

An Analysis of Volatility in the Derivative Spot Market

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Abstract

Purpose: The derivative market has given a new dimension to the investors as well as the stock market structure. In India, there are a lot of investors who are not able to take high risks, so the development of derivatives has encouraged investors to trade in the stock market safely which may also affect the stock market volatility. In the current study, we have evaluated the influence of derivatives on spot market volatility in the last twelve years (2009 to 2022).

Design/Methodology/Approach: - For the analysis, time series data has been gathered for a period of twelve years from January 2009 to December 2022. Data has been collected from various indices such as the Nifty Junior Index, Nifty Index, Index futures, and S&P 500 Index. By taking the first log difference the closing price values have been converted into daily compound returns. Augmented Dicky Fuller test has been applied to convert time series data into stationary series. The Lagrange Multiplier test is performed to determine whether the data could be utilized in a GARCH (Generalized Autoregressive Conditional Heteroscedasticity) iterative procedure. The GARCH (1,1) model has been employed for the analysis.

Findings: Results of the GARCH (1,1) model indicate that whole spot market volatility has been reduced after introducing the derivatives. According to the findings, Nifty Junior Returns have an inverse relationship with Nifty returns. Similar results can be seen for S&P 500 returns and Nifty Junior which have an inverse relationship. The volatility has been reduced after introducing options and futures in the market. But it is also found that following the GARCH model utilized, options have a greater impact on Nifty returns because their coefficients are greater than the futures.

Research Implications/ Future Scope: - The findings of this study are important for stock exchange executives, retail and institutional investors, as well as regulators. The results suggest that futures and options trading assist in their prescribed role of improving the quality of information and pricing efficiency to the spot market. This will empower the investors to prudently structure their strategies in both options and futures markets. This study can be extended to commodity and currency derivatives too.

Originality of the Research: - This research is an original study towards investigating the impact of derivative trading on spot market volatility in an emergent market such as India.

Keywords: Market Analysis, Derivatives, Volatility, Trading, Spot Market

1. Introduction

Economic policy in India has been introduced in 1991 for implementing structural reforms for increasing the economic balance in India (Kumar & Suat Erturk, 2021). For regulating the stock market activities, the Security Exchange Board of India (SEBI) was established. The emergence or growth of the derivatives is to protect against the uncertainties to the investors (Arfaoui & Rejeb, n.d.). The core objective of derivatives is to reduce the risk of investments. For implementing various financial/economic policies, derivatives has given a new dimension towards the financial system (Venter & Maré, 2022). Derivatives contributed to tremendous progress in investments through contract trading and stock volume. Unfavourable price change may be a cause of sustaining losses (Sharif et al., 2020). The derivative market gives an option to the firm to transfer the risk towards its counterparty. That is why hedging is the major reason behind the introduction of contract trading through derivatives (Atkins et al., 2018). Between 2008 to 2010, SEBI introduced the derivatives contract on the volatility index. SEBI also introduced the index options with three years of tenure. The option contracts are introduced through the SENSEX and the Nifty with the term of five years (Gürbüz & Şahbaz, 2022a).

The derivative market is an interesting area for researchers, policymakers, investors, and financial organizations. The derivative market has given a great contribution to the various aspects of economic development (Kim & Won, 2018). A lot of empirical and theoretical studies defined the role of derivatives in emerging economies. A derivative market gives an effective system that can facilitate an atmosphere of sharing the price risk for the securities and commodities (Bala &

Takimoto, 2017). Derivatives play a very vital role in hedging and risk management by increasing the cash flow in developing and emerging countries (Aiswarya & Janani, 2020). But it has a negative factor also related to unpredictable crises (Yadav, n.d.). The derivative market is the channel of risk hedging and redistribution. With the help of the derivative market, the relevant information flow can be increased, because the future demand for the securities and commodities depends on the future price (Hong Vo et al., 2019). Risk hedging plays a very important role in economic growth and both factors have an inverse relationship with each other (Blanco & Wehrheim, 2017). Risk affects the aggregate volatility and unnecessary funding and economic growth can be increased through the relocation of the funds (Huang et al., 2017).

