Decoding the Nifty50 Puzzle with ANN: FIIs, DIIs and Market Magic

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ABSTRACT

In the context of a dynamic and highly competitive financial market, understanding the behaviour of various categories of investors becomes a key factor in developing effective investment strategies and forecasting market trends. This study examines the phenomenon of Nifty50 — a group of the 50 most liquid and significant stocks in the Indian stock market, which play an important role in forming the overall index. The **purpose** of the study is to determine the influence of foreign institutional investors (FIIs) and domestic institutional investors (DIIs) on the dynamics of Nifty50. The authors apply classical research **methods**: correlation analysis, a statistical model for analysing and forecasting the volatility of time series (GARCH), and artificial neural networks (ANN). The study is based on daily data on investments from the two specified groups of investors and the values of the Nifty50 index of the National Stock Exchange. The study period from 31.12.2019 to 30.11.2023 is divided into two sub-periods: before COVID-19 and after. In periods of economic shocks, such as the COVID-19 pandemic, the behaviour of these two types of investors becomes particularly contrasting. The results of the study showed that FIIs and DIIs are opposite to each other: when FIIs invest, DIIs are net sellers, and when FIIs sell, DIIs are net investors. In the context of the pandemic, FIIs often increased their investments in Indian assets, while DIIs, on the contrary, reduced their positions. However, in the post-pandemic period, the situation changed: DIIs began to play a more significant role in the dynamics of Nifty50, while the influence of FIIs decreased. Thus, the analysis of the interaction between FIIs and DIIs allows us to conclude the complex and multifaceted nature of the influence of institutional investors on the Indian stock market. Their strategies and behaviour have a significant impact on market indices and volatility, which requires careful monitoring and analysis for effective management of investment risks and making informed decisions in unstable conditions.

Keywords: Indian stock market; institutional investors; FIIs; DIIs; Nifty50; GARCH; ANN

INTRODUCTION

Foreign Institutional Investors (FIIs) and Domestic Institutional Investors (DIIs) exert a profound impact on the Indian stock market, reflecting the dynamic interplay between global and domestic factors. In recent times, FIIs have significantly influenced market trends. Their substantial investments can lead to rapid market movements, affecting indices and stock prices. FIIs often respond to global economic conditions, currency movements, and geopolitical events, creating volatility in the Indian market.

Conversely, DIIs, comprising mutual funds, insurance companies, and other domestic entities, contribute to market stability. Their investment decisions are typically driven by long-term considerations and align with domestic economic growth. DIIs act as stabilizing forces during market fluctuations, providing consistent demand and mitigating the impact of external shocks.

The synergy between FIIs and DIIs influences market sentiment, liquidity, and overall investor confidence. Striking a balance between foreign and domestic investments is crucial for sustaining a resilient and thriving stock market. Their combined influence impacts Nifty50 movements.

The intention behind this study is to investigate the influence of FIIs and DIIs on the capital market, which is reflected in the movements of Nifty 50, the leading index of the National Stock Exchange of India (NSE). Our findings are expected to contribute to the existing knowledge as they examined the effects of international and domestic capital flows on Nifty50 using a robust methodology.

REVIEW OF LITERATURE

The following reviews illustrate essential information from many notable publications on FII and DII capital flow.

Chakraborty investigated the FIIs' effect on the Indian securities market for the period April 1997 to March 2005. The research study made use of secondary data. The monthly flow of FIIs and the monthly average BSE index return were employed in this research study. For each of the two-time series, correlation, standard deviation, skewness, and kurtosis are displayed in order to determine the trend in the two estimated variables across the sample period. On the question of whether FIIs affect stock market returns, there are several competing theories. This paper gives some insight into the direction of the causality relation of FII inflows and stock market returns in Indian Stocks. [1] Similarly, Siddiqui and Seth studied the interconnectedness between Nifty50, BSE 30 and Shanghai Composite and found that Indian markets were not cointegrated with the Indian stock markets [2].

