Impact of High Frequency Trading on Equity Market with Reference to NSE India

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Abstract

The study focused on the high-frequency trading impact on the stock market. The study considered the 1 minute, 5 minutes, 10 minutes, 15 minutes, 30 minutes, and 1 hour time periods. The study considered the historical time-series data from NSE India for the period of three months, that is, April – June 2019. The ARCH method was applied with the GARCH, and the results indicated that the Nifty volatility had a significant impact on the Bank Nifty volatility. The ordinary least square method results indicated that the Nifty 1 minute had a greater effect than the other time periods on the Bank Nifty.

Keywords : **high frequency trading, price volatility, financial markets, equity market**

JEL Classification Codes : D53, G20, G14, L1

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High-frequency trading is an automated trading platform for large investor banks, hedge funds, and institutional investors to place high-speed orders. This enables companies to operate HFT via super computers in microseconds or milliseconds. These high-speed trading platforms allow traders to place thousands of purchases in seconds, scan different markets, and trade. Higher market trading became common following the return of liquidity to markets for organizations. By offering small incentives to these producers, exchanges also benefit more from all the trade they trade and from liquidity organizations, while these incentives represent a fraction of a hundred per transaction.

In general, commercially, HFT traders are trying to generate little profit. However, it has been noted that these techniques could generate huge volumes in the equity markets. The algo trading will be activated tens of thousands of times a day if the market matches with the algorithams. Quantitative trading is a high-frequency trading characteristic of short holding periods. Computerized quantitative models are used to identify all portfolio allocations. The achievement of HFT is mainly driven by the ability of normal human traders to process large amounts of data at the same time. For many individuals, dealing with small organizations and investors at high speed is unethical and unfair to big businesses. As technology can be used for abusive, ultra-short-term approaches, stock markets must be honest and likely to interfere with HFT. Speed and arbitration traders benefit from any supply-demand imbalances. They do not rely on basic business research or development opportunities, but on the chance to take action on strike action. Even if HFT is not targeted specifically, retail investors may suffer collateral damage.

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Review of Literature

Chung and Lee (2016) provided an overview of the literature on high frequency trading and discussed a number of actions taken by global regulatory authorities to address their potential adverse effects on market quality and investor welfare. Empirical evidence to date generally shows market quality improvement in high-frequency trading during normal times. It is possible to analyze the position of high-frequency traders and the effectiveness of various regulatory initiatives through distinct stages of market conditions as a good region for future studies.

The fast development in HFT has given the government great importance in terms of its effect on institutional investors and policy concerns. Previous studies demonstrated that HFT reduces the average bid distribution. The pricing effect, however, is the main element of the institutional trading expenses. Tong (2015) observed that HFT improved trading expenses of traditional institutional investors by combining the information on corporate trades and HFT. Specifically, any rise in HFT intensity by one normal deviation improved institutional implementation cost by one-third. The research also conducted multiple experiments in order to rule out an alternative account of the fact that high frequency traders have high trading cost stocks.

Menkveld (2016) assessed the latest literature on HFTs to identify the financial mechanisms through which HFTs influence the performance of the economy. The first group consisted of the different theoretical studies according to the common denominators. The review of the empirical literature, which refers either to the assumptions or predictions of the model, allowed the researcher to make a "data-weighted" evaluation of the financial value of HFTs.

According to Baldauf and Mollner (2018), model studies provide expensive data on the effects of high-frequency trade. Faster speeds improve the efficiency and the economically relevant impacts of certain high-frequency trading strategies. First of all, basic research is overwhelmed by the fact that data trading takes less time to take advantage of it before high-speed traders respond. Second, as information asymmetries are reduced, the distribution of the bid-ask decreases. The study characterized the boundary between small scales and intensive research. The Book of Limits, though omnipresent, does not generally deliver results at this border.

Dikshita and Singh (2019) examined the different volatility estimators and determined the most efficient volatility estimator. The study described the accuracy of the forecasting technique with respect to various volatility estimators. The study evaluated the efficiency and bias of various volatility estimators. The comparative analyses based on various error measuring parameters like ME, RMSE, MAE, MPE, MAPE, MASE, and ACF1 gave the accuracy of forecasting with the best volatility estimator. The study suggested that the forecasted values were accurate based on the values of MAE and RMSE. This research was conducted in order to meet the demand of knowing the most efficient volatility estimator for forecasting volatility with high accuracy by traders, option practitioners, and various players of the stock market.

Objectives of the Study

(1) To study the HFT effect on price volatility of Nifty indices on Bank Nifty indices.

(2) To examine the role of HFT in price discovery of Nifty indices on Bank Nifty indices.

Scope of the Study

The present study considers the impact of HFT on equity markets in perspective of price discovery, efficiency, and volatility. The study considers the secondary data from NSE India and examines six different time horizon periods. The study considers 3 months data of Nifty and Bank Nifty (from April 1, 2019 – June 30, 2019). The

following are the time periods considered to examine the HFT effect : 1 minute, 5 minutes, 10 minutes, 15 minutes, 30 minutes, and 1 hour.

Research Methodology

The present study has considered the time series data from NSE India for secondary data. The study has considered the following statistical methods to examine the proposed objectives :

(i) Augmented Dicky – Fuller Test : The study applies the ADF to examine the stationarity of secondary data under the unit root test. The ADF removes the seasonality effect from the data and stabilizes the variables.

(ii) Ordinary Least Square Method : The study applies the Ordinary Least Square to know the impact of independent variable on the dependent variable.

(iii) ARCH Model : The study applies the auto regressive conditional heteroskedasticity test to know the influence of the independent variable's volatility impact on the dependent variable's volatility.

Data Analysis and Results

(1) Time Period Examination of HFT

(i) Nifty and Bank Nifty 1 Minute Analysis

↳ **H01 :** ARCH effect does not exist between the volatility of Nifty 1 minute on Bank Nifty 1 minute.

