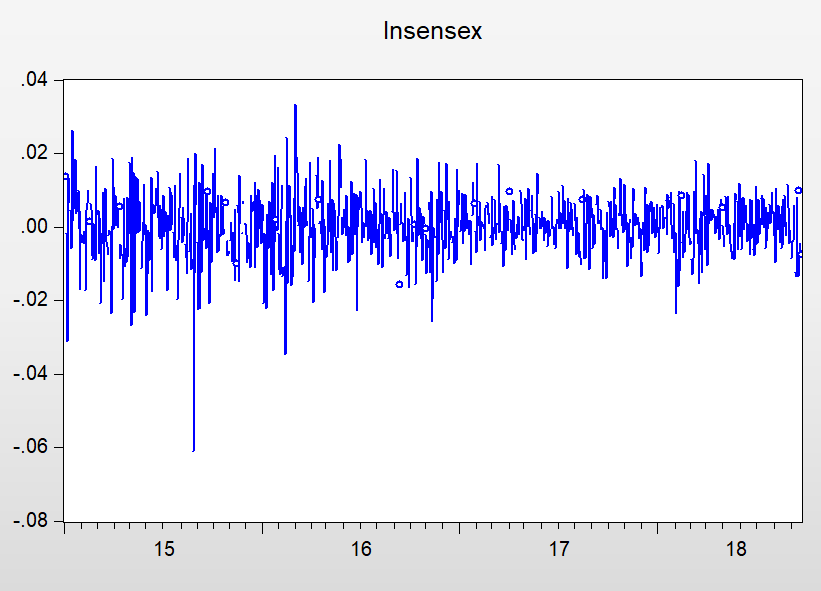
**Q.3)**

**Objectives of the Study**

The primary objective of study is to fit the best method to estimate the Volatility pattern of Indian Stock Market.

This graph shows that volatility is present.

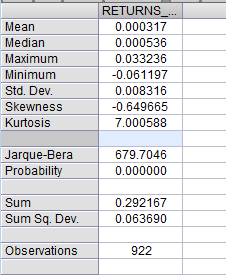


**Descriptive Statistics of lnsensex variable:**

**Histogram and Stats:**



**Stats Table:**



**Unit root test:**

**Dickey-Fuller test:**

Null hypothesis Ho: Has unit root

Alternative hypothesis H1: Does not have unit root i.e. stationary

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Null Hypothesis: LNSENSEX has a unit root | | | |  |
| Exogenous: Constant | | |  |  |
| Lag Length: 5 (Automatic - based on AIC, maxlag=20) | | | | |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  | t-Statistic | Prob.\* |
|  |  |  |  |  |
|  |  |  |  |  |
| Augmented Dickey-Fuller test statistic | | | -13.42998 | 0.0000 |
| Test critical values: | 1% level |  | -3.437267 |  |
|  | 5% level |  | -2.864483 |  |
|  | 10% level |  | -2.568390 |  |
|  |  |  |  |  |
|  |  |  |  |  |
| \*MacKinnon (1996) one-sided p-values. | | | |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Augmented Dickey-Fuller Test Equation | | | |  |
| Dependent Variable: D(LNSENSEX) | | | |  |
| Method: Least Squares | | |  |  |
| Date: 11/16/18 Time: 14:20 | | |  |  |
| Sample (adjusted): 1/12/2015 9/21/2018 | | | |  |
| Included observations: 916 after adjustments | | | |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|  |  |  |  |  |
|  |  |  |  |  |
| LNSENSEX(-1) | -1.035740 | 0.077122 | -13.42998 | 0.0000 |
| D(LNSENSEX(-1)) | 0.101481 | 0.069867 | 1.452483 | 0.1467 |
| D(LNSENSEX(-2)) | 0.072761 | 0.062484 | 1.164476 | 0.2445 |
| D(LNSENSEX(-3)) | 0.147768 | 0.054968 | 2.688272 | 0.0073 |
| D(LNSENSEX(-4)) | 0.094868 | 0.044919 | 2.111979 | 0.0350 |
| D(LNSENSEX(-5)) | 0.051907 | 0.032876 | 1.578885 | 0.1147 |
| C | 0.000332 | 0.000272 | 1.217134 | 0.2239 |
|  |  |  |  |  |
|  |  |  |  |  |
| R-squared | 0.475023 | Mean dependent var | | -1.56E-05 |
| Adjusted R-squared | 0.471558 | S.D. dependent var | | 0.011289 |
| S.E. of regression | 0.008206 | Akaike info criterion | | -6.760232 |
| Sum squared resid | 0.061214 | Schwarz criterion | | -6.723398 |
| Log likelihood | 3103.186 | Hannan-Quinn criter. | | -6.746173 |
| F-statistic | 137.0842 | Durbin-Watson stat | | 1.996949 |
| Prob(F-statistic) | 0.000000 |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

