Auctions Cycles and Price Dynamics: Evidence of the V-Shape Effect in Brazilian Treasury Bond Auctions

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Abstract

This paper investigates the presence and causes of the 'V-shape' effect in Brazilian government bond auctions—characterized by a decline in bond prices prior to auction dates, followed by a rebound afterward. Using a rich dataset of LTN and NTN-F securities from 2014 to 2023, we document robust price dynamics surrounding auctions that are more pronounced for longer-maturity bonds. We exploit a natural experiment—the shift in the auction frequency of NTN-F securities from biweekly to weekly in 2018—to test the risk-bearing capacity hypothesis. Empirical tests, panel regressions, and difference-in-differences estimations confirm that shorter auction cycles reduce the cost of debt up to 6 bps. We find no supporting evidence for alternative explanations such as strategic trading or slow-moving capital. These results highlight the relevance of auction frequency design as a debt management tool to reduce price distortions and issuance costs.

Key-words: V-shape effect, auction cycles, treasury bonds, public debt management, Brazil, risk-bearing capacity.
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1 Introduction

Government bond auctions play a central role in public debt financing, and their design can significantly affect both market efficiency and issuance costs. The rapid growth of government debt underscores the urgent need for continuous improvement in debt management strategies.

As of 2025, Brazil's federal public debt exceeds R$ 7 trillion, with annual refinancing needs of approximately R$ 1.5 trillion. Since 2018, several changes in Treasury auction procedures have been introduced to refine the country's debt issuance strategy.

A recurring empirical pattern in several countries is the so-called 'V-shape' effect — a price cycle in which yields rise prior to auction dates and fall afterward. This pattern is typically attributed to dealers' limited risk-bearing capacity and the frictions in reallocating securities post-auction.

A growing body of empirical research has identified this systematic price dynamics surrounding government bond auctions for the United States, Japan, Spain, Germany and Italy, respectively by Lou, Yan e Zhang (2013), Hamao e Jegadeesh (1998), Alvarez e Mazon (2019) and Beetsma et al. (2016).

Brazil's public debt market presents distinctive institutional features—including the central role of primary dealers, varying levels of foreign investor participation, and evolving auction formats—that are likely to influence both the occurrence and intensity of auction-related price cycles.

This paper fills that gap by providing the first empirical assessment of V-shape price patterns in Brazilian Treasury auctions, with a focus on fixed-rate bonds (LTNs and NTN-Fs) between 2014 and 2023. We examine price dynamics around 450 auction dates and test key hypotheses regarding the sources of auction-related price fluctuations. The choice of these fixed-rate bonds enables us to compare securities with similar risk profiles.

To identify causal effects, we exploit a policy change implemented in 2018, when the National Treasury increased the frequency of NTN-F auctions from biweekly to weekly. This change offers a natural experiment that allows us to isolate the impact of auction frequency on price dynamics.

We hypothesize that fluctuations in bond yields around auction dates are primarily driven by the limited risk-bearing capacity of major market participants. Our interpretation aligns more closely with Lou, Yan e Zhang (2013), who attribute the phenomenon to dealers' constrained risk capacity and capital immobility, than with Amin e Tédongap (2023), who emphasize slow-moving capital as the key driver.

Our findings support the former hypothesis: the price trajectories of NTN-Fs became smoother following the transition to weekly auctions, reducing the cost of debt in around 6 bps for longer NTN-Fs and 3 bps for its shorter maturities. Specifically, the characteristic 'V-shape' effect — a decline in bond prices in the days leading up to auctions followed by a recovery afterward — became less pronounced under the new auction frequency.

This interpretation is reinforced by our empirical strategy, which includes panel regressions controlling for omitted variables and unobserved heterogeneity, difference-in-differences (DiD) models capturing the effect of policy shifts, and IV-2SLS regressions addressing potential endogeneity concerns.

Results indicate that auction frequency, bond maturity, and the amount of risk issued significantly affect yield fluctuations. Moreover, external risk factors played a more prominent role in explaining price changes for NTN-Fs — mostly held by foreign investors — than for LTNs. In short, smaller and more frequent auctions reduced the severity of 'V-shaped' movements.

Importantly, the change in price behavior was not accompanied by a decline in trading volumes or by abnormal returns for risk-taking participants, weakening alternative explanations that point to strategic behavior or slow-moving capital as the sources of the 'V-shape' pattern.

There is no evidence that the increased issuance frequency led to a crowding-out effect in the secondary market—that is, there was no indication that participants were strategically waiting for auctions instead of trading in the secondary market. Additionally, time-series analysis of hedge fund returns shows no significant correlation with auction cycles.

The remainder of the paper is organized as follows. Section 2 reviews the related literature. Section 3 presents the empirical strategy. Section 4 describes the data. Section 5 discusses the main findings. Section 6 concludes.

2 Literature Review

Papers in this section look into price movements (e.g. shape, volatility, direction) prior, throughout and after auctions.

One the first researches on this field (NYBORG; SUNDARESAN, 1996) used treasuries trading data from the when-issued market. Those are forward contracts on treasuries, negotiated between auction announcement and the actual issue date of a given security, in which settlement occurs on the issue date. Securities' transactions are based on its expected yield and dealers can be long on short in this market, covering its positions through auction purchases. As for investors, when-issued market is helpful for acquiring certain positions without the need for primary or secondary market transactions. Essentially, this is a very powerful private source of information for dealers regarding demand depth, participation and price discovery.

His findings suggested uniform-price auctions had higher trading volume in the when-issued market compared to auctions under the discriminatory pricing, particularly prior to auctions - suggesting greater information dissemination, which would reduce uncertainty before auctions and the winner's curse. Also, dealers mark-ups in the when-issued market were not significant under uniform-price regime, whereas positive in discriminatory auctions.

In a study on bid shading and bidder surplus in US Treasury auctions, Hortaçsu, Kastl e Zhang (2018) incorporated modifications to the previous model to extract bidder true valuation by Hortaçsu e Kastl (2012), considering information asymmetries and three types of participants: dealers, direct bidders and indirect bidders (participants who need to submit their bids through dealers).

The authors point out dealers shade their bids more than other participants (submit bids below their true valuation). To understand whether this bid shading comes from different valuations or market power, they estimate a structural model for the three types of participants comparing bid shading between groups. Then, they estimate bidder surplus, finding dealers are less willing to buy bonds at lower rates, having the ability to shade their bids more efficiently, obtaining better auction prices. In their auction efficiency computations, participants' surplus in US Treasury auctions was close to 3 basis points, with efficiency losses around 2 basis points. These shading effectively dampen clearing prices and contributes to price rebounds after auctions.

Recent literature begun to address another interesting phenomena in security price dynamics, the "V-shaped" effect on bond prices surrounding auctions.

This 'V-shaped' price pattern is attributed to several hypothesized mechanisms. One explanation is imperfectly anticipated supply shocks (uncertainty regarding the amount of government bond sales and price effects arising from natural buyers). According to this explanation, investors reduce their positions as noise decreases closer to auctions with more available information, creating temporary downward price pressure (SIGAUX, 2020). Another potential mechanism is limited risk-bearing capacity, which amplifies pre-auction price declines as primary dealers adjust their inventories in anticipation of significant supply (LOU; YAN; ZHANG, 2013). Additionally, speculative and strategic behavior by market participants may play a role, as they withhold bids in secondary markets and/or shade their auction bids to influence clearing prices. Finally, imperfect capital mobility, characterized by the slow adjustment of capital flows toward auctioned securities, can extend temporary price distortions (AMIN; TéDONGAP, 2023).

Our results signals the main hypothesis for this auction cycles of prices are closer to Lou, Yan e Zhang (2013). According to him, these price fluctuations are probably caused by limited risk-bearing capacity by dealers accompanied by imperfect capital mobility(LOU; YAN; ZHANG, 2013): dealers would short securities in order to hedge future auction purchases, whereas end investors positions were established at a slower rate. He showed in his paper significant returns were possible under this strategy, however it was not done possibly by imperfect capital mobility.

Lou, Yan e Zhang (2013) claims issuers would benefit from an increased auction frequency with lower auction sizes. This would in turn dilute dealer behavior. Although, in this thesis, we did find a smoother 'V' with an increased NTN-F auction frequency, external risk factors played an important role in this security, mostly owned by foreign investors.

Other research related risk-bearing capacity to 'V-shape' patterns, such as Beetsma et al. (2016), Alvarez e Mazon (2019) and Smales (2020).

Beetsma et al. (2016) investigated auction price cycles around new public debt issues in Germany and Italy. They pointed out volatility as a contributing factor for this phenomenon, reinforcing the risk-bearing capacity of dealers hypothesis as the likely source of these cycles.

Contrary to auction theory, Alvarez e Mazon (2019) observed consistent bidders' losses in Spanish treasury issuances - secondary markets prices were lower than auction clearing prices (overpricing). He investigated determinants to this overpricing, arguing dealer institutional regulation was the main reason for it due to increased participation requirements on primary markets. According to him, results signal auction losses were related to "V-shaped" patterns and market manipulation.

Whereas Smales (2020) examined futures market data to assess the impact on rates of U.S. treasury auctions. Corroborating Lou, Yan e Zhang (2013) hypothesis, he claimed increases in prices, volatility, and traded volumes of securities after auctions were due to dealer's activities covering shorts (buying back positions protecting assets from price declines).

Early research on slow-moving capital include Duffie (2010) description of asset price dynamics caused by the slow moving capital to trading opportunities. According to him, sharp reactions to supply/demand shocks are impeded of arbitrage due to institutional impediments.

From a different perspective, Amin e Tédongap (2023) inspected price cycles before and after auctions. Based on primary and secondary market data, they concluded slow-moving capital hypothesis would be more plausible for 'V-shaped' patterns in TIPS (Treasury Inflation-Protected Securities) auctions due to investors awaiting auctions to purchase securities rather than dealers shorting positions.

They also found evidence of strategic behavior prior to auctions, where direct and indirect bidders reduce demand in days prior to auctions. Unlike (AMIN; TéDONGAP, 2023), analysis of hedge fund returns in Brazil and security trading volumes did not support slow-moving capital and strategic behavior as 'V' source.