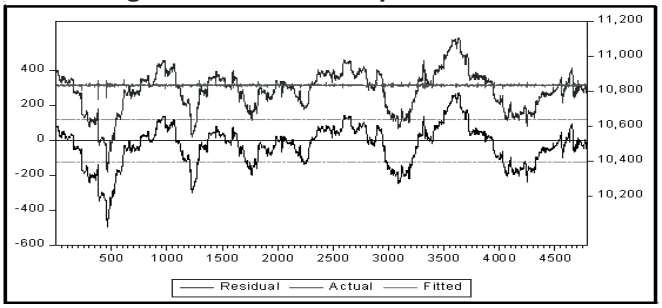
Table 1 illustrates the heteroskedasticity of Nifty 1 minute prices on Bank Nifty 1 minute prices. The results show that the *F* - statistics calculated value is observed to be greater than the critical value (i.e, 3.93 > 3.85). Further, the *p* - value is observed to be less than 0.05, which reveals that the null hypothesis (H01) has been rejected. Hence, the ARCH effect exists between the volatility of Nifty 1 minute on Bank Nifty 1 minute.

Figure 1 represents the volatility of Nifty 1 minute on the volatility of Bank Nifty 1 minute. Here, the plotted

Table 1. Heteroskedasticity Test : ARCH - 1 Minute

F-statisc`	3.938434	Prob. *F*(1,23808)		0.0030
Obs**R*-squared	1.138475	Prob. Chi-Square(1)		0.0060
Variable	**Coefficient**	**Std. Error**	***t*-Statisc`**	**Prob.**
C	0.992479	0.082600	12.01553	0.0000
WGT_RESID^2(–1)	0.006915	0.006481	1.066974	0.0060
R-squared	0.000048	Mean dependent var		0.999389
Adjusted *R*-squared	0.000006	*S.D.* dependent var		12.70633
S.E. of regression	12.70630	Akaike info criterion		7.922156
Sum squared resid	3843800.	Schwarz criterion		7.922835
Log likelihood	–94311.27	Hannan-Quinn criter.		7.922376
F-statisc`	1.138434	Durbin-Watson stat		1.999985
Prob (*F*-statisc)`	0.285994			

Figure 1. Residual Graph – 1 Minute



lines are fitting across the fitted lines and it is also observed that there are prolonged clusters between the plotted lines. Hence, it is concluded that volatility of Nifty 1 minute has a significant influence on volatility of Bank Nifty 1 minute.

Table 2 illustrates the influence of volatility of Nifty 1 minute on the volatility of Bank Nifty 1 minute. The results show that the coefficient value of Bank Nifty is 0.963, which signifies that with 1 unit increase in the 1 minute prices of Nifty, 0.963 unit will increase in the Bank Nifty 1 minute prices. Hence, the table reveals that 1 minute prices of Nifty have a high significant influence on Bank Nifty.

Table 2. Bank Nifty's Volatility Impact on Nifty Volatility - 1 Minute

Dependent Variable : *DNIFTY1MIN*

Sample (Adjusted) : 2 23812

Included Observaons` : 23811 a. er adjustments

Variable	Coefficient	Std. Error	*z*-Statisc`	Prob.
C	–0.034109	0.013098	–2.604146	0.0092
DBN1MIN	0.963958	0.000274	961.8521	0.0000
	Variance Equaon`			
C	0.091068	0.002644	34.44832	0.0000
RESID(–1)^2	0.114910	0.001533	74.93425	0.0000
GARCH(–1)	0.900838	0.000956	942.3890	0.0000
R-squared	0.154670	Mean dependent var		–0.005804
Adjusted *R*-squared	0.154634	*S.D.* dependent var		4.279608
S.E. of regression	3.934833	Akaike info criterion		5.125731
Sum squared resid	368632.7	Schwarz criterion		5.127427
Log likelihood	–61019.38	Hannan-Quinn criter.		5.126281
Durbin-Watson stat	2.288948			

(ii) Nifty and Bank Nifty 5 Minutes Analysis

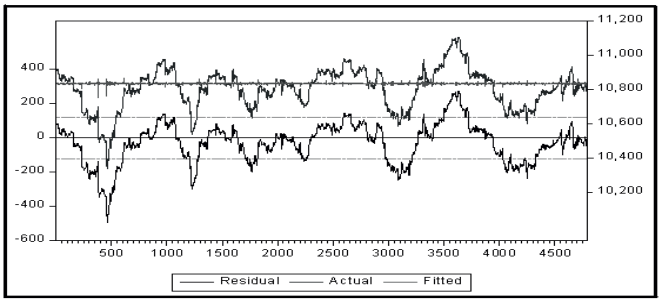
↳ **H02 :** ARCH effect does not exist between the volatility of Nifty 5 minutes on Bank Nifty 5 minutes.

Table 3 illustrates the heteroskedasticity of 5 minutes prices of Nifty on Bank Nifty. The results show that *F*-statistics calculated value is observed to be greater than the critical value (i.e. 34.71 > 3.85). Furthermore, the

Table 3. Heteroskedasticity Test : ARCH - 5 Minutes

F-stas c	34.71359	Prob. *F*(1,4782)		0.0000
Obs**R*-squared	34.47783	Prob. Chi-Square(1)		0.0000
Variable	**Coefficient**	**Std. Error**	***t*-Statisc`**	**Prob.**
C	0.915046	0.018459	49.57095	0.0000
WGT_RESID^2(–1)	0.084894	0.014409	5.891824	0.0000
R-squared	0.007207	Mean dependent var		0.999947
Adjusted *R*-squared	0.006999	*S.D.* dependent var		0.800781
S.E. of regression	0.797973	Akaike info criterion		2.386934
Sum squared resid	3044.992	Schwarz criterion		2.389640
Log likelihood	–5707.547	Hannan-Quinn criter.		2.387885
F-stas c	34.71359	Durbin-Watson stat		2.000268
Prob (*F*-stas c)	0.000000			

Figure 2. Residual Graph – 5 Minutes



p - value is observed to be less than 0.05, which reveals that the null hypothesis (H02) has been rejected. Hence, the ARCH effect exists between the volatility of Nifty 5 minutes on Bank Nifty 5 minutes.

