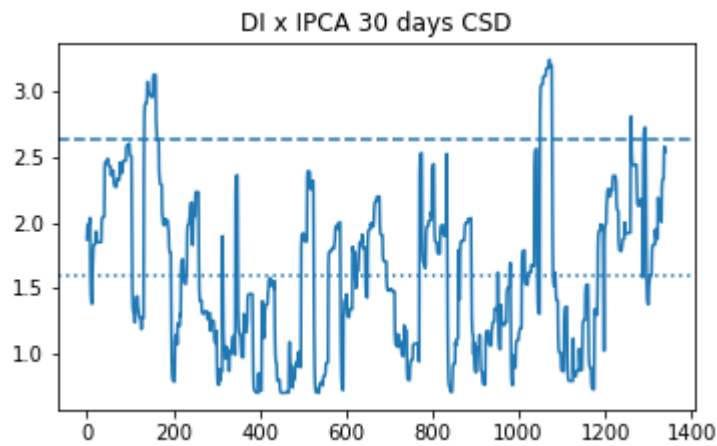
Source: Author

5 RESULTS AND DISCUSSION

After filtering the abnormal volatility periods, we can match the first day of each period of abnormal volatility with the news headlines of these days.

5.1 PARAMETRIC RESULTS

Table 31 shows the relevant news from the first days of each period of abnormal volatility on DI x Pre Variation.

Table 31 – Parametric DIxPre News

2017/05/17	o dono do frigorífico JBS gravou Temer dando aval para comprar o silêncio de Eduardo Cunha na Operação Lava Jato e entregou o áudio em delação à Procuradoria-Geral da República (PGR). É mais um grande abalo no terremoto político que o país vive nos últimos anos.
2018/06/8	Avança a investigação sobre a reforma da casa de Maristela Temer, filha do presidente. [...] A greve dos caminhoneiros continua na pauta do dia[...] O dólar caiu após intervenção do BC e fechou a R$ 3,70.
2020-03-11	OMS declara pandemia de coronavírus
2020-03-17	A 1ª morte pelo novo coronavírus no Brasil. Mais de 8 mil casos suspeitos. [...] Todas as fronteiras fechadas na Europa. Um guia para o isolamento domiciliar [...]
2020/04/23	O Brasil tem o maior número de mortes pelo novo coronavírus em um só dia. [...] Bolsonaro anuncia intenção de trocar comando da Polícia Federal e ministro Sergio Moro ameaça pedir demissão. E o dólar bate recorde mais uma vez.
2020-08-11	Ministro Paulo Guedes fala em debandada da equipe econômica

Table 32 shows the relevant news for Dollar x Pre and DI x Dollar first days of each abnormal volatility period.

Table 33 shows the relevant news from the first day for each period of abnormal volatility on DI x IPCA.

