DERIVATIVES TRADING AND VOLATILITY - A STUDY OF THE INDIAN STOCK MARKETS

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Abstract:
The study is to understand the volatility linked between Nifty index and Nifty derivative segment i.e. Nifty futures and options while applying the Arch and Garch(1,1)model of time series. The study uses the daily closing price of Nifty index and Nifty future and option contract traded price of both the exchanges and period taken for analysis before and after the pioneer of nifty future and options were introduced is (1996-2000) and (2000-2020) for futures and (2001-2020) for options. This paper aims to analyse the volatility of the market with the linkage between NSE and nifty derivative segment, it helps the investor to better understand the market scenario and its implementation for investors.

Key words: Nifty index, Nifty derivative segment, Time series model, volatility

DOI: 10.53555/ecb/2021.10.2.05

Introduction

Financial market is known to play a Vitol role in understanding the economics of the country.it helps to understand one of the major aspects of the country development. importance of the financial market is to understand the financial scenario and volatility of the market with the help of time series model. The volatility of any market is considered to be to be uncertain with the changes in any economic situation.

Equity derivatives in India were launched as part of capital market reforms to hedge price risk from greater financial integration between nations in the 1990s, these reforms were an integral part financial sector reforms recommended by the Narasimham Committee Report on the Financial System, in September 1992. These reforms were aimed at strengthening, competition, transparency and efficiency in Indian financial market. More than a decade of reforms brought about a major transformation and structural changes during this period such as the transition to electronic trading from floor level trading, cancellations "Badla" transactions and introduction of "rolling" settlement gradually on "T+2" to improve the cash market operations in India. Furthermore, not only new financial products such as derivatives, exchange-traded funds and hedge funds were allowed, but so were foreign players such as foreign institutional investors (FIIs). invest in India. The introduction of derivatives in India was recommended by L.C. Gupta Committee Report on derivatives in 1997 by stages. Accordingly, stock index futures were introduced First. BSE was the first exchange in the country to start trading in BSE-based index futures Sensex on 9 June 2000. NSE also started its trading on 12 June 2000 based on S&P Nifty. Subsequently, other products such as stock futures for individual securities were introduced in November 2001. This was followed by the approval of index options trading based on these two indices and options about individual securities. Volumes in derivatives markets, especially futures and options the NSE segment has witnessed a huge increase and now the turnover is much higher than u turnover in cash markets. Till date only four derivatives are available in India markets, namely index futures, index options, stock futures and stock options.

One of the major aspects for introducing the derivative segment in India was the high volatility. The Indian stock market is one of the most volatile markets compared to other developed countries in the world. This study is to understand the impact of derivative segment over the cash segment. This paper also tries to explain their impact on people mindset towards the derivative segment.

Review of literature:

Najaar,(2016) To capture the symmetry effect in Amman Stock exchange data, both ARCH and GARCH (1, 1) model is employed. The primary empirical findings of the stock return data is far from normality, whereas it showed existence of conditional Heteroscedasticity; in other words volatility clustering. Moreover, the statistical output reveals evidence for leptokurtosis, long memory, skewed to left (fat tailed), and persistence of volatility (Najjar, 2016).

Sirisha & Kalyan(2019) study concludes that the Options give more returns compared to futures. The stock market will give high returns to the investors who can bear high risk. Where derivatives are an instrument used to minimize the risk and covered the loss occurred in the stock market. The options will give more returns and less risk when compared to futures (Sirisha & kalayan, 2019).

Wats(2017) It is found that the effect of both the expiration days and expiration weeks on the spot market volatility is very significant. Volatility on expiration and expiration days designates those investors are unsure and desire to roll over their position. It can be concluded that due to the introduction of futures and options of the near month, the spot market volatility has increased in the expiration days and expiration weeks. The manipulation by speculators may be the central basis behind high volatility during and subsequent to expiry of these contracts. The effect of expiry day volume on return and volatility shows that affirmative and significant causality is running from volume to volatility and return which focuses on the fact that prices are speculative and the traders take large spot positions to cover their risk thereby accentuating the volatility during the expiration period.

Gakhar,(2016) The study suggests that after the introduction of derivatives in the Indian financial markets, volatility of spot market has reduced. The final AR (1)-GARCH (1,1) model show that overall volatility has reduced in the spot market after the introduction of derivatives. In the model all variables are highly significant. An analysis shows that overall derivatives market has been able to achieve the purpose for which it was established. It has been able to reduce the volatility of the stock market over a period of more than a decade of its establishment (Gakhar, Indian Derivatives Market: A Study of Impact on Volatility and Investor Perception, 12, December 2016) (sah & omkarnath, 2019).

GAHLOT, Datta, & Kapil (2010) He has studied the behaviour of volatility of stock market after introduction of future by using GARCH (1, 1) model. He has considered S&P CNX Nifty and 10 individual stocks of which 5 are derivative stock and another 5 are derivative stocks. In case of index future, the volatility in the S&P CNX Nifty has declined after the introduction of S&P CNX Nifty future but the magnitude of dummy variable is very low which shows decline in volatility is very low. In case of 7 individual stocks, it shows an increase in volatility but there are 3 stocks which shows reduction in the volatility. There is, thus, mixed results regarding the impact of introduction of future on the underlying spot market volatility. Nifty shows contradictory pattern of increase in its unconditional GARCH volatility. This may be due to bundling effect of constituent stocks of Nifty (GAHLOT, Datta, & Kapil, 2010)

Sah & Omkarnath, (2006) The impact of the introduction of the futures and options on the volatility of the underlying markets is negligible as evident from the magnitude of the coefficients of the futures and options dummies. The impact of recent news has increased in the post- introduction phase of Nifty futures while the volatility in returns arising from the effect of old news has declined implying that the quality of information flowing has improved to the cash market (sah & omkarnath, 2019).