Figure 2 represents the volatility of Nifty 5 minutes on the volatility of Bank Nifty 5 minutes. Here, the plotted lines fit across the fitted lines and it can also be observed that there are prolonged clusters between the plotted lines. Hence, it is concluded that the volatility of Nifty 5 minutes has a significant influence on the volatility of Bank Nifty 5 minutes.

Table 4 depicts the influence of volatility of Nifty 5 minutes on the volatility of Bank Nifty 5 minutes. The results show that the coefficient value of Bank Nifty is 0.147, which signifies that with 1 unit increase in the 5 minutes prices of Nifty, 0.147 unit will increase in the Bank Nifty 5 minutes prices. Hence, Table 4 reveals that 5 minutes prices of Nifty have a high significant influence on Bank Nifty.

(iii) Nifty and Bank Nifty 10 Minutes Analysis

↳ **H03 :** ARCH effect does not exist between the volatility of Nifty 10 minutes on Bank Nifty 10 minutes.

Table 5 illustrates the heteroskedasticity of 10 minutes prices of Nifty on Bank Nifty. The results show that the *F*-statistics calculated value is observed to be greater than the critical value (i.e., 30.78 > 3.85). Further, the *p* - value is observed to be less than 0.05, which reveals that the null hypothesis (H03) has been rejected. Hence, the ARCH effect exists between the volatility of Nifty 10 minutes on Bank Nifty 10 minutes.

Table 4. Bank Nifty's Volatility Impact on Nifty Volatility - 5 Minutes

Dependent Variable : *NIFTY5MIN*

Sample (Adjusted) : 2 4786

Included Observaons : 4785 a er Adjustments

Variable	Coefficient	Std. Error	*z*-Statisc`	Prob.
C	10835.88	0.297374	36438.60	0.0000
DBN5MIN	0.147604	0.005526	26.71091	0.0000
	Variance Equation			
C	30.96695	4.609910	6.717475	0.0000
RESID(–1)^2	0.892410	0.089535	9.967134	0.0000
GARCH(–1)	0.115042	0.025767	4.464615	0.0000
R-squared	–0.068721	*S.D.* dependent var		117.4423
S.E. of regression	121.4106	Akaike info criterion		11.07652
Sum squared resid	70503951	Schwarz criterion		11.08328
Log likelihood	–26495.57	Hannan-Quinn criter.		11.07889
Durbin-Watson stat	0.003856			

Table 5. Heteroskedasticity Test : ARCH - 10 Minutes

F-stas c	30.78771	Prob. *F*(1,2378)		0.0000
Obs**R*-squared	30.41976	Prob. Chi-Square(1)		0.0000
Variable	**Coefficient**	**Std. Error**	***t*-Statisc`**	**Prob.**
C	0.886769	0.025599	34.64050	0.0000
WGT_RESID^2(–1)	0.113054	0.020375	5.548667	0.0000
R-squared	0.012781	Mean dependent var		0.999840
Adjusted *R*-squared	0.012366	*S.D.* dependent var		0.760572
S.E. of regression	0.755854	Akaike info criterion		2.278904
Sum squared resid	1358.589	Schwarz criterion		2.283756
Log likelihood	–2709.895	Hannan-Quinn criter.		2.280670
F-stas c	30.78771	Durbin-Watson stat		1.993864
Prob(*F*-stas c)	0.000000			

Figure 3. Residual Graph – 10 Minutes

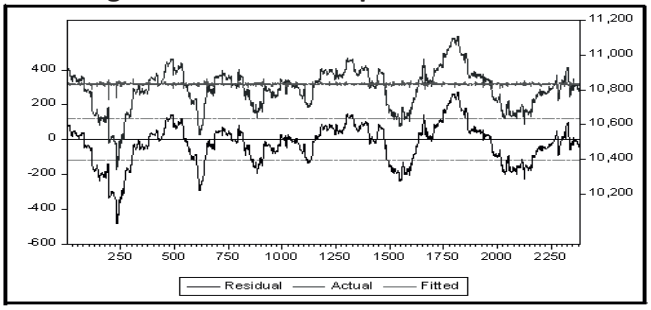


Figure 3 represents the volatility of Nifty 10 minutes on the volatility of Bank Nifty 10 minutes. Here, the plotted lines fit across the fitted lines and it is also observed that there are prolonged clusters between the plotted lines. Hence, it is concluded that volatility of Nifty 10 minutes has a significant influence on the volatility of Bank Nifty 10 minutes.

Table 6 illustrates the influence of volatility of Nifty 10 minutes on the volatility of Bank Nifty 10 minutes. The results show that the coefficient value of Bank Nifty is 0.163, which signifies that with 1 unit increase in the 10 minutes prices of Nifty, 0.163 unit will increase in the Bank Nifty 10 minutes prices. Hence, it can be concluded from Table 6 that 10 minutes prices of Nifty have a high significant influence on Bank Nifty.

Table 6. Bank Nifty's Volatility Impact on Nifty Volatility - 10 Minutes

Dependent Variable : *NIFTY10MIN*

Sample (Adjusted) : 2 2382

Included observaons : 2381 a er adjustments

Variable	Coefficient	Std. Error	*z*-Statisc`	Prob.
C	10833.87	0.524913	20639.37	0.0000
DBN10MIN	0.163729	0.008901	18.39360	0.0000
	Variance Equaon`			
C	65.68617	9.206212	7.134984	0.0000
RESID(–1)^2	0.932754	0.111529	8.363342	0.0000
GARCH(–1)	0.073502	0.030603	2.401770	0.0163
R-squared	–0.058817	Mean dependent var		10804.96
Adjusted *R*-squared	–0.059262	*S.D.* dependent var		117.8139
S.E. of regression	121.2545	Akaike info criterion		11.14632
Sum squared resid	34977642	Schwarz criterion		11.15844
Log likelihood	–13264.69	Hannan-Quinn criter.		11.15073
Durbin-Watson stat	0.007583			

(iv) Nifty and Bank Nifty 15 Minutes Analysis

↳ **H04 :** ARCH effect does not exist between the volatility of Nifty 15 minutes on Bank Nifty 15 minutes.

