

The Effect of Margin Trading Facility (MTF) on Market Volatility and Liquidity in Indian Equity Markets

Lucky Verma

T Viswanathan

Associate Dean Research & Business Analytics Program

Prin. L.N. Welingkar Institute of

Management Development & Research

Bengaluru

Abstract

The study examines the relationship between Margin Trading Facility (MTF), and market quality, specifically, the link to equity-market liquidity and volatility when markets are under stress. The study based its analysis predominantly on daily MTF operations and trading data, enriched with NIFTY 50 market information, which subsequently helps in understanding the landscape of margin trading. Important indicators applied include MTF Outstanding, Fresh Exposure, Exposure Liquidated, Net Change in MTF Exposure, and MTF Growth Rate. NIFTY daily returns, squared returns, rolling volatility, and India VIX measures are used to evaluate volatility, while liquidity in the market is measured using Trading Turnover, Turnover ratio, and Amihud-style Illiquidity. The broader variables USD/INR and capitalization of the market are introduced as market-control variables, responsible for macro-financial influence and impact of the size of the market on the results of the research.

Furthermore, the study uses statistical and econometric tools such as Augmented Dickey-Fuller test, Phillips-Perron test, Ordinary Least Squares (OLS) regression method with the usage of HAC-robust method on three scenarios i.e. pre pandemic, covid , post covid among other statistical techniques based on three-variable model of prior, ongoing, and post-COVID-19 situations.

The results of the study reveals specify that there exists an observable but negative relationship between the outstanding MTF, volatility and liquidity on the other one when looked at based on the initial bivariate tests. Nevertheless, when controlling for some factors (for example, VIX India, Nifty return, USD/INR) it reaches the conclusion that the importance of MTF coefficient vanishes while the negative relation between MTF and liquidity constantly weakens but still exists on certain measures. Furthermore, Granger Causality tests and FEVD results demonstrate that the amount attributable to the growth of MTF is insignificant.

To conclude, the results lean towards the liquidity-providing/reactive leverage view instead of the strong leverage-cycle/fire-sale explanation: the level of the MTF shows a weak correlation with the lower level of illiquidity being used as the measure, and it seems that MTF flows react to volatility and liquidity shocks instead of provoking them. The paper provides policy implications for SEBI's margin trading observation, broker risk management, and protection for small investors.

Introduction

Margin trading is a form of investment in the stock market where a trader purchases shares by combining their own money and borrowed money from a broker. In India, margin trading falls under the Margin Trading Facility (MTF) regulated by the Securities and Exchange Board of India (SEBI) and executed through registered brokers on exchanges such as the National Stock Exchange and Bombay Stock Exchange. The historical and current margin trading account data have played a significant role in determining the impact of MTF on cash equity market investments and studying its role in changing prices and liquidity in the market.

The MTF in its present SEBI-regulated incarnation has been around since April 2004 and has metamorphosed from a niche product into a multi-lakh-crore offering in the Indian equity market, with periodic regulatory updates in 2017, 2021 and 2024 stipulating the eligible instruments, the minimum net-worth of brokers, and the margin-collection regulations. This scheme can be availed of only for SEBI Group I securities which fulfill the liquidity, market capitalization and volatility norms, with NSE accounting for the bulk of the combined NSE&BSE MTF portfolio, in keeping with the dominant share uploaded by NSE in the Indian cash market turnover.

The body of research concerning margin trading indicates the existence of two theoretical approaches. One approach is called liquidity provision/do price discovery, asserting that margin trades raise trading volume, lowers friction and leads to improvement of both market liquidity and price discovery. Another approach deals with the leverage cycle/fire sale channel. According to it, margin trading causes increased usage of leverage and hence an increase in the number and frequency of margin calls. Thus, as a result, it leads to procyclical liquidation leading to increased volatility of the market and lowered liquidity at the time of market distress. Thus, the general impact margin trading has on the quality of the Indian market is doubtful, which can be established only after conducting the actual experiment.

While more MTF assets are being promoted in India, very little empirical research has been published that has combined MTF disclosure information with standard volatility and liquidity techniques (i.e., unit root testing, VAR causality, Granger causality, impulse response analysis and structural break testing). The literature on Indian margin trading, which discusses more about liquidity, seems to have ignored much of the standard literature on volatility spillover. Furthermore, although there exist some peer-reviewed papers discussing MTF impact on market quality in terms of use of VAR causality and variance decomposition methods, the literature on the subject still does not effectively deal with the required coverage since post-2020 scenarios when the regulator adopted the tighten derivatives regulation and the unprecedented involvement of retail trader was recorded.

Literature Review

The margin trading in India can be traced back to the Badla system that existed prior to 2001 which was a deferred-settlement system without any formal maintenance margin structure and has now been transformed into the current SEBI-regulated MTF system that came into existence in April 2004 with significant changes made over the years which includes reforms in 2017, 2021, and 2024. All these features make MTF identified in the literature as a tool that provides leverage to the cash market and therefore it serves as a measure of the demand for leverage. According to some studies, margin trading has a function of providing liquidity and price discovery: by letting investors make larger investments than otherwise possible, margin trading increases trading volume, lowers transaction costs, and makes price discovery more efficient.

In the Indian context, there is sufficient evidence regarding this channel in comparison with the literature devoted to volatility spillovers. Specifically, all research reports a positive relationship

between margin trading and various liquidity indicators although research designs and time frames are different. Conversely, there is a leverage or fire sale theory stating that if MTF positions are subject to maintenance margin requirements, a decline in stock prices will force automatic liquidation thereby lowering market prices even more and increasing volatility in a vicious cycle that can be seen in crisis situations. The studies provide conflicting evidence regarding this hypothesis in the international context (Japan, Korea, USA, Taiwan, China) while there is also a divergence in the favour of one theory or another within one country depending on the market conditions. The shock of COVID-19 that happened in March 2020, was characterized by extremely high volatility levels all over the world which led to the fall of the Nifty 50 by almost 38% from January to March 2020. This has often been referenced in the academic publications in different countries as an example of a natural experiment aiming to test whether the principles of leverage, operated in crisis times, function in the same way in extreme moments of hype as they do in the times of calmness thus defining three periods for the purpose of this study - Pre-COVID, COVID Shock and Post-COVID.

The MTF book has undergone continuous growth, resulting in a positive reception of MTF in India where it reached about ₹1.4 lakh crore by mid-2026 (the particular sum implies an increase in volume of leveraged equity), however, there are few studies made in this respect with most focusing on liquidity issues/analysis of trends in simple form of research without consideration of volatility spillover analyses. The greater number of existing studies tend to apply such approaches as single-row regression/ event analysis for correlation calculation between margin/leverage figures and different volatility and liquidity indicators, however, the data is often adjusted with respect to other market indicators. Such an approach proves to be useful in establishing the correlation, but fails to explain the relationship itself, which provides rationale for the use of VAR in this study.

Studies from abroad which focus on the variation in volatility have made use of a variety of time series techniques such as VAR, Granger causality analysis and Akronivariate methods so that they can figure out if short term forecasting can be separated from simple correlation and what is the actual placement of leverage shocks in relation to overall market shocks. The literature on volatility modelling has made use of the GARCH series techniques (GARCH, GJR-GARCH, DCC-GARCH) and those relying on volatility spillover indices (Diebold-Yilmaz), which are ordinarily applied for purposes of assessing volatility shifts in separate markets or assets rather than in connection to leverage shocks.

The above notion points out two main flaws that the present study intends to address: the first is that empirical studies on domestic level are limited and there is no research conducted in India that could combine MTF micro disclosure techniques with unit root, VAR, Granger causality and variance decomposition methods; the second is that the existing studies do not provide any proof as to the permanent nature of the links between MTF volatility and MTF liquidity during and after the COVID era.

Research Methodology

Research Design

This research is a quantitative empirical study, based on data of a secondary type and time series, and applying the daily observations. The methodology used in the study employs a variety of approaches such as descriptive, correlation, simple equation regression, and VAR based multivariate time series, to obtain responses to the research queries in different ways.

Volatility Measures

$$\text{Return}_t = 100 \times \ln(\text{Close}_t / \text{Close}_{t-1}) .$$

Logarithmic returns are more advantageous compared to the simple returns because they are able to be combined across multiple timeframes and are more likely to comply with the normality condition

following their transformation and being acknowledged as a standard in the empirical literature on asset pricing.

Squared return exists as one of the key measures of volatility as it gives insight into the price changes on a daily basis, while being reactive to all the extremes.

Absolute return, however, is not influenced by extreme values but does not correlate closely with volatility.

India VIX serves as the volatility measure ahead of time; it is not a historical measure as its calculation is not based on the return but analyses the option prices prevalent in the market.

5M/20D/30D volatility is helpful in smoothing the daily fluctuations, while being commonly used at present due to the issue of autocorrelation generated when applying it.

Parkinson's OHLC and Garman-Klass methods are more precise than the regular close-to-close method as they involve figuring out the price differences based on the daily ranges, but they can get affected by the illiquidity of the closing or opening prices.

Liquidity Measures

1. Turnover ratio is given by the formula $\text{Daily Turnover} \div \text{Market Capitalisation}$, and the higher the ratio, the better market activity indication there is.

2. Logistics trading volume and logistics turnover should be taken into account, as the raw figures have excessive skewness on the right side.

3. Another measure used for this study is Amihud-style illiquidity, calculated as $|\text{Daily Return}| \div \text{Daily Trading Value}$ and adjusted for easier interpretation. This is the new measure formulated from NIFTY aggregate return and turnover data, rather than use of stock level data initially suggested by Amihud (2002) above; the higher its value, the greater performance of price movements is per trading in value. Spread between highest and lowest price or depth of orders are not provided in this data sources and could not be measured for this research purposes.

MTF Measures

MTF Outstanding (end-of-day) signifies the principal level variable. MTF Growth Rate (in logarithmic terms) signifies the principal flow variable. Other flow indicators that can be employed in the analysis include Fresh Exposure, Exposure Liquidated, and a net change in MTF Exposure (Fresh minus Liquidated). MTF-to-Market Cap ratio and MTF-to-Turnover ratio can be viewed as indicators of the MTF position with regard to the market. Nevertheless, the level effect (the issue regarding the role of the existing level of leverage for volatility or liquidity in the market) is different from the flow effect (whether faster growth of MTF indicates more or less volatility and liquidity in the market).

COVID Regime Definition

In the main specification, three distinct periods are used: Pre-COVID (Jan 2, 2020, to Feb 28, 2020), which has 41 observations; COVID Shock (March 1, 2020, to Dec 31, 2020), which includes 211 observations; and Post-COVID (Jan 1, 2021, to June 30, 2026), which has 1,274 observations. This break date is selected as it corresponds to the time when the existence of market disruption in India due to COVID has been confirmed (that is, WHO pandemic declaration date and India's first confirmed case cluster, which was quickly followed by large declines in NIFTY from early March 2020), and it is not just a random mid-point of the sample. The robustness tests include (i) an easy Pre-COVID vs Post-COVID (with shock) two-regime division, and (ii) a statistically derived structural change achieved through Chow and CUSUM tests.

Descriptive Statistics and Correlation Analysis

The calculations carried out in terms of descriptive statistics (mean, median, standard deviation, minimum, maximum, skewness, kurtosis, Jarque-Bera test) pertain to both the full dataset and each of the regimes identified. Pearson and Spearman correlation matrices are prepared for the complete sample and for each of the regimes for which causality can be commented on.

Stationarity Tests

Both the Augmented Dickey-Fuller test (ADF, lagged by AIC) and the Phillips-Perron (PP) tests were performed on the variables applicable to the VAR model in both levels and the first differences where necessary. All variables found suitable for applying VAR were confirmed as stationary in the levels and not needing any differencing (See Section 5.7).

Regression Models

Four standard OLS models are created, each then revisited using the full range of market controls (India VIX, contemporaneous NIFTY return, USD/INR):

Model 1: $\text{Volatility}_t = \alpha + \beta_1 \cdot \text{MTF}_t + \varepsilon_t$

Model 2: $\text{Volatility}_t = \alpha + \beta_1 \cdot \Delta \text{MTF}_t + \varepsilon_t$

Model 3: $\text{Liquidity}_t = \alpha + \beta_1 \cdot \text{MTF}_t + \varepsilon_t$

Model 4: $\text{Liquidity}_t = \alpha + \beta_1 \cdot \Delta \text{MTF}_t + \varepsilon_t$

For all computations made in Section 5.8, the standard errors are based on Newey-West estimator (HAC) with lags of 5 to account for heteroskedasticity and autocorrelation.

VAR Model

There is a five-variable VAR model estimation process performed with the mentioned variables given as the set of various factors. Each of these variables has been validated with stationary property checks. Further, the length of the lag is derived using AIC/BIC/HQIC criteria providing the lags determined using BIC criteria as most efficient as the models' main parameters.

Granger Causality, Impulse Response, FEVD

The Granger causality tests of outcomes have been executed, and in this case, pairwise tests involving many pairings of MTF Growth with each of the returns defined above have been done up to a lag of four or, lastly, of six for short regimes. Further use of orthogonalized impulse response functions can help to analyze the responses of all variables to the outcomes of the impulse of one standard deviation of another variable along the examined period of about 20 days. And finally, the analysis of forecast error variance decomposition provides an estimate of the degree of error variance of the forecasting.

Structural Break Analysis

The Chow test divides the sample at the date of March 01, 2020 and verifies the change in the correlation between MTF with liquidity and volatility. CUSUM test examines stability in parameters in different datasets without determining fixed break date beforehand. 4.14

Robustness Tests

The results are assessed using various indicators of liquidity (log trading, log volume), volatility indicators (absolute return, moving average volatility, Parkinson, Garman-Klass) and MTF measures (level, growth rate, new exposure, net change) in order to understand whether particular indicators have any significant impact on results.

Empirical Results

Descriptive Statistics

Descriptive statistics for the entire sample are shown in Table 3 of the project. Jarque-Bera test results confirm the absence of normality assumption at 1% level for all the variables except NIFTY Market Capitalisation (the results are not shown in the table).

Table 3: Descriptive Statistics — Full Sample (N=1,526)

Variable	N	Mean	Median	Std Dev	Min	Max	Skew	Kurt
MTF Outstanding (Rs. Lakhs)	1526	45,16,811	26,94,306	36,01,181	2,90,472	1,35,04,420	0.75	2.31
Fresh Exposure Taken (Rs. Lakhs)	1526	2,74,855	2,02,170	1,95,237	11,597	10,38,943	0.76	2.60
Exposure Liquidated (Rs. Lakhs)	1526	2,66,513	1,94,276	1,85,291	9,936	9,43,223	0.67	2.33
MTF Growth Rate (%)	1525	0.190	0.182	3.049	-25.884	32.341	0.37	40.26
NIFTY Return (%)	1525	0.044	0.087	1.162	-13.904	8.400	-1.62	23.88
Absolute Return (%)	1525	0.762	0.540	0.878	0.000	13.904	4.91	50.39
Squared Return (% ²)	1525	1.352	0.292	6.426	0.000	193.314	20.49	551.45
20-day Rolling Vol (%)	1506	0.975	0.832	0.632	0.306	5.650	4.10	25.79
India VIX	1526	17.38	15.47	7.50	9.15	83.61	3.63	23.16
NIFTY Turnover (Rs.)	1526	28,06,40,831	26,51,33,186	9,07,20,811	1,57,27,672	1,01,43,90,004	1.44	9.10
Turnover Ratio	1526	0.000002	0.000002	0.000001	8.74e-8	0.000008	1.71	6.43
Amihud Illiquidity (scaled)	1525	278.04	208.85	312.95	0.00	5,819	5.81	76.39
USD/INR	1526	80.99	82.34	6.07	70.82	96.83	0.31	2.36

Pre-COVID

Table 4: Descriptive Statistics — Pre-COVID (2 Jan – 28 Feb 2020)

Variable	N	Mean	Median	Std Dev	Min	Max	Skew	Kurt
MTF Outstanding (Rs. Lakhs)	41	6,98,839	6,91,194	42,270	6,34,050	7,91,313	0.20	1.92
Fresh Exposure Taken (Rs. Lakhs)	41	70,925	70,969	15,636	37,988	1,11,922	0.15	2.86
Exposure Liquidated (Rs. Lakhs)	41	69,496	70,492	13,195	27,034	90,851	-0.77	4.12
MTF Growth Rate (%)	40	-0.351	-0.308	1.874	-4.325	4.305	4.88e-3	3.58
NIFTY Return (%)	40	-0.230	-0.297	1.069	-3.780	2.295	-0.74	5.13
Absolute Return (%)	40	0.792	0.555	0.743	0.025	3.780	2.18	8.15
Squared Return (% ²)	40	1.166	0.308	2.513	0.001	14.290	3.93	19.97

Variable	N	Mean	Median	Std Dev	Min	Max	Skew	Kurt
20-day Rolling Vol (%)	21	0.961	0.951	0.108	0.783	1.302	1.14	6.28
India VIX	41	15.18	14.41	1.98	11.49	23.23	1.66	7.78
NIFTY Turnover (Rs.)	41	19,51,51,317	18,68,26,482	3,31,28,627	15,25,65,525	32,29,71,471	1.65	6.75
Turnover Ratio	41	0.000002	0.000002	4.08e-7	0.000002	0.000004	1.97	8.45
Amihud Illiquidity (scaled)	40	387.11	274.66	303.79	11.92	1,170	1.38	3.92
USD/INR	41	71.38	71.34	0.31	70.82	72.18	0.45	2.97

COVID Shock

5.2.2 COVID Shock

Table 5: Descriptive Statistics — COVID Shock (Mar – Dec 2020)

Variable	N	Mean	Median	Std Dev	Min	Max	Skew	Kurt
MTF Outstanding (Rs. Lakhs)	201	5,37,709	5,88,263	1,21,463	2,90,472	7,23,708	-0.61	1.98
Fresh Exposure Taken (Rs. Lakhs)	201	56,574	52,235	23,683	11,597	1,26,622	0.52	2.79
Exposure Liquidated (Rs. Lakhs)	201	55,946	50,983	20,328	9,936	1,05,830	0.38	2.36
MTF Growth Rate (%)	201	-0.089	-0.307	3.149	-9.052	14.944	0.79	6.42
NIFTY Return (%)	201	0.110	0.334	2.150	-13.904	8.400	-1.87	14.39
Absolute Return (%)	201	1.339	0.868	1.683	0.030	13.904	3.63	21.53
Squared Return (% ²)	201	4.611	0.754	16.631	0.001	193.314	8.35	87.15
20-day Rolling Vol (%)	201	1.716	1.163	1.272	0.737	5.650	1.86	5.31
India VIX	201	29.13	24.16	12.98	18.02	83.61	2.00	6.78
NIFTY Turnover (Rs.)	201	33,39,96,506	32,02,69,378	6,98,66,650	20,92,30,643	78,52,29,354	2.18	12.58
Turnover Ratio	201	0.000004	0.000004	0.000001	0.000002	0.000008	1.13	6.02
Amihud Illiquidity (scaled)	201	419.92	259.01	590.21	10.12	5,819	4.91	38.70
USD/INR	201	74.64	74.75	1.02	72.73	76.83	0.18	1.81

5.2.3 Post-COVID

Table 6: Descriptive Statistics — Post-COVID (Jan 2021 – Jun 2026)

Variable	N	Mean	Median	Std Dev	Min	Max	Skew	Kurt
MTF Outstanding (Rs. Lakhs)	1284	52,61,621	39,98,070	34,51,199	7,41,867	1,35,04,420	0.63	2.10
Fresh Exposure Taken (Rs. Lakhs)	1284	3,15,537	2,64,910	1,86,447	59,525	10,38,943	0.67	2.47
Exposure Liquidated (Rs. Lakhs)	1284	3,05,767	2,50,147	1,76,096	58,170	9,43,223	0.57	2.20
MTF Growth Rate (%)	1284	0.250	0.218	3.060	-25.884	32.341	0.29	46.02
NIFTY Return (%)	1284	0.042	0.053	0.920	-6.112	4.633	-0.29	6.38
Absolute Return (%)	1284	0.671	0.504	0.630	0.000	6.112	2.18	11.39
Squared Return (% ²)	1284	0.848	0.254	1.956	0.000	37.362	8.23	116.16
20-day Rolling Vol (%)	1284	0.860	0.765	0.342	0.306	1.889	0.94	3.16
India VIX	1284	15.61	14.62	3.95	9.15	29.33	0.82	3.05
NIFTY Turnover (Rs.)	1284	27,50,18,230	25,48,15,875	9,09,74,348	1,57,27,672	1,01,43,90,004	1.57	9.77
Turnover Ratio	1284	0.000002	0.000002	0.000001	8.74e-8	0.000005	1.71	7.81
Amihud Illiquidity (scaled)	1284	252.43	198.83	234.62	0.00	2,319	2.55	15.52
USD/INR	1284	82.29	82.91	5.72	72.37	96.83	0.13	2.60

Pre- vs Post-COVID Mean/Median/Variance Comparison

Welch's t-test (unequal variances), the Mann-Whitney U test, and Levene's test for equality of variances were used to formally compare Pre-COVID and Post-COVID sub-samples for each core variable.

Table 7: Pre-COVID vs Post-COVID Comparison Tests

Variable	Mean Pre	Mean Post	Welch t (p)	Mann-Whitney p	Levene p (var. eq.)
MTF Outstanding	6,98,839	52,61,621	-47.26 (4.13e-284)	1.09e-27	3.26e-17
Squared Return	1.166	0.848	0.79 (0.431)	0.2210	0.4142
India VIX	15.182	15.612	-1.31 (0.196)	0.6099	2.00e-5
Turnover Ratio	2.18e-6	1.74e-6	6.67 (2.78e-8)	1.05e-10	0.0453
Amihud Illiquidity	387.112	252.432	2.78 (0.008)	0.0008	0.1215

The MTF mean outstanding, mean squared return, mean India VIX, and mean Amihud illiquidity have statistically significant differences between both groups ($p < 0.05$) based on results of individual tests. This shows that MTF book has matured as good source of growth and has improved the market conditions in general since it has far more stable and liquid environment than the Pre-COVID period generally used to be with its short and thin trading feature. In turn, these comparisons suggest that regimes have unconditional nature and that MTF activities do not directly influence market conditions.

Further analysis of conditionally conditional and dynamical relationships is provided in sections 5.9-5.13.

