# 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

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**Doi:** 10.53555/ecb/2022.11.12.448

**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 informationflowing 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 musthave 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<br>1996-2001(Future)<br>1996-2002(options)<br>After the introduction of future and options<br>2001-2020 (Future)<br>2002-2020 (Option) |

**Objective of the study:**

**Data Analysis:**

**1. To understand the volatility of Nifty before the Introduction of options**

**2. To understand the volatility of Nifty before the Introduction of future**

**3. To understand the volatility of Nifty after the Introduction of future**

**4. To understand the volatility of Nifty after the Introduction of options**

**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 convertinto 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 stationaryH1- 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**

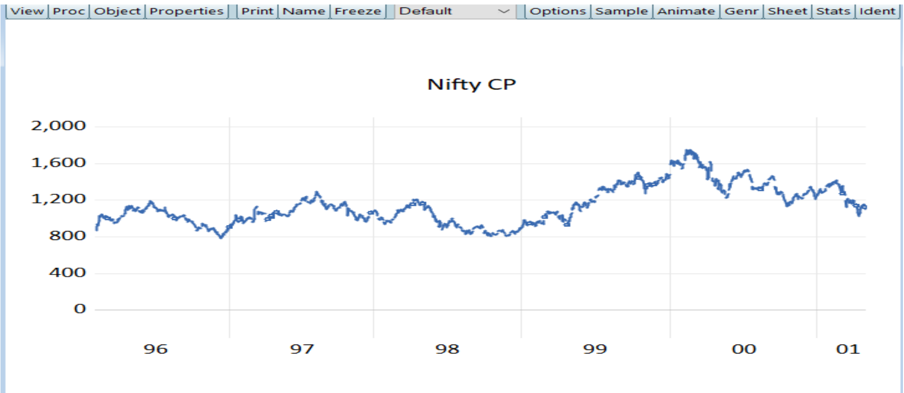


**Figure -1 Non- stationary graph of before introduction of Option treading**

As we can understand that the probability in 25% which means H0 is accepted an also as we see the graphit can be explained that the graph as soon trends in its which Cleary shows that the data is non stationaryso 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**

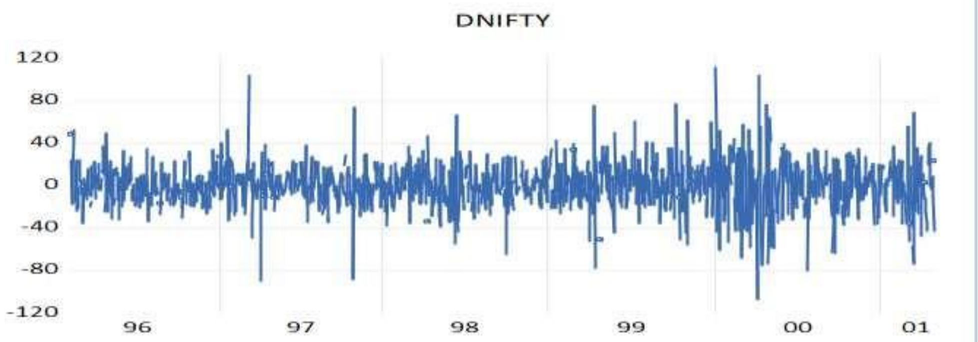


**Figure -2 stationary graph of before introduction of Option treading**

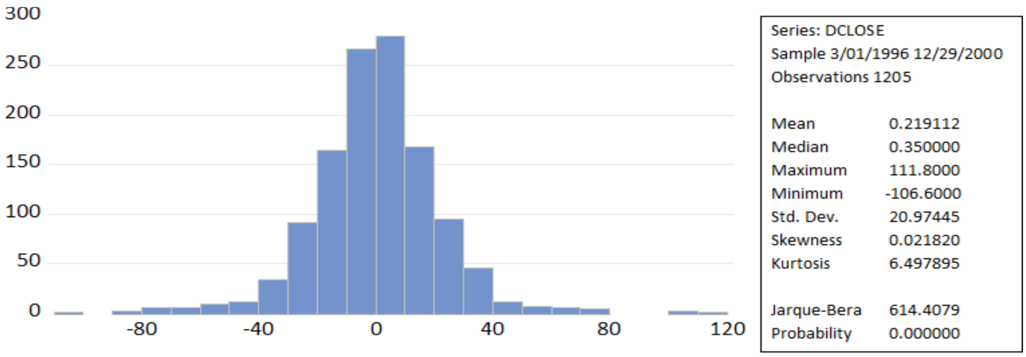


**Figure-3 Histogram ADF SR NIFTY50**

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.**

**Modelling the Arch ModelAs 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 variableequation

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 convertinto 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 stationaryH1- 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**