Mallikarjunappa & E.M., (2008) study concludes that the introduction of derivatives has not brought the desired outcome of decline in volatility. However, the result of the Chow test for parameter stability clearly indicates structural change in the coefficients of pre-futures and post-futures periods, suggesting a change in the nature of volatility patterns during the post futures period. Based on the results, it is inferred that any change in the volatility process is not due to the introduction of derivatives, but may be due to many other factors, including better information dissemination and more transparency. The speed of information flow must have increased so that the response level of stocks is more sensitive to recent innovations in the post- derivatives period. Further research is recommended to measure the changes in information flow due to the introduction of derivatives (Mallikarjunappa & Afsal, 2008**)**.

Research Methodology:

Date type	Analytical and secondary data
Sampling type	Non probability and convince
Sampling frame	Nifty Equity and Nifty derivative index
Duration of study	Before the introduction of future and options 1996-2001(Future) 1996-2002(options) After the introduction of future and options 2001-2020 (Future) 2002-2020 (Option)

Objective of the study:

Data Analysis:

Case1- To understand the volatility of Nifty before the Introduction of options

1. The data is taken between the time of February 1996 to April 2001 before the future is introduced.
2. To conduct the unit root test for understanding the data is stationary or non-stationary, if not the convert into stationary data to further continue with variable model

To estimate the data hypothesis testing is done
H0- There is a unit root series that means that data is not stationary H1- There is a unit root test that means that the data is stationary

Where Probability should be ≤ 5% (means series is stationary)

Augmented Dickey-Fuller Unit Root Test on NIFTY_CP

Null Hypothesis: NIFTY_CP has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=22)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.083018	0.2517
Test critical values:	1% level	-3.435142	
	5% level	-2.863544	
	10% level	-2.567886	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(NIFTY_CP)
Method: Least Squares
Date: 02/11/22 Time: 23:15
Sample (adjusted): 2/02/1996 4/30/2001
Included observations: 1307 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
NIFTY_CP(-1)	-0.005874	0.002820	-2.083018	0.0374
C	6.928556	3.285524	2.108813	0.0352

R-squared	0.003314	Mean dependent var	0.195608
Adjusted R-squared	0.002550	S.D. dependent var	21.31956
S.E. of regression	21.29236	Akaike info criterion	8.956103
Sum squared resid	591640.8	Schwarz criterion	8.964022
Log likelihood	-5850.813	Hannan-Quinn criter.	8.959073
F-statistic	4.338963	Durbin-Watson stat	1.890660
Prob(F-statistic)	0.037444		

Table-1 unit root test SR

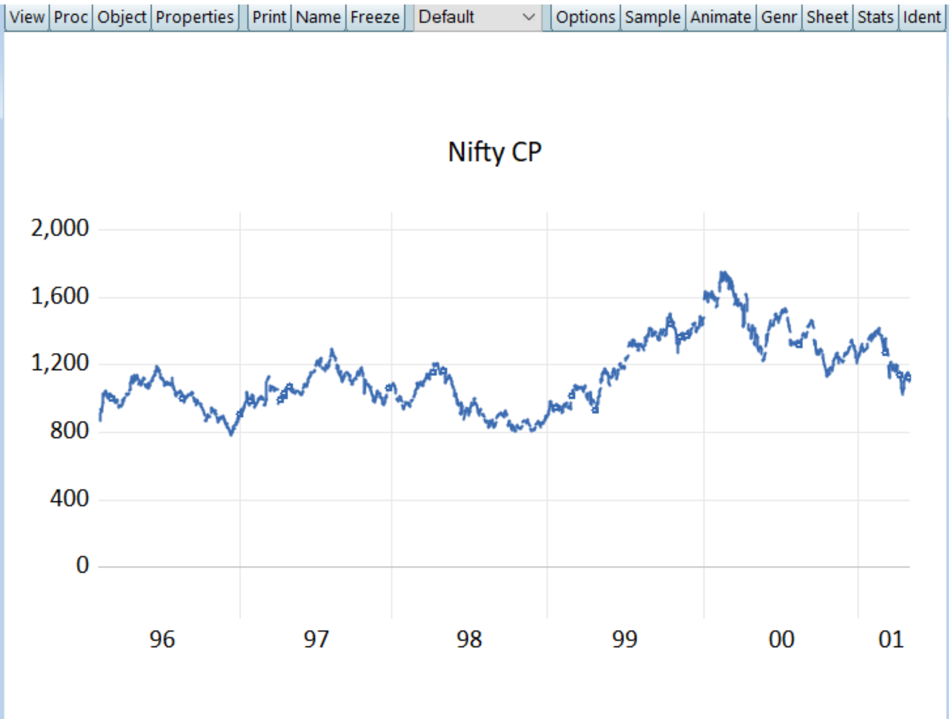


Figure -1 Non- stationary graph of before introduction of Option treading

As we can understand that the probability in 25% which means H0 is accepted an also as we see the graph it can be explained that the graph as soon trends in its which Cleary shows that the data is non stationary so it needs to be converted into stationary data.

To convert it into stationary data the new object should be created and command is return.

Augmented Dickey-Fuller Unit Root Test on DNIFTY

Null Hypothesis: DNIFTY has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=22)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-34.40661	0.0000
Test critical values:	1% level	-3.435146	
	5% level	-2.863545	
	10% level	-2.567887	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DNIFTY)
Method: Least Squares
Date: 02/11/22 Time: 23:13
Sample (adjusted): 2/05/1996 4/30/2001
Included observations: 1306 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DNIFTY(-1)	-0.950171	0.027616	-34.40661	0.0000
C	0.149573	0.588501	0.254158	0.7994

R-squared	0.475845	Mean dependent var	-0.019043
Adjusted R-squared	0.475443	S.D. dependent var	29.36350
S.E. of regression	21.26689	Akaike info criterion	8.953711
Sum squared resid	589774.2	Schwarz criterion	8.961635
Log likelihood	-5844.773	Hannan-Quinn criter.	8.956683
F-statistic	1183.815	Durbin-Watson stat	1.998660
Prob(F-statistic)	0.000000		