In a theoretical approach, emphasizing movements prior to auctions, Sigaux (2020) developed a model explaining price decreases before Italy's treasury auctions, where investors imperfectly anticipate demand, deciding whether to establish long positions or to go short. The result of long positions increases prices, bringing it above expect prices. According to the model, this is followed by noise decline over time, accompanied by reduced purchases, driving prices lower as there is more available information and auctions take place.

Unlike Andrade e Rocha (2024), who examined intermediation costs of public debt, we focus on the implications of policy changes in auction frequencies of assets which have similar risk profiles.

In essence, these research encompass mostly risk as main source of 'V' patterns, with notable different hypothesis arising from imperfectly anticipated demand for the bonds issued by governments, slow-moving capital and strategic behavior. The shift in Brazilian treasury auction frequency enabled us to test these hypotheses, alongside market data from hedge fund daily returns, market data on traded volume and security holders.

Therefore, throughout the next sections we aim to empirically: establish evidence of 'V-shape' price dynamics using daily price data; test prevailing hypothesis, such as dealers' risk-bearing capacity, slow-moving capital or strategic behavior to identify underlying causes; and to examine the impact of auction frequency on price movements, especially comparing pre-2018 fortnightly NTN-F auctions with post-2018 weekly auctions, to understand how auction policies mitigate 'V-shaped' patterns.

3 Empirical Strategy

This research incorporates a public policy experiment in Brazil, specifically the change in auction frequency for NTN-F securities, which enables checking risk-bearing hypothesis proposed by (LOU; YAN; ZHANG, 2013).

The impact of this policy change was assessed using distribution comparisons, statistical tests, and linear regressions measuring price changes around auctions before and after the shift to weekly NTN-F issuances. Additionally, a difference-in-differences (DiD) approach was employed to compare the magnitude of 'V-shaped' patterns between 48-month LTN's and 7-year/10-year NTN-Fs, pre and post policy change.

We began by documenting the 'V-shaped' price patterns observed around Treasury auctions, analyzing their distribution across different benchmarks for Brazilian government bonds LTN and NTN-F. LTNs were categorized into three maturity (benchmark) groups: 6–12 months, 24 months, and 48 months. Whereas NTN-Fs included benchmarks with maturities of 7 and 10 years.

Subsequently, we tested the existence of significant price changes prior and following auctions for each benchmark with two distinct statistics: T-tests and Wilcoxon Statistic. The latter provides robustness to our results due to its non-parametric nature. Those tests were also computed before and after NTN-F auctions became weekly for both sets of maturities.

We ran tests on d_{ij}, which is the sample mean of bond's benchmark j rate change between auction clearing price and closing price of date i, ranging from -3 to +2, where 0 is the auction date. In other words, rate differences from three days prior to auctions and to the next three closing prices after the particular benchmark auction observation.

Exclusively for NTN-Fs, this test is performed additionally for each period and for differences in d_{ij} for each sample: 2014–2017 and 2018–2023.

We also carry out the non parametric Wilcoxon test as a robustness check on the previous exercise. As before, the test was performed separately for each period (2014–2017 and 2018–2023), as well as for the entire sample across all benchmarks.

Next, we turn to the main suspects for auction price cycles, limited risk-bearing capacity by dealers, imperfect capital mobility or strategic behavior: dealers would short securities to hedge future auction purchases, whereas end investors establish positions at a slower rate or would wait for auctions to establish positions.

The following regression analysis considered distinct models evaluating those hypothesis, including pooled regressions incorporating dummy variables for each benchmark (maturity group), comparisons between fixed and random effects, and DiD.

Now, let the dependent variable $d_{i,t}$ represent bond yield changes from clearing to one specific closing date (we used the third closing date, d+2, although robustness analysis for d+0 and d+1 presented similar results), for bond i at auction t.

The panel regression model can be specified as:

$$d_{i,t} = \beta_0 + \beta_1 \text{Market\_Risk}_t + \beta_2 \text{Benchmark\_Risk}_{i,t} + \beta_3 \text{Dummies}_{i,t} + \epsilon_{i,t} \qquad (1)$$

where Market_Risk_t measures market risk factors, such as exchange-rate, VIX, CDS, DXY and Selic Rate; $\text{Benchmark\_Risk}_{i,t}$ captures benchmark-specific risk factors, such as benchmark rate variations, amount issued, dv01 supplied, bid-to-cover, supply adjustments, number of bids etc.; and $\text{Dummies}_{i,t}$ are dummy variables for structural and/or benchmark-specific effects, such as auction frequency or auction type.

To control for unobserved heterogeneity across bonds, we introduce bond-specific fixed effects. This could captures, for instance, regulatory demand or bond specific demand arising from a particular specialist dealer of that benchmark. Alternatively, we estimate a random effects model, assuming this heterogeneity is uncorrelated with the regressors.

To account for structural breaks, such as policy shifts in 2018, we employ a Difference-in-Differences (DiD) approach. Since both LTN and NTN-F are fixed-rate bonds and LTN has been for decades issued weekly and NTN-F frequency became weekly in 2018 we model DiD as:

$$\begin{aligned} d_{i,t} = \gamma_0 &+ \gamma_1 \text{Market\_Risk}_t + \gamma_2 \text{Benchmark\_Risk}_{i,t} \\ &+ \gamma_3 \text{d\_2018}_t + \gamma_4 \text{d\_bench}_i + \gamma_5 (\text{d\_2018}_t \times \text{d\_bench}_i) \\ &+ \epsilon_{i,t} \end{aligned} \tag{2}$$

where d_2018_t is a dummy variable for the post-2018 period and d_bench_i indicates whether bond i is subject to new benchmark auction frequency rules (i.e. NTN-F 7y or 10y), we mark as 0 the 48-month LTN, which in our sample is the closest in duration to NTN-Fs.

As another robustness check accounting for potential endogenous variables we estimate equations through IV-2SLS with lagged variables.

Our first results point out to risk-bearing capacity as a fundamental source of 'V-shape' size, not for only dealers, but for end investors too. Also, we show shorter cycles of auctions decrease the magnitude of this price dynamic.

In order to test speculation hypothesis, we performed a brazilian hedge fund index data analysis (Índice de Hedge Funds ANBIMA - IHFA). This assessment looked into whetter there was any return seasonality on days around auctions through autocorrelation analysis and Fourier Transform, not finding enough evidence for speculation as 'V-shape' patterns primary source, where $R(t)$ represents the returns of the hedge fund index IHFA at business day t. We tried to uncover if there was any relation or peak in returns of hedge funds in specific days of the week which would coincide with auction price dynamics.

Lastly, we inspected traded volume and turnover of outstanding government bonds. Our results suggest dealers' smaller short cycle is probably a smoothing factor for prices, as there is no clear indicator of significant impact on traded volume for those securities nor signs of a crowding out effect by increasing the number of auctions. In short, there was not a declining trend in secondary market due to increased primary market activity leading investors to predominantly await auctions to make strategic purchases.

4 Data

Our data comprises LTN and NTN-F auctions between 2014 and 2023, those are fixed income government securities. We group LTN maturties into benchmarks of 6–12 months, 24 months, and 48 months; NTN-Fs are divided into 7 and 10 year benchmarks. For both types of securities we fit those categories of benchmarks according to maturity windows. We end up with about 450 auctions for LTNs and 350 for NTN-Fs.

For clarity, we organize our variables as market risk factors, benchmark-specific risk factors, dummies and deltas (yield changes from a certain auction clearing rate to a specific date).

Market risk variables reflect the broader economic environment, influencing investor behavior and auction outcomes. Benchmark-specific risk factors, such as benchmark rate variations, amount issued, dv01 supplied, bid-to-cover and supply adjustments take into account idiosyncrasies of each auction/maturity. Lastly, deltas are our main dependent variables, from where we capture 'V-Shape' price patterns.

In our sample, we have **USD/BRL**, the exchange rate between Brazilian Real and the US Dollar, higher values might indicate riskier environments for locals and cheaper prices for foreign investors. Our sample captures the move from 2.50 up to the 5 range.

Also **VIX (Volatility Index)** is a gauge for global market uncertainty, arising from implied volatility on near term index options on the S&P 500. Most of the sample is below 20, averaging 18, which is historically low.

We include **CDS (Credit Default Swap Spreads)**, which measures Brazilian 5-year sovereign credit risk. Three quarters of the sample is below 255 basis points, also historically low.

SELIC which is Brazil's policy interest rate, directly influencing yield curves. It ranges from 1.9% to 14.15%. Higher SELIC levels correlate with increased yields across all benchmarks.

And **DXY (US Dollar Index)** is an index of exchange rates between major currencies and the US Dollar, it correlates with USD/BRL, and international risk-aversion periods.

As benchmark specific we include **dv01_of**, computed as the price change from a 1 basis-point increase in the bond yield times the amount issued that date, divided by 1 million here. We end up not using it too much due to LFTs extreme issuances driving this indicator upward, and not really reflecting risk.

Dv01_of_bench, computed as the price change from a 1 basis-point increase in the bond yield times the amount issued that date for the specific benchmark, divided by 1 million here. As expected, 48-month benchmarks have significant larger means and medians. Median 48-month benchmark supply is almost ten times larger than 6&12-month LTNs. NTN-F benchmarks dv01 supply is closer to LTN 24-month benchmark since the amount offered is quite lower than LTNs.

Number_bids, the bid count for each auction. Very similar for both NTN-Fs, around 10, with higher values for LTN benchmarks. 48-month and 24-month present close to 23 and 17 bids per auction, whereas 6&12-month LTNs are closer to 13.

Number_bids_ac, the accepted bid count for each auction, approximately 50-60% for all benchmarks.

Ac_ratio corresponding to supply adjustments, reducing the amount issued and profits. It is computed as the ratio between Issuance and Supply. We adjust this indicator for hybrid auctions dividing the supply by the number benchmarks, making it appear above 1 when one benchmark is allocated more than the supply divided by the number of benchmarks.

