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Relation of Equity Index, INR and FIIs

Theoretical frameworks across the globe have weighed in on the interdependence of different variables of financial markets. In order to understand the same and capture any possible relation, the study investigates the volatility spillover effects of various macroeconomic variables including stock indices return, exchange rate and movement of FIIs flow through a range of econometric models. The study spans a 26-year period, including various market conditions, during this timeline. The analysis underscores the importance of predicting the volatility of different parameters of financial markets and spillover effects. The results based on empirical evidence imply that certain variables are interdependent on each other, with their past outcomes playing a role in shaping their future outcome. Moreover, there is spillover impact of these variables on other variables, such as the interconnection of equity indices with FIIs flow and exchange rate.

Purpose of the study is to examine the relationship between Sensex, FIIs and exchange rate. The time frame for this study ranges from FY00 to FY26, wherein monthly returns (end-point) has been taken for Sensex and exchange rate. For FIIs data, monthly flows has been taken for estimation. The study has been divided in to 3-parts, with periodicity running between Mar'00 to Mar'26 which has been further split into i) Mar'00 to Mar'22 ii) Apr'22 to Mar'26. In terms of hypothesis, the study is segregated by firstly a) analyzing if there is a correlation between any of variables, b) If there is any causation, c) regression analysis, d) Volatility spillover effects- past variable has any impact on future variable and also if one variable has any spillover effect on any other variable. Clustering explains that changes will be followed by large changes and similar phenomena for small changes.

Background

Indian economy had undergone a series of rapid transformations, bringing forth the structural and economic reforms, especially in the 1990s, a time when new policy measures like liberalization and globalization were adopted. This, as a result, opened new avenues for growth. India, which was at a cusp of economic revolution, was battling the BoP crisis and falling foreign currency reserves during this time. The reforms in 1991 played a key role in opening of India's financial market to the globe.

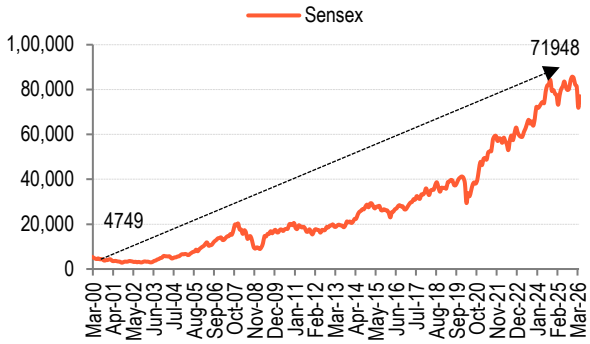
The implementation of these changes, opened a new door of opportunities in the form of FIIs, which have played a dominant role in the capital market. From 1991(Mar-end) to FY26 (Mar-end), the Sensex has grown by 1% (CAGR) every month during this period, and its market capitalization for FY26 has actually grown to US$ 4.5 tn, nearing 120% of the market cap to GDP ratio for this period. In this time span, the Sensex has reached an all-time high as it crossed the 85000 mark, while INR in terms of CAGR has depreciated by 0.4% for each month. Table 1, highlights CAGR growth for equity index and exchange rate across the study period of Mar'00 to Mar'26, which has been further split into 2 phases under consideration, which is Mar'00 to Mar'22 and Apr'22 to Mar'26 (post covid period).

Table 1: CAGR growth over the years

Periods	Sensex	INR
Mar'00-Mar'26	0.9%	-0.2%
Mar'00-Mar'22	0.9%	-0.2%
Apr'22-Mar'26	0.5%	-0.4%

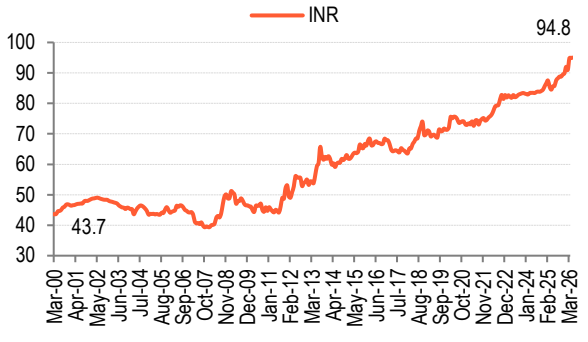
Source: Bloomberg, Bank of Baroda Research

