FIERY NATURE EVALUATION USING ARCH FAMILY MODELS: AN APPLICATION TO INSTITUTIONAL INVESTORS ON ENERGYCOMMODITY DERIVATIVES MARKET

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Abstract

Volatility estimation has been at the centre stage of management is derivative market. There are various methods, which comes to rescue for estimation of volatility. The purpose of this paper is to estimate the volatility using ARCH family models: contrast with Institutional Investors and energy commodity derivatives market for a period of January 2017 to December 2019. The monthly closing price for Institutional Investors and monthly total value for energy commodities includes Crude oil and Natural gas, totally 36 monthly observations have been taken for the study to analyze the volatility of the market. ARCH (5,0), GARCH (1,1), TGARCH (1,1) and EGARCH (1,1) model is applied for evaluating the explosive nature of the institutional investors on energy commodity derivatives market. By analyzing the volatility of crude oil energy commodity shows there is a influence on institutional investors by applying the GARCH (1,1) model; Natural Gas energy commodity proves there is an influence on institutional investors with the proof of EGARCH (1,1) model were applied. Overall, the study found that there is an influence of energy commodity market on institutional investors investment pattern by adopting the ARCH family models with Normal Gaussian error distribution.

Keywords: GARCH Family, ARCH(5,0), GARCH(1,1), TGARCH(1,1), EGARCH(1,1) Volatility, Energy commodity market, Foreign Institutional Investors and Domestic Institutional Investors.

JEL Classification Code:B15, C01,C22, C50, C51, F55

Introduction

Commodities are a gaze at as separate assets in the monarchy of all assests classes. Commodity derivatives, as a substitute financial asset class, have also gained increasing

importance. Commodity prices are volatile and Volatility varies over time. Investing in commodities has engendered heavy returns and has become increasingly popular, in spite of the high risks associated with this type of speculation, due to the intrinsic volatility of commodity price. Since the stability of the market is always at a stake, the importance to look at the volatility of the stock has got greater importance in the recent past. Basically, what is volatility; it is a statistical measure of the dispersion of returns for a given security or market index. Volatility can either be measured by using the standard deviation or variance between returns from that same security or market index. The number of crashes and the size of their effects have forced all to look more carefully to the level and stationarity of volatility in time, researchers shifting their attention towards development and then improvement of econometric models able to produce accurate forecasts of such swings in returns' volatility. There are numerous models established to calculate the volatility of the stocks. Some of the most important univariate volatility models are the autoregressive conditional Heteroskedasticity (ARCH) model compiled by Engle (1982), generalized ARCH (GARCH) model compiled by Bollerslev (1986), the exponential GARCH (EGARCH) model of Nelson& Cao (1991) and the Threshold GARCH (TGARCH) model of Zakoian(1994) is similar to GJR GARCH model all designed to serve to the same scope, it is important to correctly distinguish between various models in order to find the one which provides the most accurate predictions.

Review of Literature

(Bonga, 2019) empirically proved a study on stock market volatility analysis using GARCH family models evidence from Zimbabwe stock exchange. The volatility of the Zimbabwean stock market is modeled using monthly return series consisting of 109 observations from January 2010 to January 2019. ARCH effects test established the use of GARCH family models. Symmetric and asymmetric models were used namely GARCH(1,1), GARCH-M(1,1), IGARCH(1,1) and EGARCH(1,1). Post-estimation test for further ARCH effects were done for each model to confirm its efficiency for policy. EGARCH(1,1) turned to be the best model using both the AIC and SIC criterions; with the presence of asymmetry found to be significant. The study concludes that positive and negative shocks have different effects on the stock market returns series. The study simply implies that the investors of stock market react differently to information depending be in positive and negative in making the investment decision.

(Hassan and Hady 2014)coined a study on modeling volatility with GARCH family models: An application to daily stock log-returns in pharmaceutical companies. In their study they adopted to analyze the research by using the ARCH model and some GARCH family models namely, GARCH, TGARCH and EGARCH. The daily log-returns of three pharmaceutical companies registered in Egypt stock market covering the period from January 2, 2000 to July 23, 2008 were used for the application of models in the three models for the study. Results of the study show that the OLS regression model for Arab Drugs Company is sufficient since no serial correlation and no ARCH effect is depicted in the data. For Alex Pharma the best fit model is TGARCH (p,q) model while for EPICO Company, the best fit model is EGARCH (p,q).

(Musunuru, Yu, and Larson 2013)the researchers investigate the research on forecasting volatility of returns for corn using GARCH models. They adopt the non-linear models from the GARCH family specifically TGARCH and EGARCH are employed to assess the role of asymmetries and to analyze the time varying volatility of corn futures prices. The daily settlement prices for corn were used in the study for a period of January 3, 1995 to June 16, 2012. The presence of leverage effect would imply that the negative news has bigger impact on volatility than positive news of the same magnitude. The estimated volatility models were compared using symmetric measures for their forecasting accuracy. In their study they found that the EGARCH model provides the best out of sample forecast for corn among all the GARCH specifications.

Statement of the problem

The volatility of commodity prices has drawn considerable interest from academics, investors and economist in recent years. Commodity that is of considerable interest to all parties is energy segment. Accordingly, investment proclamation involves going through a logical analysis of the circumstances prevalent based on an integer of dynamics, investors are eager to stay away from suspicions allied with the vital decisions they employ in. Thus, investors have to consider the volatility evaluation of the futures commodity derivative market. This endeavored the researcher to design the study on explosive nature evaluation of institutional Investors on energy futures commodity derivatives market in India by using ARCH family model.