Bid_to_cover which captures the ratio of amount bid relative to initial supply. It tends to be a little bit higher for 6&12-month benchmark securities, probably due to supply restrictions, otherwise demand is around 60% higher than supply (bid_to_cover close to 1.6).

Profit, also regarded as auction premium, the difference between the auction's clearing rate and the secondary market rate. It is almost zero on average, or slightly negative by 1 basis-point on average across LTNs and NTN-Fs.

Supply, the amount offered for each benchmark. 48-month LTNs has been the most offered fixed-income securities (not including SELIC-linked bonds, such as LFTs), with 4MM bonds auctioned on average, closely followed by 24-month and 6&12-month benchmarks. The latter, has recently been practically pegged to 1MM bonds a week. Its median reflect the issuer strategy. NTN-Fs have similar average issuance, around 700k bonds per issuance.

Issuance, the amount issued for each benchmark, are very close to supply since supply adjustments are very low (ac_ratio close to one).

Clearing Rate, the last accepted bid auction yield for the specific security. This definition works well for 'V-shape' analysis, however we change it for revenue equivalence investigations, becoming average yield.

Closing Rate, the secondary market end of the day yield for the specific security.

MAturity_months, the number of months until maturity, as expected it is very close to the benchmark classification.

anb-5, which is a proxy of the yield changes between last auction date closing price and current auction opening yield - also very close to zero across all benchmarks.

Deltas, as expected by the 'V-shape' price patterns, exhibit higher means for days further from auctions, either before or after, where: delta-3 is the difference in yield for the specific benchmark 3 closing dates prior to the auction to the clearing rate; delta+0 is the difference from the auction date closing yield to the clearing rate; and delta+2 is the yield difference between the third closing rate after the auction and the clearing rate.

Figures 1 and 2 document clearly ‘V-shape’ price patterns for LTNs and NTN-Fs. The darker line is the mean delta and the shaded areas comprise 2 standard-deviations from it. At a first glance, we find longer durations increasing deltas for both types of bonds. All benchmarks present clear ‘V-shape’ patterns, except the less risky of them (6&12-month benchmark), which on top of that has restricted supply. Also, deviations are larger as we move away from auctions as other variables influence yield changes over time.

Tables 1, 2, 3, 4, 5, encompass descriptive statistics for each of the three LTN benchmarks and the two NTN-F benchmarks.

Table 1 covers data on the 24-month benchmarks. This intermediary LTN supplied risk (dv01_of_bench) is about half of its 48-month counterpart and double the shorter duration LTNs. Median offering is 2 million bonds, with the first and third quarter ranging from 1.5 million to 3.5 million. This indicators show more risk and therefore more probable ‘V-shape’ dynamics, than 6&12-month LTNS. Supply adjustments are very close to zero, since ac_ratio is nearing 1, as in all LTNs. Demand is about two-thirds greater than its supply as we can see in the bid_to_cover. In tandem, these show good demand in our sample and low need for supply adjustment diminishing profits. Median and mean profits are almost zero reflecting decent calibration of supply by the issuer. Deltas reflect ‘V-shape’ patterns with means above zero across the table. Market variables reflecting the macroeconomic environment are very close between tables as our samples have the same date range. They are discussed briefly on its description.

The 48-month LTN benchmark in Table 2 exhibits the highest duration risk among the zero-coupon fixed-rate bonds in our sample, as reflected in its average dv01_of_bench, which is more than twice that of the 24-month benchmark. Issuance size is also notably larger, with a median offering of 3.5 million bonds and an interquartile range from 2 to 5 million, indicating greater market absorption capacity, specially due to regulatory demand throughout great part of the sample. Despite the increased maturity and duration risk, supply adjustments remain minimal, with acceptance ratios tightly clustered around one, suggesting stable allocation practices. Investor demand, measured by the bid_to_cover ratio, is strong and consistent, averaging around 1.63. Mean and median profits near zero suggests that auction pricing is well calibrated, minimizing excess returns to bidders. Price adjustments following auctions display the typical ‘V-shape’, with positive average deltas on and after the auction date, marginally higher than in the 24-month case - probably due to higher risk supply.

The shortest zero-coupon in the sample — those maturing within 6 to 12 months— exhibit the lowest duration risk, as evidenced by their average dv01_of_bench, which stands at just 0.19 (Table 3). This figure is less than half that of the 24-month benchmark and approximately one-fifth that of the 48-month bonds, confirming the relatively limited exposure to interest rate risk. Limited offerings set interquartile range to zero, with median of 1 million supplied bonds and a highly skewed distribution, as indicated by a long upper tail reaching up to 30 million. This cap on supply brought bid_to_cover ratio averages above 2 — the highest across all LTN benchmarks - and to profits below zero. Acceptance ratios remain tightly centered around one, again indicating minimal supply adjustment in the allocation process. As expected by the limited risk-bearing hypothesis, deltas are close to zero with a less pronounced 'V-shape' pattern as there is less risk involved in these benchmarks.

Table 4 shows descriptive statistics for the 7y NTN-F benchmark. As its supply is reduced in relation to LTN benchmarks due to its duration, demand profile and number of auctions (close to 350 for NTN-Fs and 450 for LTNs), average dv01_of_bench is 0.30, close to the 24-month benchmark. Issuance is relatively measured, with a median of 500,000 bonds and an interquartile range from 150,000 to 1 million, indicating a more cautious supply approach. Auction participation is modest, averaging around 10 bids per auction, with roughly half accepted, and an acceptance ratio below one suggests more caution in bidding. The bid_to_cover ratio, averaging 1.66, indicates healthy but demand, while profits remain slightly negative on average, reflecting tight calibration by the issuer. Price dynamics around the auction shows deltas consistently above zero, suggesting presence of 'V' price patterns.

The 10y NTN-F benchmark in Table 5 presents the longest maturity in this sample, with average dv01_of_bench at 0.39 —higher than the 7y counterpart, reflecting increased interest rate exposure, although not as big as the 48-month LTN due to its smaller supply. Issuance remains measured, with a median of 500,000 bonds and an interquartile range from 150,000 to 1 million, mirroring the 7y benchmark. Auctions are relatively thin, with a median of just 8 bids submitted and 4 accepted, while the acceptance ratio of 0.90 suggests selective supply allocation. Relative demand is shorter than LTN benchmarks, as indicated by a lower average bid_to_cover ratio of 1.51. Profits are close to zero and slightly negative on average, consistent with the 7y benchmark. Price dynamics surrounding the auction reveal persistent positive deltas, with post-auction days showing upward adjustments consistent with 'V-shape' dynamics.

5 Results - Issuance's Price Dynamics

Our results point out to risk-bearing capacity as a fundamental source of 'V-shape' size, not for only dealers, but for end investors too. Also, we show shorter cycles of auctions decrease the magnitude of this price dynamic.