Table 7 illustrates the heteroskedasticity of 15 minutes prices of Nifty on Bank Nifty. The results show that the *F*-statistics calculated value is observed to be greater than the critical value (i.e, 39.19 > 3.85). Further, the *p* - value is observed to be less than 0.05, which reveals that the H04 has been rejected. Hence, it is clear that the ARCH effect exists between the volatility of Nifty 15 minutes on Bank Nifty 15 minutes.

Figure 4 represents the volatility of Nifty 15 minutes on the volatility of Bank Nifty 15 minutes. Here, the plotted lines are fitted across the fitted lines and it is also observed that there are prolonged clusters between the plotted lines. Hence, it is concluded that volatility of Nifty 15 minutes has a significant influence on the volatility of Bank Nifty 15 minutes.

Table 8 reveals the influence of volatility of Nifty 15 minutes on the volatility of Bank Nifty 15 minutes. The results show that the coefficient value of Bank Nifty is 0.173, which signifies that with 1 unit increase in the 15 minutes prices of Nifty, 0.173 unit will increase in the Bank Nifty 15 minutes prices. Hence, Table 8 reveals that 15 minutes prices of Nifty have a high significant influence on Bank Nifty.

Table 7. Heteroskedasticity Test : ARCH - 15 Minutes

F-stas c	39.19986	Prob. *F*(1,1622)	0.0000	
Obs**R*-squared	38.32204	Prob. Chi-Square(1)	0.0000	
Variable	**Coefficient**	**Std. Error**	***t*-Statisc`**	**Prob.**
C	0.846218	0.030460	27.78114	0.0000
WGT_RESID^2(–1)	0.153610	0.024535	6.260979	0.0000
R-squared	0.023597	Mean dependent var		0.999805
Adjusted *R*-squared	0.022995	*S.D.* dependent var		0.736193
S.E. of regression	0.727679	Akaike info criterion		2.203318
Sum squared resid	858.8768	Schwarz criterion		2.209959
Log likelihood	–1787.094	Hannan-Quinn criter.		2.205782
F-stas c	39.19986	Durbin-Watson stat		1.994291
Prob(*F*-stas c)	0.000000			

Figure 4. Residual Graph – 15 Minutes

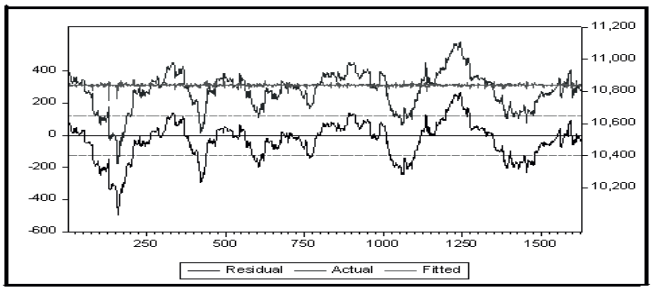


Table 8. Bank Nifty's Volatility Impact on Nifty Volatility - 15 Minutes

Dependent Variable : *NIFTY15MIN*

Sample (Adjusted) : 2 1626

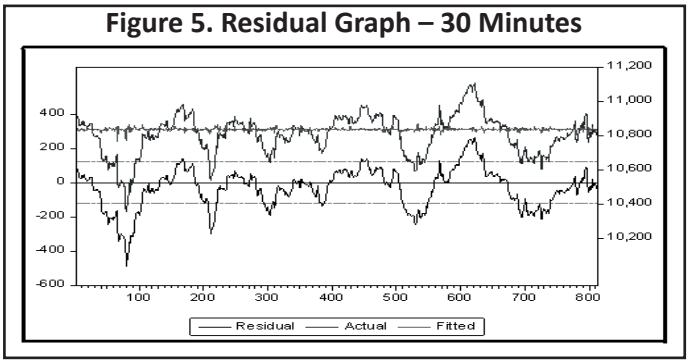
Included Observaons : 1625 a er adjustments

Variable	**Coefficient**	**Std. Error**	***z*-Statisc`**	**Prob.**
C	10839.68	0.736458	14718.67	0.0000
DBN15MIN	0.173327	0.015238	11.37435	0.0000
	Variance Equaon`			
C	82.15262	18.47814	4.445935	0.0000
RESID(–1)^2	0.905203	0.116458	7.772765	0.0000
GARCH(–1)	0.106988	0.041181	2.598014	0.0094
R-squared	–0.085348	Mean dependent var		10804.87
Adjusted *R*-squared	–0.086017	*S.D.* dependent var		117.8585
S.E. of regression	122.8229	Akaike info criterion		11.19344
Sum squared resid	24483699	Schwarz criterion		11.21003
Log likelihood	–9089.666	Hannan-Quinn criter.		11.19959
Durbin-Watson stat	0.011138			

Table 9. Heteroskedasticity Test : ARCH - 30 Minutes

F-stas c	23.69049	Prob. *F*(1,809)		0.0000
Obs**R*-squared	23.07339	Prob. Chi-Square(1)		0.0000
Variable	**Coefficient**	**Std. Error**	***t*-Statisc`**	**Prob.**
C	0.830761	0.044859	18.51943	0.0000
WGT_RESID^2(–1)	0.168633	0.034646	4.867288	0.0000
R-squared	0.028451	Mean dependent var		0.999347
Adjusted *R*-squared	0.027250	*S.D.* dependent var		0.823106
S.E. of regression	0.811814	Akaike info criterion		2.423373
Sum squared resid	533.1653	Schwarz criterion		2.434959
Log likelihood	–980.6776	Hannan-Quinn criter.		2.427821
F-stas c	23.69049	Durbin-Watson stat		1.979537
Prob(*F*-stas c)	0.000001			

Figure 5. Residual Graph – 30 Minutes



(v) Nifty and Bank Nifty 30 Minutes Analysis

↳ **H05 :** ARCH effect does not exist between the volatility of Nifty 30 minutes on Bank Nifty 30 minutes.