Table 32 – Parametric Dollar x Pre and DI x Dollar News

2017/02/20	Relatório da Polícia Federal concluiu que os ex-presidentes Dilma e Lula e o ex-ministro Aloizio Mercadante atuaram para obstruir as investigações da operação.[...] A PF sugere que os três sejam denunciados por obstrução de Justiça. Eles negam as acusações.
2017/04/04	O Tribunal Superior Eleitoral (TSE) decidiu reabrir a etapa de coleta de provas, deu mais prazo para as defesas e adiou o julgamento da chapa Dilma-Temer. [...]
2017/05/17	O dono do frigorífico JBS gravou Temer dando aval para comprar o silêncio de Eduardo Cunha na Operação Lava Jato e entregou o áudio em delação à Procuradoria-Geral da República (PGR). É mais um grande abalo no terremoto político que o país vive nos últimos anos.
2018/06/09	Avança a investigação sobre a reforma da casa de Maristela Temer, filha do presidente.[...] A greve dos caminhoneiros continua na pauta do dia[...] O dólar caiu após intervenção do BC e fechou a R$ 3,70.
2018/06/28	No Brasil, Joesley Batista e o ex-procurador Marcello Miller viram réus por corrupção [...]
2018/09/01	Eleições 2018: O TSE começou a decidir se Lula pode ou não ser candidato.[...] Devagar, quase parando: a economia brasileira cresceu 0,2% no 2º trimestre do ano.[...] Entre os fatores para o PIB em marcha lenta, a greve dos caminhoneiros[...] Enquanto isso, o dólar acumula alta de 8,5% no mês.
2018/09/28	Os novos números da corrida presidencial
2019/03/29	Depois de ser preso e virar réu, Temer é denunciado mais uma vez. [...] Paulo Guedes vai ao Senado para defender a reforma da Previdência [...]
2019/09/28	Maioria do STF vota a favor de tese que pode anular sentenças da Lava Jato.[...] O Congresso dos EUA divulga o conteúdo da denúncia que é estopim para o processo de impeachment contra Trump.
2020/03/06	Mais de 100 mil casos de coronavírus no mundo, 13 deles no Brasil. [...] Mais um dia de perdas na Bovespa e o dólar em queda pela 1ª vez em 12 dias. [...]
2020/03/11	A OMS declara pandemia de coronavírus.
2020/03/16	Casos de coronavírus no Brasil sobem para quase 300. Europa e América do Sul fecham fronteiras.[...] Trump admite possível recessão nos EUA por causa da pandemia[...] Bolsonaro volta a falar em 'histeria'. O dólar fecha acima de R$ 5 pela 1ª vez, a bolsa desaba mais de 13%. E o Ministério da Economia anuncia injeção de R$ 147,3 bi na economia.
2020/03/17	A 1ª morte pelo novo coronavírus no Brasil. Mais de 8 mil casos suspeitos.[...]
2020/04/24	Sergio Moro anunciou sua saída do Ministério da Justiça e acusou interferência política na Polícia Federal.[...] No final da tarde foi a vez do presidente Jair Bolsonaro se pronunciar.[...]
2020/05/27	Operação da PF mira políticos, empresários, blogueiros e militantes bolsonaristas suspeitos de disseminação de fake news e ataques a instituições nas redes sociais. Número de mortes pelo coronavírus passa de 25 mil no Brasil.
2020/07/21	Guedes entrega a 1ª parte da reforma tributária ao Congresso
2020/08/26	Bolsonaro interrompe as discussões sobre o substituto do Bolsa Família, critica publicamente a proposta e amplia o desgaste com o ministro Paulo Guedes.

Table 33 – Parametric DI x IPCA news

2017/06/14	Eduardo Cunha (PMDB-RJ) prestou depoimento por cerca de 1h30 na sede da PF, em Curitiba. Ele falou no inquérito que investiga o presidente Michel Temer (PMDB).[...]
2019/12/16	Fabrício Queiroz e parentes da ex-mulher do presidente Bolsonaro são alvos de operação do MP do RJ. [...]

From the dates and headlines we can visualize defined periods and political moments compiled on Table 34.

Table 34 – Political events from parametric results

February 2017	Former presidents Lula and Dilma Roussef accused of justice obstruction
April 2017	Investigations of current president Michel Temer
May 2017	Former president Lula testimony New evidences of current president Michel Temer supposed corruption scandal
June 2017	Investigations of current president continue
June 2018	New investigations of president Temer
September 2018	Electoral Court decides if former president Lula can be a candidate
October 2018	Presidential elections
March 2019	Former president Michel Temer is arrested New social security and retirement plans in discussion
March 2020	First cases and deaths of Covid-19 in Brazil.
April 2020	Minister of Justice Sergio Moro leaves government
July 2020	Tax reform advances
August 2020	Permanence of Minister of Economy Paulo Guedes is uncertain Covid-19 reaches 100.000 deaths

The start of our sample in February 2017 shows abnormal volatility in Dollar x Pre longer maturities, during investigations of former presidents Luiz Inacio "Lula" da Silva and Dilma Roussef on "Lava Jato" operation, a set of investigations of brazilian Federal Police focused on money laundering and political corruption.