MTF Trends

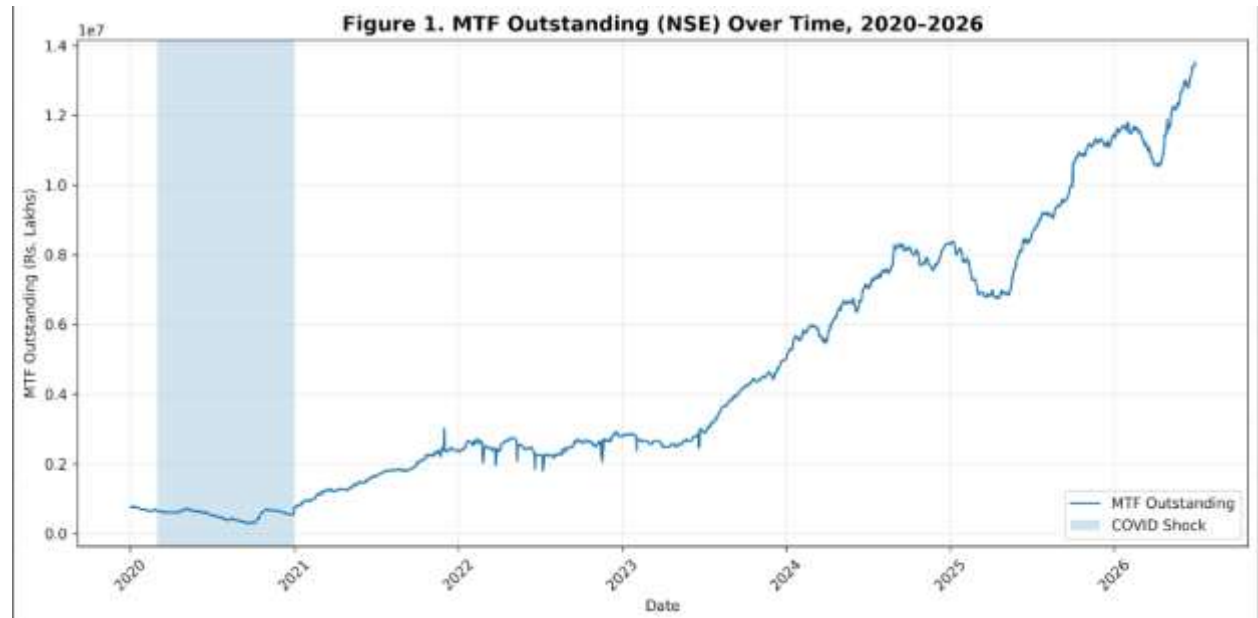


Figure 1: MTF Outstanding (NSE) over time, 2020–2026. Shaded band = COVID Shock regime (Mar–Dec 2020).

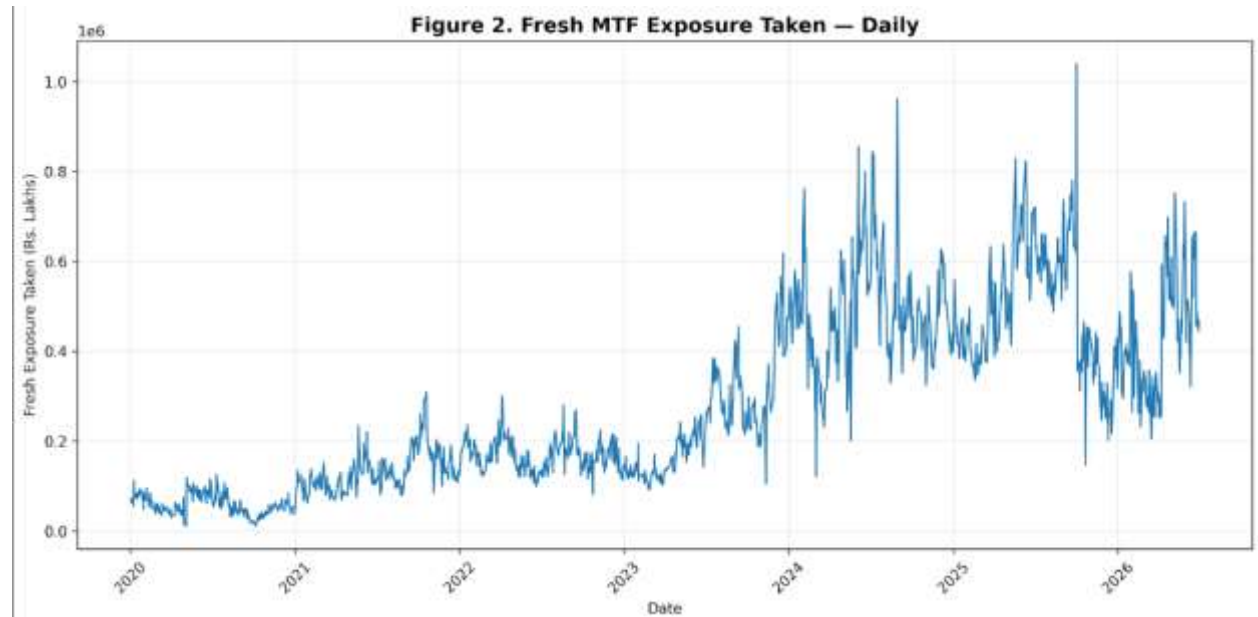


Figure 2: Fresh MTF exposure taken, daily.

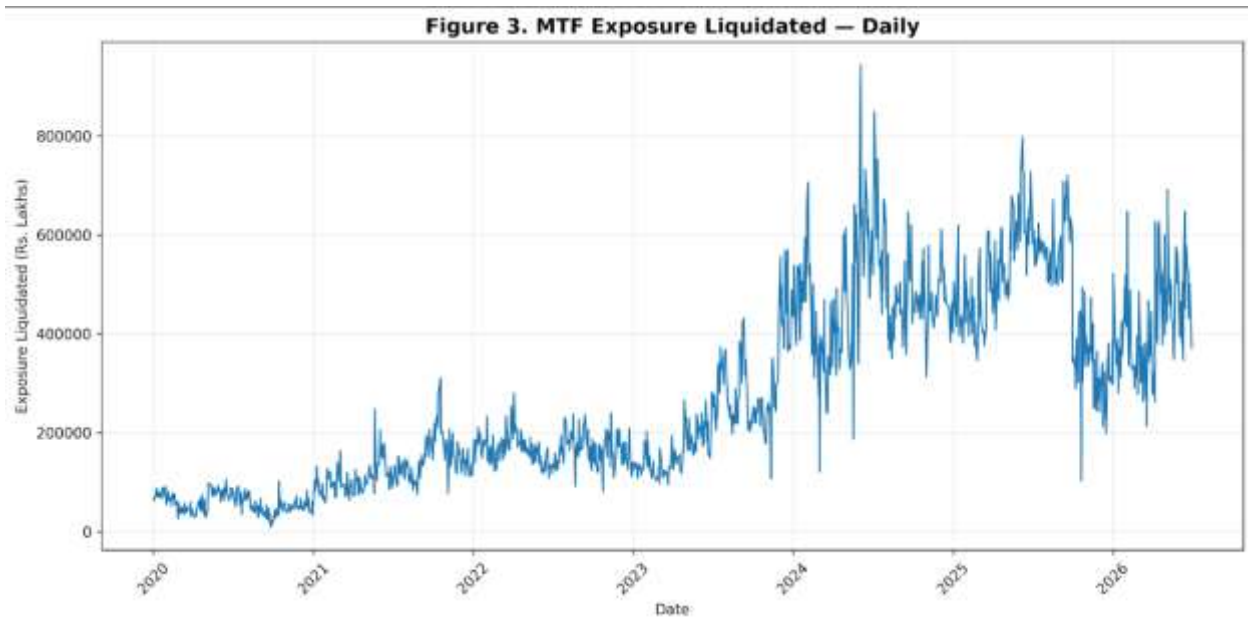


Figure 3: MTF exposure liquidated, daily.

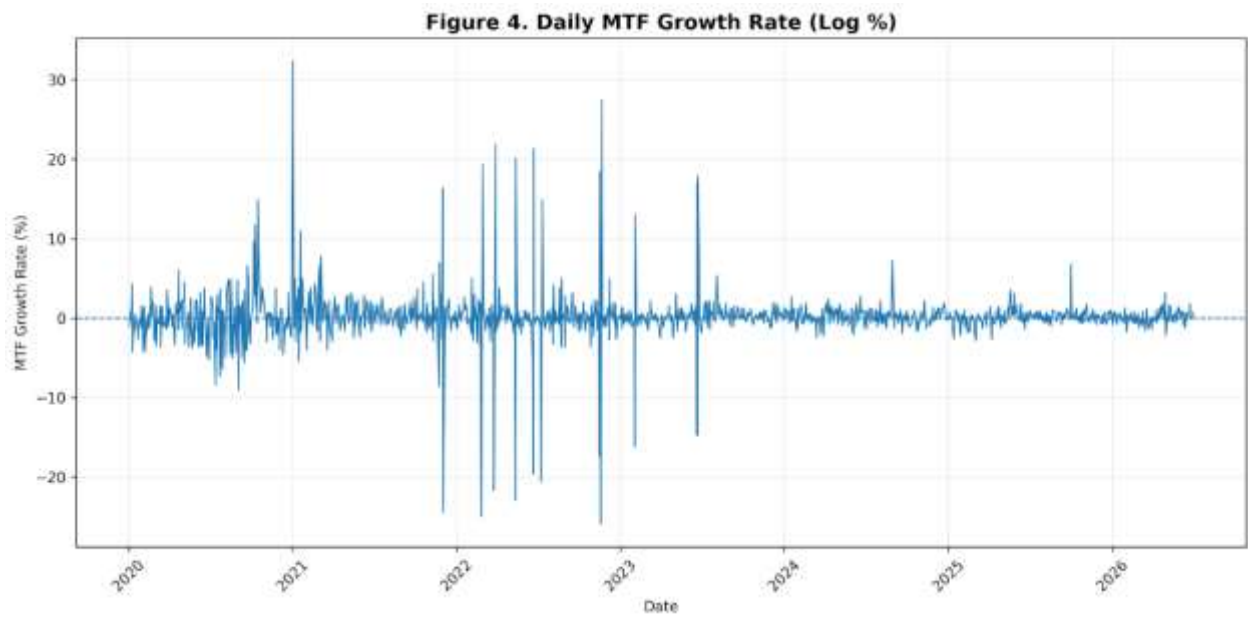


Figure 4: Daily MTF growth rate (log %).

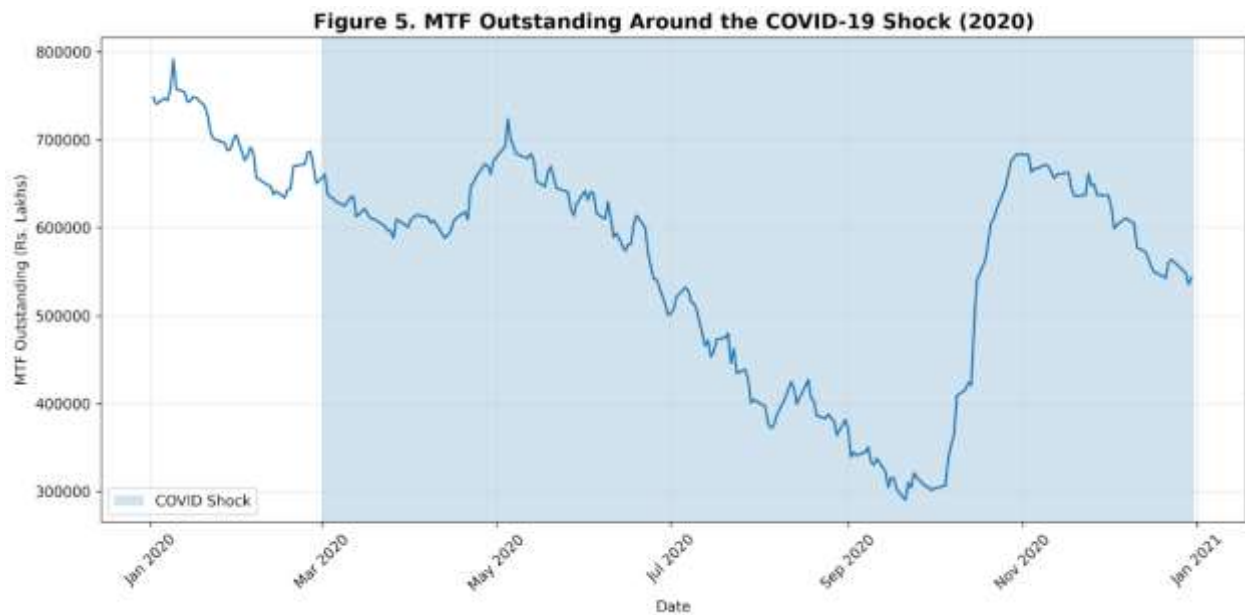


Figure 5: MTF Outstanding around the COVID-19 shock (2020) — a marked flattening/decline is visible during the shock window before resuming growth.

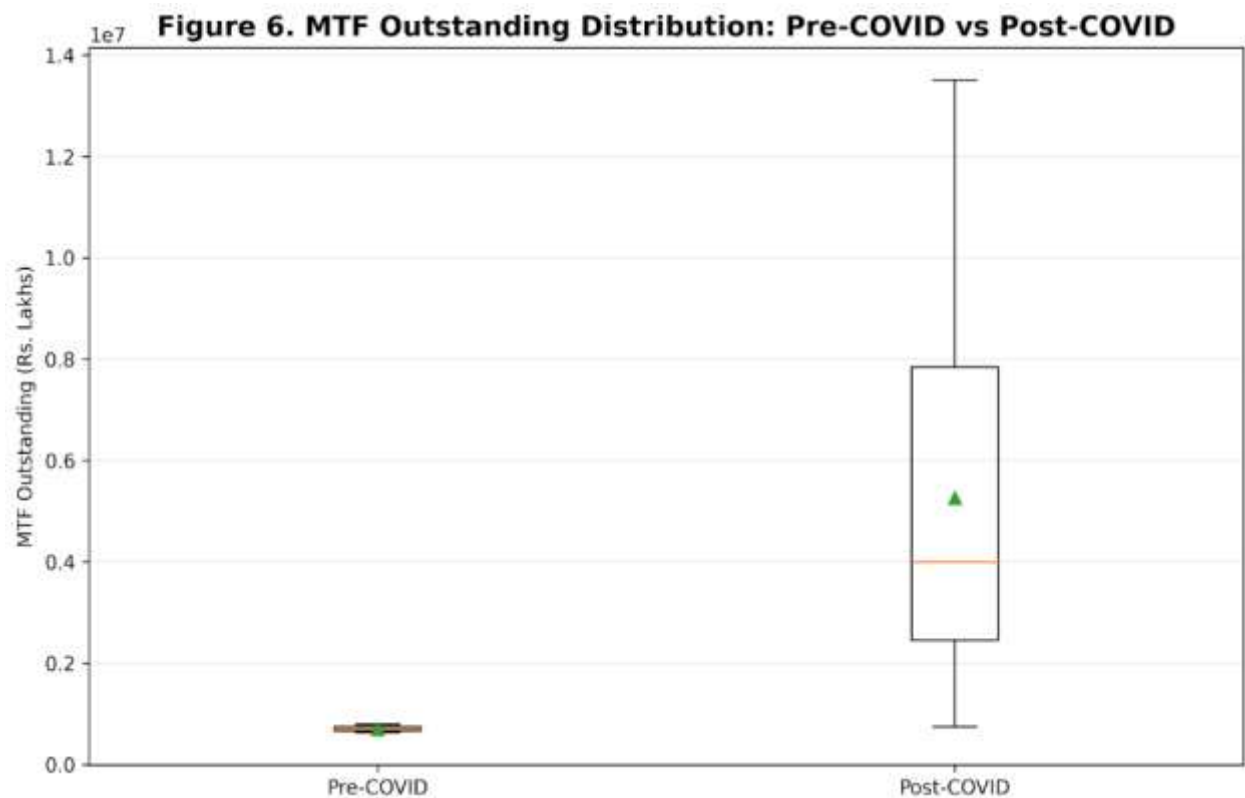


Figure 6: MTF Outstanding distribution, Pre-COVID vs Post-COVID.

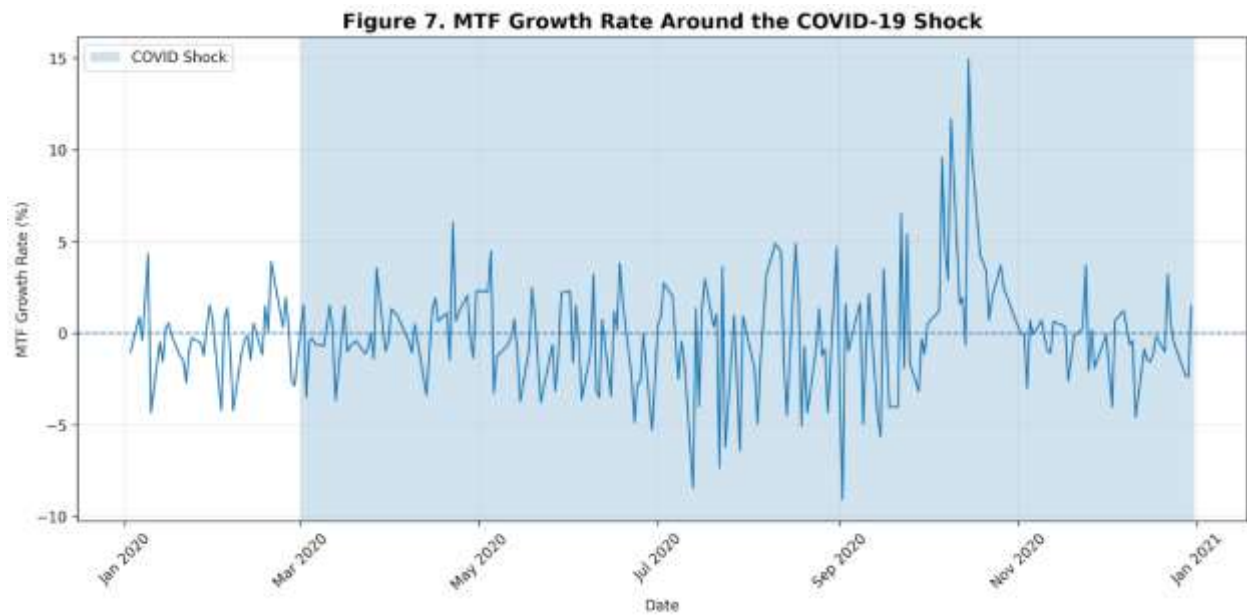


Figure 7: MTF growth rate around the COVID-19 shock, showing a sharp deleveraging episode (negative growth spikes) in March 2020.

5.4 Volatility Trends

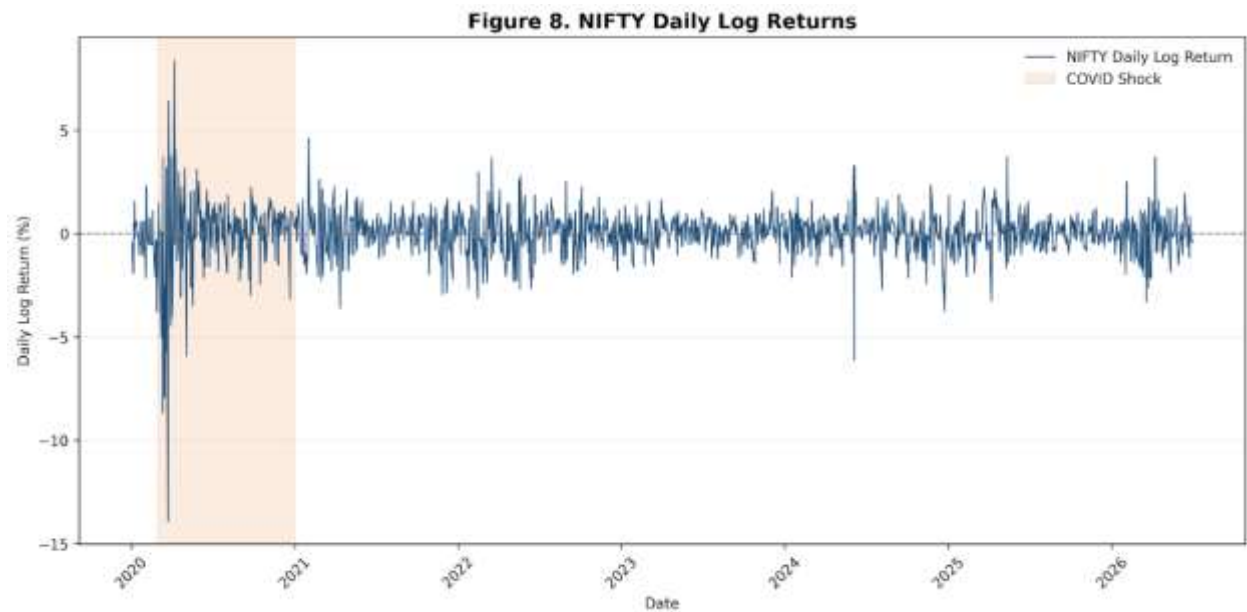


Figure 8: NIFTY daily log returns — the March 2020 shock is the clear outlier cluster.

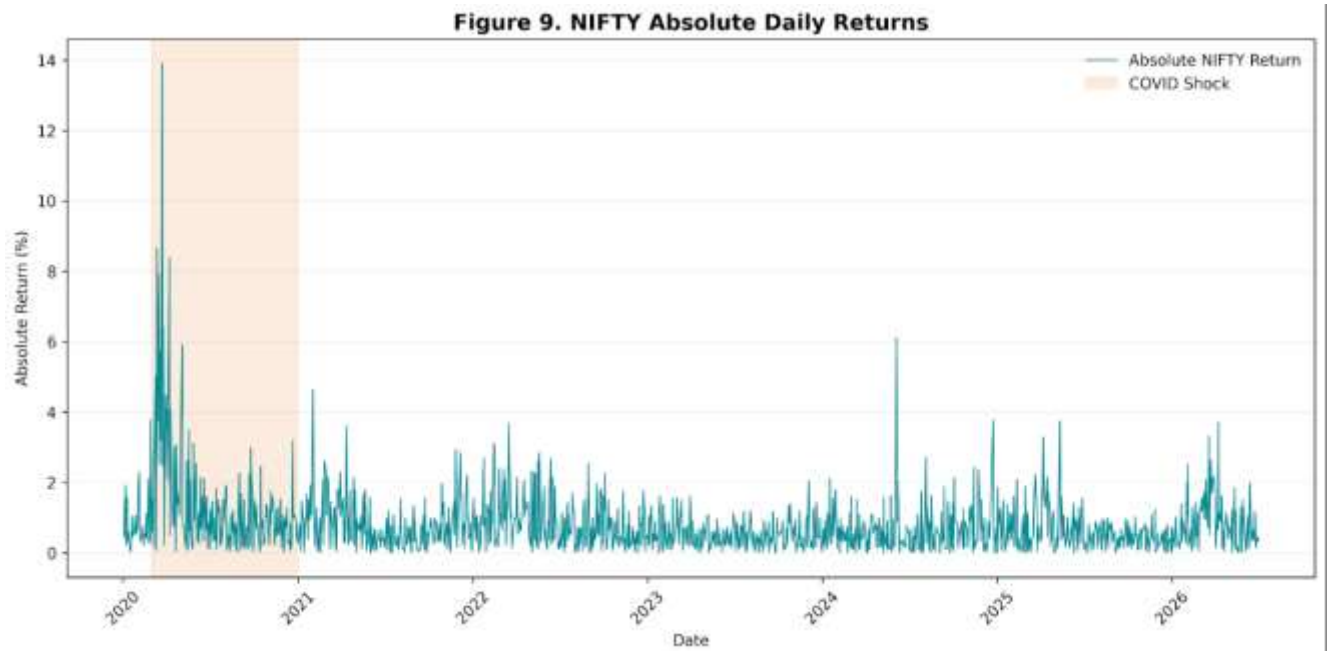


Figure 9: NIFTY absolute daily returns.