Table 9 illustrates the heteroskedasticity of 30 minutes prices of Nifty on Bank Nifty. The results show that the *F*-statistics calculated value is observed to be greater than the critical value (i.e., 23.69 > 3.85). Furthermore, the *p* - value is observed to be less than 0.05, which states that the H05 is rejected. Hence, the ARCH effect exists between the volatility of Nifty 30 minutes on Bank Nifty 30 minutes.

Figure 5 represents the volatility of Nifty 30 minutes on the volatility of Bank Nifty 30 minutes. Here, the plotted lines fit across the fitted lines and it is also observed that there are prolonged clusters between the plotted lines. Hence, it is concluded that the volatility of Nifty 30 minutes has a significant influence on volatility of Bank Nifty 30 minutes.

The ARCH Table 10 reveals the influence of volatility of Nifty 30 minutes on the volatility of Bank Nifty 30 minutes. The results show that the coefficient value of Bank Nifty is 0.131, which signifies that with 1 unit increase in the 30 minutes prices of Nifty, 0.131 unit will increase in the Bank Nifty 30 minutes prices. Hence, Table 10 reveals that 30 minutes prices of Nifty have a high significant influence on Bank Nifty.

Table 10. Bank Nifty's Volatility Impact on Nifty Volatility - 30 Minutes

Dependent Variable : *NIFTY30MIN*

Sample (adjusted) : 2 813

Included observaons : 812 a er adjustments

Variable	Coefficient	Std. Error	z-Statisc`	Prob.
C	10836.57	1.305960	8297.783	0.0000
DBN30MIN	0.131283	0.015276	8.594220	0.0000
	Variance Equation			
C	160.9134	53.43905	3.011157	0.0026
RESID(–1)^2	0.937588	0.157777	5.942474	0.0000
GARCH(–1)	0.088468	0.059223	1.493820	0.1352
R-squared	–0.066713	Mean dependent var		10805.03
Adjusted *R*-squared	–0.068030	*S.D.* dependent var		118.0363
S.E. of regression	121.9853	Akaike info criterion		11.28524
Sum squared resid	12053130	Schwarz criterion		11.31418
Log likelihood	–4576.809	Hannan-Quinn criter.		11.29635
Durbin-Watson stat	0.023768			

(vi) Nifty and Bank Nifty 1 Hour Analysis

↳ **H06 :** ARCH effect does not exist between the volatility of Nifty 1 hour on Bank Nifty 1 hour.

Table 11 depicts the heteroskedasticity of 1 hour prices of Nifty on Bank Nifty. The results show that the *F*-statistics calculated value is observed to be greater than the critical value (i.e., 6.09 > 3.85). Furthermore, the *p* - value is observed to be less than 0.05, which reveals that the hypothesis H06 is rejected. Hence, the ARCH effect exists between the volatility of Nifty 1 hour on Bank Nifty 1 hour.

Figure 6 represents the volatility of Nifty 1 hour on the volatility of Bank Nifty 1 hour. Here, the plotted

Table 11. Heteroskedasticity Test : ARCH - 1 Hour

F-stas c	6.097340	Prob. *F*(1,428)		0.0252
Obs**R*-squared	0.097773	Prob. Chi-Square(1)		0.0145
Variable	**Coefficient**	**Std. Error**	***t*-Statisc`**	**Prob.**
C	0.982166	0.071877	13.66454	0.0000
WGT_RESID^2(–1)	0.015061	0.048273	0.311993	0.0552
R-squared	0.000227	Mean dependent var		0.997224
Adjusted *R*-squared	–0.002109	*S.D.* dependent var		1.103307
S.E. of regression	1.104470	Akaike info criterion		3.041248
Sum squared resid	522.0974	Schwarz criterion		3.060150
Log likelihood	–651.8684	Hannan-Quinn criter.		3.048712
F-stas c	0.097340	Durbin-Watson stat		1.995973
Prob(*F*-stas c)	0.755197			

Figure 6. Residual Graph – 1 Hour

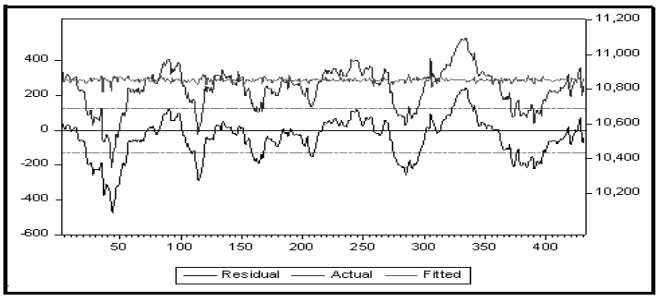


Table 12. Bank Nifty's Volatility Impact on Nifty Volatility - 1 Hour

Dependent Variable: *NIFTY1HOUR*

Sample (Adjusted): 2 432

Included Observaons: 431 a er Adjustments

Variable	Coefficient	Std. Error	*z*-Statisc`	Prob.
C	10853.03	2.547123	4260.897	0.0000
DBN1HOUR	0.129141	0.020377	6.337480	0.0000
	Variance Equaon`			
C	654.9073	144.1944	4.541835	0.0000
RESID(–1)^2	1.012994	0.211907	4.780360	0.0000
GARCH(–1)	–0.079788	0.101656	–0.784884	0.4325
R-squared	–0.153586	Mean dependent var		10804.94
Adjusted *R*-squared	–0.156275	*S.D.* dependent var		118.7892
S.E. of regression	127.7343	Akaike info criterion		11.45072
Sum squared resid	6999585.	Schwarz criterion		11.49789
Log likelihood	–2462.631	Hannan-Quinn criter.		11.46935
Durbin-Watson stat	0.043548			

lines are fit across the fitted lines and it is also observed that there are prolonged clusters between the plotted lines. Hence, it is concluded that the volatility of Nifty 1 hour has a significant influence on the volatility of Bank Nifty 1 hour.

ARCH Table 12 illustrates the influence of volatility of Nifty 1 hour on the volatility of Bank Nifty 1 hour. The results show that the coefficient value of Bank Nifty is 0.129, which signifies that with 1 unit increase in the 1 hour prices of Nifty, 0.129 unit will increase in the Bank Nifty 1 hour prices. Hence, Table 12 reveals that 1 hour prices of Nifty have a high significant influence on Bank Nifty.