Goudarzi and Ramanarayanan examined the relationship between FII net inflow and BSE 500 stock index movement. The study relies on secondary sources of information like monthly data. To evaluate the collected data from various sources and find the relationship between the FIIs and BSE 500 stock index, the correlation analysis was applied. They investigated Johansen's co-integration test as well. The econometric results show that the causation between the BSE 500 and the FII is bilateral [3].

The goal of Gupta's study is to determine if FIIs are the cause or consequence of the Indian stock market's growth or fall. With data from 1 April 2006 to 28 February 2011, the research investigation was conducted. The daily flow of FII was gathered from the NSE and SEBI official websites. The study used correlation and regression analysis. It says that FIIs have a noteworthy impact on the capital market's growth and decline [4].

Misra conducted the study to see if there is any asymmetry in FIIs' conduct during bull and downturn market cycles. The research study used daily as well as monthly data on Net FII inflows for the time period starting from April 2007 to December 2011. For the stock market returns, they used the closing prices of S&P CNX Nifty index. The author applied causality tests and a parametric regression framework to examine the influences of FII on the Indian stock market. The results also indicate that FIIs reduce risk premiums in the Indian equity market and do not destabilize it [5].

Sultana and Pradhasaradhi made an analysis that is based on 10-year secondary data obtained from the RBI Bulletins and publications available on the Ministry of Commerce's website. In this research study, Correlation, Multiple Regression, and OLS Models are applied to investigate the relationship among the variables FII, FDI, BSE Sensex and CNX Nifty. The study discovered and showed that FDI, SENSEX and NIFTY have a significant positive correlation, while FII, SENSEX and NIFTY have a moderate positive correlation. Their study concluded that the flow of foreign capital flow in the Indian stock market determines the direction of the Indian stock market [6].

Loomba worked to measure the movement of BSE Sensex, the major index of the Indian stock market due to the inflow and outflow of FIIs. The research study is descriptive in nature. The study used secondary data from BSE's website. The data was analysed using Karl Pearson's correlation. The analysis showed that there was a good positive relationship between the FIIs and BSE Sensex [7].

Joo and Mir looked into the FIIs' net investment flow into the Indian stock market. The study looked at the contributions made by FDI that have an influence on the Indian stock market volatility. Secondary data was obtained over a 15-year period from a variety of sources, including websites of SEBI, NSE and BSE, journals and papers. The relationship between FII and the equities in India is determined using a statistical method called correlation. The unit root test was performed to see if the time series was stationary. The authors used the GARCH model to examine the impact of FIIs on Indian stocks. According to the findings, the net inflow of FIIs into India influenced the volatility of India's key stock market indices, the Nifty and Sensex. According to the findings, there is a considerable association in market-leading indexes of NSE and BSE. The unit root test was conducted to see if the time-series data were valid. The study also found that FIIs' investments have a statistically significant impact on the volatility of the NIFTY and SENSEX, two of India's most popular indices [8].

Aswini and Kumar investigated the significant effect of FIIs on the Indian equity market to analyze the relationship between FII and the Indian equity market. The study is based on secondary data gathered over a 20-year period from multiple sources such as the BSE, NSE and SEBI. The research is descriptive in nature. It used correlation analysis to examine the relationship between FII and the stock market. From the research analysis findings, it was revealed that there is a strong correlation between FII and index return. It was found that FII has less impact in the long-term, whereas it has a high impact in the short-term [9].

The purpose of the study by Agarwal is to see how FII capital flows affect the Indian primary market. The research study used secondary data from six years, from 2006 to 2011, which was collected from the SEBI's official website. The acquired data is analysed using statistical tools such as correlation and the OLS model in multiple regression. The study shows how FII inflows in the form of initial public offerings (IPOs) affect the Indian capital market. The capacity of GDP to predict FII inflows in IPOs is compared. The beta value of GDP is higher than the inflow of FIIs, indicating that FIIs do not have significant impact on the Indian financial market [10].