Figure 1: Movement of Sensex



Source: Bloomberg, Bank of Baroda Research

Figure 2: Journey of INR over the years



Source: Bloomberg, Bank of Baroda Research

There are possible interlinkages with other macroeconomic variables and stock indices. This includes the exchange rate and the movement of FII flows. There have been strongly held views about the importance of FIIs in Indian capital market and how their movement has an impact on these indices. On exchange rate, there have been many policy debates and literature in the past, affirming the relation between stock indices and exchange rate. As per one of the theories, a fall in stock indices will encourage investors to look at investing their money in other asset classes for better returns. This in turn can lower the demand for money, interest rates and result in further outflows and, in turn, depreciate the currency. There is different literature that points at a contrarian view, currency depreciation enhances export competitiveness, revenue earned in foreign currencies is now higher and is beneficial for export oriented firms such as IT, pharma and this in turn lifts similar stock indices. As part of the study, the purpose is to analyze the interrelationship amidst the ongoing volatilities of the rupee-dollar exchange rate, Sensex and FII flows. There also has been an attempt to study any spillover effect from the stock market to other variables.

Table 2 highlights the yearly returns across various macroeconomic variables, post the covid-19 pandemic. Equity indices had registered double digit growth in FY22, while currency had depreciated by 3.5% during this period. This was followed by a marginal increase in the Sensex for FY23, while the currency depreciated further to the 82.2/$ level and FII equity noted an outflow for the same period. In the next 2 years, domestic indices scaled higher to a record high and even surpassed the 84,000 mark. INR weakened and FII registered an inflow in FY24. In FY26, the Sensex surpassed the 85,000 level, a new record high before slipping down. INR weakened further due to a multitude of global factors, and FII also noted an outflow for this period.

Table 2: Post Covid- Returns

Years	Sensex	INR	Net FII-Equity (US$ mn)
FY22	18.3%	-3.5%	-18,468
FY23	0.7%	-7.8%	-5,114
FY24	24.9%	-1.5%	25,272
FY25	5.1%	-2.4%	-14,626
FY26	-7.1%	-9.9%	-19,690

Source: Bloomberg, Bank of Baroda Research

Data

The study, through the medium of empirical analysis, tries to capture and throws light on the interlinkages. The note captures data from FY00 to FY26 as a whole and has been further divided into 2-phases or time frames, with monthly data being taken. This includes i) dataset for the 23-year period (monthly data for return from Mar'00 to Mar'22), with end points for each month, ii) data from Apr'22

to Mar'26, to largely measure post covid changes across various variables. There are 3 variables that have been included in this study; BSE Sensex, INR and FIIs flow. The idea is to see if the shocks in any of the variables are transmitted to others. This helps in studying any possible implication of these relationships on economic policies and any such impact on investment decisions. For eg, changes in the stock market can have an effect on the exchange rate or vice versa, which can be used by investors to predict the market, given the extreme presence of volatility in each of these variables. The objective of the study is to evaluate the volatility of the series and measure the influence of each of these variables on other macroeconomic variables. The study is based on secondary data. For estimation, monthly returns have been used for most of the variables, though for FIIs, net inflow or outflow has been used. Only FII-equity has been used for estimation.

Results and Discussion

Initial analysis was conducted to analyze the behaviour of different data series. The result of the same has been tabulated (Appendix), which provides details across different variables in monthly returns. In addition to providing details of mean values, maximum and minimum value of each variables have also been computed. For the entire series ranging between the period,Mar'00 to Mar'26, all the 3 variables have negative skewness and as per the Jarque Bera test, all the series are not normally distributed.