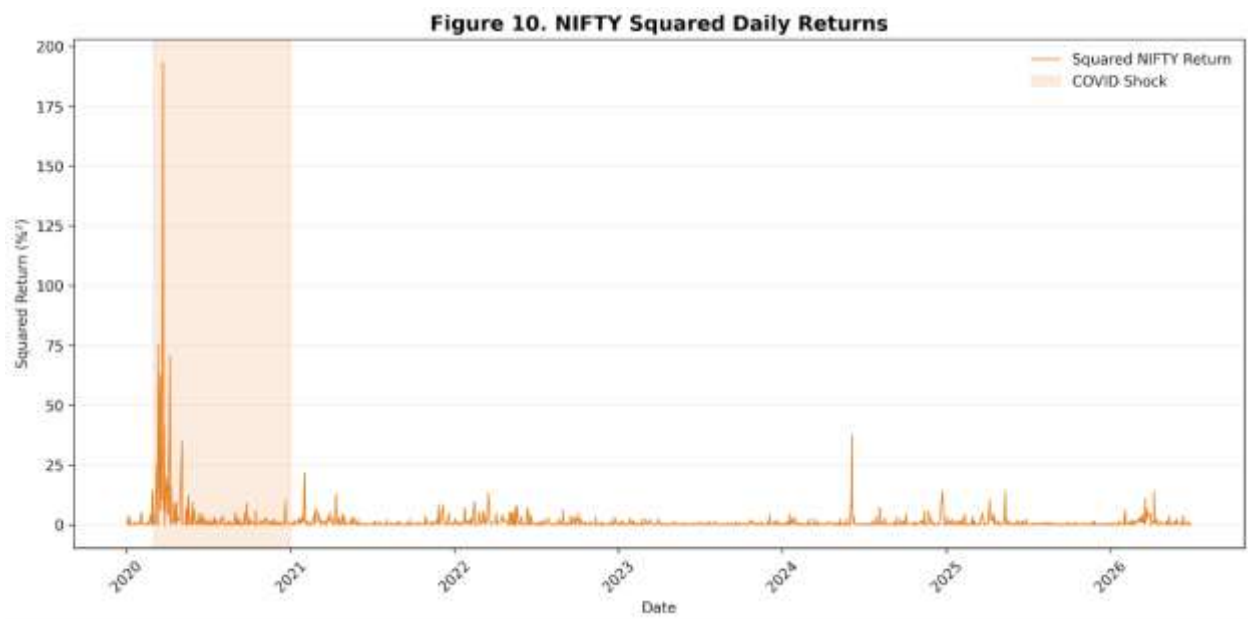


Figure 10: NIFTY squared daily returns (primary volatility proxy).

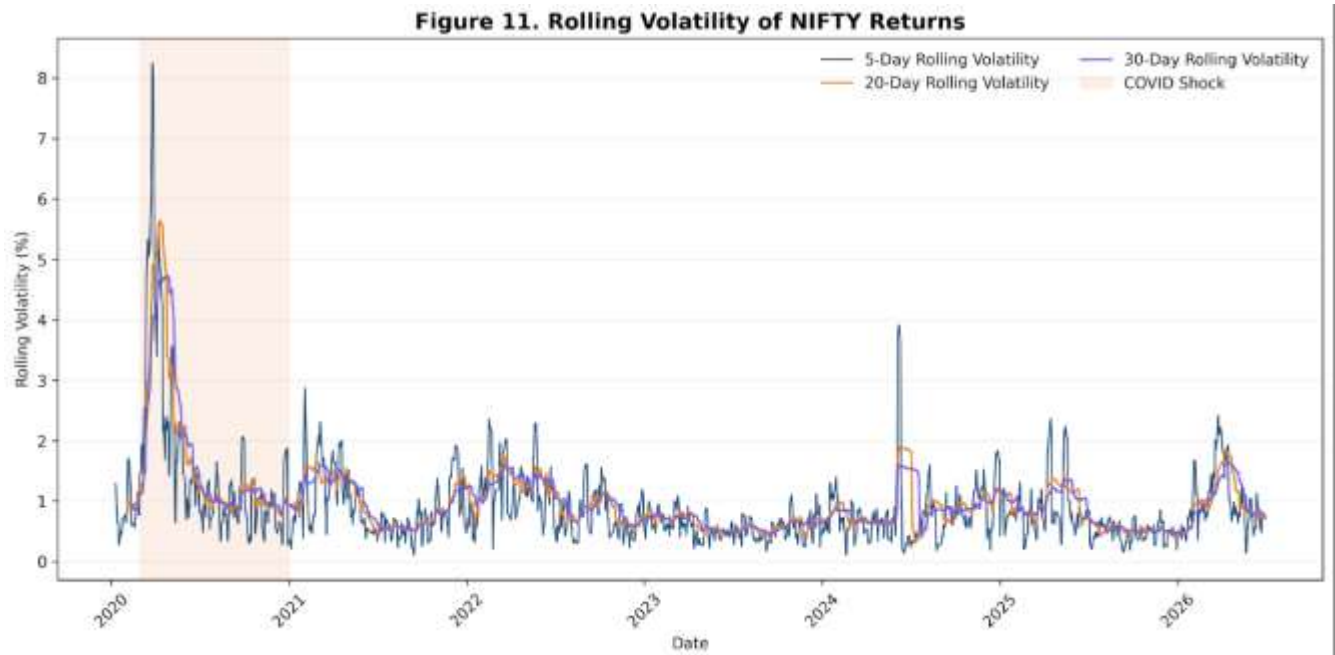


Figure 11: 5-, 20- and 30-day rolling volatility of NIFTY returns.

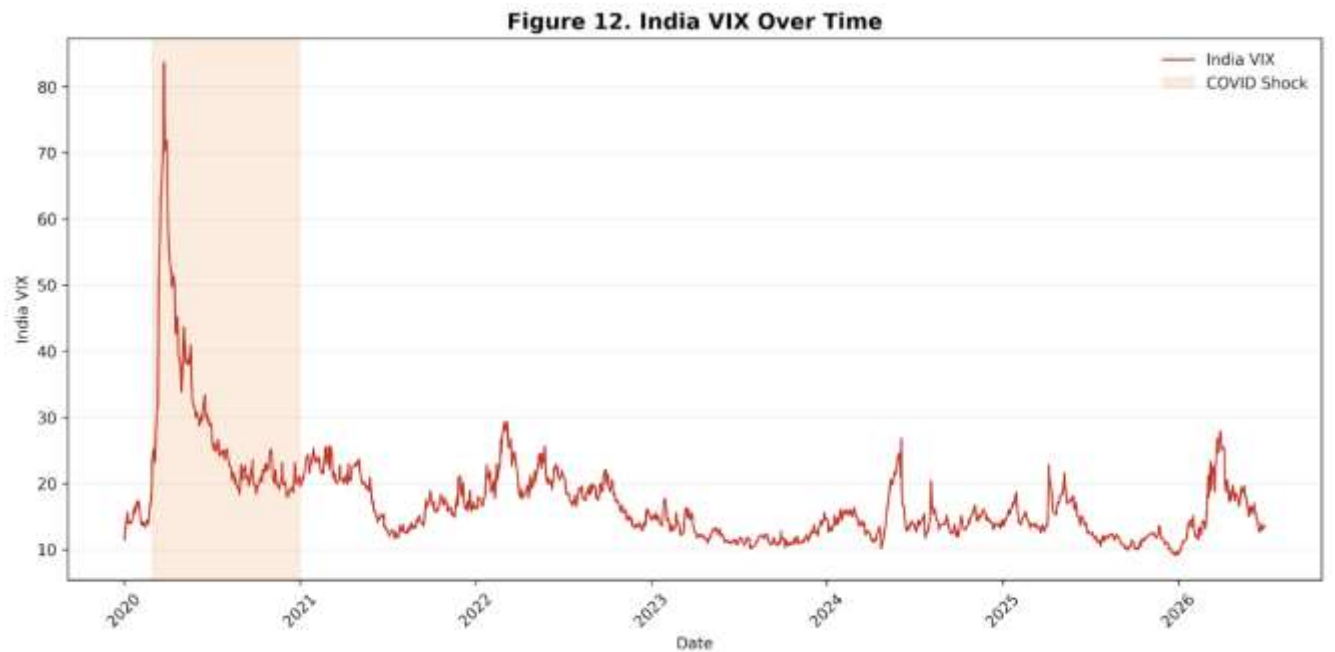


Figure 12: India VIX over time.

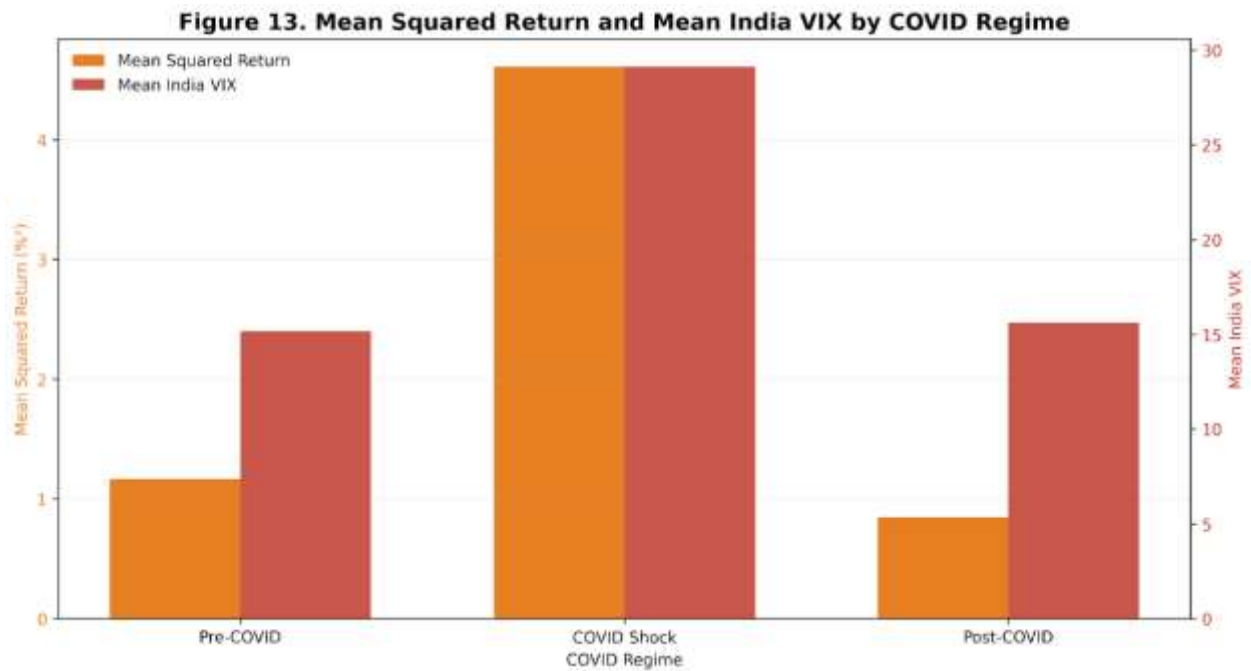


Figure 13: Mean squared return and mean India VIX by COVID regime — both peak sharply during the COVID Shock window.

5.5 Liquidity Trends

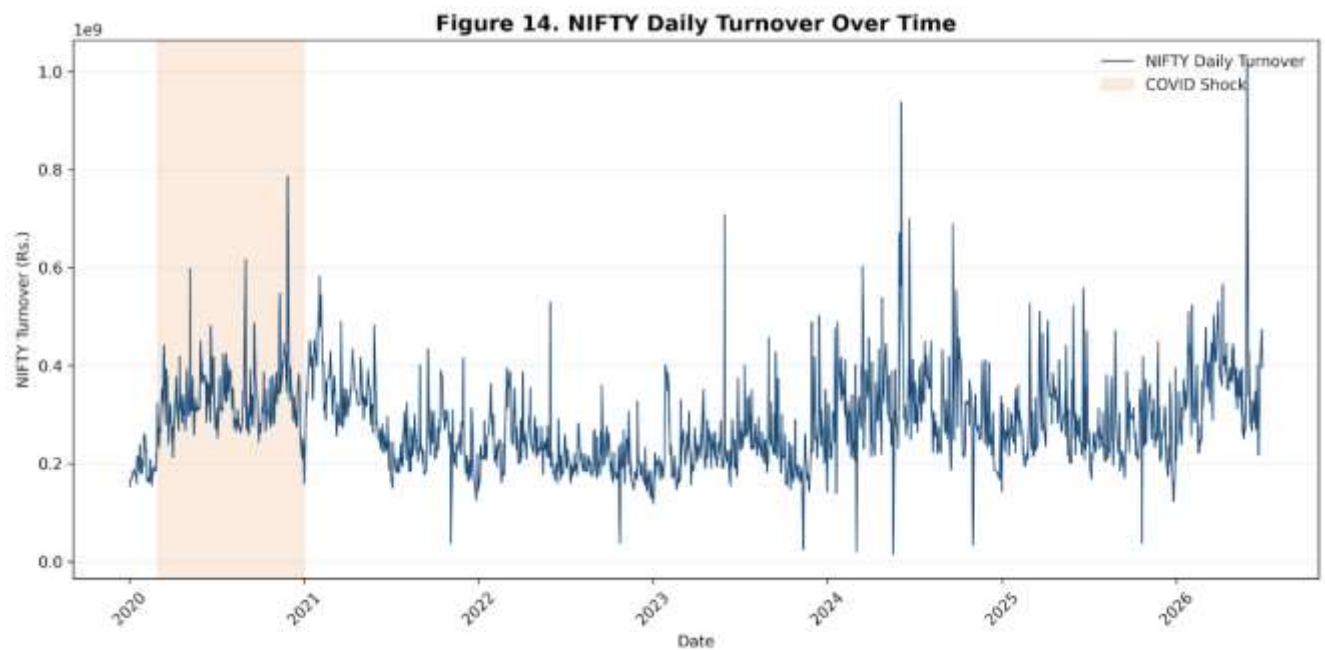


Figure 14: NIFTY daily turnover over time.

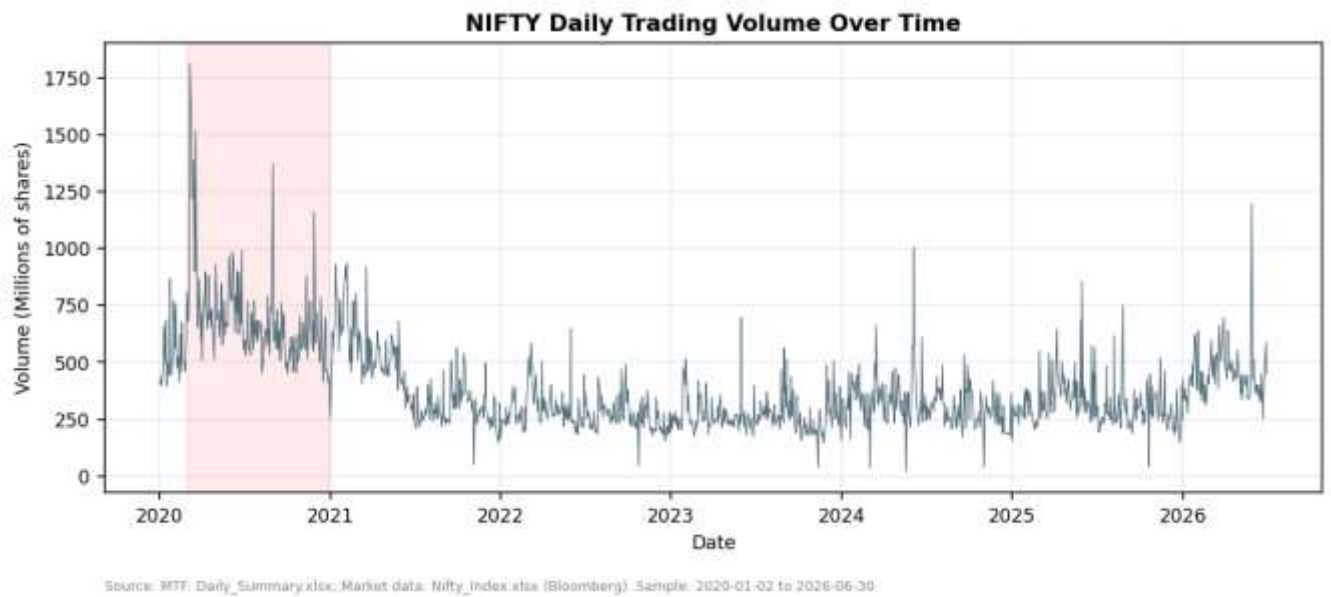


Figure 15: NIFTY daily trading volume over time.

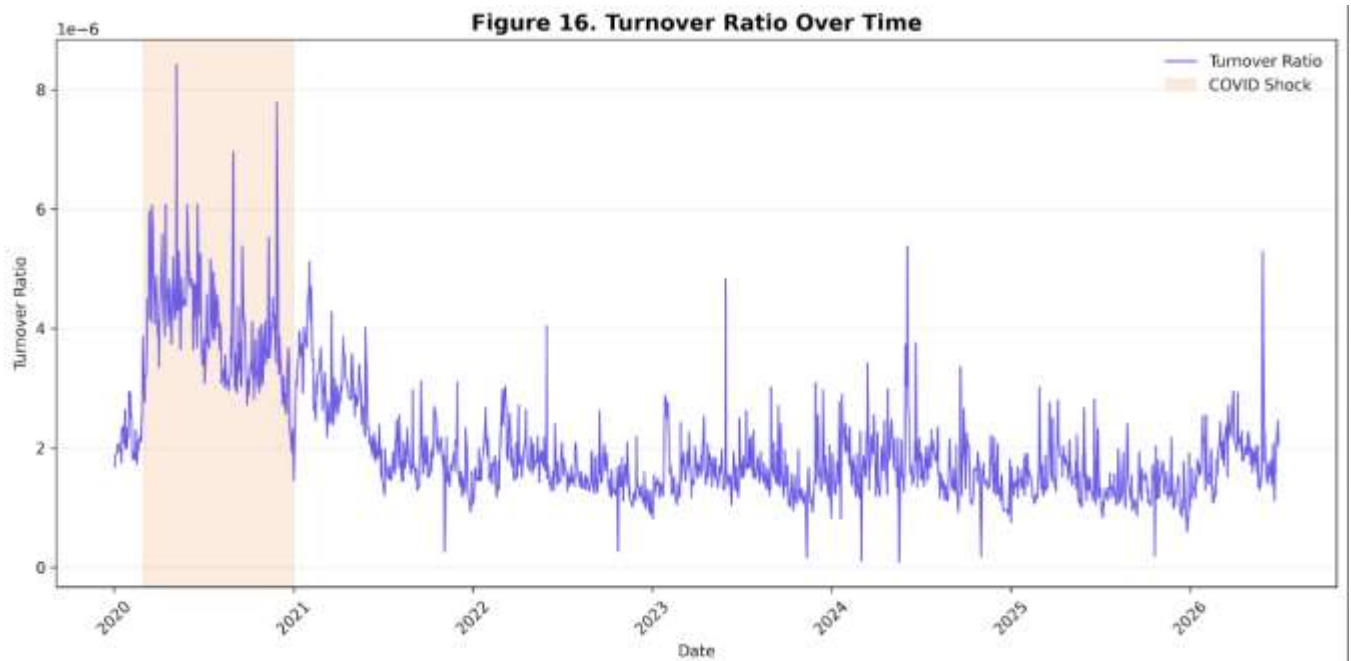


Figure 16: Turnover ratio (turnover / market capitalisation) over time.

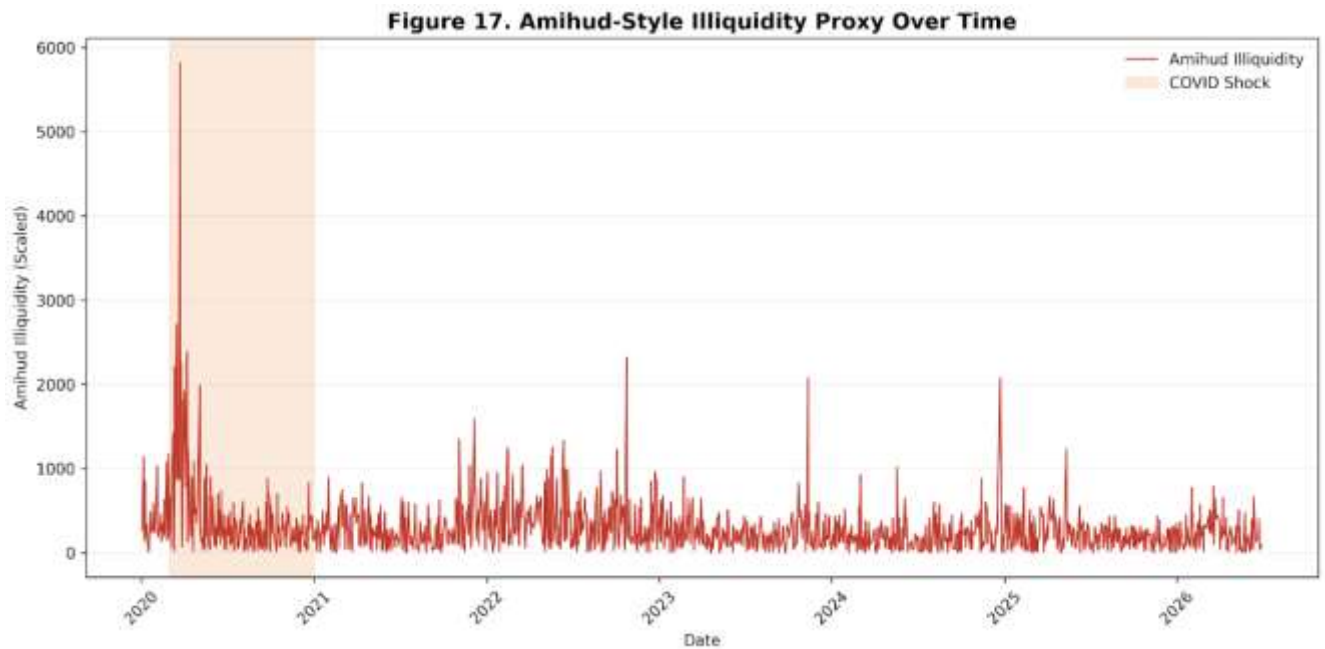


Figure 17: Amihud-style illiquidity proxy over time — visibly spikes during the COVID Shock window.