Some studies examined the dynamic associations among derivative markets, volatility, economic growth, and some other macroeconomic growth (Ding et al., 2017). The financial system can be complicated and varied in other countries, including banking and non-banking financial organizations, products (Roy & Sinha Roy, 2017a). Indian financial system can be divided into two groups, first is institutional and another is regulators. In the last decade, due to globalization and liberalization, there are multiple growths in the Indian economy have been witnessed (Morema & Bonga-Bonga, 2020). As a result, the demand for financial security and international funds have been increased at the international level (Woo & Kim, n.d.). Apart from it, changes in macroeconomic variables such as exchange rate, interest rate, etc., increase the risk in investments in the corporate world (Ghazali et al., 2020). Adverse changes can be dangerous for the survival of businesses (Singh et al., 2020). To reduce these risks, the financial derivative has been introduced dynamically in the security market, which provides a safe option to the investors for heavy investments in the form of, options, futures, swaps, and forwards via the OTC market as well as in exchange market (Vardar et al., 2018). This derivative also offers an option to gain profits for those investors who are not ready to take higher risk (Sharma & Rastogi, 2020). This instrument transfers the risk from those who are not able to take the risk to those investors who are ready to bear the risk (Junior et al., 2020). Changes in the prices of shares arising out of the selling and buying decisions of the potential investors. The volatility is the degree of price movements in a stock (Gürbüz & Şahbaz, 2022b). A higher degree of volatility means, the prices of the stock fluctuate in a wide range. The falling in price and immediately rising in price are associated with increased volatility. Increased volatility commonly related to the demand arises from the investors (Basher & Sadorsky, 2016).

In the early 1980s, index futures created a wide variety of market participants and investors seeking to alleviate market risk and provide major profits in trading, which attract major market players. Stock index futures have increased the attention of regulatory bodies, academicians, and researchers across the world (Dai & Zhu, 2022). Expiration day affects the abnormal movements of stock prices and the trading volume around the settlement day (Kumar & Suat Erturk, 2021) (Woo & Kim, n.d.). Four potential sources derived the effect of the expiration day. First is arbitrage trading in which the investors take benefit of the profitable difference between the index future and the value of underlying stocks (Kuang, 2022). Over the years, the derivative market become a trillion-dollar market (Farid et al., 2021). These are the financial commitments through contracts linked to changes in the value of the underlying assets. Derivatives are linked to currencies, equity, or equity indices (Basher & Sadorsky, 2016).

The first section of the present study focuses on understanding the derivative market, specifically trading in options and futures, by examining the website and market information along with the study of existing literature on derivative market and the volatility in derivative spot market. Further, the second section of this research paper is an explanation on the various aspects of derivatives market and the volatility in spot market which have been studied in the previous studies. Derivative spot market is rife with information asymmetry and uncertainty which provide an understanding of other factors that most frequently affect the volatility. To evaluate the volatility in spot market, the study undertakes to analyse Nifty Junior Index, Nifty Index, Index futures, and S&P 500 Index. The findings of this study reveal that overall spot market volatility has been reduced after introducing the derivatives and the overall variables are extremely considerable in the model. Nifty Junior Returns have an inverse relationship with Nifty returns. Similar results can be seen for S&P 500 returns and Nifty Junior which have an inverse relationship. The volatility has been reduced after introducing options and futures in the market. But in the GARCH model, options have a greater effect on Nifty returns because their coefficients are greater than the futures. The third section, outlines, the research methodology, data, and econometric model defined and collected for this study. Section four deals with the results and a discussion on the findings. Finally, the last section of the study given the conclusion followed by practical implications. Additionally, the study also defined the limitations and provides some indications for future research.