Next is the series ranging between Mar'00 to Mar'22, wherein both Sensex and INR have exhibited negative skewness, while FII have noted positive skewness. As per the Jarque Bera test, all the variables have indicated that the time series are not normally distributed, yet again.

Lastly, the same test have been done for post covid series, it has been computed on data from Apr'22 to Mar'26. All the variables across the data series are now showcasing negative skewness for this time period too. As per the test, apart from exchange rate, the other two series are normally distributed for this period.

Correlation matrix

The correlation coefficient across different indicators are measured. Any positive correlation signifies any change in one variable, be it an increase or decrease, will also change the other variable in the same way, a mirror relation. However, a negative correlation implies that if one variable increases or decreases, the other variable will have an opposite reaction. The matrix helps in comparing the relationship between different variables.

Sensex and FII have a positive correlation signaling any increase in Sensex will also result in an increase in FII. A similar relation has also been noted between Sensex and INR. For phase-2, the periodicity between Apr'22-Mar'26 has been used wherein higher positive correlation has been noted between Sensex and INR (at 0.6) and with FIIs (0.7). Additionally, in the post the covid period, INR continue to being positively correlated with FIIs.

Table 3: Correlation matrix across all the phases

Variable	Sensex	INR	FII
	Mar'00-Mar'26		
Sensex	1.0	0.5	0.4
INR	0.5	1.0	0.4
FII	0.4	0.4	1
	Phase-1 (Mar'00-Mar'22)		
Sensex	1.0	0.5	0.5
INR	0.5	1.0	0.4
FII	0.5	0.4	1
	Phase-2 (Apr'22 –Mar'26)		
Sensex	1.0	0.6	0.7
INR	0.6	1.0	0.4
FII	0.7	0.4	1.0

Source: Bank of Baroda Research

Stationarity test

Next in line is testing the stationarity of each of the series. To measure the same, the Augmented Dickey Fuller (ADF) and the Phillips-Perron (PP) unit root test are done, across the variables. The same has been represented in Table 4, this actually indicates that all the time series are stationary at 1% level of significance at level I (0). Even as it was significant at I (0), the stationarity test has also been conducted at first difference I (1). A similar exercise was carried out for variables in both the phases, in order to test the unit root. Similar results have been observed with all the variables stationary at the level itself.

Table 4: Stationarity test (Mar'00-Mar'26)

Indices	ADF				Philipps Perron				
	Level		First Difference		Level		First Difference		
	T-statistic	P-value	T-statistic	P-value	T-statistic	P-value	T-statistic	P-value	Decision
Sensex	-16.4286	0	-17.3291	0	-16.4248	0	-188.563	0	I(0)
INR	-3.98775	0	-15.1249	0	-16.4893	0	-117.577	0	I(0)
FII	-12.5523	0	-11.7155	0	-12.7246	0	-60.5266	0	I(0)

Source: Bank of Baroda Research

Table 5: Stationarity test Phase-1

Indices	ADF				Philipps Perron				
	Level		First Difference		Level		First Difference		
	T-statistic	P-value	T-statistic	P-value	T-statistic	P-value	T-statistic	P-value	Decision
Sensex	-15.208	0	-16.0164	0	-15.2569	0	-82.6055	0	I(0)
INR	-15.080	0	-13.9594	0	-15.0619	0	-92.864	0	I(0)
FII	-10.397	0	-10.6564	0	-10.5712	0	-51.3339	0	I(0)

Source: Bank of Baroda Research

Table 6: Stationarity test Phase-2

Indices	ADF				Philipps Perron				
	Level		First Difference		Level		First Difference		
	T-statistic	P-value	T-statistic	P-value	T-statistic	P-value	T-statistic	P-value	Decision
Sensex	-5.6597	0	-9.86561	0	-5.55956	0.0002	-14.049	0	I(0)
INR	-7.10308	0	-12.5074	0	-7.10308	0	-25.7912	0	I(0)
FII	-5.81579	0	-9.01707	0	-5.79789	0.0001	-13.5172	0	I(0)