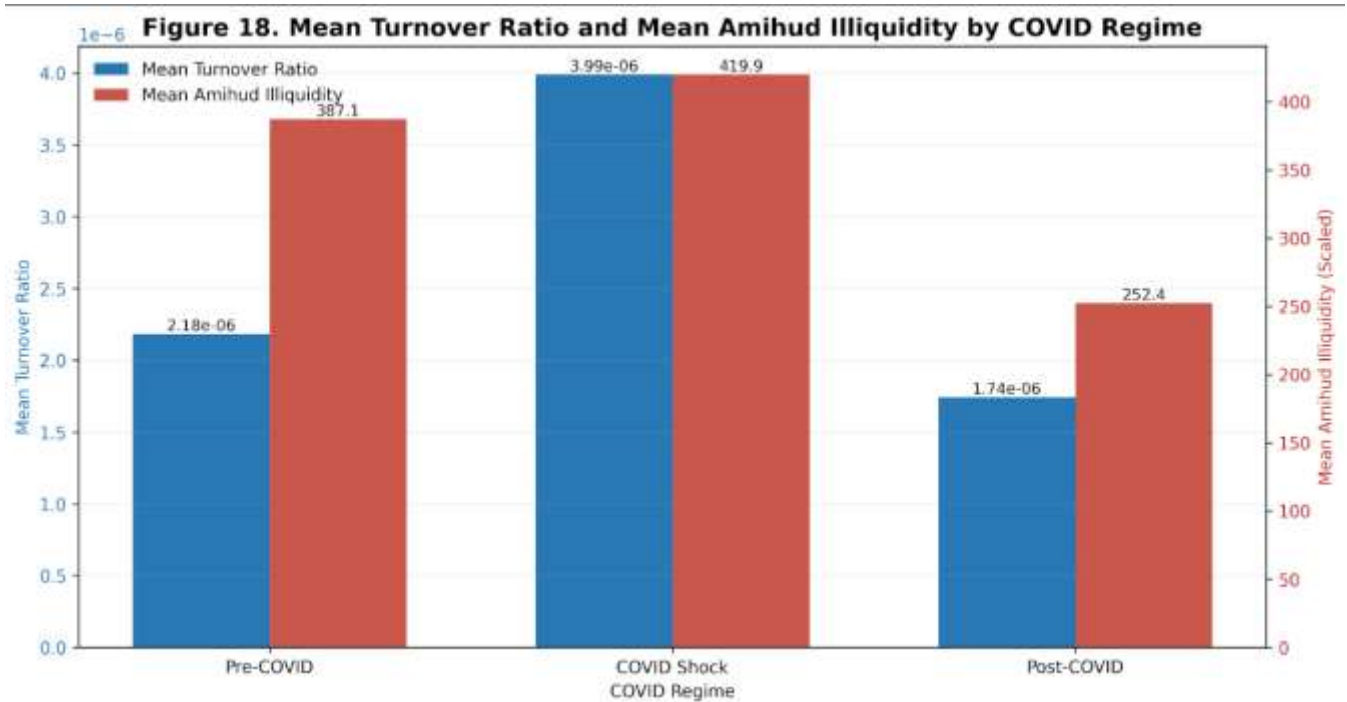


Figure 18: Mean turnover ratio and mean Amihud illiquidity by COVID regime.

Post-COVID Market-Event Context (2021–2026)

This chapter gives a detailed description of the market developments after COVID and employs the concepts of NSE/NIFTY and Market Timing Function that have been mentioned earlier in the chapters 4.5 to 4.9 and also brings into consideration two fresh external series i.e. FPI flows, Crude oil price. The discussion pertaining to the work involving Market Timing Function or the outcomes obtained through regression, VAR modelling, Granger causality, response functions or variance decomposition, and so on which have been previously discussed is appropriately made. The data used for all the figures is obtained from the time between January 1 2021 and June 30 2026.

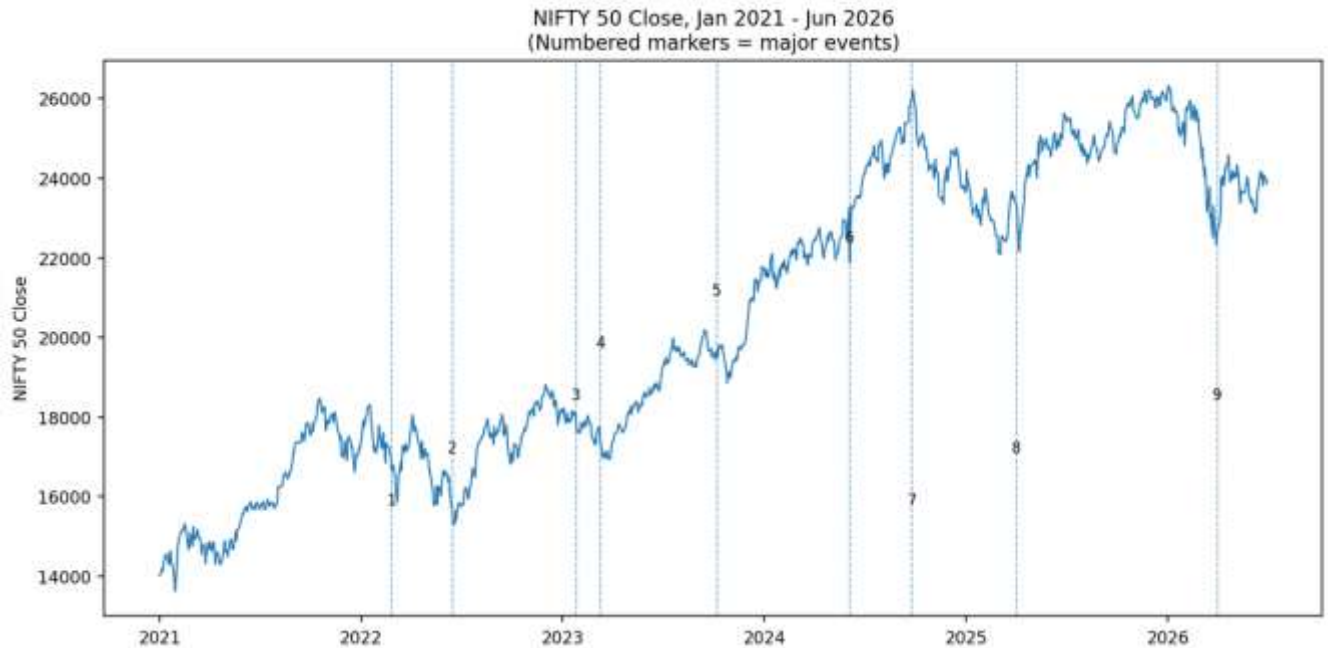


Figure 19: Post-COVID NIFTY 50 Performance with Major Market Events.

Details of Events :

- (1) The Russia-Ukraine war flare-ups opened on February 24, 2022.
- (2) Inflation and the Fed interest-tightening policy announced in mid-2022
- (3) The Adani Group news as per Hindenburg Report – January 24, 2023.
- (4) The banking crisis in the United States – March 2023.
- (5) The commencement of conflicts in West Asia – October 2023.
- (6) Outcome of the Indian elections in 2024- June 4, 2024.
- (7) China's stimulus package and moving funds in the portfolio investments – Late September 2024.
- (8) U.S Tariff upheavals – Between April 2025 onward.
- (9) WWRI – Nifty going up and down 2026 onwards.

Summary:

The NIFTY 50 index has shown an uninterrupted upward trend from around 14,000 to more than 26,000 after the month of January 2021, but several incidents can affect the trend in NIFTY.

Effects on Indian stock markets:

The above incidents provide a slowdown in Indian equities; however, the NIFTY index keeps showing an upward trend.

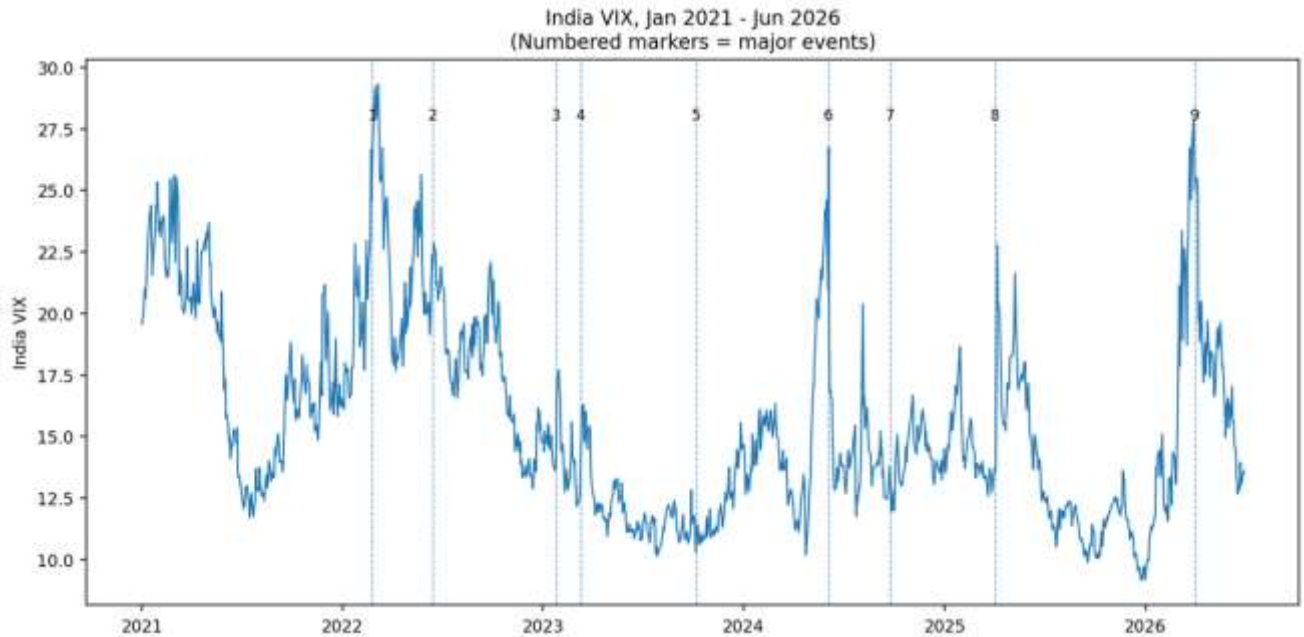


Figure 20: India VIX and Major Post-COVID Market Events.

Interpretation: India VIX is typically in the 12–15 range in calm periods, rising to roughly 22–26 around the Russia–Ukraine war, the 2024 election result and the Q2 2026 West Asia escalation. The Adani–Hindenburg episode and the October 2023 West Asia onset show only a modest VIX response by comparison.

Implication for Indian Equity Markets: Forward-looking sentiment, as priced in India VIX, appears more sensitive to global monetary-policy and war-related shocks than to India-specific corporate-governance news; this is an association observed in the series, not a formal test.

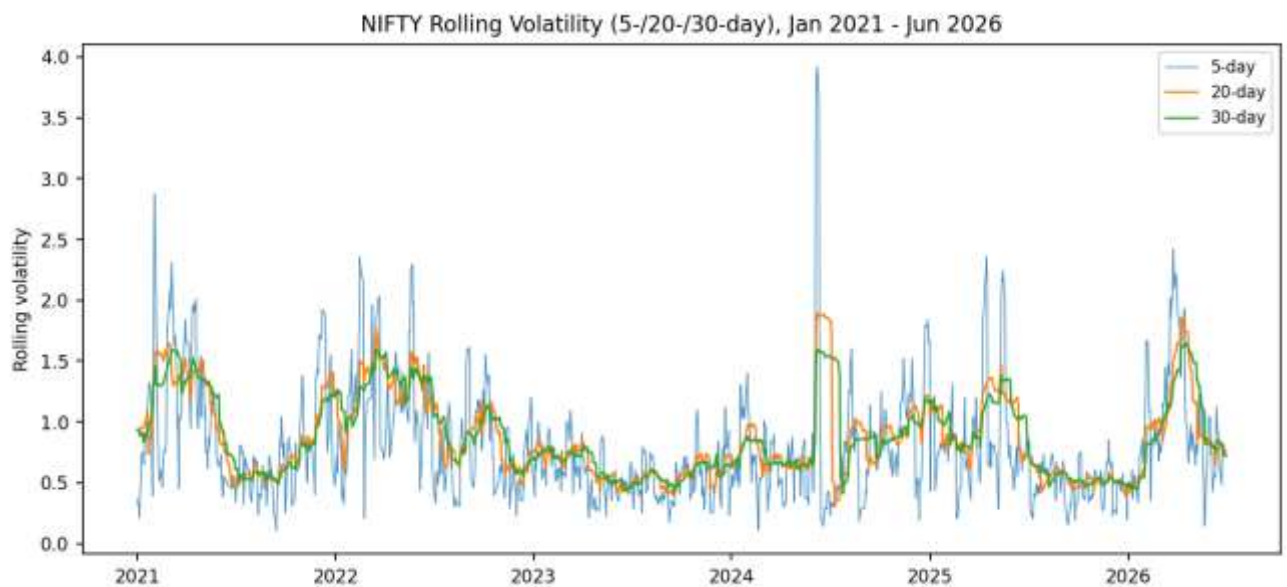


Figure 21: Post-COVID NIFTY 50 Rolling Volatility.

Event/Market Context: Same nine events as Figure 19 (unmarked on this chart for readability; compare timing with Figure 19/20).

Interpretation: Rolling volatility shows the same clustering as India VIX — elevated in 2022 and again around the 2024–2026 event windows — and otherwise trends lower through 2023–2024, consistent with a stabilising post-COVID market punctuated by episodic shocks.

Implication for Indian Equity Markets: The volatility-clustering pattern here is consistent with the report's existing GARCH-style discussion (Section 4.6) and structural-break findings; post-COVID leverage-sensitive periods appear episodic rather than a permanent regime shift.

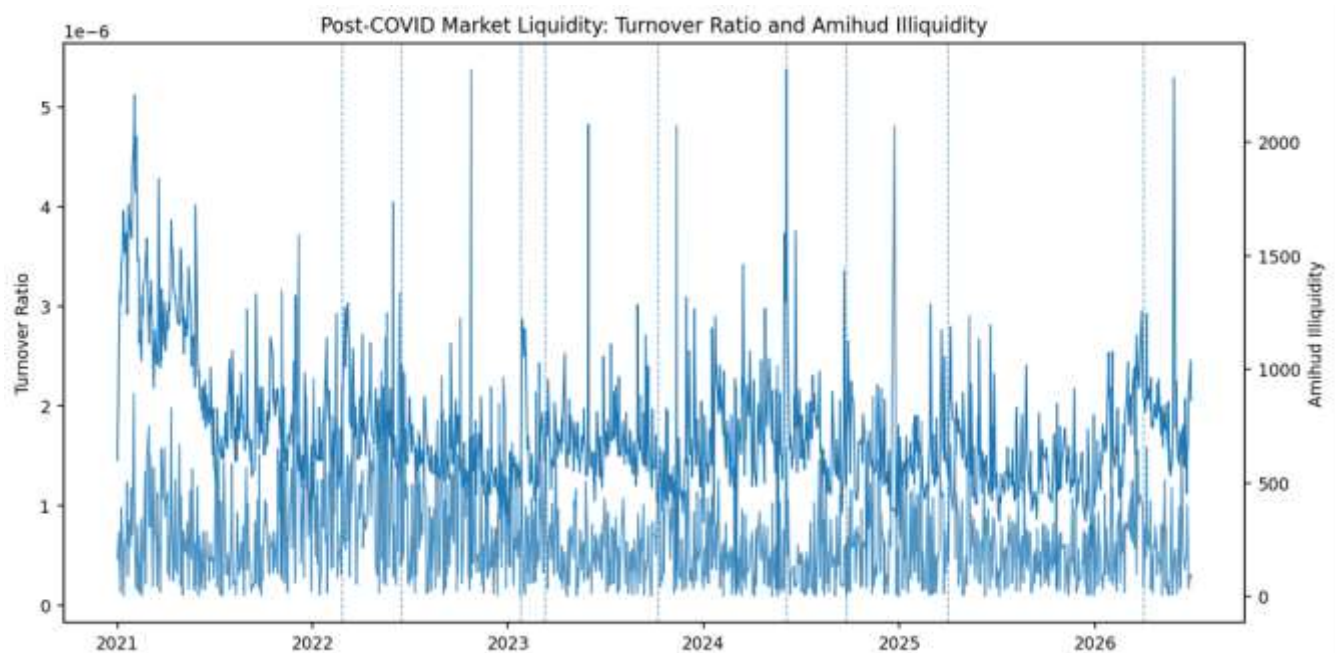


Figure 22: Post-COVID Market Liquidity: Turnover Ratio and Amihud Illiquidity.

Event/Market Context: Same nine events featured in Figure 19 (indicated by the broken lines).

Interpretation: The Amihud illiquidity index rises in a similar pattern to those seen in the VIX and rolling volatility graphs during the same windows — most noticeable around the time the Russia–Ukraine war took place and during periods of Fed restrictions — while the turnover ratio does not depict the same trend, indicating that price impact per trading activity has gone up at the same time when the overall trading activity has remained stable.

Implication for the Indian Equity Markets: Liquidity measures based on price impact (like Amihud) seem to provide more insights compared to volume-based measures during shock situations, which is of importance in terms of estimating collateral demands/liquidity risk on MTF portfolio during the times of stress.

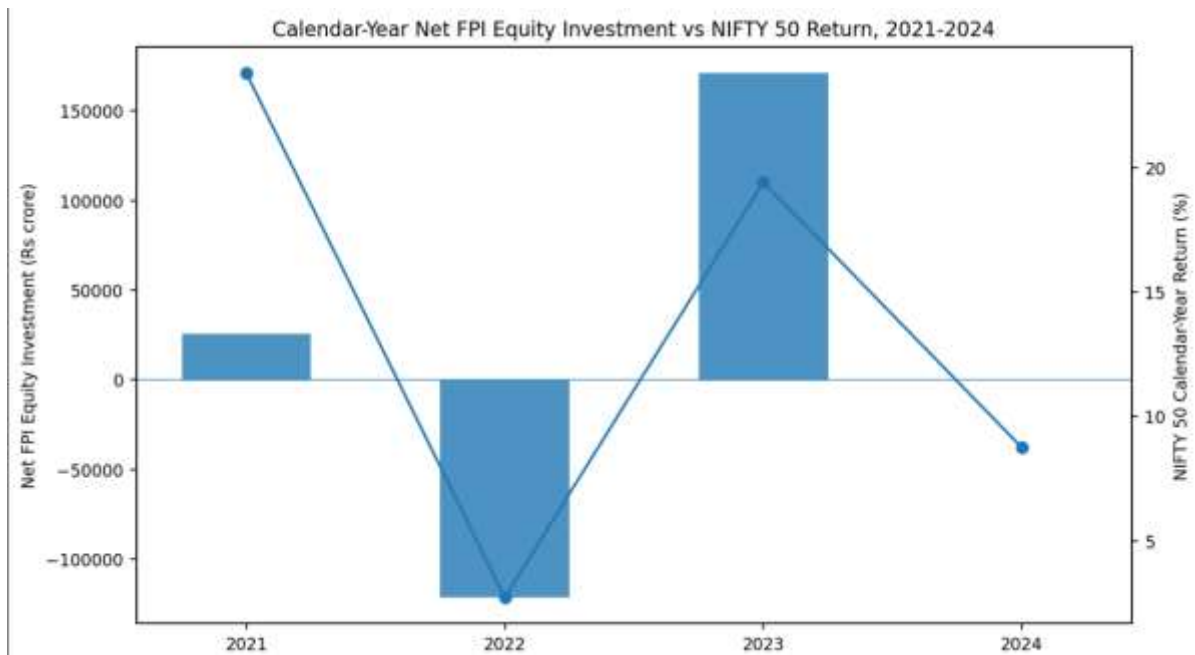


Figure 23: FPI Flows and NIFTY 50 Performance.

Event/Market Context: The year 2022 witnessed the highest outflow of foreign portfolio investment (FPI) of about ₹(1.21) lakh crore due to the tightening of the monetary policy by the Federal Reserve. Conversely, the year 2023 has been marked by the highest inflow of foreign investment amounting to about ₹1.71 lakh crore.

Interpretation: The outflow in 2022 was recorded during the year when the NIFTY returns were the lowest (positively 2.7%), and the record inflow in 2023 took place when the indices experienced high returns (positively 19.4%). In 2024, FPI flows remained nearly constant (positively ₹427 crore), although the NIFTY returns were 8.8% suggesting that the activity of domestic institutional investors began diminishing the effect of weak FPI flows.

Implication for Indian Equity Markets: As per the historical trend, outflows from the FPIs correlates with lower index performance, but the trend of 2024 is indicating that domestic institutional investment is superior to foreign investments, thus pointing to the correlation rather than causation of the phenomenon.

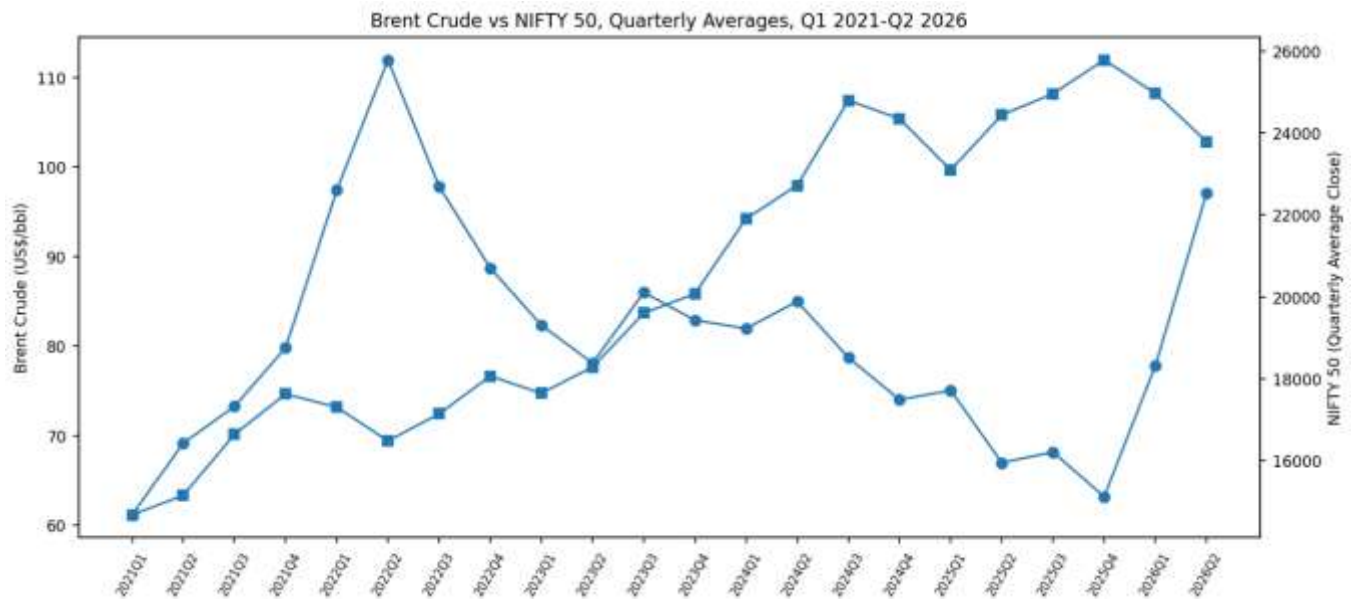


Figure 24: Brent Crude Oil and NIFTY 50 During Major Geopolitical Shocks.

Ukraine (Q1 and Q2 2022) and the ongoing crisis in West Asia (Q2 2026) with Iran's involvement interpreted as escalation.

Interpretation: Brent prices surged during Q2 2022 (~\$112/bbl) during the Russia-Ukraine war even when Nifty was unperturbed; Brent prices declined through the entire period of 2023 (and till the first quarter of 2025), while Nifty gained in value, then Brent prices shot up again in Q2 2026 (~\$97/bbl) coincided with the decline in Nifty prices as illustrated in Figure 19.

Implication for Indian Equity Markets: Since oil prices fluctuating due to the geopolitical disturbances is one of the major challenges for Indian equities due to India's dependence on oil imports, the figure only depicts correlation/ co-movement between the two data series but does not imply causation.