(2) Examining the Impact of HFT on Select Equity Indices

(i) Nifty and Bank Nifty 1 Minute Analysis

↳ **H01 :** There is no significant influence of Nifty 1 minute indices on Bank Nifty.

Table 13. Impact of Bank Nifty on Nifty Returns - 1 Minute

Dependent Variable : *DNIFTY1MIN*

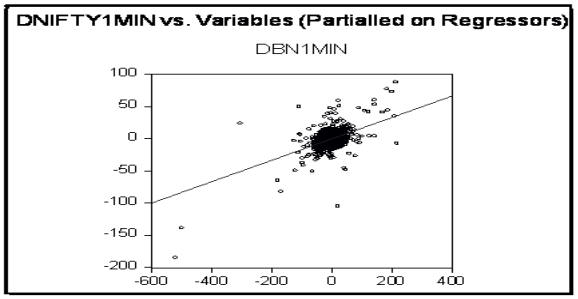
Method : Least Squares

Sample (adjusted) : 2 23812

Included Observaons : 23811 a er Adjustments

Variable	Coefficient	Std. Error	*t*-Statisc`	Prob.
C	–0.004234	0.024227	–0.174766	0.0313
DBN1MIN	0.166107	0.001932	85.98460	0.0000
R-squared	0.236949	Mean dependent var		–0.005804
Adjusted *R*-squared	0.236916	*S.D.* dependent var		4.279608
S.E. of regression	3.738436	Akaike info criterion		5.475296
Sum squared resid	332752.4	Schwarz criterion		5.475974
Log likelihood	–65184.14	Hannan-Quinn criter.		5.475516
F-stas c	7393.352	Durbin-Watson stat		2.450410
Prob(*F*-stas c)	0.000000			

Figure 7. Leverage Plotted Graph – 1 Minute



Least square method depicts the regression weights of Nifty on Bank Nifty 1 minute data (i.e., from April 1, 2019 – June 30, 2019). The results show that the Bank Nifty coefficient value is observed to be 0.166, which indicates that Bank Nifty has a positive influence on Nifty. Furthermore, the *p* (probability) value seems to be less than 0.05, which means that the model is statistically significant at the 5% level and the *R* - squared value is 0.23, which indicates that the model is a weak fit. Hence, Table 13 reveals that the null hypothesis H01 is rejected. Hence, there is a significant influence of Nifty 1 minute on Bank Nifty.

Leverage plot (Figure 7) has been plotted between the 1 minute data of Nifty vs. Bank Nifty. The plotted lines are observed to be moving in the upward direction, which represents that Nifty 1 minute data is pushing Bank Nifty towards an upward direction. Hence, it is concluded that Nifty 1 minute prices have a significant influence on the Bank Nifty prices.

(ii) Nifty and Bank Nifty 5 Minutes Analysis

↳ **H02 :** There is no significant influence of Nifty 5 minutes indices on Bank Nifty.

The least square method depicts the regression weights of Nifty on Bank Nifty 5 minutes data (i.e., from April 1, 2019 – June 30, 2019). The results show that Bank Nifty's coefficient value is observed to be 0.122, which

Table 14. Impact of Bank Nifty on Nifty Returns - 5 Minutes

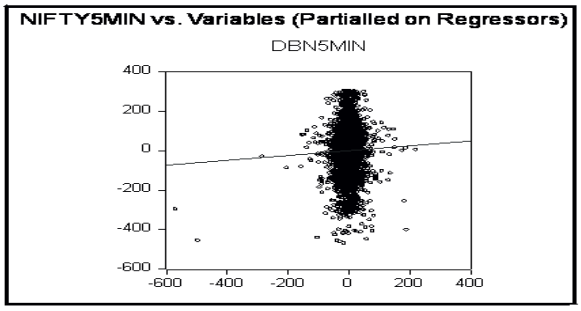
Dependent Variable : *NIFTY5MIN*

Method : Least Squares

Sample (Adjusted) : 2 4786

Variable	Coefficient	Std. Error	*t*-Statisc`	Prob.
C	10804.97	1.697284	6366.035	0.0000
DBN5MIN	0.122194	0.062232	1.963531	0.0396
R-squared	0.000805	Mean dependent var		10804.96
Adjusted *R*-squared	0.000597	*S.D.* dependent var		117.4423
S.E. of regression	117.4072	Akaike info criterion		12.36959
Sum squared resid	65931071	Schwarz criterion		12.37230
Log likelihood	29592.25	Hannan-Quinn criter.		12.37054
F-stas c	3.855454	Durbin-Watson stat		0.004239
Prob (*F*-stas c)	0.049642			

Figure 8. Leverage Plotted Graph – 5 Minutes



indicates that Bank Nifty has a positive influence on Nifty. Furthermore, the *p* (probability) value seems to be less than 0.05, which means that the model is statistically significant at the 5% level and the *R* - squared value is 0.0008, which indicates that the model is a weak fit. Hence, Table 14 reveals that the null hypothesis H02 has been rejected. Hence, there is a significant influence of Nifty 5 minutes on Bank Nifty.

Leverage plot (Figure 8) has been plotted between the 5 minutes data of Nifty vs. Bank Nifty. The plotted lines are observed to be moving in the upward direction, which represents that Nifty 5 minutes data is slightly pushing Bank Nifty towards an upward direction. Hence, it is concluded that Nifty 5 minutes prices have a significant influence on Bank Nifty prices.

(iii) Nifty and Bank Nifty 10 Minutes Analysis

↳ **H03 :** There is no significant influence of Nifty 10 minutes indices on Bank Nifty.

Least square method depicts the regression weights of Nifty on Bank Nifty 10 minutes data (i.e., from April 1, 2019 – June 30, 2019). The results show that Bank Nifty's coefficient value is observed to be 0.122, which indicates that Bank Nifty has a positive influence on Nifty. Further, the *p* (probability) value seems to be less than 0.05, which means that the model is statistically significant at the 5% level and the *R* - Squared value is 0.0015, which indicates that the model is a weak fit. Hence, the Table 15 reveals that the null hypothesis H03 is rejected.