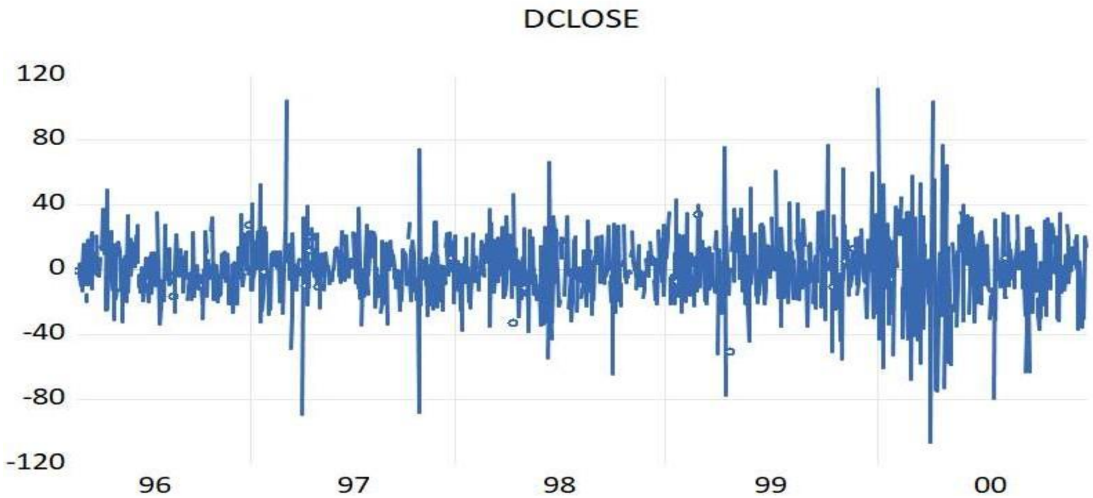


**Figure -4 stationary graph of before introduction of Future treading**

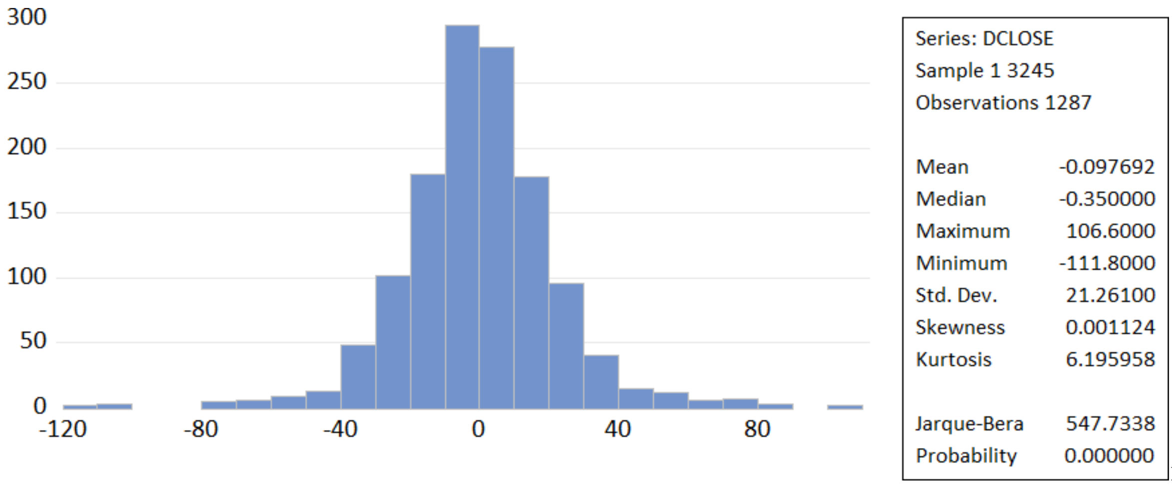


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**Figure -5 Histogram ADF SR NIFTY50**

**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 variableequation

Mean equation

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

Ht=245.6409 + 0.2593$h_{t-1}^2$

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 highervolatility.