2. Literature Review

For analysing the effect of the Index Futures on spot market efficiency and its volatility of the underlying KOSPI 200 stocks by using non-KOSPI 200 stocks and concluded a parallel increase in volatility and the market efficiency (Roy & Sinha Roy, 2017b). Some other studies had found a substantial rise in index return volatility after the implementation

of Futures market (Garikai Bonga, SSRN, n.d.). Some opposing findings have argued that the implementation of Futures trading decreased the volatility in spot market. A derivative trading destabilizes the spot market by an additional route of information transmission (Shirodkar & Anjana Raju, 2021). By using GJR-GARCH (Glosten-Jagannath-Runkle Generalized Autoregressive Conditional Heteroscedasticity) and BEKK (Baba, Angle, Kraft & Kroner) model for the 21 European countries researcher analysed the Index Future effect on the international spot market and found that Spot market volatility had declined for most of the European countries under the research (*Futures Trading, Spot Price Volatility and Structural Breaks: Evidence from Energy Sector - ProQuest*, n.d.).

Liquidity provided by the speculators also increases the volatility of the spot market. The excess liquidity helps the spot market traders to hedge their position (Vadivel, 2021). Several studies Substantial decline in Indian spot market. The impact of trading in Future Index on the stocks of Dow Jones Industrial Average (DJIA) by using GARCH (1,1) model and found no change in volatility (Rahman, 2001). Changes in spot market volatility is not only due to derivatives, other factors are also responsible equally such as better information dissemination and better transparency (Raju & Shirodkar, 2020).

The impact of structural break on the spot future Oil prices and found that the break point affects the predicted oil futures volatility. Major studies focused on Index Futures and its impact on Spot market volatility (Pati et al., 2017). Many literature studies the effect on volatility with the introduction of Derivatives which concluded that the derivative market increases the depth of the market which reduces the volatility in spot market (Dungore & Patel, 2021). Turnover in the derivative market constitutes the big segment of derivative market. The reduction in volatility due to the futures effect plays a very important role ("Application of Garch Models to Estimate and Predict Financial Volatility of Daily Stock Returns in Nigeria," 2017). By using ARMA-EGARCH (Autoregressive Moving Average – Generalized Autoregressive Conditional Heteroscedasticity) model to investigate the asymmetric GARCH effect and the relationship of open interest and volume (*Futures Trading and the Underlying Stock Volatility: A Case of the FTSE/JSE TOP 40 | International Journal of Finance*, n.d.). According to the findings, volume is related positively with volatility where the open interest is related negatively when lagged open interest and lagged open volume have been considered (Buyukkara et al., 2022).

The effectiveness of hedging activities signified by the causality from volatility to open interest (Fong & Han, 2015). By using GARCH model it has been found a positive relationship among current open interest and lagged volume volatility in the Nifty index futures (Rasekhi & Nabavi, 2021). By using GARCH-MIDAS model it has been proved that the commodity market may be affected by both national and international levels of macroeconomic factors. Both levels of macroeconomic factors have a positive impression of the commodity market (Sreenu & Rao, 2021). A small volume of derivatives compares to the total volume, indexed in the commodity index. The international financial market had given quality changes in the last few decades due to growth in the derivative market in India (Umar et al., 2021). For implementing the financial policies, the derivative market plays a very important role, a variety of purposes may be considered but the most important purpose is hedging (Liu et al., 2020). A derivative market is helpful to the firms in transferring the market risk and the possibilities of sustaining losses due to unfavourable price changes. Derivatives need special care while processing data for their measurement. There may be an arbitrage transaction for a given underlying stock (Roy & Sinha Roy, 2017b). These underlying may be buying on the spot and selling it on the future date. For measuring accurately, the offer price at the spot market and the bid price in the future market are required (Tang et al., 2021). Bid and the offer prices fluctuate from time to time, in that case, the regular recordings of the offer price and bid price are important. Due to nonsynchronous data, the rate of returns obtained may be misleading (Nguyen & Truong, 2020).