Table 15. Impact of Bank Nifty on Nifty Returns - 10 Minutes

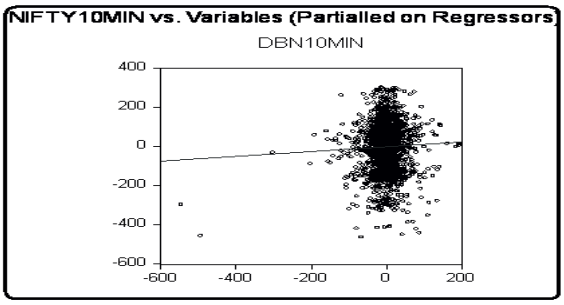
Dependent Variable : *NIFTY10MIN*

Method : Least Squares

Sample (Adjusted) : 2 2382

Variable	Coefficient	Std. Error	*t*-Statisc`	Prob.
C	10804.97	2.413132	4477.573	0.0000
DBN10MIN	0.122487	0.064593	1.896299	0.0380
R-squared	0.001509	Mean dependent var		10804.96
Adjusted *R*-squared	0.001090	*S.D.* dependent var		117.8139
S.E. of regression	117.7497	Akaike info criterion		12.37584
Sum squared resid	32984799	Schwarz criterion		12.38069
Log likelihood	–14731.44	Hannan-Quinn criter.		12.37760
F-stas c	3.595952	Durbin-Watson stat		0.008259
Prob (*F*-stas c)	0.058042			

Figure 9. Leverage Plotted Graph – 10 Minutes



Hence, there is a significant influence of Nifty 10 minutes on Bank Nifty.

Leverage plot (Figure 9) has been plotted between 10 minutes data of Nifty vs. Bank Nifty. The plotted lines are observed to be moving in the upward direction, which represents that Nifty 10 minutes data is pushing Bank Nifty towards the upward direction. Hence, it is concluded that Nifty 10 minutes prices have a significant influence on Bank Nifty prices.

(iv) Nifty and Bank Nifty 15 Minutes Analysis

↳ **H04 :** There is no significant influence of Nifty 15 minutes indices on Bank Nifty.

The least square method depicts the regression weights of Nifty on Bank Nifty 15 minutes data (i.e., from April 1, 2019 – June 30, 2019). The results show that Bank Nifty's coefficient value is observed to be 0.122, which indicates that Bank Nifty has a positive influence on Nifty. Further, the *p* (probability) value seems to be less than 0.05, which means that the model is statistically significant at the 5% level and the *R*-Squared value is 0.002, which indicates that the model is a weak fit. Hence, overall, Table 16 leads to the inference that the null hypothesis (H04) has been rejected and that there is a significant influence of Nifty 15 minutes on Bank Nifty.

Leverage plot (Figure 10) has been plotted between the 15 minutes data of Nifty vs. Bank Nifty. The plotted

Table 16. Impact of Bank Nifty on Nifty Returns - 15 Minutes

Dependent Variable : *NIFTY15MIN*

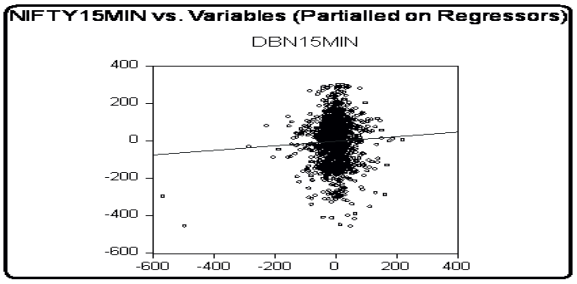
Method : Least Squares

Sample (adjusted) : 2 1626

Included observaons : 1625 a er adjustments

Variable	Coefficient	Std. Error	*t*-Statisc`	Prob.
C	10804.89	2.921368	3698.572	0.0000
DBN15MIN	0.122108	0.064216	1.901529	0.0374
R-squared	0.002223	Mean dependent var		10804.87
Adjusted *R*-squared	0.001608	*S.D.* dependent var		117.8585
S.E. of regression	117.7637	Akaike info criterion		12.37647
Sum squared resid	22508232	Schwarz criterion		12.38311
Log likelihood	–10053.88	Hannan-Quinn criter.		12.37893
F-stas c	3.615811	Durbin-Watson stat		0.012291
Prob(*F*-stas c)	0.057410			

Figure 10. Leverage Plotted Graph – 15 Minutes



lines are observed to be moving in the upward direction, which represents that Nifty 15 minutes data is pushing Bank Nifty towards the upward direction. Hence, it is concluded that Nifty 15 minutes prices have a significant influence on Bank Nifty prices.

(v) Nifty and Bank Nifty 30 Minutes Analysis

↳ **H05 :** There is no significant influence of Nifty 30 minutes indices on Bank Nifty.

Least square method depicts the regression weights of Nifty on Bank Nifty 30 minutes data (i.e., from April 1, 2019 – June 30, 2019). The results show that Bank Nifty's coefficient value is observed to be 0.123, which indicates that Bank Nifty has a positive influence on Nifty. Further, the *p* (probability) value seems to be less than 0.05, which means the model is statistically significant at the 5% level and the *R*-squared value is 0.004, which indicates that the model is a weak fit. Hence, it can be inferred from Table 17 that the null hypothesis H05 has been rejected. Hence, there is a significant influence of Nifty 30 minutes on Bank Nifty.

Leverage plot (Figure 11) has been plotted between the 30 minutes data of Nifty vs. Bank Nifty. The plotted lines are observed to be moving in the upward direction, which represents that Nifty 30 minutes data is pushing Bank Nifty towards the upward direction Hence, it is concluded that Nifty 30 minutes prices have a significant influence on Bank Nifty prices.