Table-2-unit root test SR

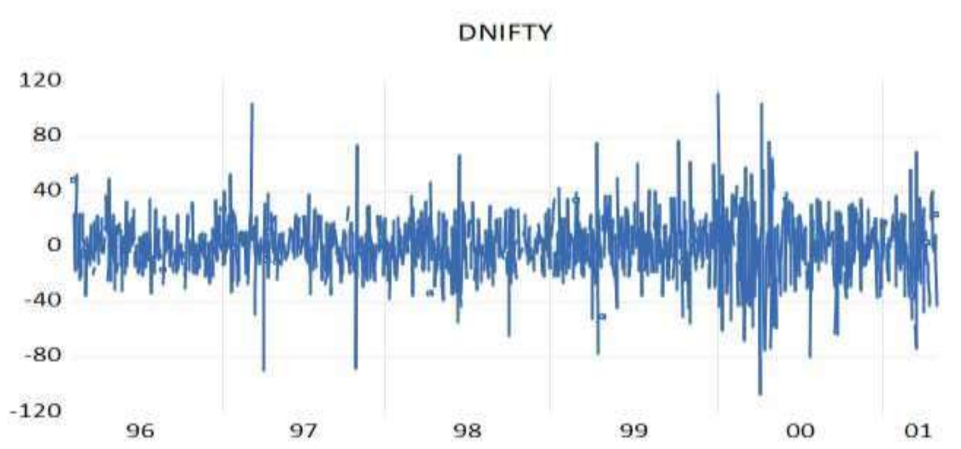


Figure -2 stationary graph of before introduction of Option treading

Form the above graph it can be seen that the it is converted into stationary data and as well as the probability value is ≤ **5% which means that the alternate hypothesis is accepted.**

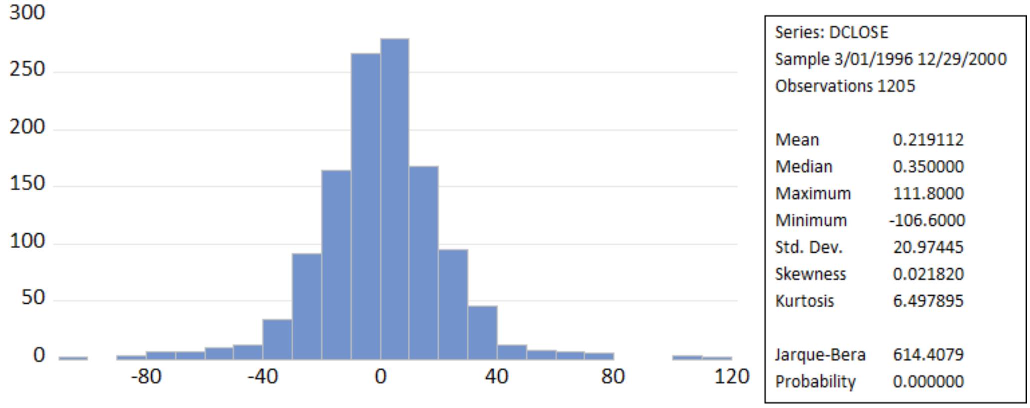


Figure-3 Histogram ADF SR NIFTY50

Modelling the Arch Model

As the unit root data shows that the data is stationary which shows the normality thus arch effect is present

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: DNIFTYCP
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Date: 02/12/22 Time: 01:35
Sample (adjusted): 3 1308
Included observations: 1306 after adjustments
Convergence achieved after 14 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*RESID(-2)^2 + C(6)*RESID(-3)^2

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.619657	0.486926	-1.272589	0.2032
DNIFTYCP(-1)	0.088648	0.031431	2.820392	0.0048
		Variance Equation		
C	245.6409	11.76182	20.88459	0.0000
RESID(-1)^2	0.246157	0.032000	7.692384	0.0000
RESID(-2)^2	0.103251	0.025641	4.026855	0.0001
RESID(-3)^2	0.130386	0.028158	4.630474	0.0000

R-squared	0.000541	Mean dependent var	-0.177458
Adjusted R-squared	-0.000225	S.D. dependent var	21.31762
S.E. of regression	21.32002	Akaike info criterion	8.850004
Sum squared resid	592724.5	Schwarz criterion	8.873778
Log likelihood	-5773.053	Hannan-Quinn criter.	8.858922
Durbin-Watson stat	2.059987		

The first part of the table corresponds to the mean equation and second part corresponds to the variable equation
Mean equation
Nifty closing price (NCP) = -0.6196 +0.0886 NCP(t-1) + ∈t
Variance equation
$Ht=245.6409 + 0.24615h^2{}_{t-1} + 0.10325\ h^2{}_{t-2} + 0.13038\ h^2{}_{t-3}$
As we can see that the variance adds up to 0.4978
The persistent of the volatility is higher as it is closed to 1. More lags can be added to achieve higher volatility.

Modelling of Garch Model

Dependent Variable: DCLOSE
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Date: 03/28/22 Time: 23:07
Sample (adjusted): 3/06/1996 12/29/2000
Included observations: 1204 after adjustments
Convergence achieved after 21 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.618092	0.568599	1.087044	0.2770
DCLOSE(-1)	0.072911	0.032419	2.249007	0.0245
Variance Equation				
C	19.07535	3.290951	5.796302	0.0000
RESID(-1)^2	0.081506	0.011420	7.137274	0.0000
GARCH(-1)	0.876402	0.013556	64.65105	0.0000

R-squared	0.000029	Mean dependent var	0.219817
Adjusted R-squared	-0.000803	S.D. dependent var	20.98315
S.E. of regression	20.99157	Akaike info criterion	8.809611
Sum squared resid	529656.6	Schwarz criterion	8.830763
Log likelihood	-5298.386	Hannan-Quinn criter.	8.817578
Durbin-Watson stat	2.064383		

Table-4 Garch Model Nifty 50

- Here dependent variable is C (spot rate)
- Garch (1,1) model is used to check significant volatility
- Coefficient of future rates is 0.618092 which shows significant with the spot rates return. Whereas constant score is 0.07291.
- Which means that if constant is 0.07291 then dependency of Spot rate is 0.618092 times of Future rate.
- Further Durbin Watson stat tells us whether our model suffer 'serial correlation problem'. The Durbin- Watson statistic will always have a value ranging between 0 and 4
- If it is close to 2; No serial correlation in the model
- If it is close to 0; positive correlation in the model
- If it is close to 4; Negative correlation in the model

A rule of thumb is that DW test statistic values in the range of 1.5 to 2.5 are relatively normal. Values outside this range could, however, be a cause for concern in our model we found 2.064833 indicating no serial correlation in the model.