The presence of unit root in the series tested using ADF tests and the presence of heteroscedasticity tested using ARCH LM test. The p values of ADF are < 0.05, which lead to conclude that the data of the time series for the entire study period is stationary. The ADF test statistics reported in reject the null hypothesis at 5% level with the critical value of –2.86 for both ADF tests of a unit root in the return series. Hence, the results of both the tests confirm that the series are stationary.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Heteroskedasticity Test**  Heteroskedasticity Test: ARCH | | |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| F-statistic | 1.029535 | Prob. F(1,918) | | 0.3105 |
| Obs\*R-squared | 1.030623 | Prob. Chi-Square(1) | | 0.3100 |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Test Equation: | |  |  |  |
| Dependent Variable: RESID^2 | | |  |  |
| Method: Least Squares | | |  |  |
| Date: 11/16/18 Time: 14:35 | | |  |  |
| Sample (adjusted): 1/06/2015 9/21/2018 | | | |  |
| Included observations: 920 after adjustments | | | |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|  |  |  |  |  |
|  |  |  |  |  |
| C | 6.64E-05 | 5.98E-06 | 11.11130 | 0.0000 |
| RESID^2(-1) | 0.033468 | 0.032984 | 1.014660 | 0.3105 |
|  |  |  |  |  |
|  |  |  |  |  |
| R-squared | 0.001120 | Mean dependent var | | 6.87E-05 |
| Adjusted R-squared | 0.000032 | S.D. dependent var | | 0.000168 |
| S.E. of regression | 0.000168 | Akaike info criterion | | -14.54518 |
| Sum squared resid | 2.59E-05 | Schwarz criterion | | -14.53469 |
| Log likelihood | 6692.782 | Hannan-Quinn criter. | | -14.54118 |
| F-statistic | 1.029535 | Durbin-Watson stat | | 1.969132 |
| Prob(F-statistic) | 0.310535 |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

The arch-lm test is applied to find out the presence of arch effect in the residuals of the return series. It is inferred that the test statistics is highly significant. Since F-statistics > 0.05, the null hypothesis of ‘no arch effect’ is rejected at 5% level, which confirms the presence of arch effects in the residuals of time series models in the returns.

**ARCH (1) Model**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Dependent Variable: LNSENSEX | | |  |  |
| Method: ML ARCH - Normal distribution (BFGS / Marquardt steps) | | | | |
| Date: 11/16/18 Time: 14:50 | | |  |  |
| Sample (adjusted): 1/05/2015 9/21/2018 | | | |  |
| Included observations: 921 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 | | | |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Variable | Coefficient | Std. Error | z-Statistic | Prob. |
|  |  |  |  |  |
|  |  |  |  |  |
| C | 0.000305 | 0.000282 | 1.082150 | 0.2792 |
| LNSENSEX(-1) | 0.068380 | 0.035680 | 1.916500 | 0.0553 |
|  |  |  |  |  |
|  |  |  |  |  |
|  | Variance Equation | |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| C | 6.68E-05 | 2.69E-06 | 24.77604 | 0.0000 |
| RESID(-1)^2 | 0.027345 | 0.031769 | 0.860742 | 0.3894 |
|  |  |  |  |  |
|  |  |  |  |  |
| R-squared | 0.004253 | Mean dependent var | | 0.000302 |
| Adjusted R-squared | 0.003170 | S.D. dependent var | | 0.008309 |
| S.E. of regression | 0.008295 | Akaike info criterion | | -6.741558 |
| Sum squared resid | 0.063240 | Schwarz criterion | | -6.720601 |
| Log likelihood | 3108.488 | Hannan-Quinn criter. | | -6.733561 |
| Durbin-Watson stat | 1.998948 |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