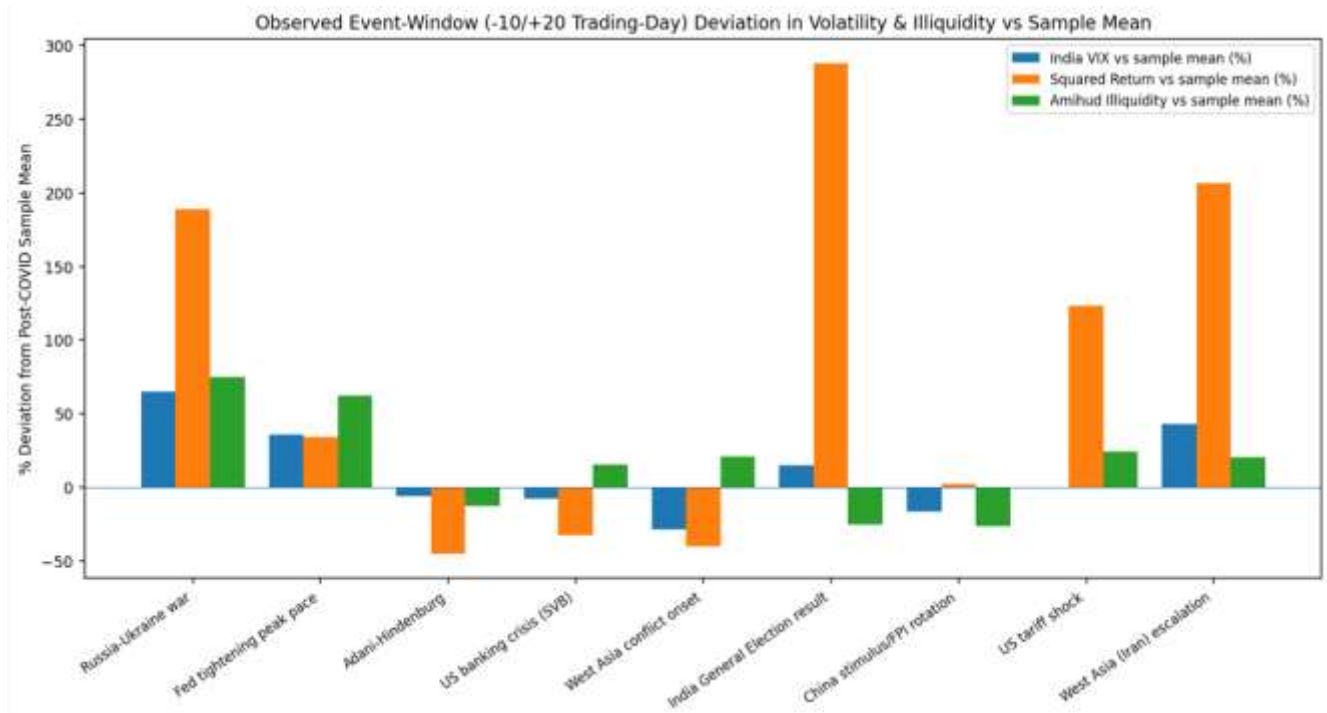


Figure 25: Major Post-COVID Events: Volatility and Liquidity Impact.

Understanding it better: The global geopolitical and macroeconomic event (events like the Russia-Ukraine conflict, the US Federal Reserve tightening, the anticipated shock from tariffs in the US, and the war escalation in West Asia in the second quarter of 2026) would lead to one of the highest surges of VIX and squared returns in its history. As for the occurrences regarding India (Adani and Hindenburg case and measures taken by China to support FPI investments) during this period, their impact on the studied entities will be smaller than after above-mentioned global political and economic events. From the data, it can be concluded about the impact of the 2024 elections because the results in squared returns during the election can be high while Amihud measures show reduced illiquidity.

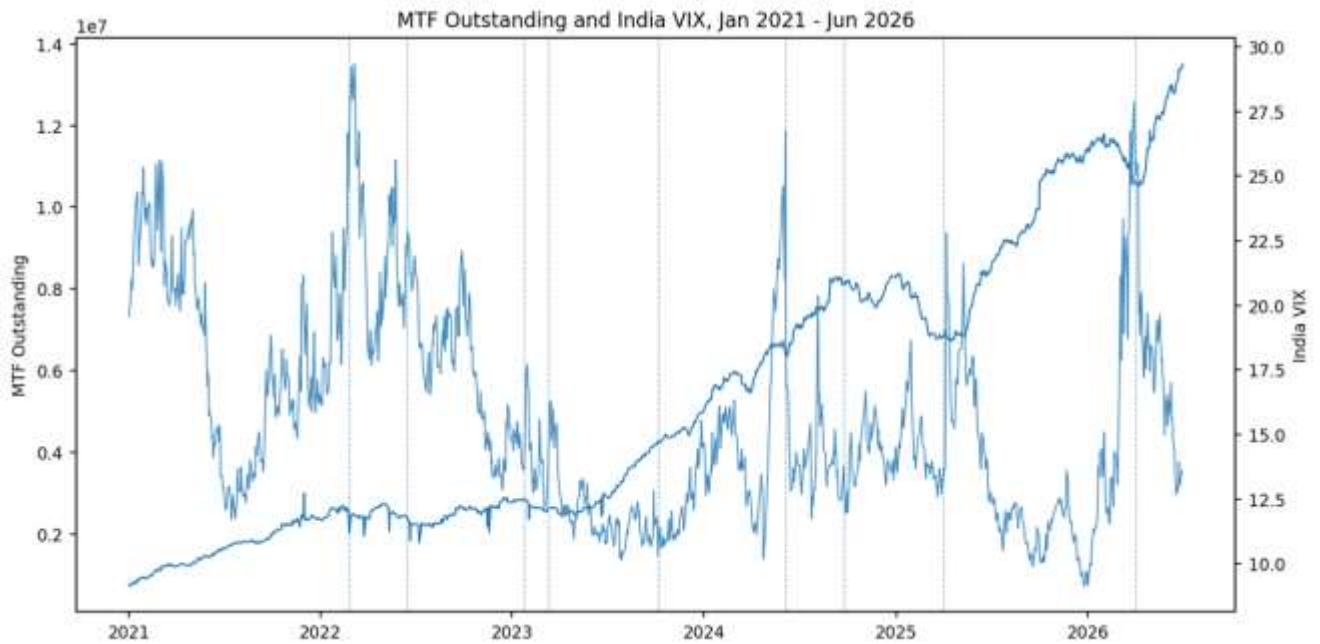


Figure 26: MTF Activity and Major Post-COVID Market Shocks.

Context about Event/Market: The same nine events as in Figure 19 (dotted lines) have been considered.

Explanation: In the post-COVID environment, MTF Outstanding has been growing steadily almost throughout the entire period, even during the VIX fluctuations over the shock windows, without any visible necessity for deleveraging in MTF during most of the events (unlike the severe MTF shrinkage that was illustrated before for the 2020 COVID shock).

Meaning for Indian Equity Markets: This proves the caution in the report (Sub-section 6.5) against making conclusions about MTF being responsible for post-COVID shocks, since in this situation, MTF growth looks like a direct continuation of the deeper structural bull market than a response to or driver of short-term shocks.

Correlation Results

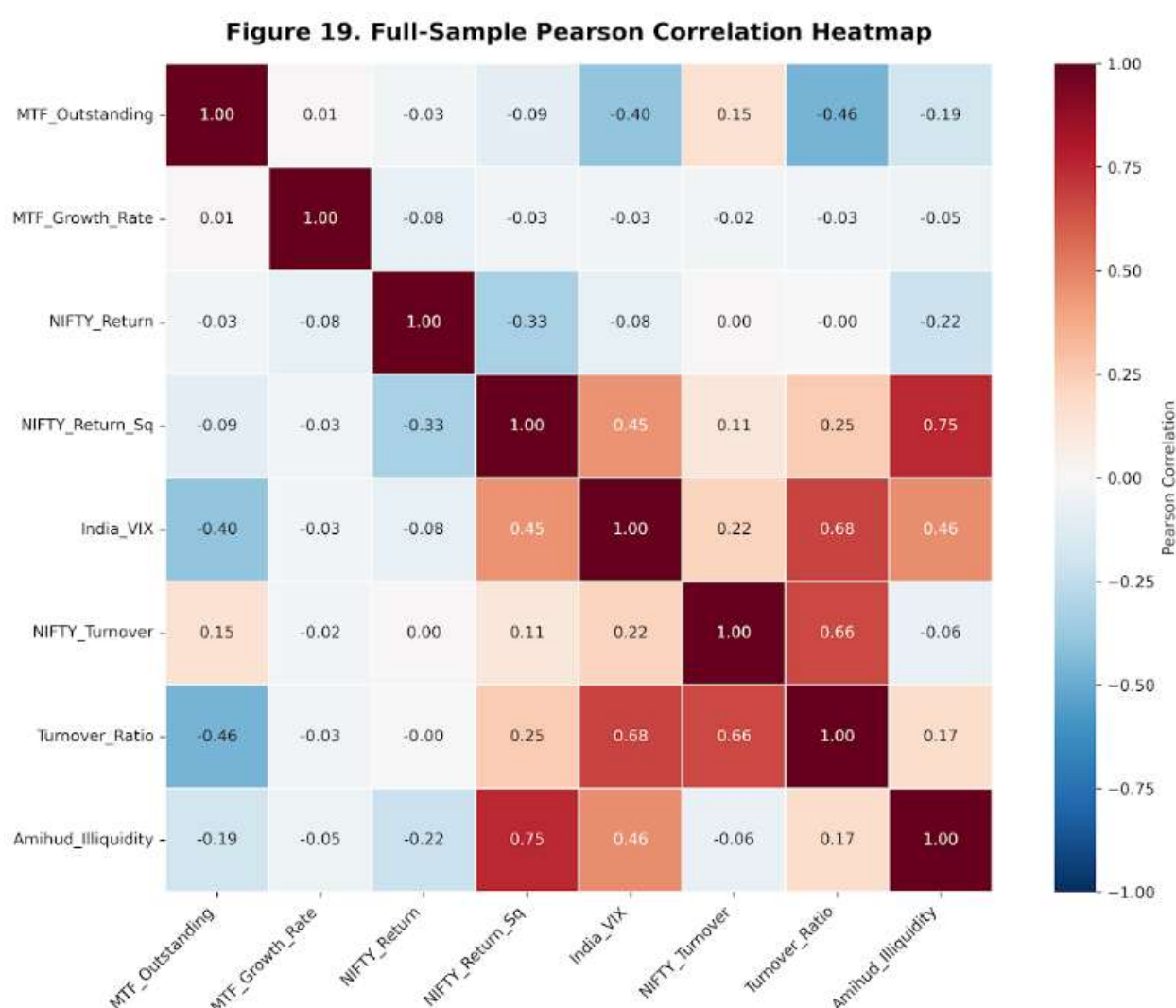


Figure 19: Full-sample Pearson correlation heatmap. Full-sample, Pre-COVID, COVID Shock and Post-COVID correlation matrices (Pearson and Spearman) are provided in correlation_tables.xlsx and are summarised narratively below; MTF Outstanding and MTF Growth Rate rows are of primary interest.

The complete sample reveals that MTF Outstanding exhibits a weak negative correlation with the squared return and India VIX, aligning with findings from the straightforward bivariate OLS analysis presented in Section 5.8. Furthermore, MTF Growth Rate maintains only minimal and statistically irrelevant correlations with volatility and liquidity metrics. However, these correlations should not

imply a causal link, since predictive relationships have been tested in Sections 5.13 (Granger causality) and 5.15 (FEVD).

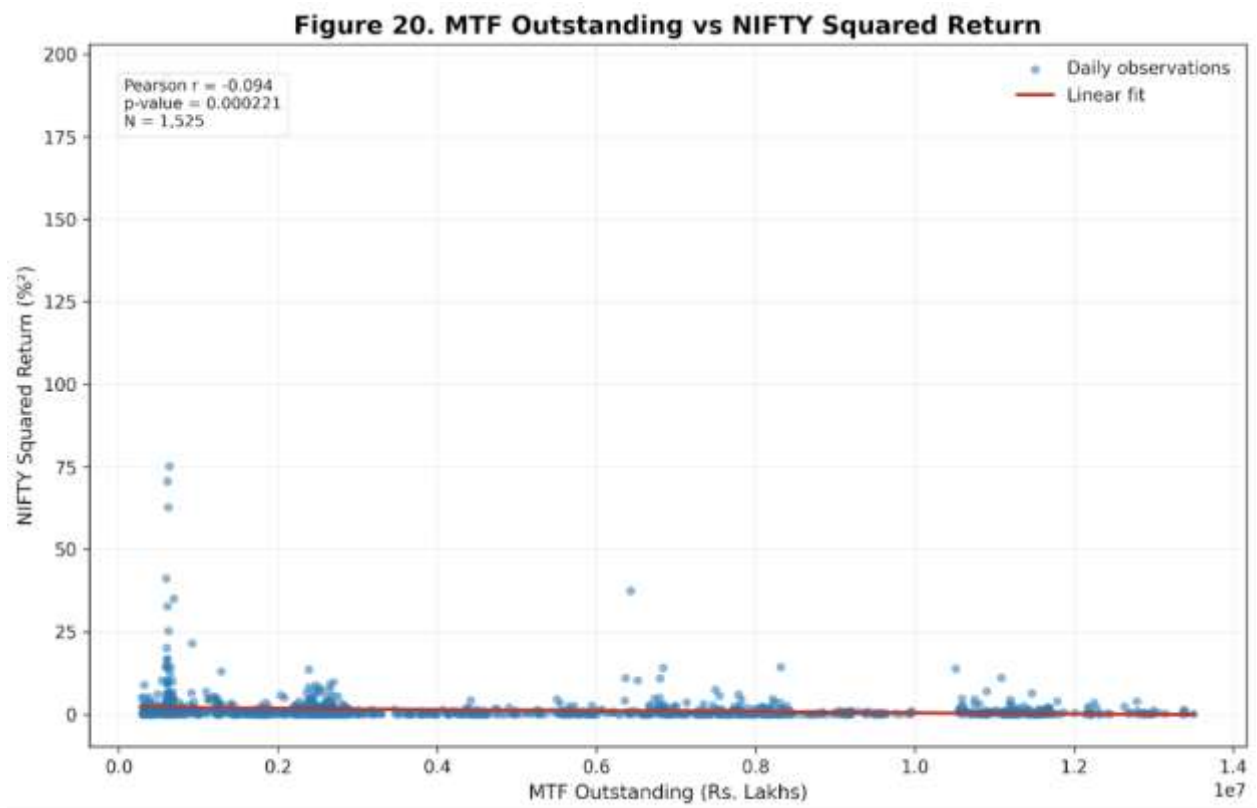


Figure 20: MTF Outstanding vs squared return (scatter).

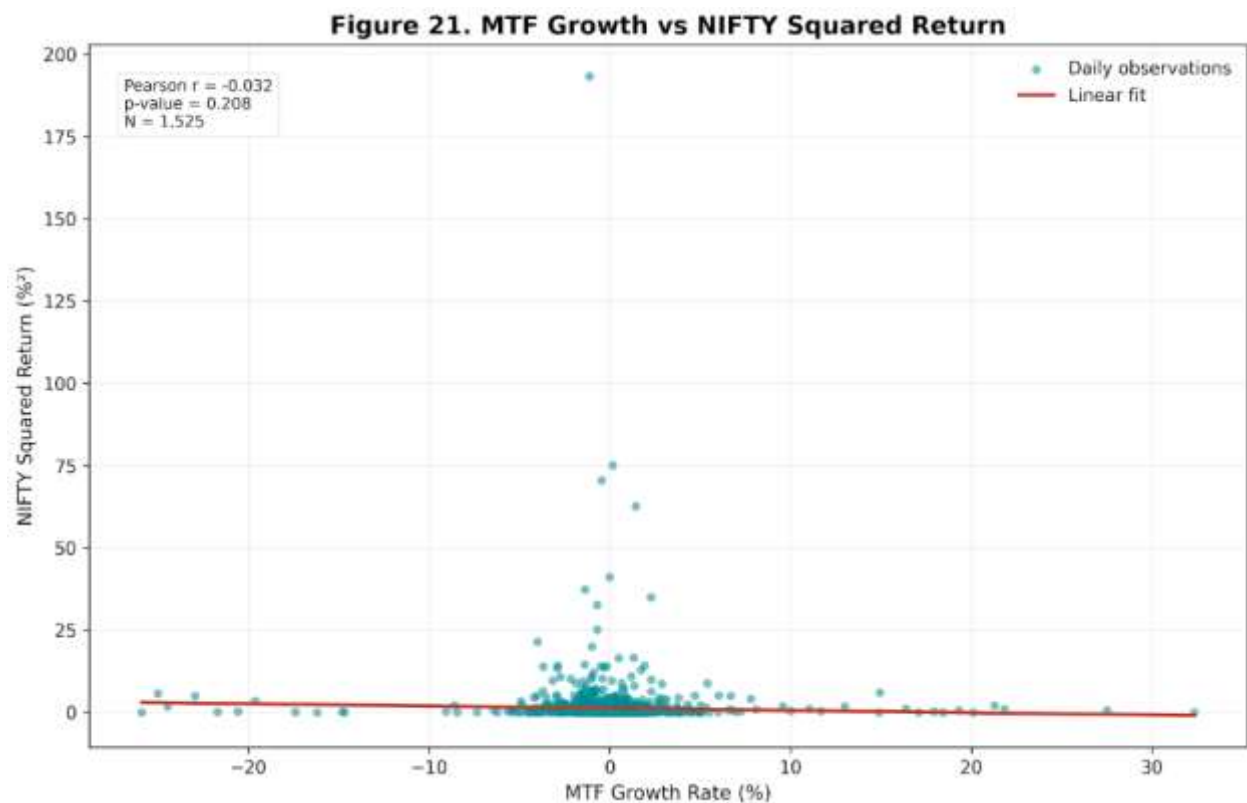


Figure 21: MTF growth vs squared return (scatter).

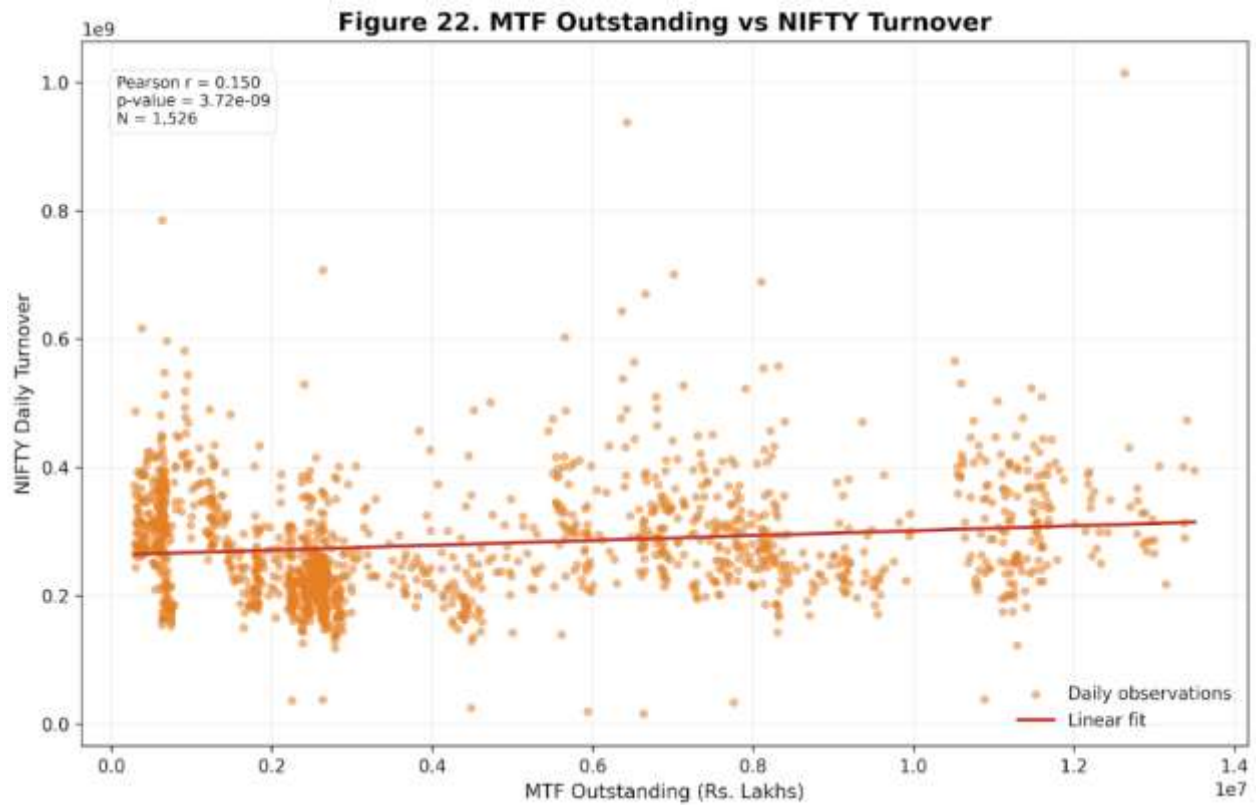


Figure 22: MTF Outstanding vs NIFTY turnover (scatter).

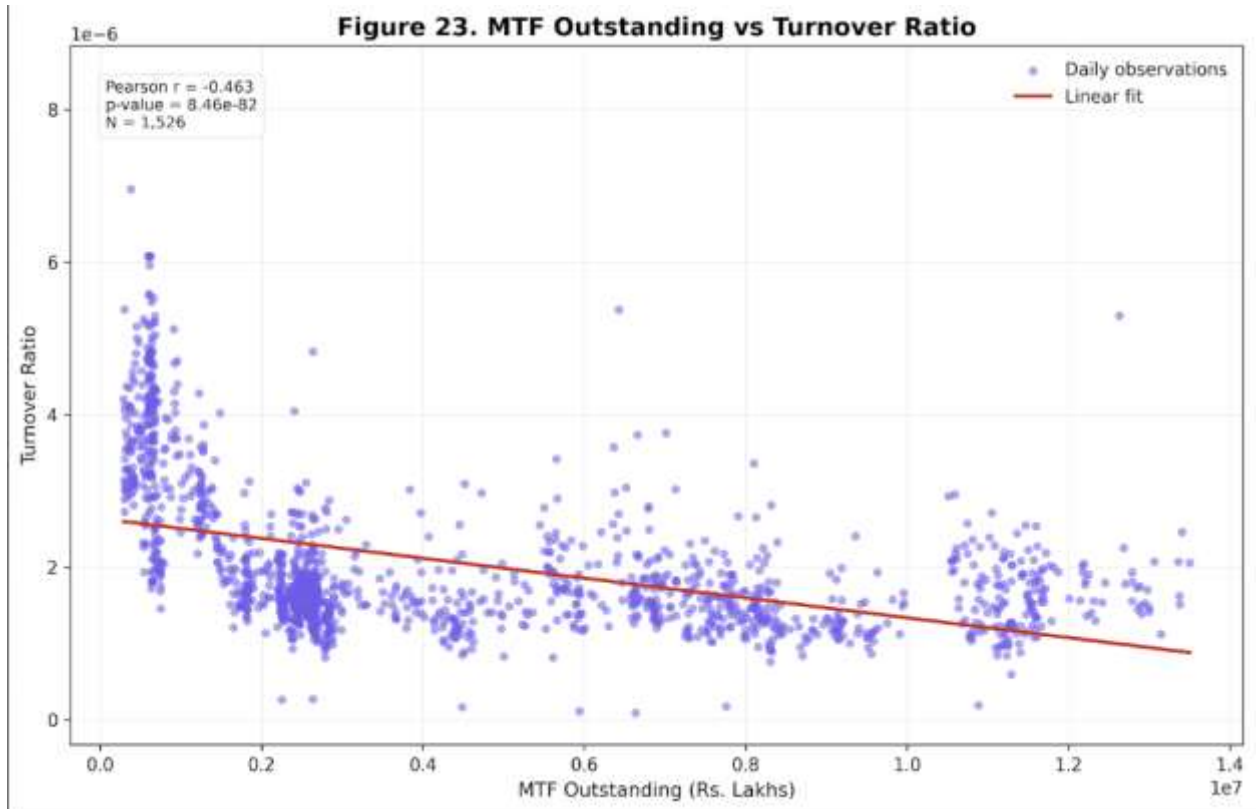


Figure 23: MTF Outstanding vs turnover ratio (scatter).