3. Objective of the Research

The study investigates the influence of financial derivatives (options & futures) on the volatility of underlying spot market.

4. Research Methodology

For the analysis, time series data has been gathered for a period of twelve years from January 2009 to December 2022. Complete data has been collected from various indices such as Nifty Junior Index, Nifty Index, Index futures, and S&P 500 Index from the website www.nseindia.com. By taking first log difference, the closing price data has been converted to daily compound returns. In this work, to isolate the specific effects of derivatives on the spot market volatility, it was essential to remove the predictability related to world returns, so lagged return of the S&P 500 index has been taken. The Lagrange Multiplier test has been performed to determine whether the data could be utilized in a GARCH iterative procedure. AR(1)-GARCH (1,1) process has been used for the analysis (Rasekhi & Nabavi, 2021) (Raju & Shirodkar, 2020).

4.1 Model Specifications

4.1.1 ARCH (1) Model :- Autoregressive conditional heteroscedasticity (ARCH) model were introduces in 1982 by Engle. This model is zero mean, uncorrelated stochastic processes with non-constant variances conditional on the past. The simplest ARCH model is the ARCH(1) model defined as random variable Z which is characterized at time t by

$$\sigma_t^2 = \alpha_0 + \alpha^1 Z_{t-1}^2 \quad \dots(1)$$

$$\sigma_t^2 = \alpha_0 + \alpha^1 Z_{t-1}^2 + \dots + \alpha_n Z_{t-n}^2 \quad \dots(2)$$

Where $\alpha_0 \dots \alpha_n$ are control parameters and $Z_{t-1} \dots Z_{t-n}$ are random variables drawn from sets of random variables with Gaussian distribution of zero mean and standard deviations $\sigma_{t-1} \dots \sigma_{t-n}$ respectively.

4.1.2 GARCH (1,1) Model :

ARCH (1) model is the simplest autoregressive model. The GARCH (1,1) (Generalized Autoregressive Conditional Heteroscedasticity) is widely used for analyse the volatility. This model is more flexible than ARCH model in the lag structure. The defined equation is:-

$$\sigma_t^2 = \alpha_0 + \alpha^1 Z_{t-1}^2 + \dots + \alpha_p Z_{t-p}^2 + \beta_1 \sigma_{t-1}^2 + \dots + \beta_q \sigma_{t-q}^2 \quad \dots(3)$$

Where the constants $\alpha_0 \dots \alpha_p, \beta_1 \dots \beta_q$ are the control variables of the GARCH stochastic model. The GARCH model is used in the modelling of prices of the financial assets.

5. Results & Discussion

Now it is the time to re-evaluate the real effect of derivatives on underlying spot markets, nearly two decades after they have been introduced in India. Results are showing the influence of derivatives on the volatility in spot market. It is also important to evaluate whether, the derivatives has been achieved the actual purpose for which they are introduced (Roy & Sinha Roy, 2017b). Table No. 1 shows the statistical values of mean returns which are positive for all of the series in the complete duration which has been taken for the study. The mean return of the Nifty index is approx. .043 % and the Standard Deviation is 1.68. The returns are negatively skewed and kurtosis is higher than 3. The results of the JB test show that the null hypothesis of the normal distribution is rejected for the whole series.