**ARCH (1) Heteroskedasticity Test**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Heteroskedasticity Test: ARCH | | |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| F-statistic | 2.95E-05 | Prob. F(1,918) | | 0.9957 |
| Obs\*R-squared | 2.96E-05 | Prob. Chi-Square(1) | | 0.9957 |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Test Equation: | |  |  |  |
| Dependent Variable: WGT\_RESID^2 | | | |  |
| Method: Least Squares | | |  |  |
| Date: 11/16/18 Time: 14:52 | | |  |  |
| Sample (adjusted): 1/06/2015 9/21/2018 | | | |  |
| Included observations: 920 after adjustments | | | |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|  |  |  |  |  |
|  |  |  |  |  |
| C | 1.001144 | 0.087241 | 11.47556 | 0.0000 |
| WGT\_RESID^2(-1) | -0.000179 | 0.033003 | -0.005433 | 0.9957 |
|  |  |  |  |  |
|  |  |  |  |  |
| R-squared | 0.000000 | Mean dependent var | | 1.000964 |
| Adjusted R-squared | -0.001089 | S.D. dependent var | | 2.448117 |
| S.E. of regression | 2.449450 | Akaike info criterion | | 4.631776 |
| Sum squared resid | 5507.822 | Schwarz criterion | | 4.642263 |
| Log likelihood | -2128.617 | Hannan-Quinn criter. | | 4.635778 |
| F-statistic | 2.95E-05 | Durbin-Watson stat | | 1.961487 |
| Prob(F-statistic) | 0.995666 |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

**GARCH (1,1) Model**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Dependent Variable: LNSENSEX | | |  |  |
| Method: ML ARCH - Normal distribution (BFGS / Marquardt steps) | | | | |
| Date: 11/16/18 Time: 14:54 | | |  |  |
| Sample (adjusted): 1/05/2015 9/21/2018 | | | |  |
| Included observations: 921 after adjustments | | | |  |
| Convergence achieved after 30 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 | 0.000529 | 0.000253 | 2.093044 | 0.0363 |
| LNSENSEX(-1) | 0.068546 | 0.039043 | 1.755656 | 0.0791 |
|  |  |  |  |  |
|  |  |  |  |  |
|  | Variance Equation | |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| C | 1.04E-06 | 4.35E-07 | 2.382608 | 0.0172 |
| RESID(-1)^2 | 0.050842 | 0.011271 | 4.511068 | 0.0000 |
| GARCH(-1) | 0.933686 | 0.014916 | 62.59716 | 0.0000 |
|  |  |  |  |  |
|  |  |  |  |  |
| R-squared | 0.003363 | Mean dependent var | | 0.000302 |
| Adjusted R-squared | 0.002279 | S.D. dependent var | | 0.008309 |
| S.E. of regression | 0.008299 | Akaike info criterion | | -6.829386 |
| Sum squared resid | 0.063296 | Schwarz criterion | | -6.803189 |
| Log likelihood | 3149.932 | Hannan-Quinn criter. | | -6.819390 |
| Durbin-Watson stat | 1.997484 |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