On May 17 2017 during investigations of President Michel Temer, was exposed a conversation of the president and Joesley Batista, CEO of JBS, one of the largest food companies of the world. The content of the conversation suggested attempts to buy favors from other politicians already in custody for results of operation "Lava Jato". The prospect of an impeachment shaked almost all brazilian markets, including our objects of study for 60, 90 and 180 days maturities. Also in May 2017, former president Lula started his testimonies to Judge Sergio Moro, and the result of his trial could affect upcoming presidential election.

In June 2018 new investigations of president Michel Temer arised, but the main fact that supposed affected the markets was the Truck Drivers Strike, that resulted in a shortage of fuel for a short period of days. This month showed abnormal volatility on Dollar x Pre and DI x Dollar swap contracts.

The same contracts saw volatility during September and October 2018, with the expectations and results of the presidential election, with the definition that former president Lula could not be a candidate, and the election of Jair Bolsonaro, the right-wing candidate. Michel Temer was arrested in March 2019, and Dollar x Pre and DI x Dollar showed a peak of volatility then.

March 2020 is when Covid-19 cases started being reported in Brazil, affecting all markets. Longer terms saw high volatility starting on March 13, and short term (30 days) high volatility

started on March 17, date of the first death reported. Several peaks of volatility happened from March to September 2020, the end of our sample, and the majority of abnormal volatility is observed during this period, with the exception of DI x IPCA.

5.2 NON PARAMETRIC

In the Non Parametric Approach the results are pretty similar with the parametric results, with few discrepancies. Table 35

Table 35 – Non Parametric DIxPre News

2017/05/17	O dono do frigorífico JBS gravou Temer dando aval para comprar o silêncio de Eduardo Cunha na Operação Lava Jato e entregou o áudio em delação à Procuradoria-Geral da República (PGR). É mais um grande abalo no terremoto político que o país vive nos últimos anos.
2018/06/8	Avança a investigação sobre a reforma da casa de Maristela Temer, filha do presidente. [...] A greve dos caminhoneiros continua na pauta do dia[...] O dólar caiu após intervenção do BC e fechou a R$ 3,70.
2020-03-11	A OMS declara pandemia de coronavírus
2020-03-17	A 1ª morte pelo novo coronavírus no Brasil. Mais de 8 mil casos suspeitos. [...] Todas as fronteiras fechadas na Europa. Um guia para o isolamento domiciliar [...]
2020/04/24	Sergio Moro anunciou sua saída do Ministério da Justiça e acusou interferência política na Polícia Federal.[...] No final da tarde foi a vez do presidente Jair Bolsonaro se pronunciar.[...]

Table 36 shows the relevant news for Dollar x Pre and DI x Dollar first days of each abnormal volatility period.

Table 37 shows relevant news on first days of abnormal volatility of DI x IPCA.

In the Non Parametric approach the periods of high volatility are the same of the ones from the parametric approach. There were minor differences in the days that volatility began, but again, Covid-19 start in Brazil established a period of high volatility with small moments of low volatility in between.