Swapna determined the investment development pattern of FIIs. Investigation of the relationship and impact of FIIs on the Indian Stock Exchange is considered. The study included 12 years of secondary data, which was collected from various sources like BSE, NSE and SEBI. The inflow and outflow net investment of FIIs and the average of the BSE and NSE indices are considered variables for the research paper. The association between these variables is examined utilizing correlation and regression. The requisite hypothesis was formulated and evaluated using ANOVA, and the findings are given in the research article. The article examines the impact of FII inflows and outflows on the BSE and NSE indexes. The research study shows how FII inflows and outflows affect the SENSEX and NIFTY 50 indexes. This study discovered a favourable correlation between FIIs' flow and both index movements [11].

Chhimwal and Bapat determine the impact of unexpected FPI and DII flows on volatility. The research study observed daily FPI and DII flow of investment between March 2009 and March 2018. Secondary data is considered for this study, collected from different sources. The ADF test is implemented to investigate the stationarity of data. TGARCH, ARMA models and t-statistics are used to measure the relationship of FII and DII with that of NIFTY 50. The results of this study show that unexpected disinvestment of Foreign Portfolio Investment (FPI) increases or influences volatility more than unexpected buying. The author reveals that the impact of the unexpected flow of domestic institutional investors (DIIs) has a strong positive relation for small-cap stocks [12].

Bansal measured the relationship between foreign and domestic institutions as Indian stock market participants. The study used daily data transactions of FII and DII investments, which were collected from a variety of sources. This research study used various statistical tools such as descriptive analysis, PP unit test, correlation, VARs, ADF unit test, etc. The author concluded in his research that there is a strong positive relationship and influence of FIIs and DIIs on Indian stock market volatility [13].

Panda and Leepsa showed in their paper the behaviour of institutional investors post-financial crisis in the Indian capital market, particularly NIFTY 500 companies. Their results suggested that FIIs had an edge over DIIs in terms of market performance [14].

Chauhan and Chaklader had used VAR in their study to find that DIIs in India follow smart money value investments, while FIIs seek a positive feedback trading approach [15].

As per Kiran and Ramesh, FIIs and DIIs, along with promoters, have a negative relationship with the dividend payment decisions of companies. These dominate the shareholding of the companies in the majority. Consequently, influencing the markets [16].

Srivastava, Solomon, and Singh examined the effect of exogenous shocks on macroeconomic variables in BSE SENSEX. They found strong evidence on the changes in stock prices because of the exogenous shocks in interest rates, crude oil prices, inflation, trade openness, and exchange rates [17].

According to Goel and Singh, ANN model had the predictive power towards the closing prices of BSE SENSEX with up to 93% accuracy [18].

Table 1

Sample Time Period of the Study and Justification

Data		Justification of starting date	Period
From	To		
31.12.2019	26.03.2023	WHO declared the pandemic	Pandemic Period
27.03.2022	30.11.2023	International Flights Started	After Pandemic Period

Source: Author's calculation.

The movement of stock prices based on the related information at the microeconomic and macroeconomic levels was influenced by the attitude of the investors [19].

Goel, Agarwal, Chhabra, and Som employed ANN to forecast the closing prices of BSE SENSEX with an accuracy rate of 99%. Hence, aiding DIIs, FIIs, and others in decision-making [20].

Panda, Tripathy, Tiwari, and Yarovaya showed that FIIs created better market value as compared to DIIs amongst companies in NIFTY 500 spanning from 2011 to 2020 [21].

Many authors in their papers described the institutional capital inflow since 1992, after the economic reform. The research studies describe how the FII and DII capital inflow and outflow affect the Indian equity market. However, there hasn't been much focus on FII and DII investment during the COVID-19 pandemic. This study mainly evaluates the impact of FIIs and DIIs in the stock market of India, as their influence on the return of Nifty50 is evident during and after the COVID-19 time.