**GARCH (1,1) Heteroskedasticity Test**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Heteroskedasticity Test: ARCH | | |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| F-statistic | 0.585351 | Prob. F(1,918) | | 0.4444 |
| Obs\*R-squared | 0.586253 | Prob. Chi-Square(1) | | 0.4439 |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Test Equation: | |  |  |  |
| Dependent Variable: WGT\_RESID^2 | | | |  |
| Method: Least Squares | | |  |  |
| Date: 11/16/18 Time: 14:55 | | |  |  |
| Sample (adjusted): 1/06/2015 9/21/2018 | | | |  |
| Included observations: 920 after adjustments | | | |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|  |  |  |  |  |
|  |  |  |  |  |
| C | 1.021218 | 0.081079 | 12.59531 | 0.0000 |
| WGT\_RESID^2(-1) | -0.025241 | 0.032991 | -0.765083 | 0.4444 |
|  |  |  |  |  |
|  |  |  |  |  |
| R-squared | 0.000637 | Mean dependent var | | 0.996102 |
| Adjusted R-squared | -0.000451 | S.D. dependent var | | 2.248153 |
| S.E. of regression | 2.248661 | Akaike info criterion | | 4.460718 |
| Sum squared resid | 4641.843 | Schwarz criterion | | 4.471206 |
| Log likelihood | -2049.930 | Hannan-Quinn criter. | | 4.464720 |
| F-statistic | 0.585351 | Durbin-Watson stat | | 1.995625 |
| Prob(F-statistic) | 0.444419 |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **GARCH-M (1,1) Model**  Dependent Variable: LNSENSEX | | |  |  |
| Method: ML ARCH - Normal distribution (BFGS / Marquardt steps) | | | | |
| Date: 11/16/18 Time: 14:56 | | |  |  |
| Sample (adjusted): 1/05/2015 9/21/2018 | | | |  |
| Included observations: 921 after adjustments | | | |  |
| Convergence achieved after 28 iterations | | | |  |
| Coefficient covariance computed using outer product of gradients | | | | |
| Presample variance: backcast (parameter = 0.7) | | | | |
| GARCH = C(4) + C(5)\*RESID(-1)^2 + C(6)\*GARCH(-1) | | | | |
|  |  |  |  |  |
|  |  |  |  |  |
| Variable | Coefficient | Std. Error | z-Statistic | Prob. |
|  |  |  |  |  |
|  |  |  |  |  |
| GARCH | 2.568172 | 9.211731 | 0.278794 | 0.7804 |
| C | 0.000385 | 0.000572 | 0.672283 | 0.5014 |
| LNSENSEX(-1) | 0.068922 | 0.039152 | 1.760365 | 0.0783 |
|  |  |  |  |  |
|  |  |  |  |  |
|  | Variance Equation | |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| C | 1.06E-06 | 4.52E-07 | 2.350732 | 0.0187 |
| RESID(-1)^2 | 0.051572 | 0.011418 | 4.516846 | 0.0000 |
| GARCH(-1) | 0.932603 | 0.015292 | 60.98611 | 0.0000 |
|  |  |  |  |  |
|  |  |  |  |  |
| R-squared | 0.003792 | Mean dependent var | | 0.000302 |
| Adjusted R-squared | 0.001622 | S.D. dependent var | | 0.008309 |
| S.E. of regression | 0.008302 | Akaike info criterion | | -6.827320 |
| Sum squared resid | 0.063269 | Schwarz criterion | | -6.795883 |
| Log likelihood | 3149.981 | Hannan-Quinn criter. | | -6.815324 |
| Durbin-Watson stat | 1.997291 |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

**GARCH-M (1,1) Heteroskedasticity Test**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Heteroskedasticity Test: ARCH | | |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| F-statistic | 0.634925 | Prob. F(1,918) | | 0.4258 |
| Obs\*R-squared | 0.635868 | Prob. Chi-Square(1) | | 0.4252 |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Test Equation: | |  |  |  |
| Dependent Variable: WGT\_RESID^2 | | | |  |
| Method: Least Squares | | |  |  |
| Date: 11/16/18 Time: 14:57 | | |  |  |
| Sample (adjusted): 1/06/2015 9/21/2018 | | | |  |
| Included observations: 920 after adjustments | | | |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|  |  |  |  |  |
|  |  |  |  |  |
| C | 1.022459 | 0.081065 | 12.61288 | 0.0000 |
| WGT\_RESID^2(-1) | -0.026287 | 0.032990 | -0.796822 | 0.4258 |
|  |  |  |  |  |
|  |  |  |  |  |
| R-squared | 0.000691 | Mean dependent var | | 0.996297 |
| Adjusted R-squared | -0.000397 | S.D. dependent var | | 2.247650 |
| S.E. of regression | 2.248096 | Akaike info criterion | | 4.460216 |
| Sum squared resid | 4639.515 | Schwarz criterion | | 4.470704 |
| Log likelihood | -2049.700 | Hannan-Quinn criter. | | 4.464219 |
| F-statistic | 0.634925 | Durbin-Watson stat | | 1.995354 |
| Prob(F-statistic) | 0.425761 |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