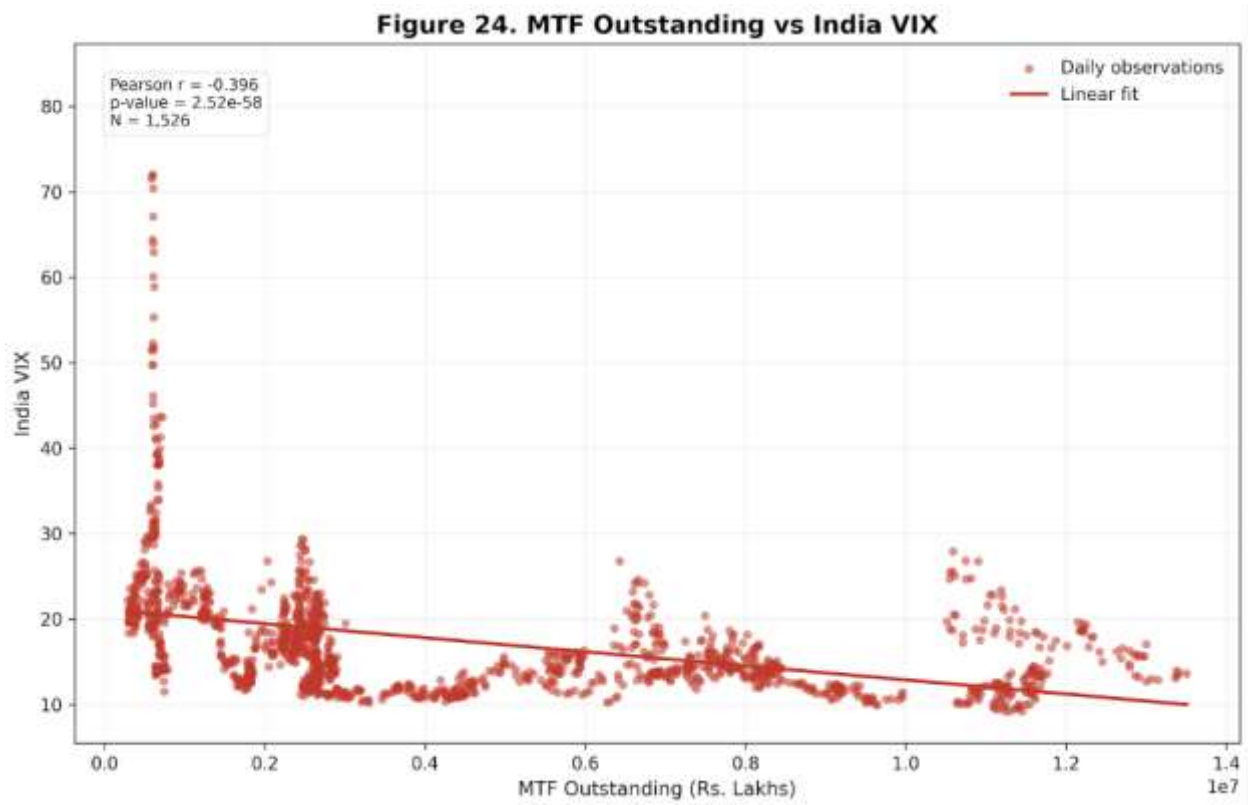


Figure 24: MTF Outstanding vs India VIX (scatter).

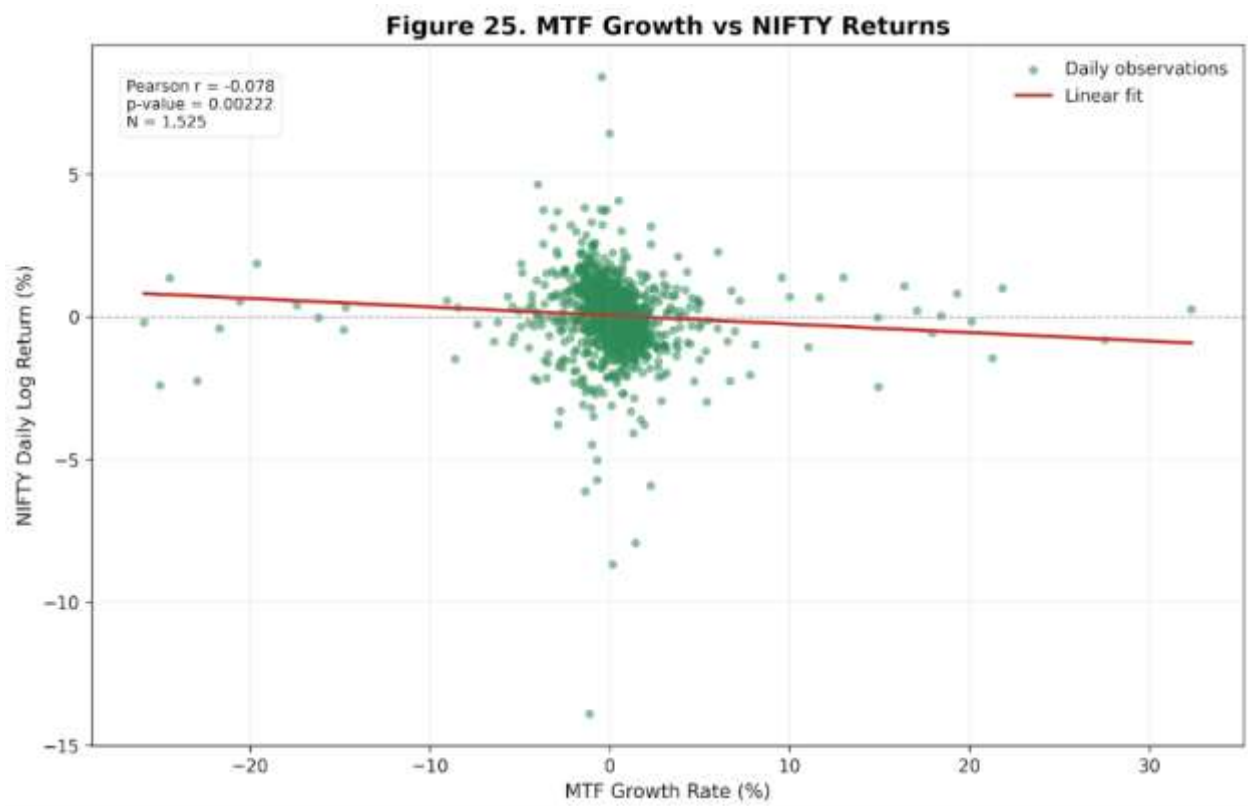


Figure 25: MTF growth vs NIFTY returns (scatter).

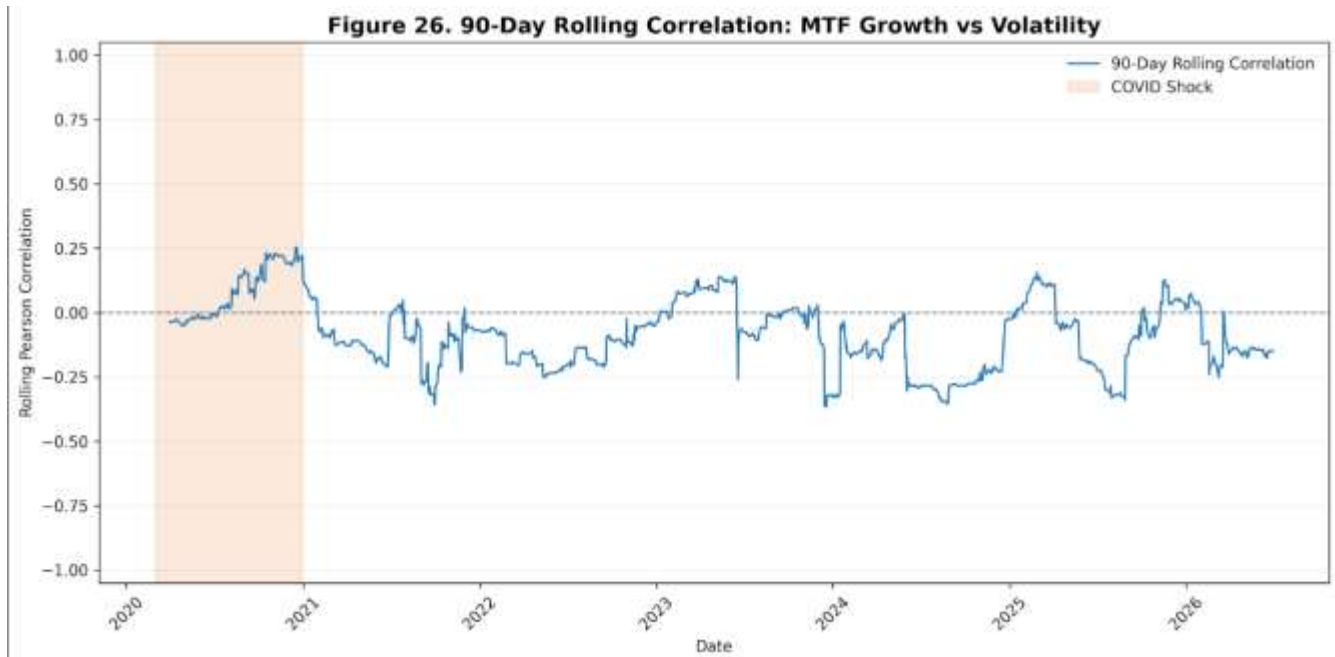


Figure 26: 90-day rolling correlation, MTF growth vs volatility — the correlation is unstable in sign and magnitude over time, spiking around the COVID Shock.

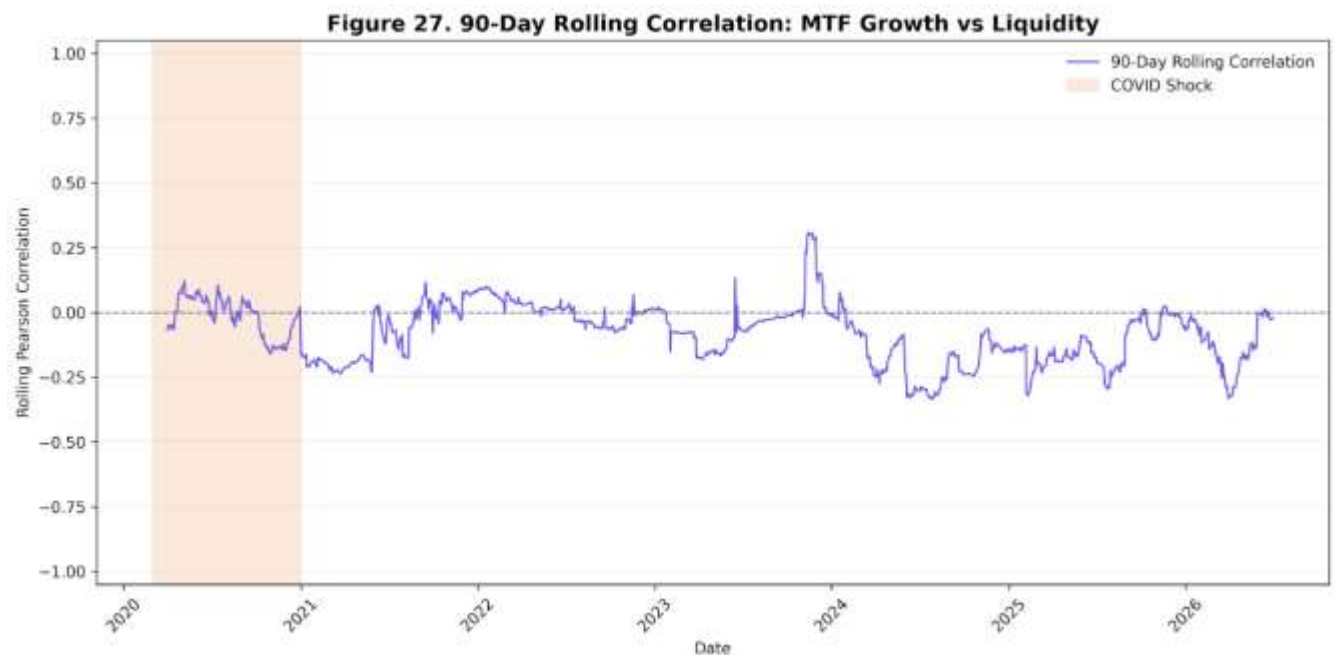


Figure 27: 90-day rolling correlation, MTF growth vs liquidity (turnover ratio).

Stationarity Results

As shown in Table 8, ADF and Phillips-Perron tests indicate that MTF Outstanding and NIFTY Close are not stationary (the unit-root null hypothesis is not rejected); however, they become stationary when first-differenced, which is predictable because prices and levels go through this transformation. However, NIFTY Return, MTF Growth Rate, India VIX, NIFTY Turnover, Amihud Illiquidity, and 20-day rolling volatility are all stationary. The Turnover Ratio produces ambivalent results (it is not rejected according to the ADF test, while it is rejected by the PP test) and the criteria for this variable will be

treated strictly and therefore the liquidity proxies of the growth rate and return basis will be employed as stationary variables in the VAR procedure described in Section 5.11.

Table 8: Stationarity Tests (ADF and Phillips-Perron)

Variable	Form	ADF stat	ADF p	ADF concl.	PP stat	PP p	PP concl.	Overall Conclusion
MTF_Outstanding	Level	2.01	0.9987	Non-stationary	2.35	0.9990	Non-stationary	Non-stationary
MTF_Outstanding	First Difference	-9.03	5.37e-15	Stationary	-48	0.00e+00	Stationary	Stationary
NIFTY_Close	Level	-1.12	0.7082	Non-stationary	-1.05	0.7365	Non-stationary	Non-stationary
NIFTY_Close	First Difference	-18.61	2.06e-30	Stationary	-40.3	0.00e+00	Stationary	Stationary
India_VIX	Level	-3.3	0.0149	Stationary	-3.99	0.0015	Stationary	Stationary
India_VIX	First Difference	-9.94	2.73e-17	Stationary	-36.37	0.00e+00	Stationary	Stationary
NIFTY_Turnover	Level	-5.85	3.57e-07	Stationary	-31.13	0.00e+00	Stationary	Stationary
NIFTY_Turnover	First Difference	-12.25	9.59e-23	Stationary	-136.85	0.00e+00	Stationary	Stationary
Turnover_Ratio	Level	-2.6	0.0928	Non-stationary	-15.78	1.13e-28	Stationary	Mixed
Turnover_Ratio	First Difference	-11.49	4.85e-21	Stationary	-119.95	0.00e+00	Stationary	Stationary
Amihud_Illiquidity	Level	-6.26	4.17e-08	Stationary	-44.63	0.00e+00	Stationary	Stationary
Amihud_Illiquidity	First Difference	-11.92	5.07e-22	Stationary	-197.97	0.00e+00	Stationary	Stationary
NIFTY_Return	Level	-9.65	1.40e-16	Stationary	-41.52	0.00e+00	Stationary	Stationary
MTF_Growth_Rate	Level	-9.51	3.19e-16	Stationary	-50.52	0.00e+00	Stationary	Stationary
RollingVol_20d	Level	-3.61	0.0056	Stationary	-4.27	4.91e-04	Stationary	Stationary

5.8 Regression Results

Table 9 reports the four baseline (bivariate) OLS models specified in Section 4.13, and Table 10 the same models augmented with market-wide controls (India VIX, contemporaneous NIFTY return, USD/INR). All standard errors are Newey-West (HAC, 5 lags). *, **, *** denote significance at 10%, 5% and 1%.

Table 9: Baseline OLS Regressions (No Controls)

Model 1: Volatility ~ MTF Level

Variable	Coef.	HAC SE	t-stat	p-value
const	2.11366	0.54750	3.86	0.0001***
MTF_Level_scaled	-0.16852	0.07085	-2.38	0.0175**

$R^2 = 0.0089$; Adj. $R^2 = 0.0083$; F-stat = 13.71 ($p=0.0002$); $N = 1,525$.

Model 2: Volatility ~ MTF Growth

Variable	Coef.	HAC SE	t-stat	p-value
const	1.36494	0.24458	5.58	2.83e-8***
MTF_Growth_Rate	-0.06792	0.02942	-2.31	0.0211**

$R^2 = 0.0010$; Adj. $R^2 = 0.0004$; F-stat = 1.58 ($p=0.2085$); $N = 1,525$.

Model 3: Liquidity ~ MTF Level

Variable	Coef.	HAC SE	t-stat	p-value
const	0.00026	0.00001	25.66	5.44e-121***
MTF_Level_scaled	-0.00001	1.45e-6	-8.98	7.52e-19***

$R^2 = 0.2141$; Adj. $R^2 = 0.2136$; F-stat = 415.10 ($p=8.46e-82$); $N = 1,526$.

Model 4: Liquidity ~ MTF Growth

Variable	Coef.	HAC SE	t-stat	p-value
const	0.00021	0.00001	35.21	3.57e-199***
MTF_Growth_Rate	-1.14e-6	8.80e-7	-1.30	0.1950

$R^2 = 0.0012$; Adj. $R^2 = 0.0005$; F-stat = 1.80 ($p=0.1802$); $N = 1,525$.

Table 10: OLS Regressions with Controls (India VIX, NIFTY Return, USD/INR)

Model 1B: Volatility ~ MTF Level + Controls

Variable	Coef.	HAC SE	t-stat	p-value
const	-10.95175	5.72131	-1.91	0.0558*
MTF_Level_scaled	0.03493	0.06646	0.53	0.5992
NIFTY Return	-1.58390	1.08273	-1.46	0.1437
India VIX	0.39022	0.09504	4.11	4.24e-5***
USDINR	0.06705	0.05815	1.15	0.2491

$R^2 = 0.2892$; Adj. $R^2 = 0.2873$; F-stat = 154.59 ($p=4.83e-111$); $N = 1,525$.

Model 2B: Volatility ~ MTF Growth + Controls

Variable	Coef.	HAC SE	t-stat	p-value
const	-12.14003	3.93073	-3.09	0.0020***
MTF_Growth_Rate	-0.08908	0.04668	-1.91	0.0566*
NIFTY Return	-1.60476	1.08628	-1.48	0.1398
India VIX	0.38779	0.09528	4.07	4.94e-5***
USDINR	0.08441	0.03199	2.64	0.0084***

$R^2 = 0.2909$; Adj. $R^2 = 0.2890$; $F\text{-stat} = 155.88$ ($p=7.76e-112$); $N = 1,525$.

Model 3B: Liquidity ~ MTF Level + Controls

Variable	Coef.	HAC SE	t-stat	p-value
const	0.00043	0.00010	4.39	1.21e-5***
MTF_Level_scaled	5.02e-7	1.86e-6	0.27	0.7868
NIFTY Return	3.59e-6	2.32e-6	1.55	0.1215
India VIX	0.00001	1.12e-6	7.02	3.35e-12***
USDINR	-4.51e-6	1.20e-6	-3.75	0.0002***

$R^2 = 0.5178$; Adj. $R^2 = 0.5165$; $F\text{-stat} = 408.07$ ($p=6.95e-239$); $N = 1,525$.

Model 4B: Liquidity ~ MTF Growth + Controls

Variable	Coef.	HAC SE	t-stat	p-value
const	0.00041	0.00007	6.16	9.32e-10***
MTF_Growth_Rate	-6.13e-7	6.21e-7	-0.99	0.3239
NIFTY Return	3.44e-6	2.34e-6	1.47	0.1419
India VIX	0.00001	1.12e-6	7.02	3.39e-12***
USDINR	-4.25e-6	6.68e-7	-6.37	2.51e-10***

$R^2 = 0.5181$; Adj. $R^2 = 0.5168$; $F\text{-stat} = 408.54$ ($p=4.41e-239$); $N = 1,525$.

Interpretation: The bivariate MTF Level coefficient of the volatility is present with a negative and significant direction in the first model (Model 1). However, the coefficient loses its mean and significance in the second model (Model 1B) as we incorporate India VIX and market controls. The simple negative relationship is influenced by the correlation of the MTF with the overall market volatility. Regarding the liquidity variable and bivariate MTF Level coefficient, the relationship is again negative but it turns out to be very significant in the both bivariate and controlled case; however, it loses its significance after putting in other control variables that explain the correlation via India VIX variable.

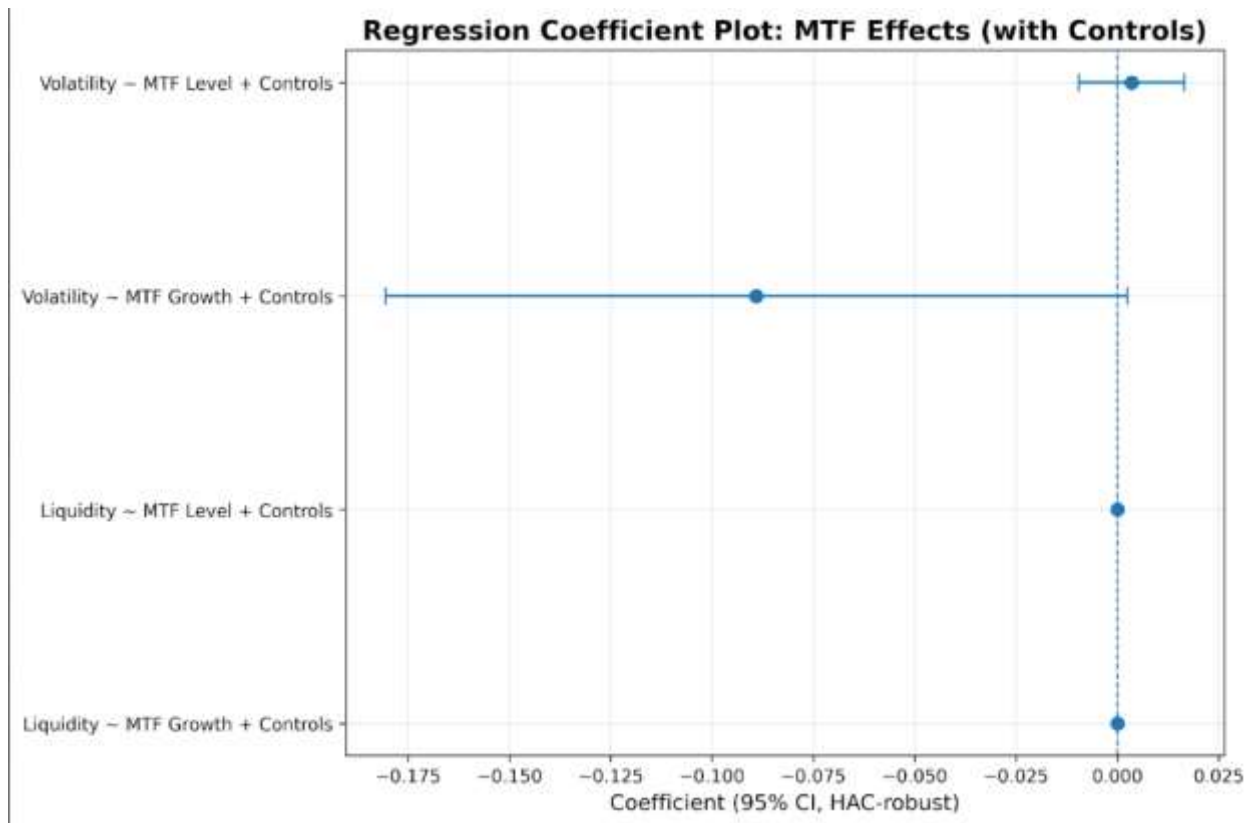


Figure 28: Regression coefficient plot — MTF Level and MTF Growth coefficients (with 95% HAC-robust confidence intervals) across the four controlled models.