**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. Whereasconstant 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 noserial 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 convertinto 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 stationaryH1- 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**

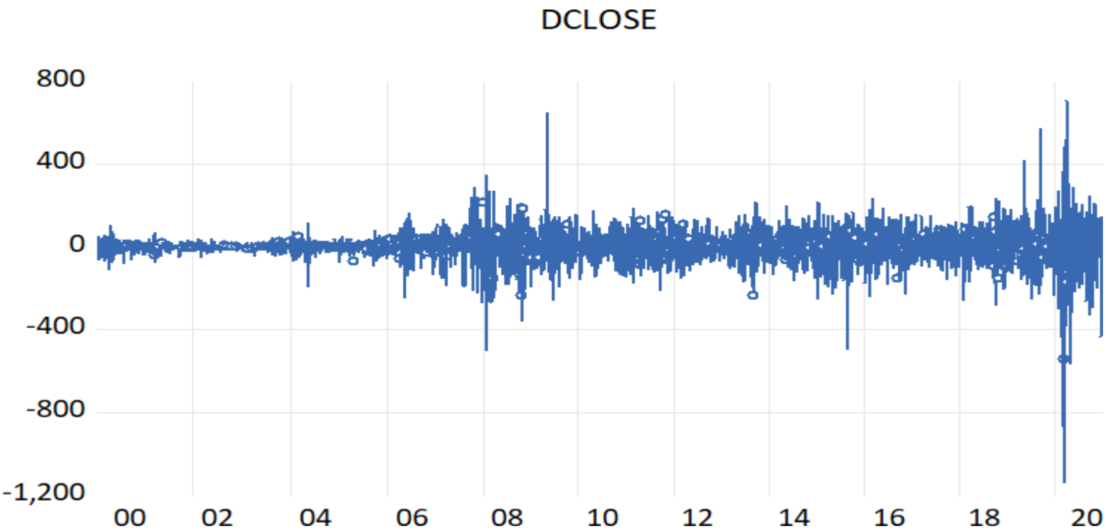


**Figure -6 stationary graph of after introduction of option treading**

Source- data ran in EViews software

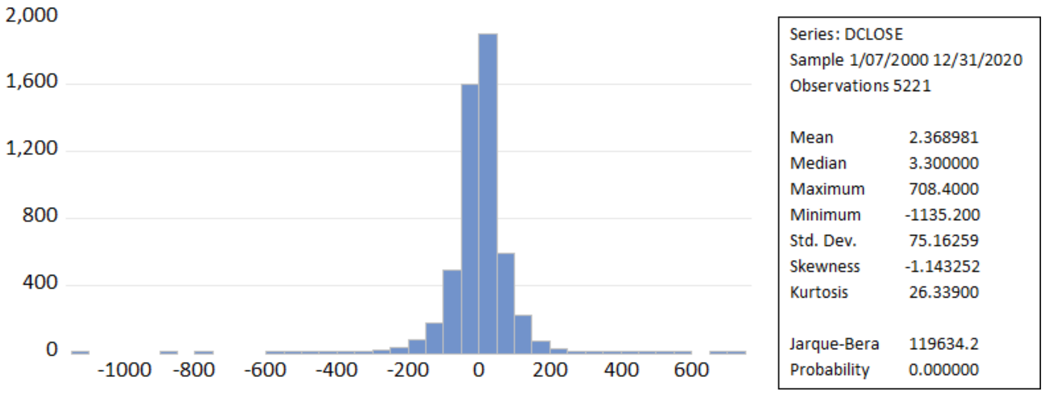


**Figure -7 Histogram ADF FR NIFTY50**

**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 variableequation
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 highervolatility.