Figure 1 – Shaded LTN

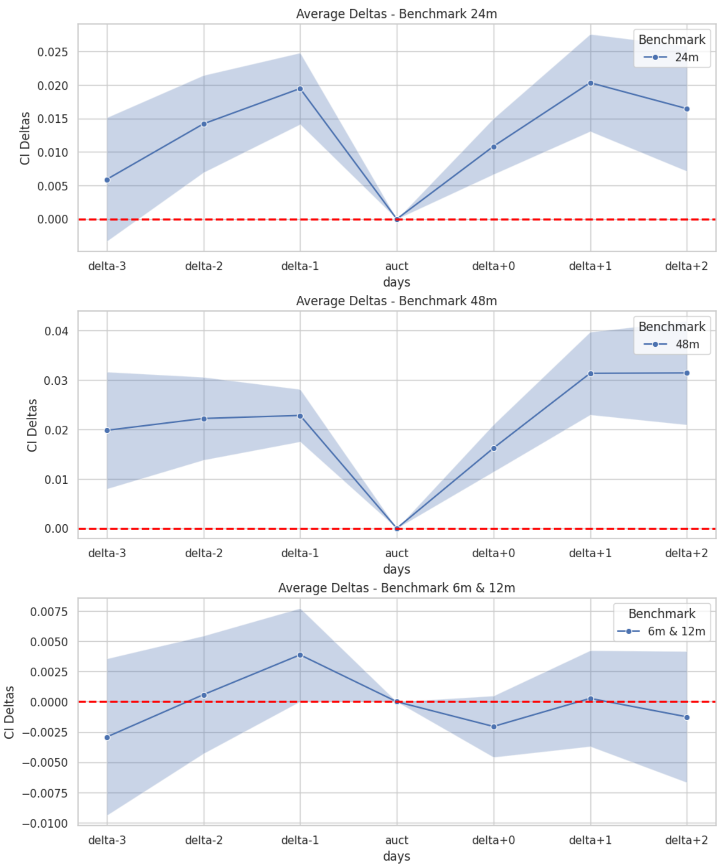


Figure 2 – Shaded NTN-F

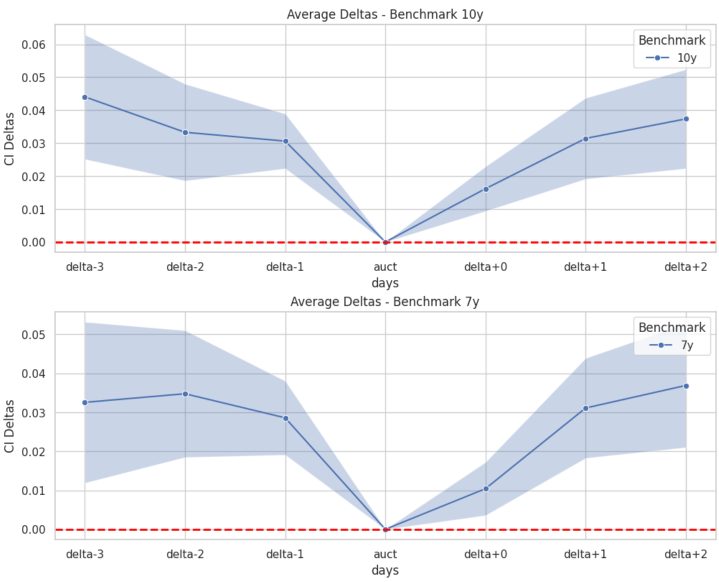


Table 1 – Descriptive Statistics LTN 24-month Benchmark

Variable	count	mean	std	min	25%	50%	75%	max
dv01_of	436.00	651.50	955.73	0.11	3.87	7.48	1166.20	9515.64
dv01_of_bench	436.00	0.41	0.27	0.01	0.23	0.33	0.55	1.64
number_bids	436.00	17.16	5.36	2.00	14.00	17.00	21.00	34.00
number_bids_ac	436.00	10.07	4.69	1.00	7.00	10.00	13.00	26.00
ac_ratio	436.00	0.98	0.08	0.12	1.00	1.00	1.00	1.00
bid_to_cover	436.00	1.66	0.63	0.61	1.24	1.52	1.92	6.00
profit	436.00	-0.00	0.02	-0.06	-0.01	-0.00	0.00	0.21
USD/BRL	435.00	4.26	0.90	2.57	3.34	4.06	5.17	5.89
DXY	424.00	114.85	4.84	103.08	111.64	114.65	117.66	128.17
VIX	428.00	18.26	6.33	9.19	13.52	16.70	21.67	50.91
UST10Y	425.00	2.29	0.93	0.55	1.66	2.21	2.85	4.98
CDS	436.00	224.30	73.49	92.52	173.62	217.65	253.08	495.45
SELIC	436.00	9.20	4.28	1.90	6.15	9.65	13.65	14.15
Supply	436.00	2711353.21	1814061.49	50000.00	1500000.00	2000000.00	3500000.00	12000000.00
Issuance	436.00	2662692.32	1825016.65	50000.00	1500000.00	2000000.00	3500000.00	12000000.00
Clearing Rate	436.00	9.64	3.26	3.44	7.28	9.64	12.40	16.31
Closing rate	420.00	9.62	3.26	3.37	7.24	9.66	12.37	16.31
maturity_months	436.00	23.82	2.13	18.00	22.00	24.00	25.25	30.00
delta-3	420.00	0.00	0.18	-0.61	-0.11	0.01	0.09	1.04
delta-2	420.00	0.01	0.14	-0.42	-0.07	0.01	0.08	0.82
delta-1	419.00	0.02	0.11	-0.41	-0.04	0.02	0.07	0.63
delta+0	420.00	0.01	0.08	-0.60	-0.03	0.01	0.05	0.37
delta+1	435.00	0.02	0.14	-0.84	-0.05	0.03	0.10	0.62
delta+2	436.00	0.02	0.18	-0.94	-0.07	0.03	0.12	0.68
anb-5	403.00	-0.02	0.22	-0.89	-0.16	-0.04	0.08	1.34

Table 2 – Descriptive Statistics LTN 48-month Benchmark

Variable	count	mean	std	min	25%	50%	75%	max
dv01_of	441.00	644.41	949.50	0.11	3.83	7.41	1136.16	9515.64
dv01_of_bench	441.00	0.90	0.67	0.01	0.48	0.78	1.13	5.27
number_bids	441.00	23.08	8.77	1.00	18.00	23.00	28.00	55.00
number_bids_ac	441.00	13.88	7.02	1.00	9.00	14.00	19.00	38.00
ac_ratio	441.00	0.97	0.12	0.03	1.00	1.00	1.00	1.33
bid_to_cover	441.00	1.63	0.65	0.33	1.22	1.47	1.87	5.33
profit	441.00	-0.00	0.03	-0.12	-0.01	-0.00	0.00	0.31
USD/BRL	440.00	4.25	0.90	2.57	3.33	4.03	5.16	5.89
DXY	429.00	114.80	4.80	103.08	111.76	114.63	117.56	128.17
VIX	433.00	18.13	6.23	9.19	13.49	16.59	21.58	50.91
UST10Y	430.00	2.30	0.92	0.55	1.68	2.23	2.86	4.98
CDS	441.00	224.60	72.99	92.52	173.74	218.31	254.21	495.45
SELIC	441.00	9.21	4.25	1.90	6.40	10.15	13.65	14.15
Supply	441.00	3901247.17	2942950.67	50000.00	2000000.00	3500000.00	5000000.00	20000000.00
Issuance	441.00	3800021.09	2928794.62	40000.00	2000000.00	3137500.00	5000000.00	20000000.00
Clearing Rate	441.00	10.18	2.70	4.82	8.28	10.32	12.14	16.82
Closing rate	426.00	10.15	2.71	4.77	8.21	10.33	12.12	16.65
maturity_months	441.00	42.79	3.67	36.00	40.00	43.00	46.00	51.00
delta-3	426.00	0.01	0.23	-0.89	-0.10	0.01	0.11	1.72
delta-2	426.00	0.02	0.17	-0.49	-0.07	0.01	0.10	1.52
delta-1	425.00	0.02	0.10	-0.40	-0.04	0.02	0.07	0.66
delta+0	426.00	0.02	0.10	-0.56	-0.03	0.02	0.07	0.35
delta+1	440.00	0.03	0.16	-0.65	-0.06	0.03	0.12	0.60
delta+2	441.00	0.03	0.20	-0.60	-0.09	0.04	0.14	0.74
anb-5	410.00	-0.01	0.28	-0.95	-0.17	-0.03	0.11	1.90

Table 3 – Descriptive Statistics LTN 6&12-month Benchmark

Variable	count	mean	std	min	25%	50%	75%	max
dv01_of	430.00	652.52	957.04	0.11	3.89	7.60	1152.64	9515.64
dv01_of_bench	430.00	0.19	0.29	0.00	0.05	0.09	0.17	1.99
number_bids	430.00	12.86	7.02	1.00	8.00	11.00	15.75	43.00
number_bids_ac	430.00	6.79	5.32	1.00	3.00	5.00	8.00	36.00
ac_ratio	430.00	0.97	0.12	0.06	1.00	1.00	1.00	1.00
bid_to_cover	430.00	2.10	0.93	0.06	1.44	2.00	2.65	6.96
profit	430.00	-0.01	0.01	-0.09	-0.02	-0.01	-0.00	0.05
USD/BRL	429.00	4.25	0.90	2.57	3.33	4.04	5.16	5.89
DXY	418.00	114.79	4.82	103.08	111.62	114.65	117.54	128.17
VIX	422.00	18.22	6.36	9.19	13.49	16.59	21.62	50.91
UST10Y	419.00	2.28	0.93	0.55	1.67	2.20	2.84	4.98
CDS	430.00	224.30	73.90	92.52	173.42	217.19	252.92	495.45
SELIC	430.00	9.18	4.28	1.90	6.21	9.15	13.65	14.15
Supply	430.00	2838372.09	4188633.99	50000.00	1000000.00	1000000.00	3000000.00	30000000.00
Issuance	430.00	2785647.21	4153857.53	25000.00	1000000.00	1000000.00	3000000.00	30000000.00
Clearing Rate	430.00	9.31	3.99	2.01	6.33	9.65	13.30	15.71
Closing rate	427.00	9.29	3.99	2.02	6.34	9.59	13.28	15.57
maturity_months	430.00	8.81	3.52	3.00	6.00	9.00	12.00	15.00
delta-3	427.00	-0.01	0.13	-0.75	-0.07	-0.01	0.05	0.73
delta-2	427.00	-0.00	0.09	-0.58	-0.05	-0.01	0.04	0.40
delta-1	426.00	0.00	0.07	-0.36	-0.03	0.00	0.03	0.38
delta+0	427.00	-0.00	0.05	-0.66	-0.02	-0.00	0.02	0.15
delta+1	430.00	-0.00	0.08	-0.46	-0.03	0.01	0.04	0.19
delta+2	430.00	-0.00	0.11	-0.61	-0.04	0.01	0.06	0.29
anb-5	426.00	-0.02	0.14	-0.53	-0.09	-0.03	0.04	1.08

Table 4 – Descriptive Statistics NTN-F 7y Benchmark

Variable	count	mean	std	min	25%	50%	75%	max
dv01_of	353.00	569.13	859.23	0.11	3.79	6.25	1137.54	6007.93
dv01_of_bench	353.00	0.30	0.33	0.01	0.07	0.19	0.40	2.51
number_bids	353.00	9.91	6.31	1.00	5.00	9.00	13.00	29.00
number_bids_ac	353.00	5.59	4.10	1.00	2.00	5.00	8.00	22.00
ac_ratio	353.00	0.90	0.23	0.07	1.00	1.00	1.00	1.33
bid_to_cover	353.00	1.66	0.77	0.09	1.22	1.60	2.00	5.30
profit	353.00	-0.01	0.02	-0.19	-0.02	-0.01	0.00	0.03
USD/BRL	353.00	4.41	0.87	2.60	3.72	4.36	5.21	5.89
DXY	342.00	115.28	4.72	103.28	112.02	115.09	118.21	128.17
VIX	346.00	18.75	5.82	9.22	14.02	17.58	22.41	39.16
UST10Y	343.00	2.31	1.00	0.55	1.60	2.19	2.91	4.98
CDS	353.00	218.16	79.57	92.52	168.68	206.59	243.19	521.36
SELIC	353.00	8.66	4.37	1.90	5.40	7.40	13.65	14.15
Supply	353.00	715722.38	749564.72	50000.00	150000.00	500000.00	1000000.00	4000000.00
Issuance	353.00	684122.10	753889.35	4500.00	150000.00	500000.00	1000000.00	4000000.00
Clearing Rate	353.00	10.20	2.53	5.96	8.46	10.26	11.99	16.40
Closing rate	353.00	10.19	2.53	5.93	8.41	10.30	11.99	16.27
maturity_months	353.00	71.88	10.90	15.00	66.00	71.00	79.00	97.00
delta-3	353.00	0.02	0.25	-0.92	-0.09	0.01	0.13	1.72
delta-2	353.00	0.02	0.18	-0.62	-0.07	0.02	0.10	1.61
delta-1	352.00	0.02	0.10	-0.36	-0.04	0.02	0.07	0.66
delta+0	353.00	0.01	0.10	-0.42	-0.04	0.02	0.06	0.33
delta+1	353.00	0.03	0.16	-0.49	-0.07	0.02	0.12	0.57
delta+2	353.00	0.03	0.21	-0.58	-0.09	0.03	0.14	0.85
anb-5	352.00	-0.00	0.28	-0.79	-0.17	-0.02	0.13	1.71