Table 36 – Non Parametric Dollar x Pre and DI x Pre News

2017/02/20	Relatório da Polícia Federal concluiu que os ex-presidentes Dilma e Lula e o ex-ministro Aloizio Mercadante atuaram para obstruir as investigações da operação.[...] A PF sugere que os três sejam denunciados por obstrução de Justiça. Eles negam as acusações.
2017/04/07	A reforma da Previdência terá mudanças em seu texto original enviado pelo governo ao Congresso
2017/05/17	O dono do frigorífico JBS gravou Temer dando aval para comprar o silêncio de Eduardo Cunha na Operação Lava Jato e entregou o áudio em delação à Procuradoria-Geral da República (PGR). É mais um grande abalo no terremoto político que o país vive nos últimos anos.
2018/06/09	Avança a investigação sobre a reforma da casa de Maristela Temer, filha do presidente.[...] A greve dos caminhoneiros continua na pauta do dia[...] O dólar caiu após intervenção do BC e fechou a R$ 3,70.
2018/06/28	No Brasil, Joesley Batista e o ex-procurador Marcello Miller viram réus por corrupção [...]
2018/09/01	Eleições 2018: O TSE começou a decidir se Lula pode ou não ser candidato.[...] Devagar, quase parando: a economia brasileira cresceu 0,2% no 2º trimestre do ano.[...] Entre os fatores para o PIB em marcha lenta, a greve dos caminhoneiros[...] Enquanto isso, o dólar acumula alta de 8,5% no mês.
2018/10/04	Eleições 2018: os números da mais recente pesquisa Datafolha com as intenções de voto para presidente (3 days before presidential elections)
2018/10/08	No primeiro dia depois das urnas e da definição do 2º turno entre Bolsonaro e Haddad, o impacto no mercado.[...] (day after elections
2019/03/29	Depois de ser preso e virar réu, Temer é denunciado mais uma vez. [...] Paulo Guedes vai ao Senado para defender a reforma da Previdência.[...]
2019/09/28	Maioria do STF vota a favor de tese que pode anular sentenças da Lava Jato.[...] O Congresso dos EUA divulga o conteúdo da denúncia que é estopim para o processo de impeachment contra Trump.
2020/03/16	Casos de coronavírus no Brasil sobem para quase 300. Europa e América do Sul fecham fronteiras.[...] Trump admite possível recessão nos EUA por causa da pandemia[...] Bolsonaro volta a falar em 'histeria'. O dólar fecha acima de R$ 5 pela 1ª vez, a bolsa desaba mais de 13%. E o Ministério da Economia anuncia injeção de R$ 147,3 bi na economia.
2020/03/17	A 1ª morte pelo novo coronavírus no Brasil. Mais de 8 mil casos suspeitos.[...]
2020/04/24	Sergio Moro anunciou sua saída do Ministério da Justiça e acusou interferência política na Polícia Federal.[...] No final da tarde foi a vez do presidente Jair Bolsonaro se pronunciar.[...]
2020/06/03	Bolsonaro veta R$ 8,6 bilhões para ações de combate à pandemia.[...]
2020/07/21	Guedes entrega a 1ª parte da reforma tributária ao Congresso
2020/08/26	Bolsonaro interrompe as discussões sobre o substituto do Bolsa Família, critica publicamente a proposta e amplia o desgaste com o ministro Paulo Guedes.

Table 37 – Non Parametric DI x IPCA news

2017/06/14	Eduardo Cunha (PMDB-RJ) prestou depoimento por cerca de 1h30 na sede da PF, em Curitiba. Ele falou no inquérito que investiga o presidente Michel Temer (PMDB).[...]
2019/12/16	Fabrício Queiroz e parentes da ex-mulher do presidente Bolsonaro são alvos de operação do MP do RJ.
2020/08/12	O Brasil tem 103 mil mortes por coronavírus. Guedes vê debandada na própria equipe e também critica os gastos públicos. Para o ministro, 'furar'o teto é caminho para impeachment. E o FGTS vai distribuir R$ 7,5 bilhões de lucros.

5.3 ABOUT THE RESULTS

We got similar results in the parametric and non-parametric approach. DI x Pre variation early days of the sample and DI x IPCA appear to not show much similarity with the other contracts. Dollar x Pre and DI x Dollar share most of its days of abnormal volatility. We also see differences in the volatility for each maturity, with the shorter term, 30 days, not showing some of the peaks seen on the other maturities contracts in the first months of our sample. Swap DI x Pre shows the biggest connection between its different maturities, sharing 56 days of abnormal volatility in all 30, 60, 90 and 180 days contracts on the parametric approach. Dollar x Pre and DI x Dollar share only 10 and 9 days, respectively. Only three days share abnormal volatility for those three contracts for all maturities, April 25 to April 27 of 2020. DI x IPCA shares no abnormal volatility days with any other contract.