**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. Whereasconstant 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 noserial 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 convertinto 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 stationaryH1- 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**

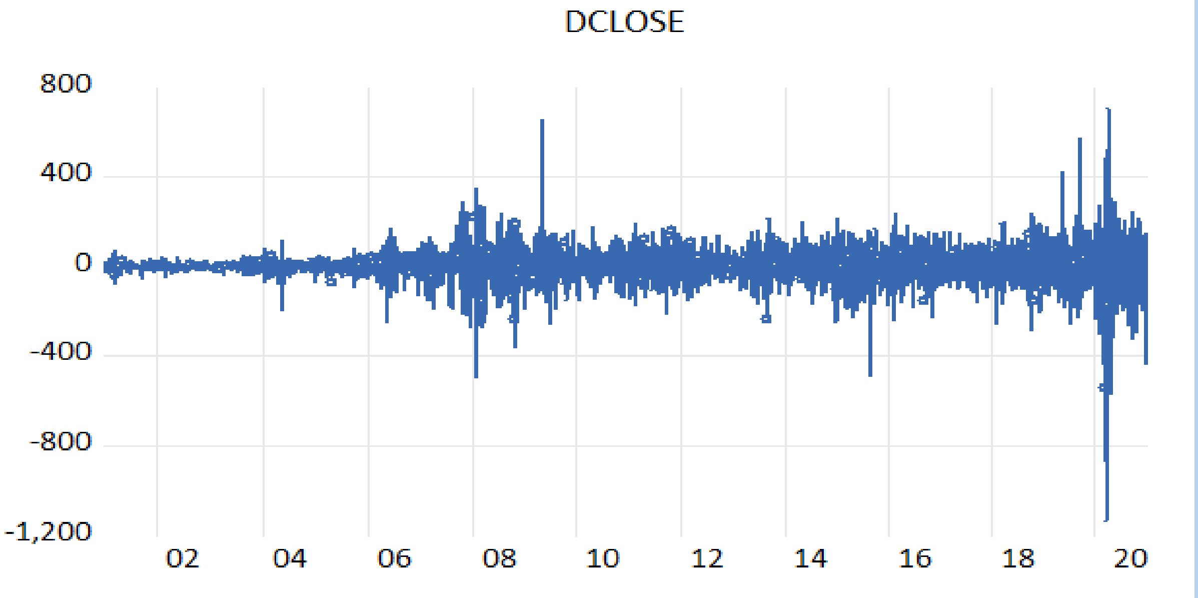


**Figure -8 stationary graph of before introduction of Future treading**

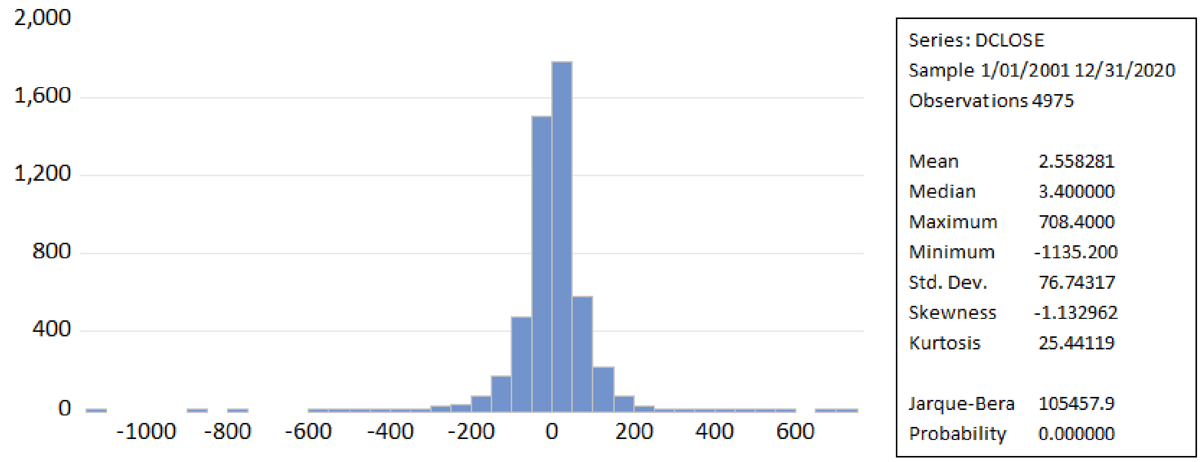


**Figure -9 Histogram ADF FR NIFTY50**

**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 variableequation

Mean equation

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

Ht=245.6409 + 0.61044$h^2_{t-1}$

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 highervolatility.

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**

**Modelling of Garch Model**

- 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. Whereasconstant 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 derivatemarket are inter linked with each other. The arch model after the introduction of derivate market also shows that the price is dependent on pastdata 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 rateis 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 rateis 0.1402827 times of Future rate.

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