Source: Bank of Baroda Research

Granger Causality

The test is conducted to measure how useful one variable is to forecast the other variable. The approach is used to determine the causal relationships between the two variables. Under this test, initially the first difference is done for all the variables and later the test is conducted. The null hypothesis is rejected at both the 5% and 1% level of significance. Across all the phases, only these results has been deduced (highly significant) by rejecting the null hypothesis of granger causality and concluding:

- Causality noted between Sensex and exchange rate
- Movement of Sensex flows to FIIs.

Table 7: Granger causality

Null Hypothesis	F-statistic	P-value
SENSEX does not Granger Cause INR	2.12901	0.05
SENSEX does not Granger Cause FII	4.78897	0.0135

Source: Bank of Baroda Research

For all the other estimations, the results were not significant.

Regression

This analysis is done across all the time periods in order to determine the relationship between all the 3 variables. Moreover, the objective is to find out how any change in exchange rate and FIIs will result in any change in stock index. All the results are highly significant, pointing that multiple variables influence stock market, in this case, both exchange rate and FIIs.

Table 8: Regression Analysis

Variable	Coefficient	Significant
Mar'00-Mar'26		
C	0.936461	Yes
FII	0.000708	Yes
INR	1.363235	Yes
Mar'00-Mar'22		
C	0.681879	Yes
FII	1.300919	Yes
INR	0.000948	Yes
Apr'22-Mar'26		
C	1.1886	Yes
FII	1.16885	Yes
INR	0.0005	Yes

Source: Bank of Baroda Research

Heteroscedasticity test

ARCH effect-Autoregressive Conditional Heteroscedasticity

The financial time series generally have a lot of volatility and also suffer from high variance. The ARCH, which is autoregressive conditional heteroscedasticity –unequal variance actually helps in such situations. These models are used to forecast conditional variance. The phenomena of volatility clustering across all the series have been noted through each of the graph of the series (Appendix).

The values of Sensex, INR (exchange rate), and FIIs are checked for the ARCH effect if there is a presence of heteroscedasticity in the data. The series were first difference and thereafter the test was applied for all the phases. However, for the post covid series (Apr'22-Mar'26), the findings are not significant and the null hypothesis has been accepted, concluding there is no heteroscedasticity and hence no presence of ARCH effects. Barring this, for the remaining 2- series with periodicity i) Mar'00-Mar-26 and the next series ii) Mar'00-Mar'22 , findings were highly significant, this is why we can reject null hypothesis, signifying heteroscedasticity is indeed there and indicating the presence of ARCH effects.

Table 9: ARCH test results

Countries	Null Hypothesis	F-statistic	Significant
	Mar'00-Mar'26		
F-statistic (Sensex)	No Heteroscedasticity	58.74155	Yes
Obs R-Squared		49.67788	
F-statistic (INR)	No Heteroscedasticity	73.40416	Yes
Obs R-Squared		59.69782	
F-statistic (FII)	No Heteroscedasticity	74.33768	Yes
Obs R-Squared		60.3098	
	Mar'00-Mar'22		
F-statistic (Sensex)	No Heteroscedasticity	46.45725	Yes
Obs R-Squared		39.73969	
F-statistic (INR)	No Heteroscedasticity	59.62466	Yes
Obs R-Squared		48.90855	
F-statistic (FII)	No Heteroscedasticity	134.6975	Yes
Obs R-Squared		89.52659	

Source: Bank of Baroda Research

GARCH- Generalized Autoregressive Conditional Heteroscedasticity

After noting the presence of ARCH effects, next the GARCH model is conducted to model the conditional volatility. This analysis has only been done on the two time series, which is between Mar'00-Mar'26 and the other is between the period ranging from Mar'00 to Mar'22. Since the post covid series, (as mentioned above) had no presence of ARCH effects, the GARCH analysis has not been included in the observation. The results of the other 2-series have been shown below in the table 9 and 10, which indicates that some of the GARCH parameters are statistically significant. It has been further observed that the volatility of the time series is based on the values of the variables. This GRACH (1,1) model is a fundamental and symmetric model, which is part of the volatility clustering and helps in estimating the time-varying volatility of high frequency series. The models capture volatility of each of the variable and shocks are quite persistent and largely significant.