Case2- To understand the volatility of Nifty before the Introduction of future

1. The data is taken between the time of February 1996 to April 2000 before the future is introduced
2. To conduct the unit root test for understanding the data is stationary or non-stationary, if not the convert into stationary data to further continue with variable model

To estimate the data hypothesis testing is done
H0- There is a unit root series that means that data is not stationary H1- There is a unit root test that means that the data is stationary

Where Probability should be ≤ 5% (means series is stationary)

Augmented Dickey-Fuller Unit Root Test on DCLOSE

Null Hypothesis: DCLOSE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=22)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-33.32595	0.0000
Test critical values:	1% level	-3.435567	
	5% level	-2.863732	
	10% level	-2.567987	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DCLOSE)
Method: Least Squares
Date: 03/26/22 Time: 14:49
Sample (adjusted): 3/06/1996 12/29/2000
Included observations: 1204 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DCLOSE(-1)	-0.960681	0.028827	-33.32595	0.0000
C	0.211672	0.604538	0.350138	0.7263

R-squared	0.480243	Mean dependent var	0.012650
Adjusted R-squared	0.479810	S.D. dependent var	29.08269
S.E. of regression	20.97565	Akaike info criterion	8.926261
Sum squared resid	528853.4	Schwarz criterion	8.934722
Log likelihood	-5371.609	Hannan-Quinn criter.	8.929448
F-statistic	1110.619	Durbin-Watson stat	1.998826
Prob(F-statistic)	0.000000		

Table-5-unit root test SR

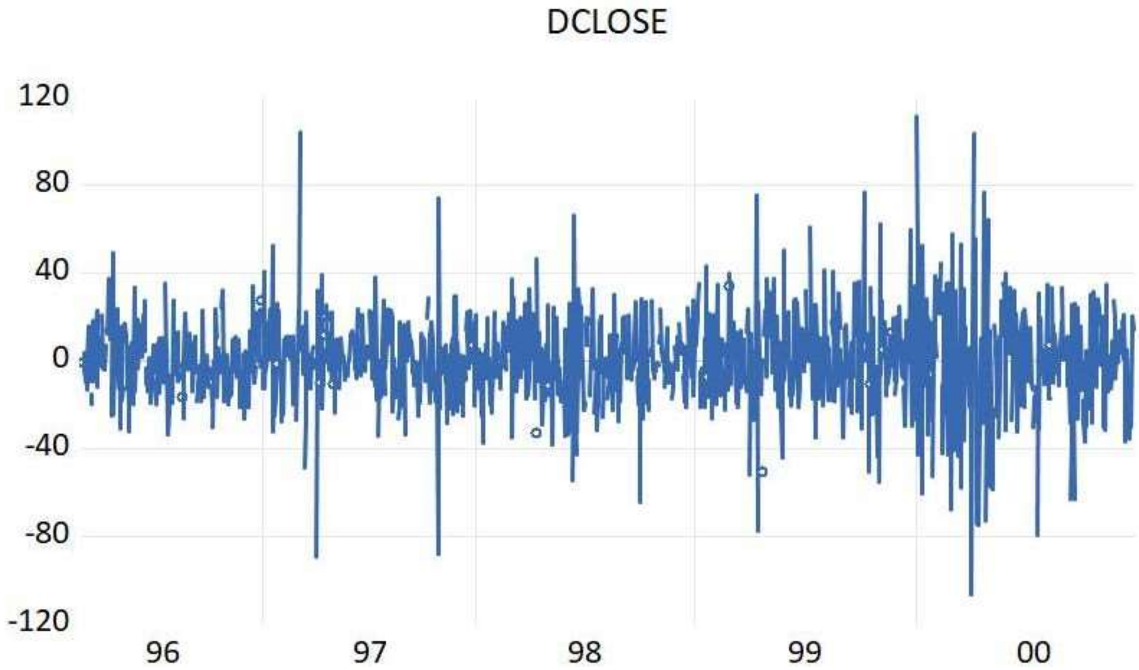
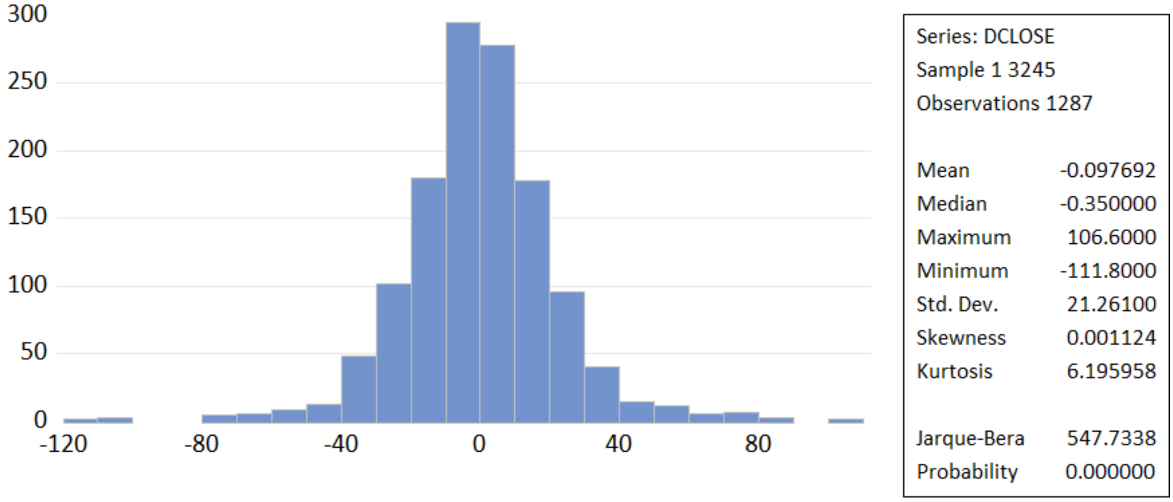


Figure -4 stationary graph of before introduction of Future treading x

Figure -5 Histogram ADF SR NIFTY50



Modelling the Arch Model

As the unit root data shows that the data is stationary which shows the normality thus arch effect is present.