The global spread of COVID-19 appear to have had the biggest effect on DI x Pre variation, Dollar x Pre and DI x Dollar. Two of the peaks of volatility for all maturities was the day World Health Organization announced the COVID-19 outbreak was pandemic, and the day of the first death reported in Brazil caused by the coronavirus, and the periods of high volatility were longer than previous ones since then. After the start of this volatile period, the main political headline that can be related to a peak of volatility is the exit of Minister of Justice, Sergio Moro, former strong ally of president Bolsonaro, after disagreements about the command of Federal Police.

Before that, some moments of high volatility are observed. Dollar x Pre 90 and 180 days contracts showed high volatility in February and April 2017, during operation "Lava Jato" investigations of high rank politicians. May 2017 shaked almost all brazilian markets, with the disclosure of private conversations of president Temer. This affected swap markets, with abnormal volatilities in DI x Pre 90 and 180 days, and Dollar x Pre and DI x Dollar 60, 90 and 180 days, with little effect on the shorter maturities contracts. Later, in June 2018, longer maturities saw abnormal volatilities again, during new repercussions of these investigations. Dollar x Pre and DI x Dollar saw new abnormal movements in September and October 2018, during the expectations and results of the presidential elections. In 2019, Dollar x Pre had a peak in March, during proposals of new social security and retirement plans.

6 CONCLUSION

In this paper, our goal was to analyze the effect of political related news in the four most liquid swap contracts negotiated in the Brazilian Stock Exchange B3, to test this market for Fama's (1970) semi-strong form efficiency. We collected headlines of political news from 581 different days spread over 44 months, and applied a GARCH model on DI x Pre variation , Dollar x Pre, DI x Dollar and DI x IPCA price reference rates data for the same period to check for abnormal movements using parametric and non-parametric analysis.

We found 21 headlines associated to days of abnormal volatility or days that started volatile periods in any of the swap contracts for any maturities in both the parametric and the non parametric analysis, 3,6% of the 581 headlines. This low percentage is in accordance with the semi-strong efficient market hypothesis, and prices are already defined by the information publicly available.

COVID-19 had a high impact on the analysis, with 73% of the higher volatility days for the three most negotiated swap contracts, DI x Pre Variation, Dollar x Pre and DI x Dollar happening after the outbreak. When compared to stock prices, this volatility had a small "delay", since stock prices started strongly decreasing three weeks prior to the beggining of volatile periods on the swap markets.

From the results, it is reasonable to assume a similar behavior in Dollar x Pre and DI x Dollar contracts for all maturities, and are similar with DI x Pre variation for the longer terms. DI x IPCA does not share a behavior with any of the other contracts.

In the period that started our sample, Brazil was leaving one of its biggest recessions, which generated a political crisis that culminated in president Dilma Rousseff's impeachment and still had investigations going four years later. "Joesley Day", May 17 2017, marked the disclosure of supposed participation of president Michel Temer in crimes of corruption that had big impact in almost all financial markets. The three most negotiated swap contracts showed high volatility on this day, except for the short term maturity. This difference in behavior between the short and longer terms may be explained by lack of liquidity, but it would need further study to find evidences.

Our outcomes also follow Smales (2015) and Marques e Santos (2016) for two of the contracts, with peaks of volatility in moments that would define a presidential candidate, and right before and right after the first round of the presidential election. The same contracts showed high volatility during the discussions and advances of government proposals for new retirement plans and new taxation rules. Other moments of abnormal volatility in those contracts and also DI x Pre Variation can be associated with a supposed reduction on the people reliance in president Bolsonaro, during the exit or uncertainty of permanence of his most popular ministers in the

government.

In summary, Swap Contracts can be a great hedging tool for banks and enterprises when used appropriately, but even those related to fixed interest rates are subject to abnormal movements caused by unexpected events.

A suggested follow-up for this study is the application of the methodology on the Brazilian Yield Curve, for an examination of the effects on products of longer maturities. It's also possible to increase the analyzed time period, add different news sources, or select different products.

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