RESEARCH METHODOLOGY

The research is descriptive and relies on secondary information. Data was obtained from the online platform by looking at secondary sources available on websites. The data on FIIs and DIIs daily flows was gathered from the Money Control website,[1] whereas the data on the Nifty50 Index's daily closing values was obtained from the NSE website.[2]

Statistical methods like descriptive analysis, Karl Pearson's coefficient of correlation, unit root test,

Johansen's cointegration test, GARCH Model and Artificial Neural Network (ANN) are employed to evaluate the acquired data.

The research spans a period of almost three years, from December 31, 2019 to November 30, 2023, presented in *Table 1*.

The time period was chosen to determine the impact of FIIs and DIIs capital net inflow on the Indian stock market during and after the pandemic. The study uses the Nifty50 as a proxy for the Indian stock market, which is a key NSE index.

OBJECTIVES

The following objectives guided the development of this research:

1. To examine the role of FIIs and DIIs in the Indian equity market, with a focus on the Nifty50.

2. To find out the correlation between FIIs, DIIs and Nifty50 index in COVID-19 and post-COVID-19 periods.

3. To forecast volatility persistence in the variables FIIs, DIIs and Nifty50 index in both periods

4. To examine the effect of FIIs and DIIs capital flow on Nifty50 in both periods.

HYPOTHESES

To fulfil the objectives of the research study, the following null hypotheses are framed:

H_{01} = No different correlation level existed between FIIs, DIIs and Nifty50 index in COVID-19 and post-COVID-19 periods.

H_{02} = No different volatility persistence in FIIs, DIIs and Nifty50, individually, in both periods.

H_{03} = No different individual significant effect of FIIs and DIIs capital flow on Nifty50, in both periods.

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[1] Website of Moneycontrol. URL: https://www.moneycontrol.com/ (accessed on 20.12.2023).

[2] Website of National Stock Exchange, India. URL: https://www.nseindia.com/ (accessed on 20.12.2023).

Summary of the Variables

Variables	Description of Variable	Frequency	Symbol COVID-19 Period	Symbol Pre-COVID-19 Period
Nifty50	National Stock Exchange Index of India	Daily Closing	Nifty1	Nifty2
DII	Net Domestic Institutional Investors	Daily	DII1	DII2
FII	Net Foreign Institutional Investors	Daily	FII1	FII2

Source: Author's calculation.

ANALYTICAL TOOLS AND TECHNIQUES

Descriptive Analysis

Descriptive analysis is a statistical method that summarises and interprets data to reveal essential characteristics. It aims to provide a comprehensive overview of the data, uncovering patterns, trends, and distributions. This method is crucial for understanding the fundamental aspects of a dataset.

Correlation

It shows the direction of the relationship between the variables. The correlation analysis demonstrates the positive and negative relationships between the variables. It lies between +1 and –1 only.

Unit Root Test

A unit root, an autoregressive approach, is used to determine if a data series is non-stationary. The enhanced Dickey-Fuller test is a renowned unit root test with large sample validity.

GARCH

The Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model is a statistical tool used in finance to analyze and predict volatility in time series data. It incorporates past volatility to forecast future volatility, making it valuable for risk assessment and modeling financial market fluctuations.

Artificial Neural Network (ANN)

An artificial neural network (ANN) is a computational model that draws inspiration from the structure and function of the human brain. The system is composed of interconnected nodes, known as neurons, that are arranged in layers. Each connection between neurons is assigned a weight. ANNs are used in machine learning to recognize patterns, make predictions, and perform tasks based on data.

A summary of the variables is presented in *Table 2*. It contains the frequency of data and the symbols.

RESULTS AND DATA ANALYSIS

It is presented as under:

Descriptive statistics

The descriptive analysis is related to various features of COVID-19 and post-COVID-19 period is shown in *Table 3*. In descriptive analysis, statistical measures such as mean, standard deviation, skewness, kurtosis, minimum, and maximum are applied.