Dependent Variable: DCLOSE
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Date: 03/28/22 Time: 23:14
Sample (adjusted): 3 1288
Included observations: 1286 after adjustments
Convergence achieved after 12 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.490886	0.516954	-0.949574	0.3423
DCLOSE(-1)	0.111366	0.029045	3.834309	0.0001
		Variance Equation		
C	336.5981	10.24467	32.85593	0.0000
RESID(-1)^2	0.259348	0.033057	7.845488	0.0000

R-squared	-0.002317	Mean dependent var	-0.079184
Adjusted R-squared	-0.003097	S.D. dependent var	21.25889
S.E. of regression	21.29179	Akaike info criterion	8.886057
Sum squared resid	582088.8	Schwarz criterion	8.902105
Log likelihood	-5709.735	Hannan-Quinn criter.	8.892082
Durbin-Watson stat	2.113625		

Table-6 Arch Model Nifty50

- The first part of the table corresponds to the mean equation and second part corresponds to the variable equation

Mean equation

Nifty closing price (NCP) = -0.4908 + 0.1111 NCP(t-1) + ∈t Variance equation

Ht=245.6409 + 0.2593h^2_{t-1}

As we can see that the variance adds up to 0.2593

The persistent of the volatility is higher as it is closed to 1. More lags can be added to achieve higher volatility.

Modelling of Garch Model

Dependent Variable: DCLOSE
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Date: 03/26/22 Time: 14:58
Sample (adjusted): 3/06/1996 12/29/2000
Included observations: 1204 after adjustments
Convergence achieved after 21 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.618092	0.568599	1.087044	0.2770
DCLOSE(-1)	0.072911	0.032419	2.249007	0.0245
Variance Equation				
C	19.07535	3.290951	5.796302	0.0000
RESID(-1)^2	0.081506	0.011420	7.137274	0.0000
GARCH(-1)	0.876402	0.013556	64.65105	0.0000

R-squared	0.000029	Mean dependent var	0.219817
Adjusted R-squared	-0.000803	S.D. dependent var	20.98315
S.E. of regression	20.99157	Akaike info criterion	8.809611
Sum squared resid	529656.6	Schwarz criterion	8.830763
Log likelihood	-5298.386	Hannan-Quinn criter.	8.817578
Durbin-Watson stat	2.064383		

Table-7 Garch Model Nifty 50

- Here dependent variable is C (spot rate)
- Garch (1,1) model is used to check significant volatility
- Coefficient of future rates is 0.618092 which shows significant with the spot rates return. Whereas constant score is 0.07291.
- Which means that if constant is 0.007291 then dependency of Spot rate is 0.618092 times of Future rate.
- Further Durbin Watson stat tells us whether our model suffer 'serial correlation problem'. The Durbin- Watson statistic will always have a value ranging between 0 and 4.
- If it is close to 2; No serial correlation in the model
- If it is close to 0; positive correlation in the model
- If it is close to 4; Negative correlation in the model

A rule of thumb is that DW test statistic values in the range of 1.5 to 2.5 are relatively normal. Values outside this range could, however, be a cause for concern in our model we found 2.064833 indicating no serial correlation in the model.

Case3 - To understand the volatility of Nifty after the Introduction of future

1. The data is taken between the time of February 2000 to March 2020 before the future is introduced
2. To conduct the unit root test for understanding the data is stationary or non-stationary, if not the convert into stationary data to further continue with variable model

To estimate the data hypothesis testing is done
H0- There is a unit root series that means that data is not stationary H1- There is a unit root test that means that the data is stationary

Where Probability should be ≤ 5% (means series is stationary)

Null Hypothesis: DCLOSE has a unit root
Exogenous: Constant
Lag Length: 6 (Automatic - based on SIC, maxlag=32)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-26.32101	0.0000
Test critical values:	1% level	-3.431423	
	5% level	-2.861899	
	10% level	-2.567004	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DCLOSE)
Method: Least Squares
Date: 03/28/22 Time: 19:58
Sample (adjusted): 1/19/2000 12/31/2020
Included observations: 5214 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DCLOSE(-1)	-0.924617	0.035128	-26.32101	0.0000
D(DCLOSE(-1))	-0.049935	0.032364	-1.542904	0.1229
D(DCLOSE(-2))	-0.022377	0.029873	-0.749064	0.4539
D(DCLOSE(-3))	-0.015042	0.026820	-0.560864	0.5749
D(DCLOSE(-4))	-0.023359	0.023424	-0.997237	0.3187
D(DCLOSE(-5))	0.025304	0.019369	1.306367	0.1915
D(DCLOSE(-6))	-0.063469	0.013847	-4.583613	0.0000
C	2.196697	1.037308	2.117689	0.0342

R-squared	0.499847	Mean dependent var	0.000901
Adjusted R-squared	0.499174	S.D. dependent var	105.5132
S.E. of regression	74.67068	Akaike info criterion	11.46559
Sum squared resid	29027148	Schwarz criterion	11.47565
Log likelihood	-29882.78	Hannan-Quinn criter.	11.46910
F-statistic	743.2581	Durbin-Watson stat	2.001126
Prob(F-statistic)	0.000000		