Table 5 – Descriptive Statistics NTN-F 10y Benchmark

Variable	count	mean	std	min	25%	50%	75%	max
dv01_of	347.00	540.22	832.66	0.19	3.73	5.80	1133.84	6007.93
dv01_of_bench	347.00	0.39	0.47	0.02	0.09	0.26	0.52	5.10
number_bids	347.00	9.29	6.51	1.00	4.00	8.00	13.00	49.00
number_bids_ac	347.00	5.48	4.16	1.00	2.00	4.00	8.00	22.00
ac_ratio	347.00	0.90	0.22	0.05	1.00	1.00	1.00	1.00
bid_to_cover	347.00	1.51	0.64	0.07	1.13	1.42	1.80	4.28
profit	347.00	-0.01	0.02	-0.20	-0.02	-0.01	0.00	0.08
USD/BRL	347.00	4.39	0.86	2.60	3.70	4.23	5.18	5.89
DXY	338.00	115.38	4.62	103.28	112.28	115.24	118.49	128.17
VIX	341.00	18.48	5.80	9.55	13.71	17.03	22.08	39.16
UST10Y	339.00	2.36	0.98	0.55	1.63	2.27	2.95	4.98
CDS	347.00	216.51	71.48	92.52	170.42	209.47	243.40	521.36
SELIC	347.00	8.73	4.24	1.90	5.90	7.40	13.15	14.15
Supply	347.00	665129.68	692993.57	50000.00	150000.00	500000.00	1000000.00	4500000.00
Issuance	347.00	630642.07	693804.28	5000.00	150000.00	325000.00	1000000.00	4500000.00
Clearing Rate	347.00	10.54	2.27	6.51	8.99	10.80	12.14	16.71
Closing rate	345.00	10.50	2.25	6.47	8.95	10.75	12.13	16.49
maturity_months	347.00	120.43	7.06	104.00	115.00	120.00	126.00	133.00
delta-3	345.00	0.03	0.24	-0.88	-0.09	0.02	0.14	1.70
delta-2	345.00	0.02	0.18	-0.88	-0.07	0.02	0.11	1.62
delta-1	344.00	0.03	0.10	-0.40	-0.03	0.02	0.08	0.69
delta+0	345.00	0.02	0.10	-0.30	-0.04	0.02	0.07	0.35
delta+1	347.00	0.03	0.16	-0.51	-0.05	0.03	0.11	0.50
delta+2	347.00	0.03	0.20	-0.54	-0.08	0.03	0.15	0.75
anb-5	341.00	-0.00	0.27	-0.79	-0.16	-0.02	0.12	1.68

After spotting ‘V-shape’ patterns in Brazilian National Treasury auctions, we delve deeper in the data. Here we present: statistical tests rejecting the null hypothesis that deltas are zero for both LTN and NTN-F; statistical tests showing the difference in the size of deltas are different from zero when we divide the data into two samples, the first slice for auctions every fortnight and the second for weekly auctions; we estimate deltas on a set of control variables through POLS with benchmark dummies, panel regressions with fixed and random effects and differences-in-differences (DiD) regressions corroborating the risk-bearing hypothesis; then we proceed to robustness analysis contrarian to strategic behavior, as Brazilian hedge-fund returns do not present enough evidence for speculation as ‘V-shape’ patterns primary source; finally, we inspect NTN-F turnover and secondary market traded volume spotting no clear signal of significant impact on traded volume for those securities arising from auction frequency.

Figure 3 tells the story of the policy change. While NTN-F auctions were every fortnight, the sample from 2014 up to the end of 2017, rates increased more sharply prior to auctions and decreased further after them. This pattern in rates (prices) has become smoother after issuances became weekly. The darker line is the mean delta and the shaded areas comprise 2 standard-deviations from it. We also see a more pronounce effect in the longer/riskier NTN-F benchmark, 10y.

Tables 6 and 7 present mean delta by type of bond and benchmark. In a nutshell,

Figure 3 – Shaded NTN-F Experiment

longer LTN benchmarks and all NTN-F benchmarks show delta significantly above 0 on T-Tests. Results are similar in the non-parametric Wilcoxon rank-sum test statistic.

Table 6 – Results by Benchmark and Delta - LTN

Benchmark	Delta	Mean	T-Statistic	P-Value (T-Test)	Wilcoxon Statistic	P-Value (Wilcoxon)	95% CI Lower	95% CI Upper	Observations
24m	delta-3	0.005917	0.710893	0.4775	52440.0	0.4511	-0.010440	0.022274	467
24m	delta-2	0.014208	2.172464	0.0303*	48208.5	0.0397*	0.001356	0.027060	467
24m	delta-1	0.019483	4.044838	0.0001*	40854.5	0.0000*	0.010018	0.028948	466
24m	delta+0	0.010852	2.884869	0.0041*	42878.0	0.0001*	0.003460	0.018244	467
24m	delta+1	0.020349	3.166633	0.0016*	45153.5	0.0000*	0.007723	0.032976	484
24m	delta+2	0.016479	1.996834	0.0464*	48851.5	0.0011*	0.000264	0.032695	485
48m	delta-3	0.019809	1.872418	0.0618	51280.5	0.1088	-0.000979	0.040598	474
48m	delta-2	0.022203	2.961552	0.0032*	48561.0	0.0096*	0.007471	0.036935	474
48m	delta-1	0.022818	4.807252	0.0000*	39784.5	0.0000*	0.013491	0.032145	473
48m	delta+0	0.016211	3.793871	0.0002*	41913.0	0.0000*	0.007815	0.024608	474
48m	delta+1	0.031335	4.248915	0.0000*	44751.5	0.0000*	0.016845	0.045825	490
48m	delta+2	0.031411	3.412180	0.0007*	49074.0	0.0003*	0.013324	0.049498	491
6m & 12m	delta-3	-0.002913	-0.504538	0.6141	53082.5	0.1932	-0.014257	0.008431	477
6m & 12m	delta-2	0.000583	0.134459	0.8931	54986.5	0.5541	-0.007940	0.009106	477
6m & 12m	delta-1	0.003874	1.126123	0.2607	51960.0	0.1272	-0.002886	0.010634	476
6m & 12m	delta+0	-0.002045	-0.903953	0.3665	55559.0	0.7469	-0.006490	0.002400	477
6m & 12m	delta+1	0.000274	0.077774	0.9380	51137.0	0.0253*	-0.006644	0.007191	481
6m & 12m	delta+2	-0.001249	-0.259390	0.7954	52733.5	0.0866	-0.010709	0.008211	481

Then, we proceed to sliced sample in Tables 8 and 9. Although deltas are significantly above zero in both slices in Table 8, these results are less common in the second sample (2018-2023). T-Tests on delta differences between samples in Table 9 are significant only in delta+2 for the 7y benchmark and in delta-2 for the 10y benchmark at the 5% level. Wilcoxon Statistics are significant in the 5% level for three 7y and 10y benchmark deltas. This last results signal less pronounced 'V-shape' for both benchmarks, as we tested diffrence in magnitude of these dynamics after the policy shift.

Next, we start regression analysis. POLS for LTN, Table 10, display results com-

Table 7 – Results by Benchmark and Delta - NTN-F

Benchmark	Delta	Mean	T-Stat.	P-Value (T-Test)	Wilcoxon Stat.	P-Value (Wilcoxon)	95% CI Lower	95% CI Upper	Obs.
10y	delta-3	0.044031	3.198832	0.0015*	27715.5	0.0017*	0.016964	0.071098	370
10y	delta-2	0.033289	3.112177	0.0020*	27435.5	0.0008*	0.012255	0.054322	370
10y	delta-1	0.030618	5.058844	0.0000*	22532.5	0.0000*	0.018716	0.042519	369
10y	delta+0	0.016169	3.284448	0.0011*	26029.5	0.0001*	0.006489	0.025850	370
10y	delta+1	0.031432	3.538466	0.0005*	26143.5	0.0000*	0.013965	0.048899	375
10y	delta+2	0.037349	3.436289	0.0007*	27976.0	0.0005*	0.015977	0.058721	375
7y	delta-3	0.032543	2.192401	0.0290*	31333.0	0.0350*	0.003357	0.061730	379
7y	delta-2	0.034754	2.972238	0.0031*	29868.0	0.0040*	0.011763	0.057745	379
7y	delta-1	0.028579	4.186018	0.0000*	25812.0	0.0000*	0.015155	0.042003	378
7y	delta+0	0.010408	2.122139	0.0345*	28646.5	0.0013*	0.000764	0.020051	379
7y	delta+1	0.031095	3.373672	0.0008*	27997.5	0.0002*	0.012972	0.049218	379
7y	delta+2	0.036875	3.230966	0.0013*	29441.5	0.0021*	0.014434	0.059316	379