It is observed from the above *Table* that the mean inflow of FIIs is negative in both the cases of COVID-19 and the post-COVID-19 period which is –519.6389 and –509.2758, respectively. It revealed that FIIs created a net withdrawal. From the result, it is observed that DIIs mean (497.8541) is higher than FIIs in COVID-19 situation and (783.4972) more in the case of post-COVID-19 situation.

During the COVID-19 period, FIIs had a maximum capital flow of 28 739.17 and in the post-COVID-19 period it, had a maximum capital inflow of 12 770.81 in a single day and a minimum capital outflow of –8295.170, whereas in post-COVID-19, it has a minimum of –7818.610 in a single day.

Table 3

Descriptive Statistics (COVID-19 Period and Post-COVID-19 Period)

Particulars	DII1	FII1	Nifty1	DII2	FII2	Nifty2
Mean	497.8541	–519.6389	14340.76	783.4972	–509.2758	18030.54
Median	381.0800	–493.6800	14956.20	609.8200	–453.7700	17956.60
Maximum	7621.160	28739.17	18477.05	6558.450	12770.81	20192.35
Minimum	–2610.130	–8295.170	7610.250	–6440.050	–7818.610	15293.50
Std. Dev.	1394.777	2582.661	3024.008	1398.244	2142.403	1160.634
Skewness	1.045547	4.522075	–0.555820	0.146911	0.681572	–0.152394
Kurtosis	5.390471	50.85957	2.028524	7.031160	9.554377	2.325767

Source: Author's calculation.

Table 4

Correlation: COVID-19 Period

Variables	DII1	FII1	Nifty1
DII1	1.000000	–0.602802	–0.195317
FII1	–0.602802	1.000000	0.201945
Nifty1	–0.195317	0.201945	1.000000

Source: Author's calculation.

Table 5

Correlation: Post-COVID-19 Period

Variables	DII2	FII2	Nifty2
DII2	1.000000	–0.589017	0.120958
FII2	–0.589017	1.000000	–0.132632
Nifty2	0.120958	–0.132632	1.000000

Source: Author's calculation.

In the case of DIIs, the descriptive analysis shows a maximum of 7621.160 and a minimum of –2610.130 in the case of COVID-19 period, while in post-pandemic duration, it has a maximum of 6558.450 and a minimum of –6440.050.

The analysis shown above in the tables revealed that FIIs have higher standard deviations of 2582.661 and 2142.403 in the pandemic and post-pandemic periods, whereas DIIs had a standard deviation of 1394.777 and 1398.244 in pandemic and post-pandemic respectively. The higher standard deviation of FIIs shows the high volatility nature of FII as compared to DII in the Indian stock market.

In statistics, skewness is an observed degree of variance in a probability density in a data set that differs from the symmetry normal curve (bell curve). From the descriptive analysis of the COVID-19 period shown in the above table, it was observed that FII and

ADF Test: COVID-19 Period

Level			First difference		
Symbol	ADF statistics	P–value	ADF statistics	P–value	
Nifty1	−1.430966	0.5677	−16.21111	0.00	
DII1	−7.839630	0.00	−16.36749	0.00	
FII1	−7.460085	0.00	−19.72738	0.00	

Source: Author's calculation.

Note: Exogenous: Constant, Lag Length: Automatic based on SIC, MAXLAG = 25. *MacKinnon (1996) one-sided p-values. Deterministic Terms: Intercept.

ADF Test: Post-COVID-19 Period

Level			First difference		
Symbol	ADF statistics	P–value	ADF statistics	P–value	
Nifty2	−0.270710	0.9265	−27.62939	0.00	
DII2	−6.241586	0.00	−23.14143	0.00	
FII2	−7.647897	0.00	−21.72918	0.00	

Source: Author's calculation.

Note: Exogenous: Constant, Lag Length: Automatic based on SIC, MAXLAG = 25. *MacKinnon (1996) one-sided p-values. Deterministic Terms: Intercept.

DII have positive skewness, which shows asymmetry in the data, whereas Nifty50 has negative skewness. In post-COVID-19 situation, data reveals the same situation.