Table-8-unit root test FR

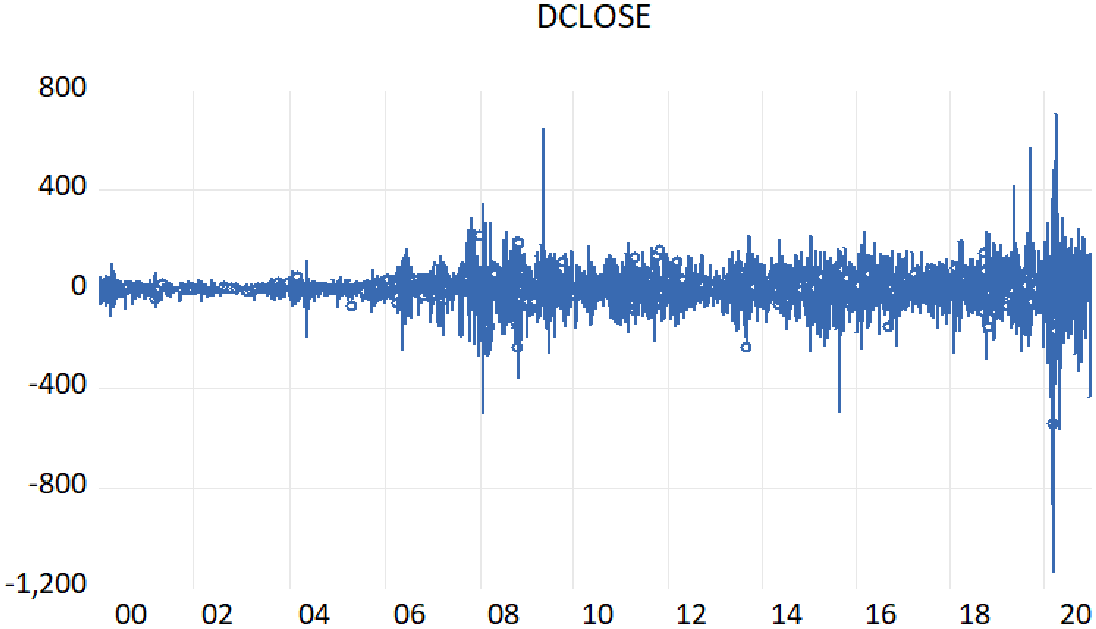
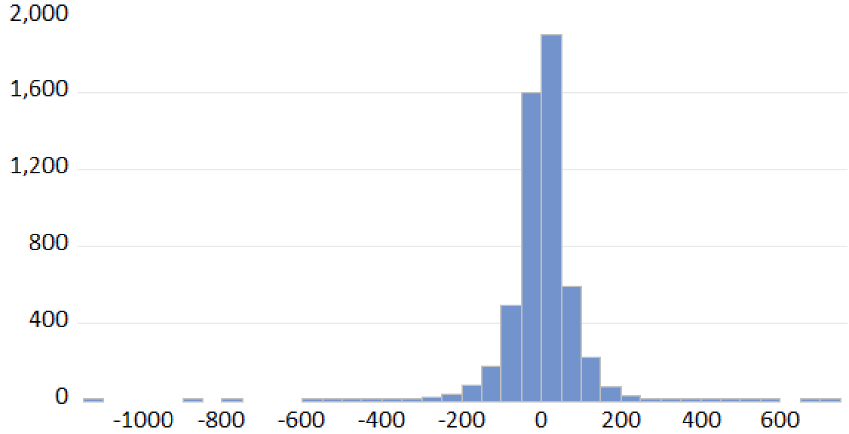


Figure -6 stationary graph of after introduction of option treading
Source- data ran in EViews software



Series: DCLOSE
Sample 1/07/2000 12/31/2020
Observations 5221

Mean	2.368981
Median	3.300000
Maximum	708.4000
Minimum	-1135.200
Std. Dev.	75.16259
Skewness	-1.143252
Kurtosis	26.33900
Jarque-Bera	119634.2
Probability	0.000000

Figure -7 Histogram ADF FR NIFTY50

Modelling Of Arch Model

As the unit root data shows that the data is stationary which shows the normality thus arch effect is present.

Dependent Variable: DCLOSE
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Date: 03/28/22 Time: 23:19
Sample (adjusted): 1/11/2000 12/31/2020
Included observations: 5220 after adjustments
Convergence achieved after 16 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	2.342266	0.680754	3.440693	0.0006
DCLOSE(-1)	0.170891	0.003096	55.20130	0.0000
Variance Equation				
C	2852.941	38.89222	73.35505	0.0000
RESID(-1)^2	0.636061	0.015867	40.08759	0.0000

R-squared	-0.023895	Mean dependent var	2.365680
Adjusted R-squared	-0.024091	S.D. dependent var	75.16941
S.E. of regression	76.06947	Akaike info criterion	11.24615
Sum squared resid	30194290	Schwarz criterion	11.25118
Log likelihood	-29348.45	Hannan-Quinn criter.	11.24791
Durbin-Watson stat	2.312891		

Table-9 Arch Model Nifty50

The first part of the table corresponds to the mean equation and second part corresponds to the variable equation

Mean equation

Nifty closing price (NCP) = 2.34 + 0.17089 NCP(t-1) + ∈t

Variance equation

Ht=245.6409 + 0.6360h^2_{t-1}

As we can see that the variance adds up to 0.6366

The persistent of the volatility is higher as it is closed to 1. More lags can be added to achieve higher volatility.