Table 8 – Results by Benchmark and Delta (2 samples) - NTN-F

Period	Benchmark	Delta	Mean	T-Stat.	P-Value (T-Test)	Wilcoxon Stat.	P-Value (Wilcoxon)	95% CI Lower	95% CI Upper	Obs.
2014-2017	10y	delta-3	0.088381	2.718998	0.0078*	1418.0	0.0009*	0.023850	0.152912	96
2014-2017	10y	delta-2	0.070156	2.705586	0.0081*	1378.0	0.0005*	0.018678	0.121634	96
2014-2017	10y	delta-1	0.047113	4.612268	0.0000*	1155.0	0.0000*	0.026834	0.067391	96
2014-2017	10y	delta+0	0.024546	2.555405	0.0122*	1580.0	0.0063*	0.005477	0.043615	96
2014-2017	10y	delta+1	0.046851	2.674342	0.0088*	1492.0	0.0023*	0.012072	0.081630	96
2014-2017	10y	delta+2	0.066641	3.016561	0.0033*	1426.5	0.0010*	0.022783	0.110498	96
2014-2017	7y	delta-3	0.053767	1.622202	0.1079	1872.0	0.0118*	-0.011983	0.119516	102
2014-2017	7y	delta-2	0.049885	2.012522	0.0468*	1779.0	0.0047*	0.000714	0.099057	102
2014-2017	7y	delta-1	0.040356	3.946604	0.0001*	1380.0	0.0001*	0.020071	0.060640	102
2014-2017	7y	delta+0	0.012175	1.265738	0.2085	2067.5	0.0620	-0.006906	0.031255	102
2014-2017	7y	delta+1	0.048679	2.893002	0.0047*	1633.5	0.0009*	0.015300	0.082059	102
2014-2017	7y	delta+2	0.076501	3.414314	0.0009*	1563.5	0.0004*	0.032054	0.120948	102
2018-2023	10y	delta-3	0.028523	1.944524	0.0529	16510.5	0.1138	-0.000355	0.057400	273
2018-2023	10y	delta-2	0.020007	1.787509	0.0750	16649.5	0.1162	-0.002028	0.042042	273
2018-2023	10y	delta-1	0.024818	3.386763	0.0008*	13508.0	0.0001*	0.010391	0.039244	273
2018-2023	10y	delta+0	0.013135	2.283217	0.0232*	14753.5	0.0033*	0.001809	0.024461	273
2018-2023	10y	delta+1	0.026028	2.477044	0.0139*	14666.0	0.0020*	0.005341	0.046714	273
2018-2023	10y	delta+2	0.026924	2.125608	0.0344*	16085.5	0.0452*	0.001987	0.051861	273
2018-2023	7y	delta-3	0.024791	1.520210	0.1296	17844.0	0.3916	-0.007313	0.056895	276
2018-2023	7y	delta-2	0.028890	2.189120	0.0294*	17228.5	0.1556	0.002910	0.054870	276
2018-2023	7y	delta-1	0.024227	2.834207	0.0049*	15407.0	0.0090*	0.007399	0.041055	276
2018-2023	7y	delta+0	0.009597	1.675524	0.0950	15330.0	0.0098*	-0.001679	0.020874	276
2018-2023	7y	delta+1	0.024567	2.230207	0.0265*	15965.0	0.0226*	0.002881	0.046253	276
2018-2023	7y	delta+2	0.022058	1.668484	0.0964	17269.5	0.1648	-0.003968	0.048085	276

Table 9 – Benchmarks and Deltas Tests for Differences in Samples - NTN-F

Benchmark	Delta	Mean Diff	T-Stat.	P-Value (T-Test)	Wilcoxon Stat.	P-Value (Wilcoxon)	Obs.2014-2017	Obs.2018-2023
7y	delta-3	-0.0290	0.8639	0.3882	15815	0.0652	102	276
7y	delta-2	-0.0210	0.7946	0.4273	16098	0.0320*	102	276
7y	delta-1	-0.0161	1.0488	0.2950	16527	0.0094*	102	276
7y	delta+0	-0.0026	0.2324	0.8164	14388	0.7407	102	276
7y	delta+1	-0.0241	1.1587	0.2473	15634	0.0985	102	276
7y	delta+2	-0.0544	2.1217	0.0345*	16359	0.0155*	102	276
10y	delta-3	-0.0599	1.9096	0.0570	15218	0.0187*	96	273
10y	delta-2	-0.0501	2.0609	0.0400*	15447	0.0091*	96	273
10y	delta-1	-0.0223	1.6197	0.1062	15155	0.0225*	96	273
10y	delta+0	-0.0114	1.0143	0.3111	13873	0.3923	96	273
10y	delta+1	-0.0208	1.0138	0.3114	14303	0.1823	96	273
10y	delta+2	-0.0397	1.5851	0.1138	14751	0.0670	96	273

patible wih the risk-bearing hypothesis: the amount of risk offered (dv01_of_bench) is positively related with price rebounds after auctions. In specifications 2, 3 and 5 containing dummies for benchmarks, d_bench24 and d_bench48, respectively LTN 24m and LTN 48m, coefficients for those dummies are significantly different from zero on the 10% and in the 1% threshold. This reflects our graphical analysis of 'V-shape' patterns increase in the longer duration bonds in Figures 1 and 2, as well statistical tests in Tables 6 and 7.

Our panel estimates, Table 11, showed similar results for POLS, fixed effects (FE) and random effects (RE) with p-value above 0.9 from Hausman Test - the same for NTN-F panel regressions. It is noteworthy that higher USD/BRL and anb-5 (yield changes between last auction date closing price and current auction opening yield) led to lower delta+2. This could be either from stops (closing losing positions by dealers/investors) after auctions or even upward trend in local rates.

Probably due to higher benchmark duration, NTN-F estimates in Tables 12 and 13 exhibit baseline delta+2 higher than LTN. Differences in risk from 7y to 10y benchmarks did not enable capturing significant relationships of dv_of_bench or d_bench10y (dummy for 10y NTN-F benchmark). Consistent with expectations, ac_ratio, higher issuance relative to auction initial supply, is negatively related to delta+2. This might be for various reasons, including supply restrictions in riskier periods.

Another interesting results: domestic risk factors move deltas for LTNs, whereas external risk factors impact more significantly NTN-Fs. The latter results steer us to risk-bearing hypothesis for end investors too, as locals/dealers are the main investors of LTNs (hence affected by local risk offered and local volatility), while foreigners predominantly hold NTN-Fs, being mostly affected by international factors, such as VIX, and exchange rate.

DiD estimates in Table 14 compared delta+2 from LTN 48-month benchmark and NTN-F 7y or NTN-F 10y through the full sample. We added dummies for the years prior to 2018, when auctions were every fortnight and deltas higher according to our data, dummies for either NTN-F benchmark and another for both year and NTN-F.

In those, it was spotted weak evidence of reduced deltas after NTN-F auctions became weekly. However, we did perform one last OLS estimate on NTN-F 10y benchmark with a dummy for years prior to 2018, with a significant coefficient on the 5% level, Table 15.

Then, we based our tests to unearth strategic behavior/timing auctions or slow moving capital through returns of hedge funds. IHFA (hedge fund index) return time series by Anbima from 2014 until the end of 2023 inspection of seasonality through autocorrelation, Fourier Transform and heatmaps in Figure 4 detected no evidence of auction

Table 10 – OLS Results for Multiple Specifications - LTN

Dependent Variable: $\delta + 2$	Spec. 1	Spec. 2	Spec. 3	Spec. 4	Spec. 5
const	0.0752 (0.094)	0.0521 (0.092)	0.0819 (0.095)	0.0756 (0.087)	0.0794 (0.087)
anb-5	-0.0657 (0.041)	-0.0721* (0.041)	-0.0657 (0.041)	-0.0728* (0.041)	-0.0770* (0.040)
USD/BRL	-0.0200** (0.008)	-0.0165** (0.008)	-0.0215*** (0.008)	-0.0167** (0.008)	-0.0102* (0.006)
VIX	0.0019 (0.001)	0.0019 (0.001)	0.0020 (0.001)	0.0016 (0.001)	
UST10Y	0.0035 (0.006)	0.0038 (0.007)	0.0065 (0.005)		
SELIC	0.0011 (0.002)	0.0008 (0.001)			
dv01_of_bench	0.0267* (0.015)		0.0247* (0.015)		
number_bids	0.0007 (0.001)	0.0013 (0.001)	0.0008 (0.001)	0.0012* (0.001)	
ac_ratio	-0.0659 (0.084)	-0.0638 (0.086)	-0.0665 (0.085)	-0.0669 (0.083)	-0.0486 (0.081)
bid_to_cover	0.0059 (0.006)	0.0052 (0.006)	0.0058 (0.006)	0.0061 (0.006)	0.0045 (0.006)
d_bench24		0.0149 (0.012)		0.0153 (0.012)	0.0194* (0.011)
d_bench48		0.0247 (0.016)		0.0247 (0.015)	0.0355*** (0.012)
Observations	1204	1204	1204	1213	1236
R-squared	0.031	0.030	0.030	0.029	0.022
BIC	-814.751	-806.863	-821.310	-831.209	-861.329

Table 11 – Fixed Effects and Random Effects Regression Results - LTN

Variable	Fixed Effects	Random Effects
const	0.1104** (0.050)	0.1120** (0.049)
bid_to_cover	0.0092 (0.007)	0.0073 (0.007)
ac_ratio	-0.0648 (0.047)	-0.0631 (0.047)
dv01_of_bench	0.0264** (0.011)	0.0335*** (0.009)
anb-5	-0.0702*** (0.022)	-0.0673*** (0.022)
VIX	0.0018* (0.001)	0.0017* (0.001)
USD/BRL	-0.0222*** (0.007)	-0.0228*** (0.007)
R-squared	0.024	0.029
Observations	1213	1213

Table 12 – OLS Results for Multiple Specifications - NTN-F

Dependent Variable: $\delta + 2$	Spec. 1	Spec. 2	Spec. 3	Spec. 4	Spec. 5
const	0.1512** (0.070)	0.1495** (0.070)	0.1690** (0.070)	0.1845*** (0.065)	0.1817*** (0.060)
anb-5	-0.0374 (0.039)	-0.0371 (0.039)	-0.0398 (0.040)	-0.0351 (0.040)	-0.0348 (0.039)
USD/BRL	-0.0176 (0.012)	-0.0178 (0.012)	-0.0244** (0.012)	-0.0261** (0.012)	-0.0255** (0.011)
VIX	0.0023 (0.002)	0.0024 (0.002)	0.0035* (0.002)	0.0034* (0.002)	0.0034* (0.002)
UST10Y	-0.0266** (0.012)	-0.0265** (0.011)	0.0030 (0.008)		
SELIC	0.0096*** (0.003)	0.0096*** (0.003)			
dv01_of_bench	-0.0045 (0.027)		0.0043 (0.029)		
number_bids	-0.0016 (0.002)	-0.0018 (0.002)	-0.0000 (0.002)	-0.0002 (0.002)	
ac_ratio	-0.0871* (0.050)	-0.0884* (0.051)	-0.1094** (0.051)	-0.1073** (0.050)	-0.1087** (0.047)
bid_to_cover	-0.0057 (0.015)	-0.0047 (0.014)	-0.0013 (0.015)	-0.0015 (0.014)	-0.0016 (0.014)
d_bench10y		0.0028 (0.016)		0.0042 (0.016)	0.0043 (0.016)
Observations	675	675	675	680	680
R-squared	0.046	0.046	0.025	0.025	0.025
BIC	-176.706	-176.719	-168.971	-176.947	-183.458