As per the variance equation, for some of the estimations, the sum of equation of the lagged squared residual (Alpha) and lagged conditional variance (Beta) is also very close to unity implying that there is a significant presence of volatility shocks in these series. This also explains that it takes a long time to overcome the shocks in the series. Thereby, showing there is a significant return and volatility spillover effect between Sensex and FIIs, changes in one variable influence the volatility in in not only that variable itself but also influences the volatility in another variable. The model shows that changes in stock market return, exchange rate and FIIs in the past can have some spillover impact in their future outcomes. Furthermore, some spillover has also been noted with changes in Sensex return will impact the exchange rate as well as for FIIs for GARCH (1,1) model. This was validated through significant result for both the mean equation and variance equation (GARCH (1,1)). However, the same could not be validated for any spillover impact of INR in the past on its future outcome, since there are various other factors that play a role in impacting such series, due to the excessive presence of volatility.

Table 10: GARCH model (1,1)- Mar'00 to Mar'26

	Coefficient	Significant
C	1.088401	Yes
Sensex	0.511535	Yes
Variance equation		
C	1.264701	Yes
Alpha RESID(-1)^2	0.184521	Yes
Beta GARCH(-1)	0.753586	Yes
Alpha+Beta	0.938107	
C	-0.19515	Yes
INR	0.510523	Yes
Variance equation		
C	0.016167	Yes
Alpha RESID(-1)^2	0.303436	Yes
Beta GARCH(-1)	0.747048	Yes
Alpha+Beta	1.05	Yes
C	175.7274	Yes
FII	0.537535	Yes
Variance equation		
C	1053.625	Yes
Alpha RESID(-1)^2	0.277487	Yes
Beta GARCH(-1)	0.785506	Yes
Alpha+Beta	1.06	
C	1.014409	Yes
INR	0.540693	Yes
FII	0.000538	Yes
Variance equation		
C	1.457553	Yes
Alpha RESID(-1)^2	0.179993	Yes
Beta GARCH(-1)	0.774711	Yes
Alpha+Beta	0.954704	

Source: Eviews

Table 11: GARCH model (1,1)- Mar'00 to Mar'22

	Coefficient	Significant
C	1.178638	Yes
Sensex	0.506353	Yes
Variance equation		
C	1.7008	Yes
Alpha RESID(-1)^2	0.207253	Yes
Beta GARCH(-1)	0.720018	Yes
Alpha+Beta	0.927271	
C	-0.07894	No
INR	0.503637	Yes
Variance equation		
C	0.199011	Yes
Alpha RESID(-1)^2	0.442179	Yes
Beta GARCH(-1)	0.533321	Yes
Alpha+Beta	0.9755	Yes
C	177.4107	Yes
FII	0.545515	Yes
Variance equation		
C	961.823	Yes
Alpha RESID(-1)^2	0.303664	Yes
Beta GARCH(-1)	0.771962	Yes
Alpha+Beta	1.07	
C	1.140701	Yes
INR	0.450042	Yes
FII	0.000938	Yes
Variance equation		
C	1.466512	No
Alpha RESID(-1)^2	0.125507	Yes
Beta GARCH(-1)	0.824616	Yes
Alpha+Beta	0.950123	