As the kurtosis of all the variables, Nifty50 for pandemic and post-pandemic is greater than 3, it shows that the data series of FII and DII have heavier tails than a normal distribution.

CORRELATION

Correlation among the variables is presented in the following *Tables 4, 5*:

As shown in *Table 4* and *Table 5*, the correlation between the daily closing value of Nifty50 and the associated market players' FIIs and DIIs was calculated for pre- and post-COVID-19 intervals. Based on the data analysis, it was observed that throughout the COVID-19 period, the FII and Nifty50 indices movement has a significant positive correlation of 0.201945, while the DIIs and Nifty50 indices movement has a significant and negative

association of 0.195317. It shows that the return from the index is moving with the inflow of DIIs. DII has a substantial negative association with FIIs, with a value of −0.602802, according to the evaluation.

The FIIs had a substantial negative association of −0.132632 in the post-COVID-19 scenario. According to the table, DIIs have a significant positive association of 0.120958 with the Nifty50 index during the post-pandemic period of this study. The study demonstrates that FII has a substantial negative association (−0.589017) with FII in both the post-pandemic and pre-pandemic periods.

UNIT ROOT TEST (ADF)

The *Tables 6, 7* are presented as under:

We checked for stationarity by looking for the series' unit root. The data is said to be non-stationary if the unit root exists in the data. The Augmented Dickey-Fuller (ADF) determines if the data is static. The ADF test was applied to the time series data of FII, DII and Nifty50. The null hypothesis, H_0, is

GARCH Model (COVID-19 Period)

Variable	Coefficient	Std. Error	z–Statistic	Prob.
C	15736.23	13.20885	1191.340	0.0000
Variance Equation				
ω	3285.946	1892.312	1.736471	0.0825
α	0.969726	0.275163	3.524185	0.0004
β	0.059852	1.145324	0.411853	0.6804
GARCH Model for FIIs				
Variable	Coefficient	Std. Error	z–Statistic	Prob.
C	−241.5143	162.7565	−1.483900	0.1378
Variance Equation				
ω	5042726	476391.4	10.58526	0.0000
α	0.381161	0.098589	3.866167	0.0010
β	0.057721	0.079010	0.730555	0.4651
GARCH Model for DIIs				
Variable	Coefficient	Std. Error	z–Statistic	Prob.
C	347.6844	64.20789	5.414979	0.0000
Variance Equation				
ω	467361.5	119235.1	3.919665	0.0001
α	0.3733168	0.075799	4.923109	0.0000
β	0.4152000	0.104807	3.961553	0.0001

Source: Author's calculation.

created at the 10%, 5% and 1% significance levels to test the non-stationary in a temporal sequence. The null hypothesis is the opposite of the alternative hypothesis. ADF test suggests that the data series of FIIs, DIIs and Nifty50 has no unit root.

From the analysis shown in the above-given *Tables 6* and *7*, it was observed that in the case of both pandemic and post-pandemic situations, unit root existed in the case of Nifty50 as the P value is higher than 0.05 which is 0.5677 in COVID-19 and 0.09265 in post-COVID-19 situation, it shows that Nifty50 data series is non-stationary at the level. As a result, the null hypothesis is ruled out. The alternative theory is also recognized, but in the case of FIIs and DIIs, the data series does not unit root at a level, as the P-value of FII and DII data series is 0.0000, which is

significant and less than 0.05 in both COVID-19 and post-COVID-19 periods, so here the null hypothesis is accepted, and alternate hypothesis is rejected in caseof FIIs and DIIs, as the data series revealed that FII and DII data series are stationary at the level.