Table:1 Descriptive statistics for sample period (January 2009 to December 2022)				
	Nifty	Nifty Junior	S&P 500 Index	Nifty Futures
Mean Returns	0.0445	0.0566	0.0243	0.0342
Maximum	15.3344	14.8345	11.9573	17.1844
Minimum	-16.8811	-18.4502	-8.4386	-16.5689
Std. Dev.	1.5877	1.8011	1.3801	1.7132
Kurtosis	11.0503	8.8332	11.0883	14.3044
Skewness	-0.3433	-0.1668	-0.1887	-0.7787
Jarque-Bera	14032.4500	7720.7230	12894.6700	23887.8000
Probability	0.0000	0.0000	0.0000	0.0000
Sum	180.0433	245.3254	103.6723	132.6432
Sum Sq. Dev.	13284.8700	14610.4500	7243.5680	8775.5390
Observations	4377	4377	4377	3401

Source: E-Views 12

Table No. 2 shows results of the ADF (Augmented Dicky-Fuller) test for converting time series data into stationary series. In this test the lag length is chosen on the Schewarz Information Criterion (SIC) criterion. As a result, all time series data are stationary at first difference. The results are also given by (Sreenu & Rao, 2021) (Rasekhi & Nabavi, 2021) and (Roy & Sinha Roy, 2017b).

Table 2: Augmented Dicky Fuller Test				
	Return Series	t-Statistics	Prob.*	Lag-length
Full Period	Nifty Junior	-56.67089	0	0
	Nifty	-45.5603	0	1
	S&P 500 Index	-50.89186	0	1

	Nifty Futures	-54.67989	0	1
*MacKinnon (1996) one-sided p-values.				
Exogenous: Linear Trend, Constant				
SC: Schwarz information criterion				

Source: E-Views 12

The ARCH-LM test outcomes are shown in Table 3. The analysis begins with the residual term for mean equation for five lags using the following model.

Table 3: Heteroskedasticity Test-ARCH				
F-Statistics	64.952	Prob.F(5,4344)	0.0000	
Obs* R squared	299.2459	Prob.Chi-Square (5)	0.0000	
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.5777	0.1402	11.2540	0.0000
RESID^2(-1)	0.1559	0.0151	10.3085	0.0000
RESID^2(-2)	0.0927	0.0153	6.0757	0.0000
RESID^2(-3)	0.0286	0.0153	1.8660	0.0621
RESID^2(-4)	0.0832	0.0153	5.4539	0.0000
RESID^2(-5)	0.0783	0.0151	5.1785	0.0000
Dependent Variable: RESID^2				
Method: Least Squares				
Observations included: 4350 after adjustments				
Adjusted R-squared	0.0675	S.D. dependent var	8.2066	
R-squared	0.0686	Mean dependent Var	2.8111	
Sum squared resid	272817.2	Schwarz criterion	6.9881	
S.E. of Regression	7.9248	Akaike info criterion	6.9793	
F-statistic	63.9516	Durbin-Watson stat	2.0061	
Log-likelihood	-15173.89	Hannan-Quinn criterion	6.9824	
Prob(F-statistic)	0			

Source: E-Views 12

The value of F statistics is 63.951 which is considered to be extremely considerable. The R-Square value is 0.068, whereas the adjusted R-Squared value is 0.0675. Therefore, we may say that ARCH's effects are adequate, even if the null hypothesis was rejected. Table No. 4 reveals AR (1)- GARCH(1,1) model regarding the pre-derivatives phase. The constant ARCH (1) lagged residual returns coefficient α_1 (lagged Nifty returns) and GARCH (1) Nifty junior returns, according to the model, are extremely significant. The highest β_1 value is 0.7883 indicates that the old information has a lasting effect on Nifty prices, especially in the pre-derivative period. The value of the significant coefficient of 0.0761 shows that current news also has an immediate effect on the Nifty prices. But the Nifty Junior returns have a negative relationship with Nifty returns in the pre-derivative period.