Modelling Of Garch Model

Table-10 Garch Model Nifty50

Dependent Variable: DCLOSE
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Date: 03/28/22 Time: 20:02
Sample (adjusted): 1/11/2000 12/31/2020
Included observations: 5220 after adjustments
Convergence achieved after 36 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	1.285864	0.359548	3.576341	0.0003
DCLOSE(-1)	0.079495	0.014883	5.341353	0.0000
Variance Equation				
C	1.837483	0.494414	3.716489	0.0002
RESID(-1)^2	0.097364	0.004930	19.74837	0.0000
GARCH(-1)	0.912524	0.004122	221.4031	0.0000

R-squared	-0.003978	Mean dependent var	2.365680
Adjusted R-squared	-0.004171	S.D. dependent var	75.16941
S.E. of regression	75.32600	Akaike info criterion	10.66068
Sum squared resid	29606967	Schwarz criterion	10.66696
Log likelihood	-27819.36	Hannan-Quinn criter.	10.66287
Durbin-Watson stat	2.131667		

Table-10 Garch Model Nifty50

- Here dependent variable is C (spot rate)
- Garch (1,1) model is used to check significant volatility
- Coefficient of future rates is 1.28564 which shows significant with the spot rates return. Whereas constant score is 0.07945.
- Which means that if constant is 0.07945 then dependency of Spot rate is 0.12856 times of Future rate.
- Further Durbin Watson stat tells us whether our model suffer 'serial correlation problem'. The Durbin- Watson statistic will always have a value ranging between 0 and 4.
- If it is close to 2; No serial correlation in the model
- If it is close to 0; positive correlation in the model
- If it is close to 4; Negative correlation in the model

A rule of thumb is that DW test statistic values in the range of 1.5 to 2.5 are relatively normal. Values outside this range could, however, be a cause for concern in our model we found 2.131667 indicating no serial correlation in the model.

Case4 – To understand the volatility of Nifty after the Introduction of options

1. The data is taken between the time of February 2001 to March 2020 before the future is introduced
2. To conduct the unit root test for understanding the data is stationary or non-stationary, if not the convert into stationary data to further continue with variable model

To estimate the data hypothesis testing is done
H0- There is a unit root series that means that data is not stationary H1- There is a unit root test that means that the data is stationary

Where Probability should be ≤ 5% (means series is stationary)

Null Hypothesis: DCLOSE has a unit root
Exogenous: Constant
Lag Length: 6 (Automatic - based on SIC, maxlag=31)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-25.69375	0.0000
Test critical values:	1% level	-3.431484	
	5% level	-2.861926	
	10% level	-2.567018	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DCLOSE)
Method: Least Squares
Date: 03/28/22 Time: 20:12
Sample (adjusted): 1/11/2001 12/31/2020
Included observations: 4968 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DCLOSE(-1)	-0.924852	0.035995	-25.69375	0.0000
D(DCLOSE(-1))	-0.050182	0.033162	-1.513217	0.1303
D(DCLOSE(-2))	-0.022487	0.030613	-0.734561	0.4626
D(DCLOSE(-3))	-0.015088	0.027484	-0.548975	0.5830
D(DCLOSE(-4))	-0.023328	0.024004	-0.971851	0.3312
D(DCLOSE(-5))	0.025939	0.019849	1.306852	0.1913
D(DCLOSE(-6))	-0.063436	0.014187	-4.471259	0.0000
C	2.366281	1.085479	2.179941	0.0293

R-squared	0.500249	Mean dependent var	0.004851
Adjusted R-squared	0.499544	S.D. dependent var	107.7791
S.E. of regression	76.24608	Akaike info criterion	11.50742
Sum squared resid	28834783	Schwarz criterion	11.51790
Log likelihood	-28576.43	Hannan-Quinn criter.	11.51109
F-statistic	709.2773	Durbin-Watson stat	2.001140
Prob(F-statistic)	0.000000		