Source: Eviews

Conclusion

- It has been observed that there exists a positive correlation between the Sensex and other macroeconomic variables namely, exchange rate and movement of FIIs flow.
- Additionally, INR and FII flows also reflect a positive correlation. Notably, higher level of positive correlation has been noted in the post covid series, between each of the variables.
- In terms of causality, it has been noted, there is firm relation between Sensex and INR, as well as between Sensex and movement of FIIs flow.
- Out of 3 series, 2 of them have been estimated to have the presence of ARCH effects on the residuals. The post covid series (Apr'22-Mar'26) have been noted to not have any ARCH effects present or volatility clustering.
- Out of different GARCH models estimated, majority of them for ARCH (alpha) and GARCH (beta) coefficients have turned out to be significant, and alpha+beta is nearing 1 for the significant models.
- Given the presence of volatility clustering, it has been observed that there is a spillover effect between the changes in the past Sensex returns to their future outcome.
- The same can also be said for FIIs but might not be true for INR as one of the coefficients in the mean equation for INR was not significant.
- Furthermore, spillover effect has been noted with changes in Sensex return can sometimes lead to changes in exchange rate, since one model validates this result.

- Change in Sensex return also have a volatility spillover effect on FIIs. Therefore, changes in the Sensex returns do actually influence the volatility of FIIs.

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Appendix

Table 1: Descriptive statistics (Mar'00-Mar'26)

	Sensex	INR	FII
Mean	1.015845	-0.22946	553.7156
Median	1.02388	-0.11583	423.5
Maximum	28.2551	7.299565	8420
Minimum	-23.0533	-8.13485	-12724
Skewness	-0.23545	-0.17777	-0.73673
Kurtosis	5.212617	6.133093	7.793727
Jarque-Bera	66.7397	129.6691	328.0094
Probability	0	0	0
Observations	313	313	313

Table 2: Descriptive statistics (Mar'00-Mar'22)

	Sensex	INR	FII
Mean	1.108622	-0.18771	707.4415
Median	1.035779	-0.02149	437
Maximum	28.2551	7.299565	8420
Minimum	-23.0533	-8.13485	-8348
Skewness	-0.25309	-0.21044	0.194985
Kurtosis	4.938812	5.724287	6.018999
Jarque-Bera	44.33473	83.90422	102.3169
Probability	0	0	0
Observations	265	265	265

Table 3: Descriptive statistics (Apr'22-Mar'26)

	Sensex	INR	FII
Mean	0.503643	-0.45994	-294.979
Median	0.668869	-0.35482	92.5
Maximum	8.58431	2.398713	7939
Minimum	-11.4897	-4.06506	-12724
Skewness	-0.33976	-0.36649	-0.59173
Kurtosis	3.587658	4.617733	3.674946
Jarque-Bera	1.614181	6.308662	3.712214
Probability	0.446154	0.042667	0.15628
Observations	48	48	48

Source: Eviews

Fig 1: Volatility clustering-Sensex (Mar'00-Mar'26)

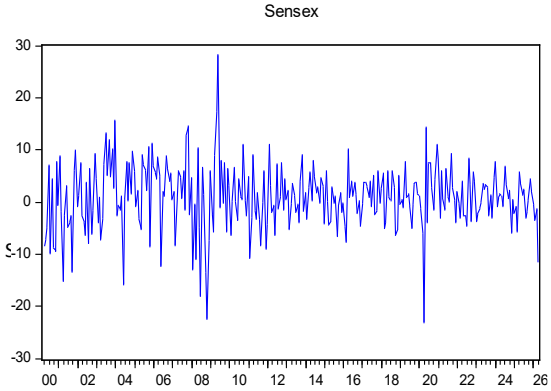
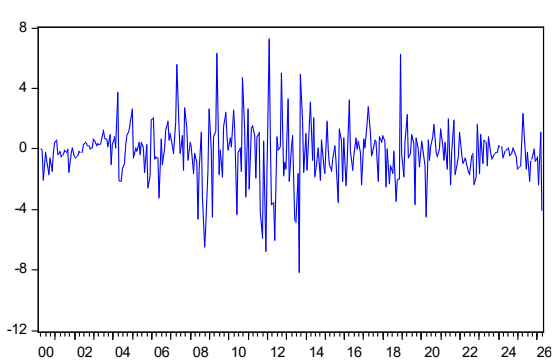
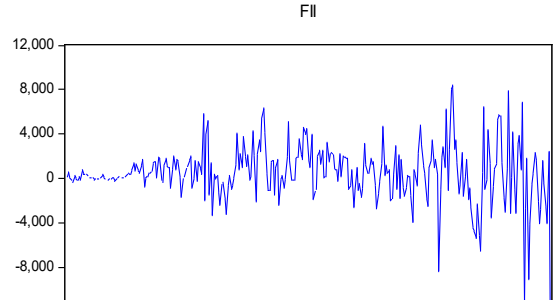