**GARCH-T (1,1) Model**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Dependent Variable: LNSENSEX | | |  |  |
| Method: ML ARCH - Normal distribution (BFGS / Marquardt steps) | | | | |
| Date: 11/16/18 Time: 14:58 | | |  |  |
| Sample (adjusted): 1/05/2015 9/21/2018 | | | |  |
| Included observations: 921 after adjustments | | | |  |
| Convergence achieved after 28 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(-1)^2\*(RESID(-1)<0) + | | | | |
| C(6)\*GARCH(-1) | | |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Variable | Coefficient | Std. Error | z-Statistic | Prob. |
|  |  |  |  |  |
|  |  |  |  |  |
| C | 0.000253 | 0.000252 | 1.004895 | 0.3149 |
| LNSENSEX(-1) | 0.097387 | 0.037093 | 2.625485 | 0.0087 |
|  |  |  |  |  |
|  |  |  |  |  |
|  | Variance Equation | |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| C | 3.09E-06 | 5.69E-07 | 5.436301 | 0.0000 |
| RESID(-1)^2 | -0.047163 | 0.014484 | -3.256195 | 0.0011 |
| RESID(-1)^2\*(RESID(-1)<0) | 0.192673 | 0.024182 | 7.967693 | 0.0000 |
| GARCH(-1) | 0.901343 | 0.017652 | 51.06314 | 0.0000 |
|  |  |  |  |  |
|  |  |  |  |  |
| R-squared | 0.003236 | Mean dependent var | | 0.000302 |
| Adjusted R-squared | 0.002152 | S.D. dependent var | | 0.008309 |
| S.E. of regression | 0.008300 | Akaike info criterion | | -6.863386 |
| Sum squared resid | 0.063304 | Schwarz criterion | | -6.831950 |
| Log likelihood | 3166.589 | Hannan-Quinn criter. | | -6.851391 |
| Durbin-Watson stat | 2.054617 |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

**GARCH-T (1,1) Heteroskedasticity Test**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Heteroskedasticity Test: ARCH | | |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| F-statistic | 2.027377 | Prob. F(1,918) | | 0.1548 |
| Obs\*R-squared | 2.027316 | Prob. Chi-Square(1) | | 0.1545 |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Test Equation: | |  |  |  |
| Dependent Variable: WGT\_RESID^2 | | | |  |
| Method: Least Squares | | |  |  |
| Date: 11/16/18 Time: 14:58 | | |  |  |
| Sample (adjusted): 1/06/2015 9/21/2018 | | | |  |
| Included observations: 920 after adjustments | | | |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|  |  |  |  |  |
|  |  |  |  |  |
| C | 1.048750 | 0.077273 | 13.57207 | 0.0000 |
| WGT\_RESID^2(-1) | -0.046938 | 0.032966 | -1.423860 | 0.1548 |
|  |  |  |  |  |
|  |  |  |  |  |
| R-squared | 0.002204 | Mean dependent var | | 1.001757 |
| Adjusted R-squared | 0.001117 | S.D. dependent var | | 2.120447 |
| S.E. of regression | 2.119262 | Akaike info criterion | | 4.342185 |
| Sum squared resid | 4122.989 | Schwarz criterion | | 4.352673 |
| Log likelihood | -1995.405 | Hannan-Quinn criter. | | 4.346187 |
| F-statistic | 2.027377 | Durbin-Watson stat | | 1.995568 |
| Prob(F-statistic) | 0.154827 |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