Table11 unit root test FR

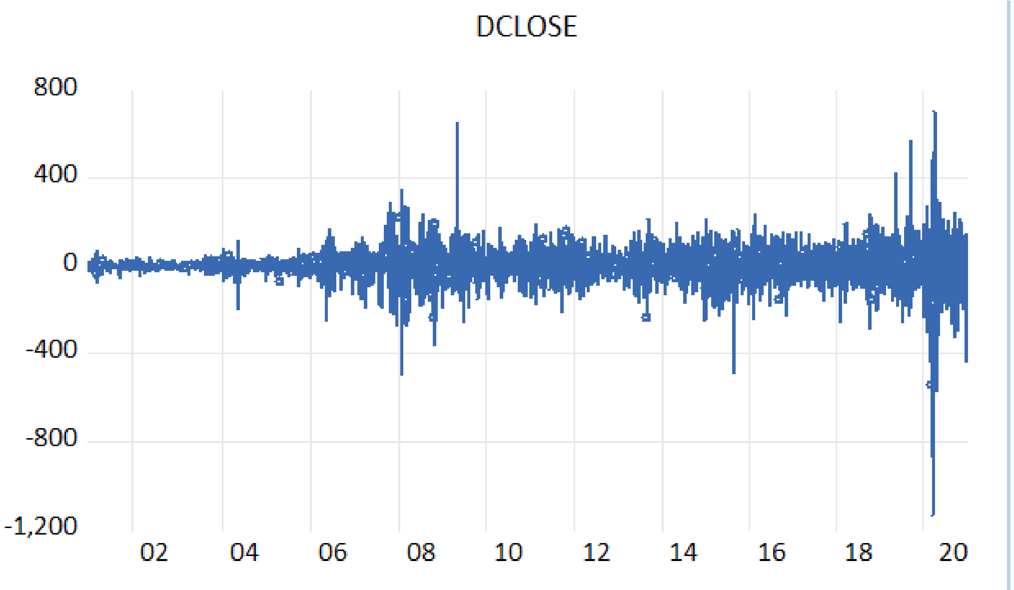


Figure -8 stationary graph of before introduction of Future treading

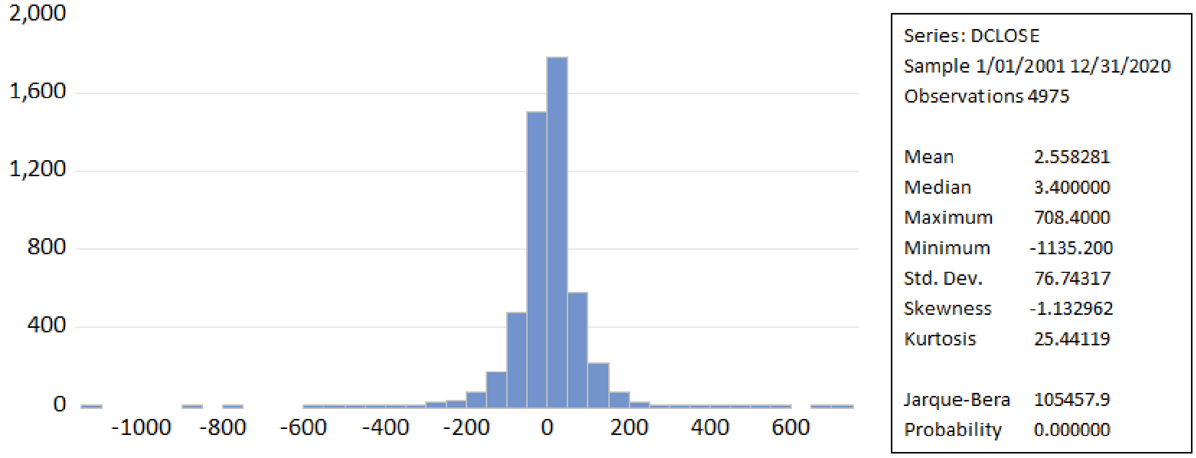


Figure -9 Histogram ADF FR NIFTY50

Modelling of Arch Model
As the unit root data shows that the data is stationary which shows the normality thus arch effect is present.

Dependent Variable: DCLOSE
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Date: 03/29/22 Time: 01:12
Sample (adjusted): 1/03/2001 12/31/2020
Included observations: 4974 after adjustments
Convergence achieved after 15 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	2.553082	0.733591	3.480250	0.0005
DCLOSE(-1)	0.168419	0.003224	52.24191	0.0000
		Variance Equation		
C	3047.691	43.67720	69.77763	0.0000
RESID(-1)^2	0.610442	0.015983	38.19323	0.0000

R-squared	-0.023292	Mean dependent var	2.555277
Adjusted R-squared	-0.023498	S.D. dependent var	76.75060
S.E. of regression	77.64711	Akaike info criterion	11.29830
Sum squared resid	29976551	Schwarz criterion	11.30354
Log likelihood	-28094.88	Hannan-Quinn criter.	11.30014
Durbin-Watson stat	2.309296		

Table-12 Arch Model Nifty50

The first part of the table corresponds to the mean equation and second part corresponds to the variable equation
Mean equation
Nifty closing price (NCP) = 2.34 + 0.17089 NCP(t-1) + ∈t Variance equation
Ht=245.6409 + 0.61044h^2_{t-1}
As we can see that the variance adds up to 0.61044
The persistent of the volatility is higher as it is closed to 1. More lags can be added to achieve higher volatility.

Modelling of Garch Model

Dependent Variable: DCLOSE
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Date: 03/28/22 Time: 20:02
Sample (adjusted): 1/11/2000 12/31/2020
Included observations: 5220 after adjustments
Convergence achieved after 36 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	1.285864	0.359548	3.576341	0.0003
DCLOSE(-1)	0.079495	0.014883	5.341353	0.0000
		Variance Equation		
C	1.837483	0.494414	3.716489	0.0002
RESID(-1)^2	0.097364	0.004930	19.74837	0.0000
GARCH(-1)	0.912524	0.004122	221.4031	0.0000

R-squared	-0.003978	Mean dependent var	2.365680
Adjusted R-squared	-0.004171	S.D. dependent var	75.16941
S.E. of regression	75.32600	Akaike info criterion	10.66068
Sum squared resid	29606967	Schwarz criterion	10.66696
Log likelihood	-27819.36	Hannan-Quinn criter.	10.66287
Durbin-Watson stat	2.131667		

Dependent Variable: DCLOSE
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Date: 03/28/22 Time: 20:14
Sample (adjusted): 1/03/2001 12/31/2020
Included observations: 4974 after adjustments
Convergence achieved after 33 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	1.402827	0.367588	3.816307	0.0001
DCLOSE(-1)	0.077356	0.015214	5.084415	0.0000
		Variance Equation		
C	1.750490	0.498406	3.512177	0.0004
RESID(-1)^2	0.097465	0.005008	19.46072	0.0000
GARCH(-1)	0.912969	0.004179	218.4709	0.0000

R-squared	-0.003794	Mean dependent var	2.555277
Adjusted R-squared	-0.003996	S.D. dependent var	76.75060
S.E. of regression	76.90380	Akaike info criterion	10.72333
Sum squared resid	29405375	Schwarz criterion	10.72987
Log likelihood	-26663.91	Hannan-Quinn criter.	10.72562
Durbin-Watson stat	2.128434		

Table-13 Garch Model Nifty50

- Here dependent variable is C (spot rate)
- Garch (1,1) model is used to check significant volatility
- Coefficient of future rates is 1.402827 which

shows significant with the spot rates return. Whereas constant score is 0.077256.

- Which means that if constant is 0.077256 then dependency of Spot rate is 0.1402827 times of Future rate.
- Further Durbin Watson stat tells us whether our model suffer 'serial correlation problem'. The Durbin- Watson statistic will always have a value ranging between 0 and 4.
- If it is close to 2; No serial correlation in the model
- If it is close to 0; positive correlation in the model
- If it is close to 4; Negative correlation in the model
- A rule of thumb is that DW test statistic values in the range of 1.5 to 2.5 are relatively normal. Values outside this range could, however, be a cause for concern in our model we found 2.128434 indicating no serial correlation in the model.

Conclusion:

The study says that before the introduction of derivate market and after the introduction of derivate market are inter linked with each other.

The arch model after the introduction of derivate market also shows that the price is dependent on past data which proves that the data is interlinked with each other.

Garch (1,1) after the intro of future which means that if constant is 0.07945 then dependency of Spot rate is 0.12856 times of Future rate.

Garch(1,1) after the intro of options Which means that if constant is 0.077256 then dependency of Spot rate is 0.1402827 times of Future rate.

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