Table 17. Impact of Bank Nifty on Nifty Returns - 30 Minutes

Dependent Variable : *NIFTY30MIN*

Method : Least Squares

Sample (adjusted) : 2 813

Included observaons : 812 a er adjustments

Variable	Coefficient	Std. Error	*t*-Statisc`	Prob.
C	10805.06	4.135245	2612.920	0.0000
DBN30MIN	0.123913	0.063822	1.941550	0.0225
R-squared	0.004632	Mean dependent var		10805.03
Adjusted *R*-squared	0.003403	*S.D.* dependent var		118.0363
S.E. of regression	117.8353	Akaike info criterion		12.37891
Sum squared resid	11246976	Schwarz criterion		12.39049
Log likelihood	–5023.839	Hannan-Quinn criter.		12.38336
F-stas c	3.769616	Durbin-Watson stat		0.025739
Prob(*F*-stas c)	0.052538			

Figure 11. Leverage Plotted Graph – 30 Minutes

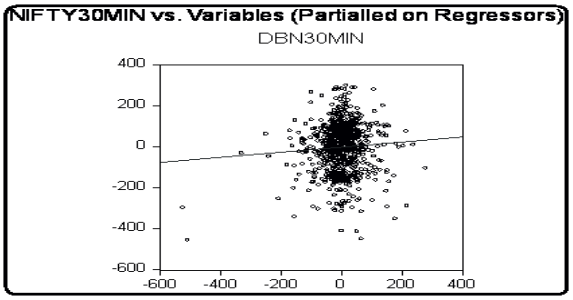


Table 18. Impact of Bank Nifty on Nifty Returns - 1 Hour

Dependent Variable : *NIFTY1HOUR*

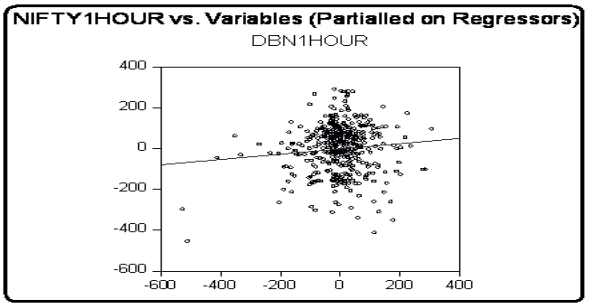
Method : Least Squares

Sample (adjusted) : 2 432

Included observaons : 431 a er adjustments

Variable	Coefficient	Std. Error	*t*-Statisc`	Prob.
C	10805.01	5.699310	1895.846	0.0000
DBN1HOUR	0.129457	0.061540	2.103631	0.0360
R-squared	0.010210	Mean dependent var		10804.94
Adjusted *R*-squared	0.007903	*S.D.* dependent var		118.7892
S.E. of regression	118.3189	Akaike info criterion		12.38927
Sum squared resid	6005724.	Schwarz criterion		12.40814
Log likelihood	–2667.888	Hannan-Quinn criter.		12.39672
F-stas c	4.425263	Durbin-Watson stat		0.050728
Prob(*F*-stas c)	0.035992			

Figure 12. Leverage Plotted Graph – 1 Hour



(vi) Nifty and Bank Nifty 1 Hour Analysis

↳ **H06 :** There is no significant influence of Nifty 1 hour indices on Bank Nifty.

The least square method depicts the regression weights of Nifty on Bank Nifty 1 hour data (i.e., from April 1, 2019 – June 30, 2019). The results show that Bank Nifty coefficient value is observed to be 0.129, which indicates that Bank Nifty has a positive influence on Nifty. Further, the *p* (probability) value seems to be less than 0.05, which means that the model is statistically significant at the 5% level and the *R* - Squared value is 0.0102, which indicates that the model is a weak fit. Hence, it is concluded from the Table 18 that the null hypothesis (H06) has been rejected. Hence, there is a significant influence of Nifty 1 hour on Bank Nifty.

The leverage plot (Figure 12) has been plotted between the 1 hour data of Nifty vs. Bank Nifty. The plotted lines are observed to be moving in the upward direction, which represents that Nifty 1 hour data is pushing Bank Nifty towards the upward direction. Hence, it is concluded that Nifty 1 hour prices have a significant influence on Bank Nifty prices.

Findings of the Study

(1) The ARCH family model, that is, the GARCH model estimates that Nifty volatility of 1 minute, 5 minutes, 10 minutes, and 15 minutes is observed to be having high volatility influence on Bank Nifty than 1 hour and 30 minutes time series data.

(2) The analysis reveals that 1 minute volatility returned prices have a significant strong influence on Bank Nifty as compared with the selected time period.

(3) The study synchronizes that 1 minute Nifty volatility has a narrow cluster than 1 hour Nifty volatility influence.

(4) Ordinary least square reveals that the coefficient value of 1 minute Bank Nifty shows a significant high influence and it is also stated that Nifty 5 minutes and 10 minutes data period also has a significant strong influence on Bank Nifty 5 minutes.

(5) The study observes that minute data of Nifty has a major influence on Bank Nifty than 1 hour prices and 30 minutes prices.

Conclusion and Implications

The present study has emphasized on the impact of the high frequency trading on the stock market. The study has

considered the historical time series data for a period of 3 months. The study has been bifurcated in 1 minute, 5 minutes, 10 minutes, 15 minutes, 30 minutes, and 1 hour time periods. The ARCH model has been applied to know the volatility impact and with the GARCH, it has been found that 1 minute Nifty volatility has a higher effect on the Bank Nifty 1 minute volatility. The OLS result states that the 1 minute Nifty influence has been observed to be higher than the other time periods on Bank Nifty.

Limitations of the Study and Scope for Further Research

The study has not considered the HFT seconds data relating to Bank Nifty and Nifty. The study has considered the 1 minute time period data to examine the HFT effect on the market. The study examined the HFT impact on indices (i.e., Bank Nifty and Nifty). The study has not considered the individual stocks, which are normally traded with the HFT. Due to time period constraints, three months historical time series data from NSE India has been considered. There is a need to do further research in this area by considering the impact of economic factors on the stock market in different time zone periods so that the investors will take informed decisions in the markets.

Author's Contribution

A. Kotishwar contributed to the design and implementation of the research, to the analysis of the results, and the writing of the manuscript.

Conflict of Interest

The author certifies that he has no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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