Table 4: GARCH (1,1) Estimates for Pre-Derivatives Period					
Variance Equation					
α_0	Variable	Coefficient	Std. Error	z-Statistics	Prob.
α_1	Constant	0.5276	0.1365	3.8643	0.0001
α_2	ARCH(1)	0.0653	0.0161	4.0509	0.0001
β_1	GARCH (1) (Rt-1)	0.7884	0.0472	16.7086	0.0000
δ_1	Lagged Nifty Junior Returns (Rt-1, Nifty Junior)	-0.0987	0.0350	-2.8236	0.0047
δ_2	S&P 500 Index Returns (Rt, S&P500)	-0.2443	0.0575	-4.2499	0.0000
Adjusted R-squared		0.0003	S.D. dependent var	1.8542	

R-squared	-0.0006	Mean dependent var	0.0464
Sum squared resid	3653.4390	Schwarz criterion	4.0502
S.E. for regression	1.8539	Akaike info criterion	4.0268
Durbin-Watson stat	1.9001		
Log-likelihood	-2135.2680	Hannan-Quinn Criter.	4.0357
Technique: ML-ARCH (Marquardt) - Normal distribution After 16 iterations, convergence was obtained. Included observations: 1063 after adjustments Pre-sample variance: backcast (parameter=0.7) GARCH = C(1) + C(2)*RESID(-1)^2 + C(3)*GARCH(-1) + C(4)*JRETURNS(-1) + C(5)*SRETURNS			

Source: Results (E-Views 12)

Table 5 shows the results of AR(1) – GARCH (1,1) approximates the post-derivative period. The coefficient of the future dummy is -0.0519, which was extremely considerable at the 1% significance level, while the coefficient of the options dummy is -0.5469, according to the findings, was also be a significant and inverse relationship with Nifty returns.

Table 5: GARCH (1,1) Estimates post-derivatives Period					
	Variable	Coefficient	Std.Error	z-Statistics	Prob.
	AR(1)	0.1161	0.0185	6.2666	0.0000
	Constant	0.1308	0.0253	5.1804	0.0000
Variance Equation					
α_0	Constant	1.0561	0.0665	15.8867	0.0000
α_1	ARCH(1)	0.2315	0.0155	14.8850	0.0000
β_1	GARCH(1) (Rt-1)	0.5848	0.0188	31.1128	0.0000
δ_1	Rt-2, Nifty Junior	-0.1020	0.0126	-8.0669	0.0000
δ_2	Rt-2,S&P 500	-0.2926	0.0091	-32.1248	0.0000

Source: Results (E-Views 12)

Table 6 clearly shows that the spot market's volatility has decreased with the introduction of derivatives, as the findings reveal. The contribution of β_1 (GARCH (1)) coefficient is higher than 0.584 in model which indicates at t01 day had a higher influence on Nifty prices on 't' day. As per the NSE data till December 2020, the Index option has traded at Rs. 53,76543 crores and Stock futures have traded around Rs 25634.50 crores.

Table 6: The traded value of NSE Futures and Options Segment as of December 2020		
Product	No. of Contracts	Traded Value (Rs. Crore)
Index Futures	674057	1807354
Stock Futures	727098	25634.50
Index Options	1794126	5376543
Stock Options	331978	6677.76
F&O Total	3527259	7216209.26

Source: Author Compilation

6. Conclusion

The present research demonstrates that derivatives may minimize spot market volatility in the financial market of India. The model's AR (1)-GERCH (1,1) reveal that overall spot market volatility has decreased with the introduction of derivatives, and the overall variables in the model are extremely significant. According to the findings, Nifty Junior Returns have an inverse relationship with Nifty returns which are lagged by two days. Similar results can be seen for S&P 500 returns and Nifty Junior which have an inverse relationship and are lagged by two days. The volatility has been reduced after introducing options and futures in the market. But in the GARCH model, options have a greater effect on Nifty returns because their coefficients are greater than the futures.

The findings of this study are important for stock exchange executives, investors, as well as for the regulators. The derivatives have significant contribution in the price determination methods. It will also play a role in risk management for mutual fund managers and institutional investors. This study can be analysed in detail through GARCH family

models. This study can also be extended to a comparative study of risk hedging factors through the derivative trading in different developing countries and their impact on overall spot market volatility.

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