Fig 2: Volatility clustering-INR (Mar'00-Mar'26)



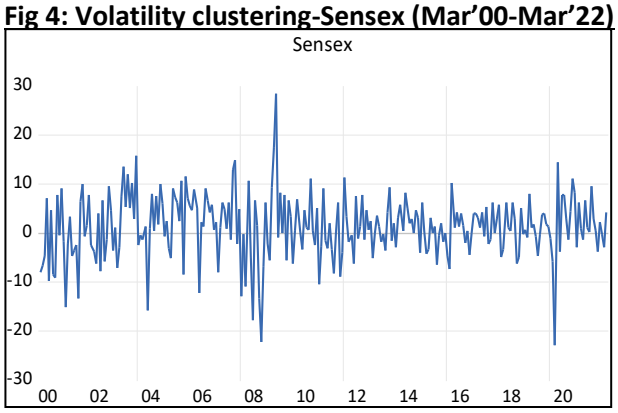
Source: Bank of Baroda Research

Fig 3: Volatility clustering-FIIs (Mar'00-Mar'26)



Source: Bank of Baroda Research

Fig 4: Volatility clustering-Sensex (Mar'00-Mar'22)



Source: Bank of Baroda Research

Fig 5: Volatility clustering-INR (Mar'00-Mar'22)

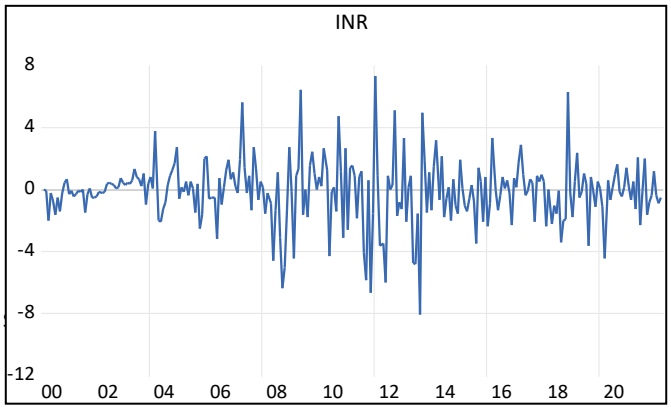
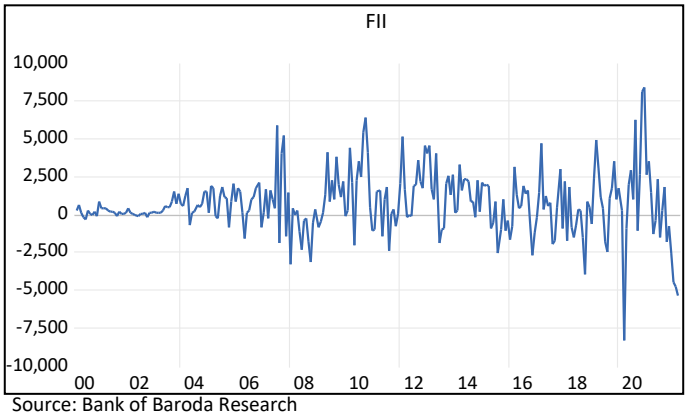


Fig 6: Volatility clustering-FIIs (Mar'00-Mar'22)



Source: Bank of Baroda Research

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