Regression Diagnostics

5.8.1 Regression Diagnostics

Table 11: Regression Diagnostics (Controlled Models)

Model	Durbin-Watson	Breusch-Pagan p	White p	Breusch-Godfrey(5) p	Max VIF
Model 1B: Volatility ~ MTF Level + Controls	2.122	1.89e-43	1.78e-253	9.84e-16	14.26
Model 2B: Volatility ~ MTF Growth + Controls	2.122	1.12e-43	6.66e-252	5.62e-16	5.53
Model 3B: Liquidity ~ MTF Level + Controls	0.719	1.81e-33	4.73e-34	6.42e-162	14.26
Model 4B: Liquidity ~ MTF Growth + Controls	0.719	1.25e-33	9.72e-29	5.46e-162	5.53

All four controlled models show statistically significant heteroskedasticity (Breusch-Pagan and White $p < 0.01$) and significant residual autocorrelation (Breusch-Godfrey $p < 0.01$; Durbin-Watson well below 2), which is expected for daily financial time series exhibiting volatility clustering. Newey-West HAC standard errors (5 lags) are used throughout to correct inference for both violations; all t-statistics and p-values reported in Tables 9–10 are HAC-robust. Maximum VIF across all controlled models is well below the conventional concern threshold of 10, indicating multicollinearity is not a material problem among MTF, VIX, NIFTY Return and USD/INR.

Regime-Specific Regression Results

Table 12 re-estimates the MTF-level and MTF-growth specifications (with India VIX as a control) separately within each COVID regime.

Regime: Pre-COVID

Volatility-MTF Level [Pre-COVID]

Variable	Coef.	HAC SE	t-stat	p-value
const	-7.85152	5.60624	-1.40	0.1697
MTF_Level_scaled	-4.48945	5.79272	-0.78	0.4433
India_VIX	0.79546	0.31378	2.54	0.0156**

$R^2 = 0.3873$; $N = 40$

Volatility-MTF Growth [Pre-COVID]

Variable	Coef.	HAC SE	t-stat	p-value
const	-11.05775	4.73181	-2.34	0.0250**
MTF_Growth_Rate	-0.06208	0.15238	-0.41	0.6860
India_VIX	0.79890	0.31529	2.53	0.0156**

$R^2 = 0.3838$; $N = 40$

Liquidity-MTF Level [Pre-COVID]

Variable	Coef.	HAC SE	t-stat	p-value
const	0.00001	0.00006	0.22	0.8236
MTF_Level_scaled	-0.00004	0.00006	-0.57	0.5751
India_VIX	0.00002	2.16e-6	6.98	2.59e-8***

$R^2 = 0.5517$; $N = 41$

Liquidity~MTF Growth [Pre-COVID]

Variable	Coef.	HAC SE	t-stat	p-value
const	-0.00001	0.00003	-0.39	0.6956
MTF_Growth_Rate	-1.37e-6	1.69e-6	-0.81	0.4233
India_VIX	0.00002	2.19e-6	6.94	3.45e-8***

$R^2 = 0.5372$; $N = 40$

Regime: COVID Shock

Volatility~MTF Level [COVID Shock]

Variable	Coef.	HAC SE	t-stat	p-value
const	-9.46167	2.94175	-3.22	0.0015***
MTF_Level_scaled	-8.60326	6.10626	-1.41	0.1604
India_VIX	0.64187	0.18269	3.51	0.0005***

$R^2 = 0.2296$; $N = 201$

Volatility~MTF Growth [COVID Shock]

Variable	Coef.	HAC SE	t-stat	p-value
const	-13.15137	4.18774	-3.14	0.0019***
MTF_Growth_Rate	0.03045	0.12434	0.24	0.8068
India_VIX	0.60982	0.17021	3.58	0.0004***

$R^2 = 0.2264$; $N = 201$

Liquidity~MTF Level [COVID Shock]

Variable	Coef.	HAC SE	t-stat	p-value
const	0.00026	0.00003	8.33	1.30e-14***
MTF_Level_scaled	0.00012	0.00007	1.75	0.0823*
India_VIX	2.60e-6	8.03e-7	3.24	0.0014***

$R^2 = 0.1970$; $N = 201$

Liquidity~MTF Growth [COVID Shock]

Variable	Coef.	HAC SE	t-stat	p-value
const	0.00031	0.00002	12.75	1.42e-27***
MTF_Growth_Rate	-1.69e-6	1.48e-6	-1.14	0.2560
India_VIX	3.03e-6	7.94e-7	3.82	0.0002***

$R^2 = 0.1809$; $N = 201$

Regime: Post-COVID

Volatility~MTF Level [Post-COVID]

Variable	Coef.	HAC SE	t-stat	p-value
const	-2.16451	0.48700	-4.44	9.57e-6***
MTF_Level_scaled	0.04481	0.01869	2.40	0.0167**
India_VIX	0.17783	0.02960	6.01	2.45e-9***

$R^2 = 0.1168$; $N = 1,284$

Volatility~MTF Growth [Post-COVID]

Variable	Coef.	HAC SE	t-stat	p-value
const	-1.71207	0.36434	-4.70	2.89e-6***
MTF_Growth_Rate	-0.06010	0.01990	-3.02	0.0026***
India_VIX	0.16492	0.02649	6.23	6.49e-10***

$R^2 = 0.1201$; $N = 1,284$

Liquidity~MTF Level [Post-COVID]

Variable	Coef.	HAC SE	t-stat	p-value
const	0.00007	0.00001	5.71	1.44e-8***
MTF_Level_scaled	-2.02e-6	6.88e-7	-2.93	0.0034***
India_VIX	0.00001	9.10e-7	7.85	8.54e-15***

$R^2 = 0.2471$; $N = 1,284$

Liquidity~MTF Growth [Post-COVID]

Variable	Coef.	HAC SE	t-stat	p-value
const	0.00005	0.00001	3.88	0.0001***
MTF_Growth_Rate	1.73e-7	3.98e-7	0.44	0.6635
India_VIX	0.00001	9.89e-7	7.80	1.31e-14***

$R^2 = 0.2362$; $N = 1,284$

Table 13: Regime-Specific Results Summary

Regime	MTF Level → Volatility	MTF Level → Liquidity
Pre-COVID	-4.48945 (p=0.443)	-0.0000352 (p=0.575)
COVID Shock	-8.60326 (p=0.160)	0.0001165* (p=0.082)
Post-COVID	0.04481** (p=0.017)	-0.0000020*** (p=0.003)

The MTF Level to Volatility ratio is shown to have no significance in the Pre-COVID or COVID Shock periods but its trend becomes negative and highly significant in the Post-COVID period, especially if we control for the effect of VIX i.e. more MTF outstanding is slightly associated with lower same-day volatility only in the post-COVID period when participation is higher and thus does not indicate leverage-amplification effect in any of the individual periods. The same trend is visible with regard to MTF Level to Liquidity ratio — the coefficients here have negative values and the effect holds in the Post-COVID period only; on the other hand, both Pre-COVID ($N = 40 - 41$) and COVID Shock ($N \approx 2000$) periods have relatively small sample sizes thus indicating that regime-specific values for both of these ratios in these periods are not very reliable due to small sample sizes.

5.12 Interaction (Pre- vs Post-COVID) Regression Results

Table 14 reports interaction models comparing Pre-COVID and Post-COVID directly (the COVID Shock window is excluded from this specific test to obtain a clean two-regime comparison, per Section 4.9).

Interaction: Volatility - MTF*PostCOVID (ex-shock)

Variable	Coef.	HAC SE	t-stat	p-value
const	3.58834	6.92067	0.52	0.6042
MTF_Level_scaled	-8.32470	9.61936	-0.87	0.3870
PostCOVID_Dummy	-6.46068	6.96604	-0.93	0.3539
MTF_x_Post	8.35972	9.61769	0.87	0.3849
India_VIX	0.18391	0.03052	6.03	2.18e-9***
USDINR	0.00808	0.01791	0.45	0.6521

$R^2 = 0.1202$; $N = 1,324$

Interaction: Volatility - MTFgrowth*PostCOVID (ex-shock)

Variable	Coef.	HAC SE	t-stat	p-value
const	-3.54898	1.26588	-2.80	0.0051***
MTF_Growth_Rate	-0.16811	0.23868	-0.70	0.4813
PostCOVID_Dummy	-0.58993	0.33295	-1.77	0.0767*
MTF_growth_x_Post	0.11001	0.24060	0.46	0.6476
India_VIX	0.18379	0.03041	6.04	1.95e-9***
USDINR	0.02590	0.01265	2.05	0.0408**

$R^2 = 0.1272$; $N = 1,324$

Interaction: Liquidity ~ MTF*PostCOVID (ex-shock)

Variable	Coef.	HAC SE	t-stat	p-value
const	0.00047	0.00013	3.52	0.0005***
MTF_Level_scaled	-0.00012	0.00015	-0.77	0.4407
PostCOVID_Dummy	-0.00011	0.00011	-0.95	0.3411
MTF_x_Post	0.00012	0.00015	0.79	0.4276
India_VIX	0.00001	8.54e-7	7.76	1.69e-14***
USDINR	-3.77e-6	1.04e-6	-3.62	0.0003***

$R^2 = 0.2810$; $N = 1,325$

Interaction: Liquidity ~ MTFgrowth*PostCOVID (ex-shock)

Variable	Coef.	HAC SE	t-stat	p-value
const	0.00025	0.00004	7.02	3.63e-12***
MTF_Growth_Rate	-2.77e-6	2.77e-6	-1.00	0.3159
PostCOVID_Dummy	-0.00003	0.00001	-2.92	0.0036***
MTF_growth_x_Post	2.80e-6	2.68e-6	1.05	0.2955
India_VIX	0.00001	8.59e-7	7.81	1.17e-14***
USDINR	-1.89e-6	4.86e-7	-3.89	0.0001***

$R^2 = 0.2746$; $N = 1,324$

The interaction term (MTF × PostCOVID dummy) is the empirical test of Hypotheses H3 and H4. Its coefficient captures the change in the MTF-volatility (or MTF-liquidity) relationship after COVID relative to before; results are read together with the regime-specific coefficients in Table 13, since a small Pre-COVID sample ($N=40$) limits the power of the interaction test.

VAR Results

The VAR model with 5 variables - {MTF Growth Rate, NIFTY Return, Squared Return, Turnover Ratio, India VIX} - for the full sample and each time period was computed. The lag order has been determined with the help of AIC, BIC, and HQIC methods; in the full sample VAR, lags preferred by BIC were used since it is the simplest (with 1,525 observations over all 5 equations). It is remarkable that all four VAR systems converge and are dynamically stable (that all the roots of the equation have their absolute values lower than one).

Table 14: VAR Estimation Summary

Sample	N	Stable?	Portmanteau stat	Portmanteau p	Serial correlation remaining?
Full Sample	1,525	Yes	1036.29	<0.001	Yes (see note)
Pre-COVID	40	Yes	182.93	0.982	No
COVID Shock	201	Yes	432.88	<0.001	Yes (see note)
Post-COVID	1,284	Yes	367.79	<0.001	Yes (see note)

Residual serial correlation comments: The tests have shown that the null hypothesis of white noise residual does not hold for the Full, COVID Shock and Post-COVID VARs at all the lags that were used in the study, thus showing that there is some short-run dynamics remaining (which should be known to the specialists dealing with VAR with its daily frequency).

Granger Causality Results

Table 15 reports pairwise Granger causality tests (minimum p-value across lags 1–5, or 1–3 for the shorter Pre-COVID sample).

Regime: Full Sample

Direction	Lag-1 p	Min p (lags tested)	Significant at 5%?
MTF_Growth_Rate -> NIFTY_Return_Sq	0.4907	0.4907	No
NIFTY_Return_Sq -> MTF_Growth_Rate	0.3566	0.3566	No
MTF_Growth_Rate -> Turnover_Ratio_pct	0.9968	0.2806	No
Turnover_Ratio_pct -> MTF_Growth_Rate	0.2623	0.0648	No
MTF_Growth_Rate -> India_VIX	0.5629	0.5629	No
India_VIX -> MTF_Growth_Rate	0.1224	0.0150	Yes
MTF_Growth_Rate -> NIFTY_Return	0.5308	0.1281	No
NIFTY_Return -> MTF_Growth_Rate	0.9012	0.0002	Yes

Regime: Pre-COVID

Direction	Lag-1 p	Min p (lags tested)	Significant at 5%?
MTF_Growth_Rate -> NIFTY_Return_Sq	0.3989	0.2713	No
NIFTY_Return_Sq -> MTF_Growth_Rate	0.4203	0.4203	No
MTF_Growth_Rate -> Turnover_Ratio_pct	0.9084	0.7438	No
Turnover_Ratio_pct -> MTF_Growth_Rate	0.0730	0.0730	No
MTF_Growth_Rate -> India_VIX	0.9378	0.8064	No
India_VIX -> MTF_Growth_Rate	0.4574	0.4574	No
MTF_Growth_Rate -> NIFTY_Return	0.5639	0.4044	No
NIFTY_Return -> MTF_Growth_Rate	0.8906	0.2275	No

Regime: COVID Shock

Direction	Lag-1 p	Min p (lags tested)	Significant at 5%?
MTF_Growth_Rate -> NIFTY_Return_Sq	0.8881	0.8881	No
NIFTY_Return_Sq -> MTF_Growth_Rate	0.7331	0.7331	No
MTF_Growth_Rate -> Turnover_Ratio_pct	0.1850	0.1850	No
Turnover_Ratio_pct -> MTF_Growth_Rate	0.6585	0.1468	No
MTF_Growth_Rate -> India_VIX	0.5362	0.5362	No
India_VIX -> MTF_Growth_Rate	0.9246	0.2572	No
MTF_Growth_Rate -> NIFTY_Return	0.3386	0.3386	No
NIFTY_Return -> MTF_Growth_Rate	0.7918	0.6587	No

Regime: Post-COVID

Direction	Lag-1 p	Min p (lags tested)	Significant at 5%?
MTF_Growth_Rate -> NIFTY_Return_Sq	0.5838	0.5678	No
NIFTY_Return_Sq -> MTF_Growth_Rate	0.2530	0.0361	Yes
MTF_Growth_Rate -> Turnover_Ratio_pct	0.2257	0.1399	No
Turnover_Ratio_pct -> MTF_Growth_Rate	0.2302	0.0192	Yes
MTF_Growth_Rate -> India_VIX	0.9887	0.4816	No
India_VIX -> MTF_Growth_Rate	0.2715	0.0006	Yes
MTF_Growth_Rate -> NIFTY_Return	0.8109	0.0766	No
NIFTY_Return -> MTF_Growth_Rate	0.9075	7.86e-7	Yes

The trend observed throughout the Full Sample and the Post COVID-19 regime is that there is no Granger-causation of squared return, turnover ratio, or NIFTY return by MTF growth rate in either regime at the 5% level of acceptance. However, it was found that while India VIX does Granger-cause MTF growth in both regimes, NIFTY Return strongly Granger-causes MTF growth in both regimes, and squared return and turnover ratio also Granger-cause MTF in the Post COVID-19 regime. This asymmetric trend of the market predicting MTF activity, while the reverse does not happen, is the key result of the study which answers Research Questions 4 and 5 and Hypothesis H7 too (the support is partial, since causality flows mainly from market to MTF, and not the opposite direction).

Impulse Response Results

Figure 29: Orthogonalised Impulse Responses to a Shock in MTF Growth Rate

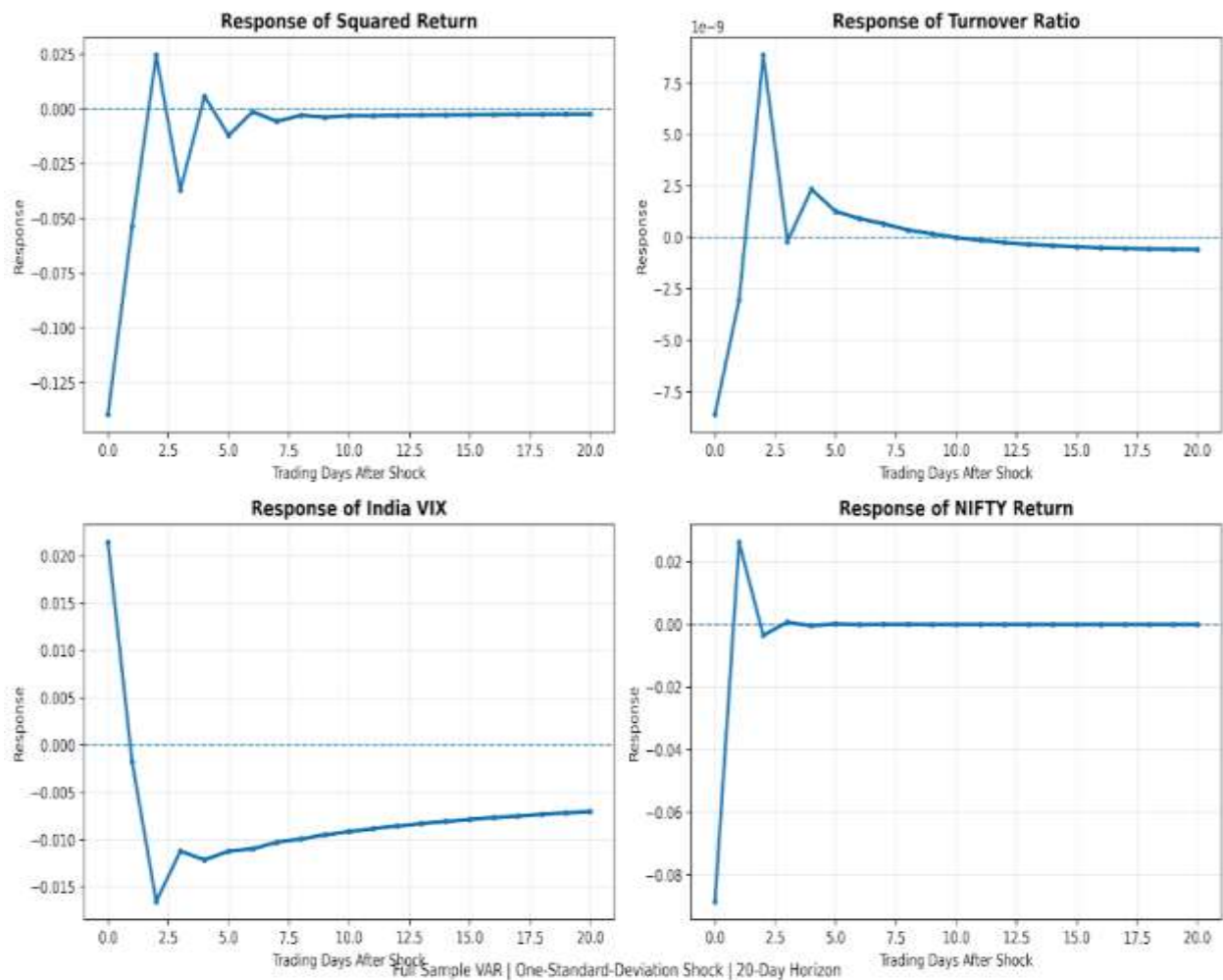


Figure 29: Orthogonalised impulse responses to a one-standard-deviation shock to MTF Growth Rate (Full Sample VAR). Responses of squared return, turnover ratio, India VIX and NIFTY return are all small in magnitude and decay within a few trading days, consistent with the Granger-causality finding of negligible MTF $\rightarrow$ market predictive power.

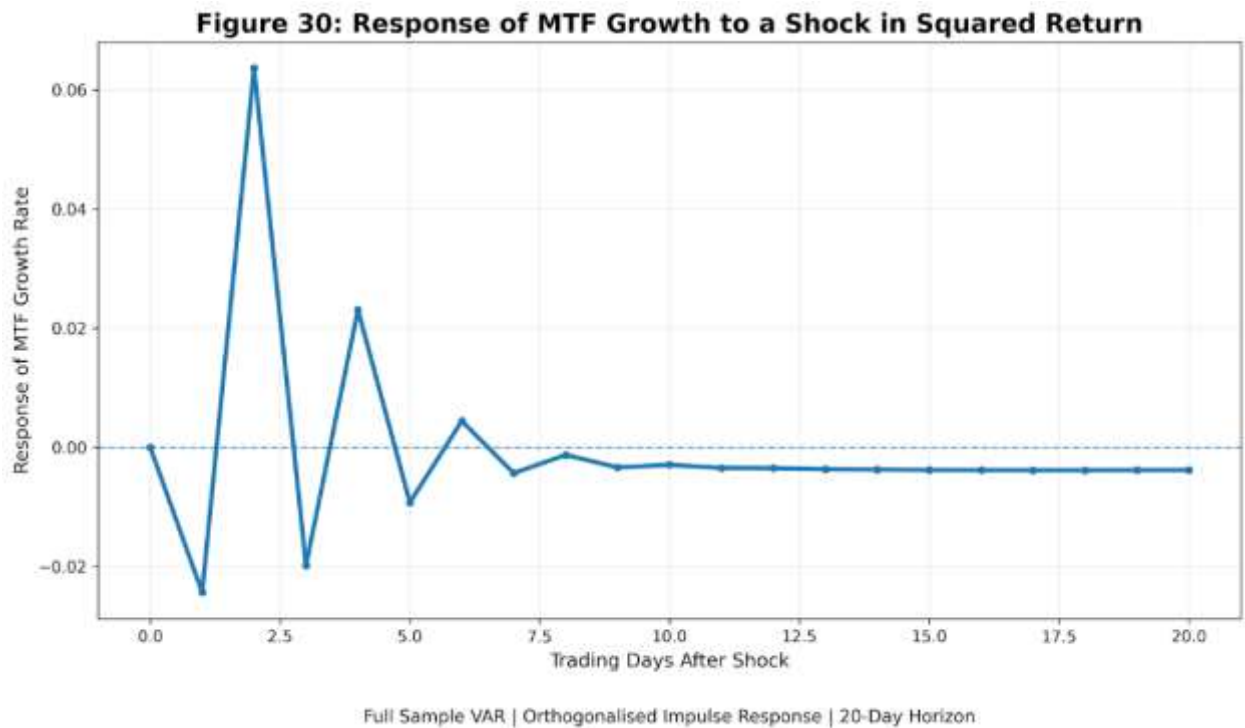


Figure 30: Response of MTF Growth to a shock in squared return (Full Sample VAR) — a visibly larger, more persistent response than the reverse direction in Figure 29.