While the Nifty50 data series is non-stationary at the level in both pre- and post-COVID-19, so here, in the case of Nifty50 the null hypothesis is rejected. It was found that when the data series were tested at levels FII and DII time series were integrated, at only 1%, 5%, and 10% significance levels, but the Nifty50 time series was not integrated so all the time series data were tested at the first difference level, where the P-value of Nifty50, become 0.0000 which is significant and less than 0.05 so the Nifty50 data series was found to be stationary at the first difference. Here, the null

GARCH Model (Post COVID-19 Period)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	17782.91	16.86718	1054.290	0.0000
Variance Equation				
ω	15423.32	7784.229	1.981354	0.0476
α	0.929087	0.284262	3.268416	0.0011
β	0.062818	0.161948	0.387887	0.6981
GARCH Model for FIIs				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	−3774.6250	92.98680	−4.028798	0.0001
Variance Equation				
ω	1258583	219369.2	5.737280	0.0000
α	0.574263	0.078068	7.355935	0.0000
β	0.315054	0.057320	5.496458	0.0000
GARCH Model for DIIs				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	657.5512	67.67952	9.715661	0.0000
Variance Equation				
ω	1231739	180222.6	6.834545	0.0000
α	0.335131	0.80990	4.142875	0.0000
β	0.031118	0.128396	0.242359	0.8085

Source: Author's calculation.

Sum of Alpha (α) and Beta (β)

Period	Sum	Nifty50	FIIs	DIIs
COVID-19 Period	α + β	1.029578	0.438882	0.7885168
Post COVID-19 Period		0.991905	0.889317	0.6463110

Source: Author's calculation.

hypothesis is accepted and the alternate hypothesis is rejected.

GARCH

Tables 8–10 related to GARCH are presented as follows:

The significance of α and β reveals that lagged squared error and lagged conditional variance have a definite impact on the conditional variance. This holds true for any variable being studied, as the volatility from earlier periods affects the current volatility of all markets. Volatility clustering is seen in the markets.

Nevertheless, the duration of fluctuations in volatility is heavily contingent on the combined values of the ARCH term (α) and GARCH term (β) parameters. When the total of the parameters is less than one, it

RMSE values (COVID-19 Period)

Network	SSE (Training)	SSE (Testing)	RMSE (Training)	RMSE (Testing)	Sample size (Training)	Sample size (Testing)
1	143.180	72.327	0.703	0.727	290	137
2	152.417	59.225	0.702	0.708	309	118
3	143.664	58.823	0.705	0.653	289	138
4	141.389	78.298	0.706	0.740	284	143
5	143.918	53.094	0.701	0.629	293	134
6	156.177	49.017	0.713	0.639	307	120
7	148.182	77.455	0.710	0.763	294	133
8	149.754	72.392	0.707	0.755	300	127
9	159.946	60.83	0.729	0.695	301	126
10	152.556	55.725	0.702	0.690	310	117
Mean	149.1183	63.7186	0.707665519	0.699954634		
S.D.	5.855273709	9.979980794	0.008001293	0.045178702		

Source: Author's calculation.

Note: SSE = Sum square of errors, RMSE = Root mean square of errors.

indicates a propensity for the volatility response to diminish gradually over time. A total of one suggests an indefinite persistence of volatility in response to shocks over time, whereas a total greater than one indicates a rising persistence of volatility over time.

From *Table 10*, it can be seen that the volatility ($\alpha + \beta$) is more than unity in the case of Nifty50, implying increasing volatility persistence over time, in COVID-19 time, which reduced marginally in the COVID-19 era. The scenario is different in the case of FIIs and DIIs. During COVID-19 period, both FIIs and DIIs showed a tendency for the volatility response to decay over time, but the coefficient combination is lesser for FIIs than DIIs. These coefficients increased in post-COVID-19 time.

Artificial Neural Network (ANN)

Analysis based on ANN is presented in *Tables 11, 12, 13* and *14*. Where Nifty50 is taken as a dependent variable, whereas DIIs and FIIs are covariates. Partitions for Training and Test are 70 per cent and 30 per cent, respectively.