**GARCH-E (1,1) Model**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Dependent Variable: LNSENSEX | | |  |  |
| Method: ML ARCH - Normal distribution (BFGS / Marquardt steps) | | | | |
| Date: 11/16/18 Time: 15:00 | | |  |  |
| Sample (adjusted): 1/05/2015 9/21/2018 | | | |  |
| Included observations: 921 after adjustments | | | |  |
| Convergence achieved after 62 iterations | | | |  |
| Coefficient covariance computed using outer product of gradients | | | | |
| Presample variance: backcast (parameter = 0.7) | | | | |
| LOG(GARCH) = C(3) + C(4)\*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(5) | | | | |
| \*RESID(-1)/@SQRT(GARCH(-1)) + C(6)\*LOG(GARCH(-1)) | | | | |
|  |  |  |  |  |
|  |  |  |  |  |
| Variable | Coefficient | Std. Error | z-Statistic | Prob. |
|  |  |  |  |  |
|  |  |  |  |  |
| C | 0.000195 | 0.000252 | 0.775034 | 0.4383 |
| LNSENSEX(-1) | 0.093613 | 0.037908 | 2.469464 | 0.0135 |
|  |  |  |  |  |
|  |  |  |  |  |
|  | Variance Equation | |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| C(3) | -0.476305 | 0.081342 | -5.855552 | 0.0000 |
| C(4) | 0.052894 | 0.026805 | 1.973288 | 0.0485 |
| C(5) | -0.147977 | 0.016177 | -9.147300 | 0.0000 |
| C(6) | 0.955303 | 0.007981 | 119.6992 | 0.0000 |
|  |  |  |  |  |
|  |  |  |  |  |
| R-squared | 0.003385 | Mean dependent var | | 0.000302 |
| Adjusted R-squared | 0.002300 | S.D. dependent var | | 0.008309 |
| S.E. of regression | 0.008299 | Akaike info criterion | | -6.884442 |
| Sum squared resid | 0.063295 | Schwarz criterion | | -6.853006 |
| Log likelihood | 3176.286 | Hannan-Quinn criter. | | -6.872447 |
| Durbin-Watson stat | 2.047234 |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

**GARCH-E (1,1) Heteroskedasticity Test**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Heteroskedasticity Test: ARCH | | |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| F-statistic | 2.744604 | Prob. F(1,918) | | 0.0979 |
| Obs\*R-squared | 2.742385 | Prob. Chi-Square(1) | | 0.0977 |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Test Equation: | |  |  |  |
| Dependent Variable: WGT\_RESID^2 | | | |  |
| Method: Least Squares | | |  |  |
| Date: 11/16/18 Time: 15:01 | | |  |  |
| Sample (adjusted): 1/06/2015 9/21/2018 | | | |  |
| Included observations: 920 after adjustments | | | |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|  |  |  |  |  |
|  |  |  |  |  |
| C | 1.056552 | 0.073319 | 14.41035 | 0.0000 |
| WGT\_RESID^2(-1) | -0.054592 | 0.032952 | -1.656685 | 0.0979 |
|  |  |  |  |  |
|  |  |  |  |  |
| R-squared | 0.002981 | Mean dependent var | | 1.001889 |
| Adjusted R-squared | 0.001895 | S.D. dependent var | | 1.987838 |
| S.E. of regression | 1.985954 | Akaike info criterion | | 4.212248 |
| Sum squared resid | 3620.605 | Schwarz criterion | | 4.222736 |
| Log likelihood | -1935.634 | Hannan-Quinn criter. | | 4.216250 |
| F-statistic | 2.744604 | Durbin-Watson stat | | 1.996379 |
| Prob(F-statistic) | 0.097925 |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

|  |  |  |
| --- | --- | --- |
|  | Akaike info criterion | Schwarz criterion |
| ARCH (1) | 4.631776 | 4.642263 |
| ARCH (2) | |  | | --- | | 4.413653 | | |  | | --- | | 4.424141 | |
| ARCH (3) | 4.468510 | 4.478998 |
| ARCH(4) | 4.518295 | 4.528783 |
| ARCH (5) | 4.517040 | 4.527528 |
| GARCH | 4.460718 | 4.471206 |
| GARCH-M | 4.460216 | 4.470704 |
| T-GARCH | 4.342185 | 4.352673 |
| E-GARCH | 4.212248 | 4.222736 |

**Results:**

In GARCH (1,1) model, the sum of the coefficient ARCH effect and GARCH effect is 0.94, which implies that the volatility is highly persistent.

**Conclusion:** ARCH model doesn’t possess ARCH effect or volatility and has AIC value of -6.741558 SC value of -6.720601. The results show that the coefficient has the expected sign both in the EGARCH and in the TGARCH models. To identify the best fitted model among the different specifications of GARCH models, TGARCH (1,1) model has been found to be the best fitted model among all to capture the symmetric effect as per AIC and SC criterion. Further**, EGARCH (1,1) model is found to be the best fitted model to capture the asymmetric volatility based on the highest log likelihood ratios and minimum AIC and SC criterion.**