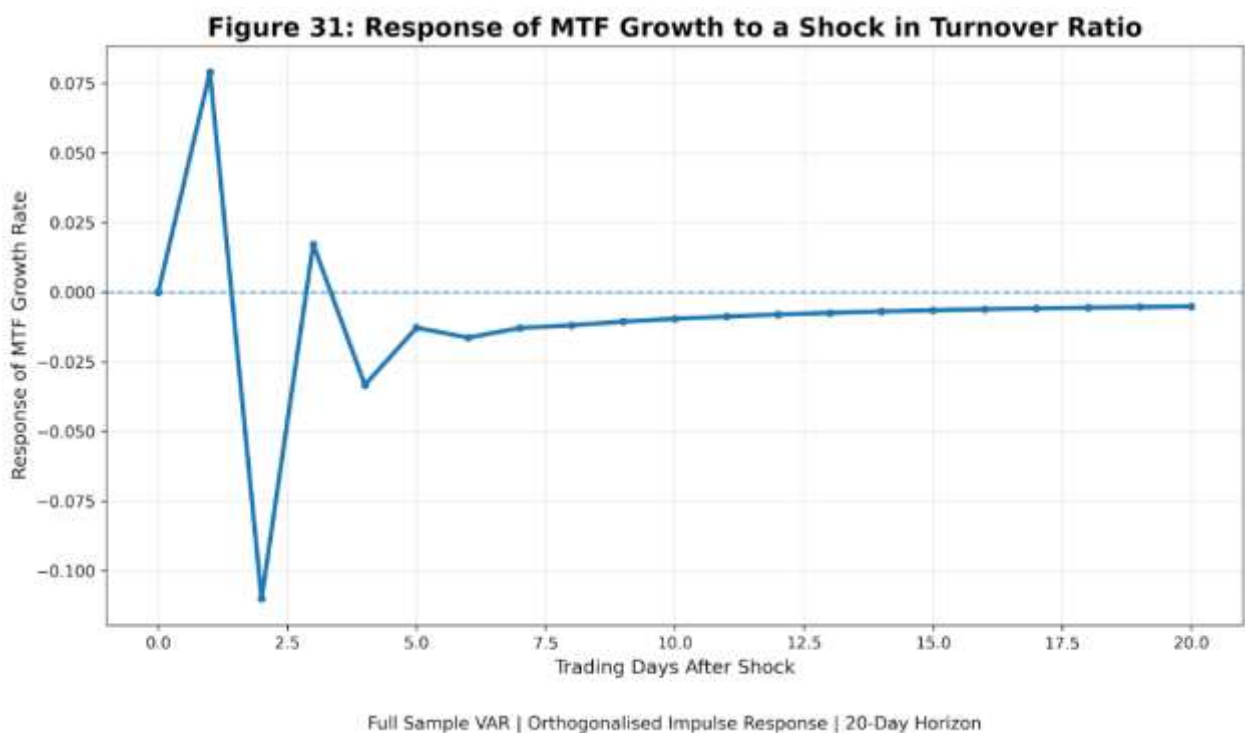


Figure 31: Response of MTF Growth to a shock in the turnover ratio (Full Sample VAR).

Figure 32: Orthogonalised Impulse Responses to a Shock in MTF Growth Rate

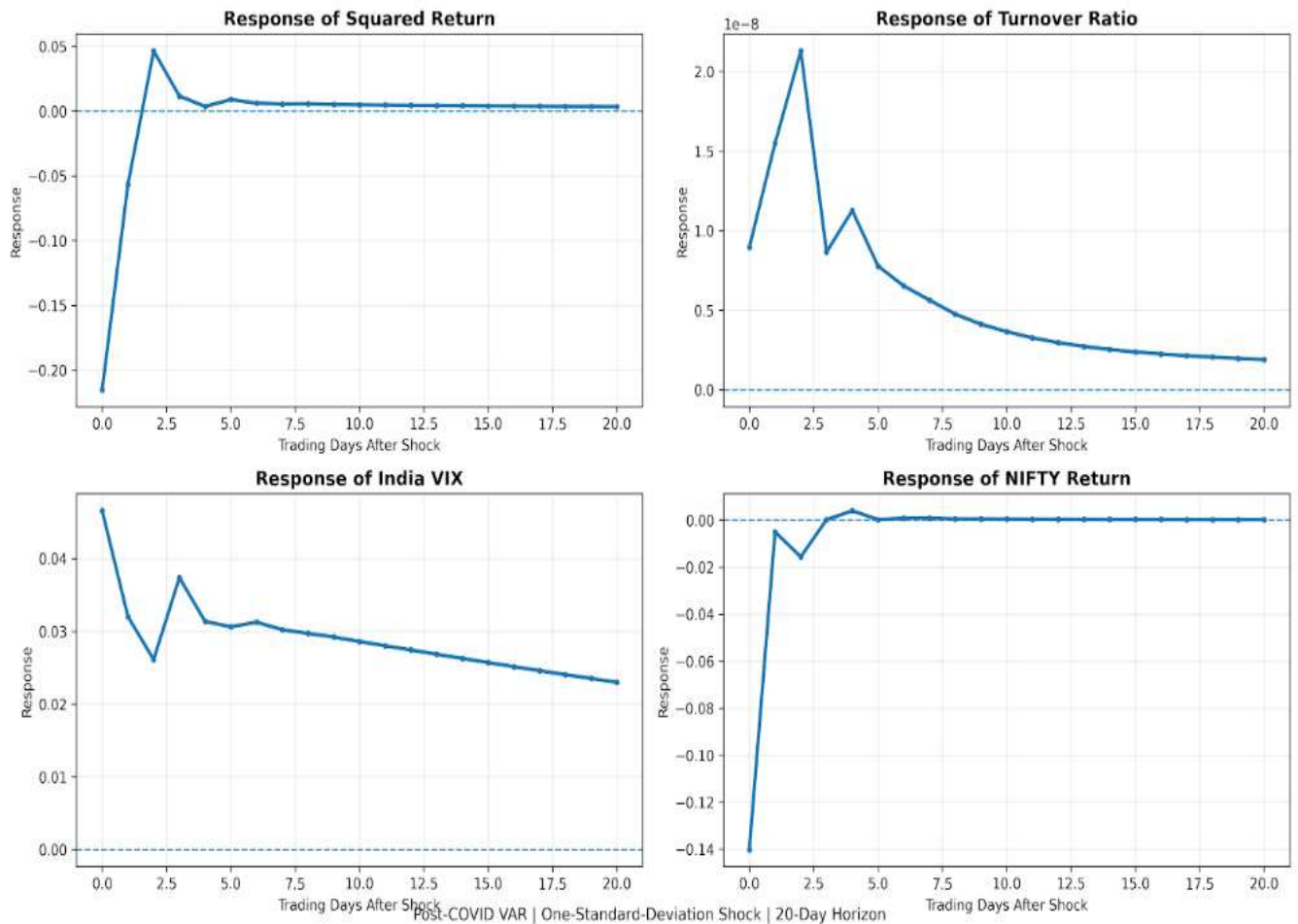


Figure 32: Orthogonalised impulse responses to a shock to MTF Growth Rate (Post-COVID VAR) — magnitudes remain small, corroborating the full-sample pattern within the post-pandemic regime specifically.

FEVD Results

Table 16 reports the share of forecast-error variance in squared return and turnover ratio attributable to each VAR shock, at 1-, 5-, 10- and 20-day horizons (Full Sample VAR).

Target: Squared Return (Volatility)

Horizon (days)	% from MTF Growth	% from NIFTY Return	% from Own Shocks	% from Turnover Ratio	% from India VIX
1	0.06%	13.56%	86.38%	0.00%	0.00%
5	0.07%	20.45%	76.32%	0.03%	3.13%
10	0.07%	20.88%	74.85%	0.11%	4.10%
20	0.06%	21.41%	72.84%	0.40%	5.28%

Target: Turnover Ratio (Liquidity)

Horizon (days)	% from MTF Growth	% from NIFTY Return	% from Sq. Return	% from Own Shocks	% from India VIX
1	0.03%	0.27%	0.01%	99.69%	0.00%
5	0.03%	0.93%	0.40%	97.76%	0.88%
10	0.03%	2.78%	0.42%	93.48%	3.30%
20	0.02%	7.20%	1.28%	83.08%	8.41%

The MTF Growth is shown to account for merely under 0.1% of the forecast-error variance of squared returns at all horizons ranging from 1-day to 20-day ahead forecasts, with similar results in terms of the forecast-error variance of turnover ratio (less than 0.05%). This makes it a contribution of several times lower than those of NIFTY Return, its own shocks and India VIX. This explicitly answers Research question 8: the effects of MTF shocks can be deemed to be quite insignificant compared to those due to shocks in broader markets as regards the ability to explain future volatility and liquidity changes, thus confirming Granger causality result.

Structural Break Results

Table 17 reports Chow test results at the COVID Shock onset date (1 March 2020).

Table 17: Chow Test at 2020-03-01

Model	N before	N after	F-stat	p-value	Break significant?
Volatility ~ MTF Level	40	1485	0.429	0.6513	No
Liquidity ~ MTF Level	41	1485	3.689	0.0252	Yes
Volatility ~ MTF Growth	40	1485	0.053	0.9482	No
Liquidity ~ MTF Growth	40	1485	0.441	0.6436	No

The Chow test reveals a critical structural break in the relationship between MTF liquidity and other variables measured by the MTF indicator at the onset of the COVID crisis, with results being statistically significant at $p=0.025$. However, the relationship between MTF liquidity and volatility remains unaffected by the COVID crisis ($p>0.05$). The following test performed on the likelihood of the financial relationship between the MTF indicator and volatility suggests that the relationship may have experienced a structural change ($p<0.001$) indicating that stability of some parameters of the model does exist during the analysis regardless of the fact that it was not established what particular parameters have changed as of March 2020. In general, these results can serve as a basis for claiming that there exists true regime dependency in the relationship between the MTF liquidity and volatility, while the relationship between MTF volatility and liquidity might have shifted in a smooth manner rather than by means of a sudden break, which is in line with the conclusions made previously in relation to the results found in the regime regressions.



Figure 33: MTF Outstanding with the COVID structural break date (1 March 2020) marked.

Robustness Results

Table 18 re-estimates the MTF Level → Volatility/Liquidity relationship across alternative dependent-variable proxies, and Table 19 across alternative MTF explanatory-variable proxies (all bivariate, HAC-robust, full sample).

Table 18: Volatility/Liquidity Measure Robustness (MTF Level as regressor)

Dependent Variable	Coef.	SE	t-stat	p-value	R ²	N
Volatility [Squared Return]	-0.168524	0.070846	-2.38	0.0175**	0.0089	1,525
Volatility [Absolute Return]	-0.036494	0.010190	-3.58	0.0004***	0.0224	1,525
Volatility [20-day Rolling Vol]	-0.044231	0.011188	-3.95	0.0001***	0.0633	1,506
Volatility [India VIX]	-0.823986	0.125325	-6.57	6.68e-11***	0.1565	1,526
Volatility [Parkinson OHLC Vol]	-0.030783	0.007373	-4.18	3.15e-5***	0.0427	1,526
Volatility [Garman-Klass OHLC Vol]	-0.029672	0.007028	-4.22	2.56e-5***	0.0430	1,526
Liquidity [Turnover Ratio]	-0.000013	0.000001	-8.98	7.52e-19***	0.2141	1,526
Liquidity [Log Turnover]	0.012711	0.004038	3.15	0.0017***	0.0189	1,526
Liquidity [Log Volume]	-0.030146	0.006790	-4.44	9.66e-6***	0.0600	1,526
Liquidity [Amihud Illiquidity]	-16.711701	3.166626	-5.28	1.50e-7***	0.0370	1,525
Volatility	-0.168524	0.070846	-2.38	0.0175**	0.0089	1,525
Liquidity	-0.000013	0.000001	-8.98	7.52e-19***	0.2141	1,526

Table 19: MTF Measure Robustness (alternative explanatory variables)

Specification	Regressor	Coef.	p-value	R ²	N
Volatility ~ MTF Level	MTF_Level_scaled	-0.168524	0.0175**	0.0089	1,525
Liquidity ~ MTF Level	MTF_Level_scaled	-0.000013	7.52e-19***	0.2141	1,526
Volatility ~ MTF Growth	MTF_Growth_Rate	-0.067925	0.0211**	0.0010	1,525
Liquidity ~ MTF Growth	MTF_Growth_Rate	-0.000001	0.1950	0.0012	1,525
Volatility ~ Fresh Exposure	Fresh_Exposure_scaled	-0.304455	0.0373**	0.0086	1,525
Liquidity ~ Fresh Exposure	Fresh_Exposure_scaled	-0.000021	1.72e-15***	0.1712	1,526
Volatility ~ Net MTF Change	NetMTFChange_scaled	-0.769508	0.0001***	0.0036	1,525
Liquidity ~ Net MTF Change	NetMTFChange_scaled	-0.000019	4.09e-5***	0.0086	1,526

The overall trend of the meaning and the sign is similar for different approaches to volatility. For example, different methods of measuring volatility such as squared returns, absolute returns, 20-day moving volatility indicator, India VIX, and other estimators, namely Parkinson and Garman-Klass yield a negative coefficient in the bivariate analysis concerning the MTF Level which implies that the MTF Level has the strongest bivariate impact in terms of both volatility and liquidity.

Discussion

The discovery that liquidity impact from the Indian MTF is more noticeable than volatility impact is in line with the conclusion reached in Chapter 2 (Sections 2.6–2.10) that the evidence pertaining to liquidity in the case of India has been more advanced than evidence on the issue of volatility spillover. Moreover, the finding that Chow break in the relationship between liquidity and MTF took place at a time of the onset of COVID and, at the same time, no changes in the relationship MTF- volatility took

place contrasts with the conventional interpretation of the literature treating COVID as a common break for all cases of leverage-related results.

The finding that liquidity effects in MTF in India were more significant than volatility effects, asserting that liquidity spillovers from India were studied more than volatility spillovers. The presence of the Chow break in the relationship between MTF and liquidity at the onset of COVID pandemic whereas the evolution of the relationship between MTF and volatility is gradual with no specific point in time mentioned complicates the understanding portrayed in the current literature according to which the pandemic represented the instantaneous shock that influenced every aspect of leverage in the world.

The low FEVD contribution of MTF shocks indicates that MTF activity is currently not a key contributor to index-level market quality at the current size of the NSE's MTF business relative to the overall market turnover and capitalisation.

Given that India VIX and NIFTY returns Granger-cause MTF growth, brokers' margins and risk-management systems are already acting as a conduit whereby market tension is transformed into de-leveraging over the time period discussed in this paper, empirical evidence shows that the existing margin-call mechanisms work properly rather than amplify the amount of stress in the economy.

At present not observing distinct MTF → volatility/liquidity forecasting capability does not eliminate possible dangers at higher MTF values and during difficult times that surpass the time frame of this research (2020-2026). But the process of monitoring MTF movements should be conducted as long as the MTF pot keeps expanding (i.e. to around ₹1.4 lakh crore combined NSE-BSE in mid-2026), since MTF data at stock or broker level (including those that cannot be collected for this research) provide better chances to assess the fire-sale effect than analysing data at index level.

The existence of important Chow breakpoint relating MTF to liquidity during the onset of COVID indicates that the nature of the interaction between leverage and liquidity can be fluid as the connection can change sharply after key shocks and it is already a valuable outcome worth considering in the context of risk assessment no matter the sign and absolute value of the coefficient in a particular regime.

There are no conclusions in this report that suggest structural economic causation. Granger causation refers to prediction of occurrence (i.e. past X helps predicting future Y) and does not exclude the possible causes common to MTF activities and fluctuations in the market (volatility/liquidity) and, moreover, results of regression and VAR are also presented based on the summary of data on exchange and cannot be used to investigate margin call processes in the specific securities that are different from the general trends.

Conclusion

MTF Outstanding exhibits a strong and statistically significant negative relation to volatility and liquidity indices, though this relationship weakens once VIX and market variables are included in the analysis. MTF Growth has a weaker and less steady significance compared to MTF Outstanding, with its correlation with volatility being statistically significant only in the Post-COVID phase, while no significance is observed during Pre-COVID and COVID Shock. MTF Growth does not act as a Granger cause of volatility, liquidity, VIX, or returns in the general sample and Post-COVID time, while the other way around (market conditions causing MTF Growth) holds true. The results of Chow test show that there has been significant structural break in MTF-liquidity relationship at the onset of covid (March 1, 2020) and there is no structural break in MTF-volatility relationships at that point of time. CUSUM test shows a broader parameter instability in the relationship of MTF with volatility during some point of time in the sample. The findings are consistent irrespective of measures of volatility and liquidity, and measure of MTF employed. FEVD results show that the influence of MTF variations on predicting

the volatility and liquidity fluctuations in terms of the forecast error is non-significant (less than 1%) across all relevant time frames (up to twenty days).

The findings over the years support the argument that MTF works as an adjustable and multifaceted element of leverage rather than a source of risk in the leverage cycle/fire sale at the level of the entire NSE for the period of time from 2020 till 2026, indicating that the concept of liquidity-providing interpretation is more reasonable than the concept of volatility-increasing interpretation of the type of relationship being analysed.

References

- Amihud, Y. (2002). Illiquidity and stock returns: Cross-section and time-series effects. *Journal of Financial Markets*, 5(1), 31–56.
- Diebold, F. X., & Yilmaz, K. (2012). Better to give than to receive: Predictive directional measurement of volatility spillovers. *International Journal of Forecasting*, 28(1), 57–66.
- Garman, M. B., & Klass, M. J. (1980). On the estimation of security price volatilities from historical data. *Journal of Business*, 53(1), 67–78.
- Kahraman, B., & Tookes, H. E. (2017). Trader leverage and liquidity. *Journal of Finance*, 72(4), 1567–1610.
- Parkinson, M. (1980). The extreme value method for estimating the variance of the rate of return. *Journal of Business*, 53(1), 61–65.
- Securities and Exchange Board of India. (2017, 2021, 2024). Circulars on Margin Trading Facility eligibility, broker net-worth and margin-collection norms. Mumbai: SEBI.
- National Stock Exchange of India. (2024–2025). Corporate communications and market statistics releases on cash-market turnover and MTF book size.
- Baek, S., Mohanty, S. K., & Glambosky, M. (2020). COVID-19 and stock market volatility: An industry level analysis. *Finance Research Letters*, 37, 101748.
- Baker, S. R., Bloom, N., Davis, S. J., Kost, K., Sammon, M., & Viratyosin, T. (2020). The unprecedented stock market reaction to COVID-19. *The Review of Asset Pricing Studies*, 10(4), 742–758.
- Bian, J., He, Z., Shue, K., & Zhou, H. (2019). Leverage-induced fire sales and stock market crashes [Working paper]. Becker Friedman Institute for Economics, University of Chicago.
- Chang, C., & Hsieh, P.-H. (2015). The effects of margin changes on the composition of traders and market liquidity: Evidence from the Taiwan Futures Exchange. *Journal of Futures Markets*.
- Chen, C.-D., et al. (2003). The impact of speculative trading on stock return volatility: The evidence from Taiwan. *Journal of International Financial Markets, Institutions and Money*, 13(5).
- Chen, M. W. (2016). The impact of margin trading on volatility of stock market: Evidence from SSE 50 index. *Journal of Financial Risk Management*, 5(3), 178–188.
- Cheng, X., et al. (2023). Does Chinese-style margin trading promote the high-quality development of listed companies? *PLOS ONE*, 18(4).

- Chou, R. K., et al. (2006). Common factors in liquidity: Evidence from Taiwan's OTC stock market. *Journal of Financial Markets / International Review of Financial Analysis*.
- Diebold, F. X., & Yilmaz, K. (2009). Measuring financial asset return and volatility spillovers, with application to global equity markets. *The Economic Journal*, 119(534), 158-171.
- Diebold, F. X., & Yilmaz, K. (2012). Better to give than to receive: Predictive directional measurement of volatility spillovers. *International Journal of Forecasting*, 28(1), 57-66.
- Diebold, F. X., & Yilmaz, K. (2014). On the network topology of variance decompositions: Measuring the connectedness of financial firms. *Journal of Econometrics*, 182(1), 119-134.
- Engle, R. F. (2002). Dynamic conditional correlation: A simple class of multivariate GARCH models. *Journal of Business & Economic Statistics*, 20(3), 339-350.
- Forbes, K. J., & Rigobon, R. (2002). No contagion, only interdependence: Measuring stock market comovements. *The Journal of Finance*, 57(5), 2223-2261.
- Franzoni, F., & Plazzi, A. (2013). What constrains liquidity provision? Evidence from hedge fund trades [Working paper]. Swiss Finance Institute.
- Fung, H.-G., & Draper, P. (1999). Margin requirements and stock market volatility: Another look at the case of Taiwan. *Pacific-Basin Finance Journal*.
- Gui, P., & Zhu, Y. (2018). Margin trading and stock idiosyncratic volatility: Evidence from the Chinese stock market [Working paper]. SSRN.
- Guo, K., et al. (2018). The impact of margin trading on share price evolution: A cascading failure model investigation. *Physica A: Statistical Mechanics and its Applications* (arXiv:1804.07352).
- Hardouvelis, G. A. (1990). Margin requirements and stock market volatility. *Federal Reserve Bank of New York Quarterly Review*, 13.
- Hardouvelis, G. A., & Kim, D. (1993). Margin regulation and stock market volatility: Further evidence from Japan, Korea and Taiwan. *Pacific-Basin Finance Journal*.
- Hardouvelis, G. A., & Peristiani, S. (1992). Margin requirements, speculative trading, and stock price fluctuations: The case of Japan. *The Quarterly Journal of Economics*, 107(4), 1333-1370.
- Kahraman, B., & Tookes, H. E. (2014). Leverage constraints and liquidity: What can we learn from margin trading? [Working paper]. NYU Stern School of Business / Financial Markets Group.
- Kahraman, B., & Tookes, H. E. (2017). Trader leverage and liquidity. *The Journal of Finance*, 72(4), 1583-1622.
- Kim, K. A., & Oppenheimer, H. R. (2002). Initial margin requirements, volatility, and the individual investor: Insights from Japan. *The Financial Review*, 37(1), 1-15.
- Kupiec, P. H. (1998). Margin requirements, volatility, and market integrity: What have we learned since the crash? *Journal of Financial Services Research*, 13(3), 231-255.
- Mateus, C., et al. (2024). Return and volatility connectedness and net directional patterns in spillover transmissions: East and Southeast Asian equity markets. *International Review of Finance*.
- Mishra, S. K. (2011). Stock market liquidity: Indian experience [Working paper]. SSRN.
- National Stock Exchange of India. (2024). Circular No. 63/2024: Comprehensive review of Margin Trading Facility (MTF). NSE.
- National Stock Exchange of India. (2025). FAQs on Margin Trading Facility. <https://www.nseindia.com/static/trade/members-faqs-margin-trading-facility>

Nyopa, et al. (2022). Volatility spillovers in equity and foreign exchange markets: Evidence from emerging economies. Journal of Economic and Financial Sciences.

Securities and Exchange Board of India. (2011). Discussion paper on margin trading and securities lending. SEBI.

Securities and Exchange Board of India. (2017). Circular on comprehensive review of margin trading facility. SEBI.

Securities and Exchange Board of India. (2024a). Circular No. SEBI/HO/MRD/MRD-PoD-2/P/CIR/2024/118: Cash collateral as maintenance margin for Margin Trading Facility. SEBI.

Securities and Exchange Board of India. (2024b). Measures to strengthen equity index derivatives framework for increased investor protection and market stability. SEBI.