Table 11 shows that the average root mean square error (RMSE) values for the training and testing methods during

Sensitivity Analysis COVID-19 Period

Network	FII	DII
NN 1	100.0%	99.2%
NN 2	100.0%	71.6%
NN 3	100.0%	10.8%
NN 4	91.1%	100.0%
NN 5	100.0%	38.1%
NN 6	39.2%	100.0%
NN 7	100.0%	95.4%
NN 8	100.0%	30.6%
NN 9	100.0%	1.3%
NN 10	100.0%	21.5%
Average Importance	0.930300905	0.56838625
Normalized Importance	100%	61%

Source: Author's calculation.

RMSE values (Post COVID-19 Period)

Network	SSE (Training)	SSE (Testing)	RMSE (Training)	RMSE (Testing)	Sample size (Training)	Sample size (Testing)
1	113.256	57.887	0.638	0.681	278	125
2	129.29	47.368	0.664	0.656	293	110
3	113.307	74.728	0.63	0.773	278	125
4	132.88	53.334	0.686	0.664	282	121
5	118.114	43.032	0.636	0.623	292	111
6	114.035	39.269	0.644	0.554	275	128
7	115.536	46.822	0.645	0.612	278	125
8	114.608	49.33	0.639	0.636	281	122
9	112.239	59.074	0.648	0.659	267	136
10	119.085	52.474	0.648	0.664	284	119
Mean	118.235	52.332	0.648657895	0.652136843		
S.D.	7.153348571	10.00034967	0.014779433	0.053104661		

Source: Author's calculation.

Note: SSE = Sum square of errors, RMSE = Root mean square of errors.

Sensitivity Analysis Post COVID-19 Period, %

Network	FII	DII
NN 1	81.9	100.0
NN 2	87.4	100.0
NN 3	62.7	100.0
NN 4	85.7	100.0
NN 5	39.9	100.0
NN 6	27.2	100.0
NN 7	39.7	100.0
NN 8	37.9	100.0
NN 9	26.8	100.0
NN 10	38.7	100.0
Average Importance	76.4	100.0
Normalized Importance	76.4	100.0

Source: Author's calculation.

the COVID-19 period are 0.7077 and 0.6999, respectively. In order to assess the predictive capabilities of each input neuron, a sensitivity analysis is performed. This analysis allowed us to determine the normalized relevance of these neurons by dividing their relative value by the maximum importance and expressing it as a percentage. The findings indicate that the FII is the primary determinant of Nifty50.

Table 13 portrays that the average RMSE values of the training and testing procedures for the post-COVID-19 period are 0.6487 and 0.6521, respectively. The result shows that the DII is more important predictor of Nifty50.

CONCLUSION

It is concluded that the net flows of DIIs in post-COVID-19 time have tremendously increased over the COVID-19 period, but that of FIIs has increased marginally. DIIs are bullish in both pre- and post-pandemic situations. The volatility in DIIs in COVID-19 and post-COVID-19 times remains almost the same, but is reduced a bit in FIIs. The research analysis illustrates that FIIs and DIIs are opposite to each other; when the FIIs invest, the DII are net sellers, while the FIIs are bearish, and the DII are the net investors.

From the analysis, it was found that in the COVID-19 period, the FIIs had a significantly positive correlation, while DIIs had a negative association with the Nifty50. Whereas, in the post-COVID-19 period, FII have a negative correlation, and DIIs have a positive association with the Nifty50.

The case of Nifty50 implies increasing volatility persistence over time, in COVID-19 time, which was reduced marginally in the COVID-19 era. During COVID-19 period, both FIIs and DIIs showed a tendency for the volatility response to decay over time, but the coefficient combination is lesser for FIIs than DIIs. This coefficient increased in post-COVID-19 time. The ANN result shows that the DIIs are a more important predictor of Nifty50 in post-COVID-19 period, but it was FIIs in COVID-19 period.

Lastly, it is noted that H_{01} is rejected as different significant correlations existed between FIIs, DIIs and Nifty50 in different periods. H_{02} is also rejected as there is different volatility persistence in FIIs, DIIs and Nifty50, individually, in both periods. H_{03} is also rejected because there is a significant difference in the effect of FII and DII capital flow on Nifty50 in different periods.

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