Table 13 – Fixed Effects and Random Effects Regression Results - NTN-F

Variable	Fixed Effects	Random Effects
const	0.1833*** (0.055)	0.1835*** (0.055)
bid_to_cover	-0.0015 (0.013)	-0.0019 (0.013)
ac_ratio	-0.1091*** (0.042)	-0.1087*** (0.042)
dv01_of_bench	0.0009 (0.025)	0.0014 (0.025)
anb-5	-0.0347 (0.029)	-0.0346 (0.029)
VIX	0.0034** (0.002)	0.0034** (0.002)
USD/BRL	-0.0255** (0.012)	-0.0254** (0.012)
R-squared	0.025	0.025
Observations	680	680

Table 14 – DiD Results LTN 48m vs NTN-F 7y and 10y

Variable	48m vs 7y	48m vs 10y
const	0.1618** (0.078)	0.1201 (0.076)
bid_to_cover	0.0037 (0.013)	-0.0113 (0.015)
ac_ratio	-0.1453** (0.059)	-0.1198* (0.064)
anb-5	-0.0446 (0.037)	-0.0314 (0.037)
VIX	0.0030* (0.002)	0.0026 (0.002)
USD/BRL	-0.0131 (0.013)	-0.0025 (0.013)
d_2018	0.0207 (0.027)	0.0338 (0.028)
d_bench7y	-0.0180 (0.018)	
d_2018_7y	0.0442 (0.036)	
d_bench10y		-0.0080 (0.017)
d_2018_10y		0.0247 (0.036)
R-squared	0.033	0.024
Observations	746	736

Table 15 – OLS NTN-F 10y Dummy 2018

Variable	Coefficient (Std. Error)	P>|z|
const	0.0412 (0.096)	0.667
bid_to_cover	-0.0271 (0.026)	0.295
ac_ratio	-0.0725 (0.071)	0.309
anb-5	-0.0174 (0.053)	0.742
VIX	0.0023 (0.002)	0.349
USD/BRL	0.0096 (0.019)	0.608
d_2018	0.0758** (0.036)	0.037
R-squared	0.034	
Observations	335	

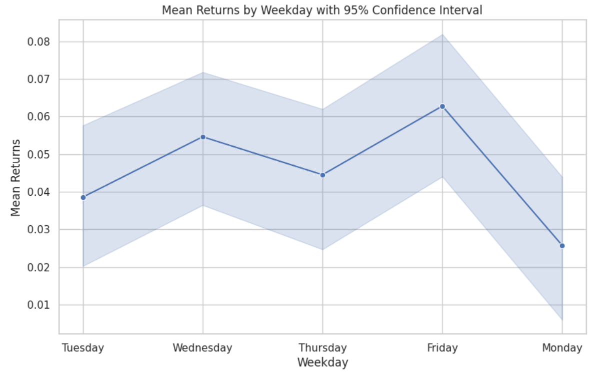
cycles impacting local funds returns. This effectively ruled out speculation as main hypothesis for ‘V-Shape’ price patterns, as those funds are major risk-takers on the Brazilian market. There was no seasonality related to auction cycles, except maybe for a weekend effect on the top row of Figures in 4, (a) and (b), where the day of the week 5 is monday in (b).

Ultimately, we checked traded volume and turnover of outstanding government bonds in Figure 5, without noticing lesser liquidity after NTN-F auctions became weekly. There were just cycles of turnover related to issuance of new benchmarks(on-the-run/off-the-run shifts). Therefore, dealer short cycle did not affect turnover or NTN-F outstanding traded volume. Nor we found strategic reduction of trading volumes in order to capture higher premiums on auctions by end investors, which by (b) and (d) remained mostly concentrated as foreign investors throughout the sample. Moreover, Figure 8 trend does not seem to be correlated to auction frequency.

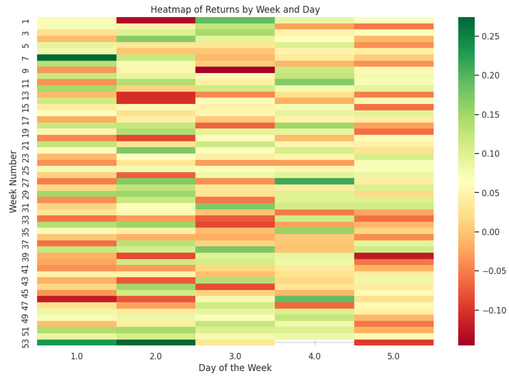
As robustness checks, we estimated panel regressions with different deltas as dependent variables for both NTN-F and LTN with results pointing to the same path as delta+2. We also present on annex residuals for the original panel estimates. Lastly, we estimate the main regression using a two-stage least squares IV approach, instrumenting all potentially endogenous variables with their respective one-period lags.

While the IV estimates are generally consistent in sign with the baseline fixed effects and random effects models, they are substantially less precise. All coefficients are statistically insignificant at conventional levels, and the model fit is poor. This imprecision

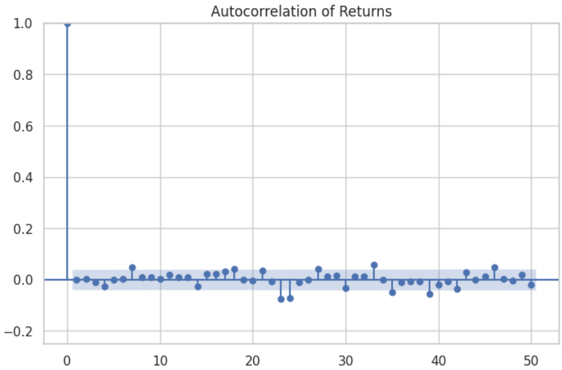
Figure 4 – IHFA: Returns, Heatmap, Autocorrelation, and Fourier Analysis.



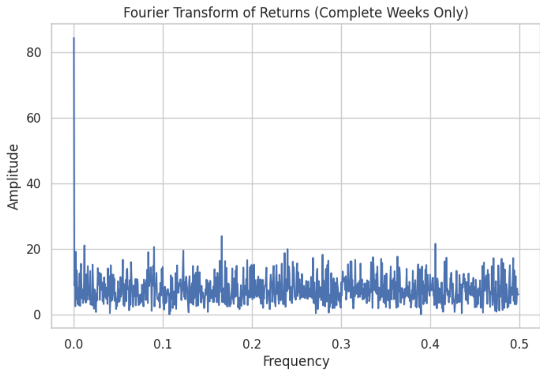
(a) Returns IHFA



(b) Heatmap IHFA



(c) Autocorrelation IHFA



(d) Fourier Analysis IHFA

is likely due to the weak predictive power of the lagged instruments in the first stage.

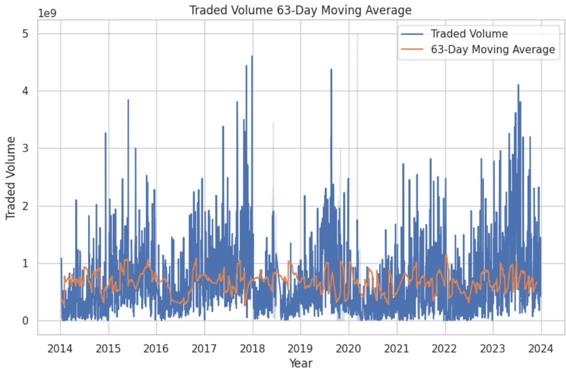
These results suggest that, although endogeneity cannot be ruled out, the main findings are robust in direction (tables 18 and 21).

6 Conclusion

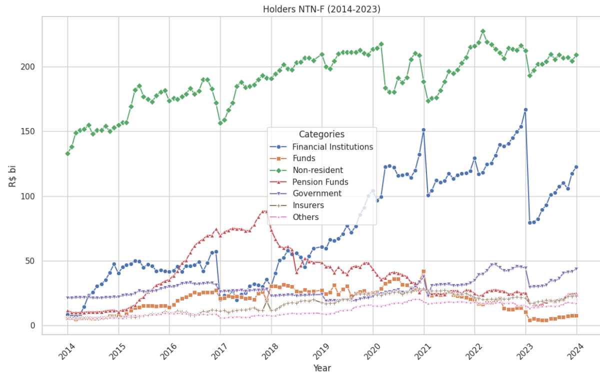
This paper has examined the phenomenon of V-shape price patterns in Treasury auctions, characterized by a decline in bond prices prior to auctions followed by a recovery afterward. Using a rich dataset from Brazilian National Treasury auctions, we provide empirical evidence of the existence of these dynamics, investigate their underlying drivers, and evaluate the impact of auction frequency on their magnitude. The 2018 shift from biweekly to weekly auctions of NTN-F securities offers a natural experiment through which to assess these effects.

Our findings indicate that the limited risk-bearing capacity of both primary dealers and end investors plays a central role in generating the V-shape pattern. We show that shortening the auction cycle significantly reduces the intensity of these price fluctuations—dampening pre-auction yield increases and post-auction corrections. This reduction

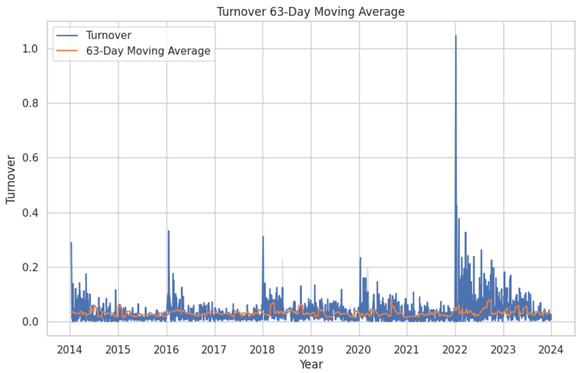
Figure 5 – Traded Volume, Turnover, Holders, and Holders Share NTN-F.



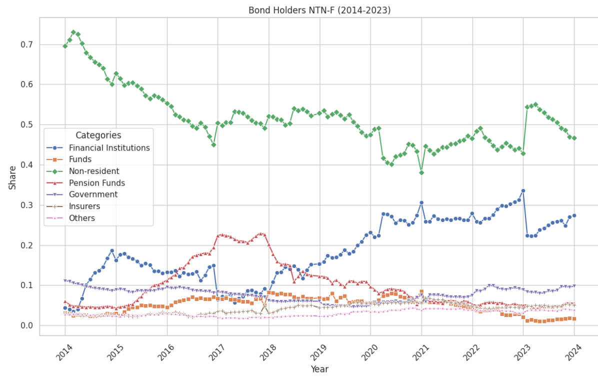
(a) Traded NTN-F



(b) Holders NTN-F



(c) Turnover NTN-F



(d) Holders Share NTN-F

correspond to a 6 bps decrease in cost of debt for 10y NTN-F and 3 bps for 7y NTN-F.

Statistical tests reject the null hypothesis of zero price deviations around auctions, confirming the presence of significant deltas in both LTN and NTN-F securities, especially for longer-maturity bonds, which naturally carry greater interest rate risk.

Additionally, the division of the data into pre- and post-2018 periods demonstrates that the size of these deltas differs significantly between fortnightly and weekly auction cycles. Panel regressions—including fixed and random effects models as well as difference-in-differences (DiD) estimations—further corroborate the risk-bearing hypothesis originally proposed by Lou, Yan e Zhang (2013). Importantly, this mechanism appears to apply not only to primary dealers, but also to other significant market participants, such as foreign investors in NTN-F securities.

In addressing alternative explanations, the study finds no evidence to support strategic behavior or slow-moving capital as primary contributors to V-shape patterns, as hypothesized by Amin e Tédongap (2023). Time-series analyses of hedge fund returns—using autocorrelation, Fourier transforms, and heatmap visualizations—reveal no seasonality related to auction cycles, apart from a potential minor weekend effect. These results effectively rule out speculation as a major driver, despite the prominent role of hedge funds as risk-takers in Brazilian markets.

Moreover, investigations into secondary market liquidity and turnover dynamics indicate that the shift to weekly auctions did not adversely affect the trading volume or turnover of NTN-F securities. There is no evidence of crowding-out behavior, whereby investors would delay purchases in the secondary market in anticipation of primary auctions. Instead, the turnover cycles observed appear to reflect the regular benchmark issuance process and transitions between on-the-run and off-the-run securities.

We contribute methodologically by leveraging the policy-driven change in auction periodicity as a source of exogenous variation. This allows us to implement a quasi-experimental identification strategy that includes difference-in-differences estimations, panel regressions with fixed and random effects, and IV-2SLS techniques to address potential endogeneity. Our empirical framework is further strengthened by robustness checks involving non-parametric tests, hedge fund return analysis, and secondary market trading volume dynamics.

Crucially, this study represents the first systematic investigation of the V-shape phenomenon in Brazil, and—to the best of our knowledge—in any Latin American sovereign debt market. Given the region's growing reliance on market-based debt financing and the unique institutional characteristics of its bond markets, our results provide an important benchmark for future research and policy design. More broadly, the findings underscore the value of auction design and issuance scheduling as tools for improving price stability and reducing borrowing costs in emerging market economies.

This research opens several avenues for future investigation. First, similar empirical strategies could be applied to other Latin American countries—such as Mexico, Chile, or Colombia—where primary dealer systems and auction formats vary. Second, the interaction between auction dynamics and investor composition (e.g., domestic vs. foreign holders) could be explored in greater depth. Third, extensions could incorporate high-frequency data or market microstructure variables to refine our understanding of price formation before and after auctions.

Lastly, our framework could be adapted to study other auctioned instruments, such as inflation-linked or floating-rate bonds, where the V-shape effect may follow distinct patterns.

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Annex

ANNEX A – Robustness Analysis LTN

Figure 6 – Residuals Panel Regressions LTN

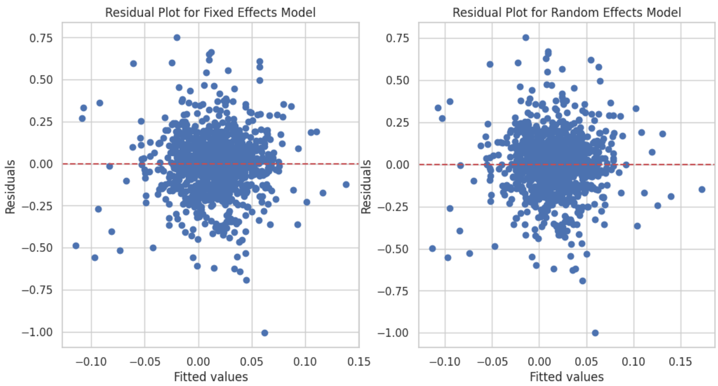

Table 16 – Fixed Effects and Random Effects Regression Results LTN - Delta+1

Variable	Fixed Effects	Random Effects
const	0.0593 (0.039)	0.0610 (0.039)
bid_to_cover	0.0049 (0.005)	0.0028 (0.005)
ac_ratio	-0.0191 (0.037)	-0.0172 (0.037)
dv01_of_bench	0.0156* (0.009)	0.0234*** (0.007)
anb-5	-0.0378** (0.018)	-0.0346** (0.018)
VIX	0.0013* (0.001)	0.0013* (0.001)
USD/BRL	-0.0159*** (0.006)	-0.0165*** (0.006)
R-squared	0.015	0.020
Observations	1213	1213

Table 17 – Fixed Effects and Random Effects Regression Results LTN - Delta+0

Variable	Fixed Effects	Random Effects
const	0.0079 (0.023)	0.0085 (0.023)
bid_to_cover	0.0040 (0.003)	0.0024 (0.003)
ac_ratio	-0.0164 (0.022)	-0.0144 (0.022)
dv01_of_bench	0.0127** (0.005)	0.0169*** (0.004)
anb-5	-0.0228** (0.010)	-0.0210** (0.010)
VIX	0.0024*** (0.000)	0.0023*** (0.000)
USD/BRL	-0.0098*** (0.003)	-0.0101*** (0.003)
R-squared	0.032	0.038
Observations	1213	1213

Table 18 – IV-2SLS LTN (Instruments: Lagged Variables)

Variável	IV-2SLS
const	0.0455 (0.723)
bid_to_cover	0.0012 (0.024)
ac_ratio	-0.0207 (0.774)
dv01_of_bench	0.0219 (0.020)
anb-5	-0.3238 (0.377)
VIX	0.0006 (0.002)
USD/BRL	-0.0097 (0.018)
R-squared	-0.085
Observations	1151

ANNEX B – Robustness Analysis NTN-F

Figure 7 – Residuals Panel Regressions NTN-F

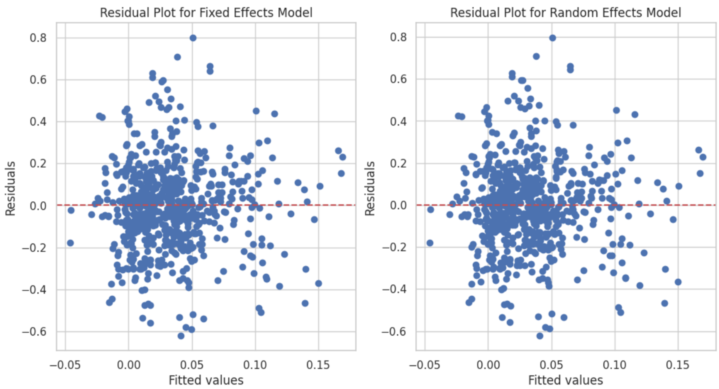

Table 19 – Fixed Effects and Random Effects Regression Results NTN-F - Delta+1

Variable	**Fixed Effects**	**Random Effects**
const	0.1033** (0.044)	0.1034** (0.044)
bid_to_cover	-0.0032 (0.010)	-0.0034 (0.010)
ac_ratio	-0.0769** (0.034)	-0.0767** (0.033)
dv01_of_bench	0.0022 (0.020)	0.0025 (0.020)
anb-5	-0.0502** (0.023)	-0.0501** (0.023)
VIX	0.0028** (0.001)	0.0028** (0.001)
USD/BRL	-0.0123 (0.009)	-0.0123 (0.009)
R-squared	0.025	0.025
Observations	680	680

Table 20 – Fixed Effects and Random Effects Regression Results NTN-F - Delta+0

Variable	**Fixed Effects**	**Random Effects**
const	0.0021 (0.026)	0.0023 (0.026)
bid_to_cover	-0.0076 (0.006)	-0.0080 (0.006)
ac_ratio	0.0021 (0.020)	0.0025 (0.020)
dv01_of_bench	0.0084 (0.012)	0.0089 (0.012)
anb-5	-0.0198 (0.014)	-0.0197 (0.014)
VIX	0.0027*** (0.001)	0.0027*** (0.001)
USD/BRL	-0.0070 (0.005)	-0.0070 (0.005)
R-squared	0.025	0.025
Observations	680	680

Table 21 – IV-2SLS NTN-F (Instruments: Lagged Variables)

Variable	**IV-2SLS**
const	0.3904 (0.277)
bid_to_cover	0.0015 (0.046)
ac_ratio	-0.3533 (0.383)
dv01_of_bench	0.0139 (0.099)
anb-5	-0.1368 (0.285)
VIX	0.0027 (0.003)
USD/BRL	-0.0218 (0.021)
R-squared	-0.047
Observations	659

ANNEX C – NTN-F Traded Volume

Figure 8 – Time Series Decomposition Traded Volume NTN-F