Objectives

To extract the volatility evaluation of Institutional Investors on Energy Commodity derivatives market in India.

Hypotheses

H01: There is no Stationarity of Institutional Investors and Select Energy commodity Derivative Market in India.

H02: There is no ARCH Family effect in Institutional Investors and Select Energy commodity Derivative Market in India.

Methodology

The study investigates the volatility in the Institutional investors and Energy Commodity Derivatives futures market in India. The study is analytical in nature and based on secondary data for a period of three years monthly data from January2017 to December 2019 with 35 observations. The Variables chosen for the study are Foreign Institutional Investors and Domestic Institutional Investors; In the Energy Commodity Derivatives futures market Natural Gas and Crude oil commodity were selected for research analysis. The data are obtained from Securities Exchange Board of India (SEBI), Multi Commodity Exchange (MCX) and National Stock Exchange (NSE). Econometric tools adopted for the study are Augmented Dickey-Fuller Unit Root test, ARCH, GARCH, TGARCH (Threshold GARCH), EGARCH (Exponential GARCH). These four models were applied to a monthly closing price of institutional investors and monthly total value of energy commodity derivatives market in India.

Results and Discussions

Objective: To extract the volatility evaluation of Institutional Investors on Energy Commodity derivatives market in India.

Augmented Dickey - Fuller Test (Unit Root Test)

***H_0**: There is no Stationarity of Institutional Investors and Select Energy Commodity futures Derivative Market in India.*

Table 1

Augmented Dickey – Fuller test of Institutional Investors and Select Energy commodity futures derivative market in India for a period from January 2017 to December 2019

Variables	Level		1st Difference	
	t statistics	Prob.*	t statistics	Prob.*
FII	-4.262036	0.0019		
DII	-3.738158	0.0075		
CRUDE OIL	-3.482104	0.0566	-10.50638	0.0000
NATURAL GAS	-2.728395	0.0792	-5.958332	0.0000

Source: Complied and Calculated

The above table exposes the upshot of the Unit root test to determine the stationarity among the time series data. The Augmented Dickey – Fuller test was used at level and first difference under the postulation of intercept, trend and constant. According to the consequence of the test, Foreign Institutional Investors (FII) and Domestic Institutional Investors (DII) are stationary at level *I(0)*. Crude oil and Natural gas energy commodity are not stationary at level, but it become a stationary when its first difference *I(1)* was taken. Hence, the null hypothesis is rejected and make obvious that the data is stationary for Institutional Investors and Select energy commodity derivatives in India.

ARCH family model on Crude oil Energy Commodity:

H_0: There is no ARCH Family effect in Institutional Investors and Crude oil Energy commodity Derivative Market in India.

Table 2

ARCH Family model and its corresponding Results for Institutional Investors and Crude Oil Energy Commodity Derivative Market in India for the period of January 2017 to December 2019

Variable	ARCH (5,0)	GARCH (1,1)	TGARCH (1,1)	EGARCH (1,1)
Mean Equation				
C	4734.429 (0.55)	5986.027 (0.47)	8877.849 (0.26)	6308.201 (0.41)
FII	-0.095183 (0.89)	-0.17067 (0.82)	-0.314752 (0.65)	-0.201495 (0.77)
DII	0.207267 (0.86)	-0.285591 (0.82)	-0.485683 (0.66)	-0.300362 (0.79)
Variable Equation				
C	3.08E+08 (0.01)			
RESID(-1)^2	0.210275 (0.66)			
RESID(-2)^2	-0.187869 (0.54)			
RESID(-3)^2	0.004271 (0.99)			
RESID(-4)^2	-0.078724 (0.90)			
RESID(-5)^2	0.174229 (0.75)			
C		2.56E+08 (0.76)		
RESID(-1)^2		0.113651 (0.65)		
GARCH(-1)		0.203384		

		(0.93)		
C			2.56E+08 (0.71)	
RESID(-1)^2			0.215949 (0.70)	
RESID(-1)^2*(RESID(-1)<0)			-0.286724 (0.71)	
GARCH(-1)			0.284911 (0.88)	
C(4)				25.98786 (0.12)
C(5)				0.562975 (0.52)
C(6)				-0.017779 (0.96)
C(7)				-0.341815 (0.69)
AIC	22.90496	**22.90328**	22.97279	22.95657
SIC	23.30084	**23.1972**	23.2807	23.26448

Source: Complied and Calculated.

The above table depicts the ARCH family effects and corresponding results of institutional investors and Crude oil energy commodity derivative market in India for the period from January 2017 to December 2019. In this analysis, estimated four models from the ARCH family. Contain the parameter estimates of ARCH(5,0), GARCH(1,1), TGARCH(1,1) and EGARCH(1,1) respectively. All the estimated models can be compared according to the Akaike Information Criterion and Schwarz criterion with the normal guassian distribution method. Guideline is how to find the best model is that lower the value of Akaike Information Criterion and Schwarz criterion better the model fitted. In this analysis for ARCH (5,0) AIC is **22.90** and SIC is **23.30**, GARCH(1,1) AIC is **22.90** and SIC is **23.19**, TARCH(1,1) AIC is **22.97** and SIC is **23.28** and finally EGARCH (1,1) AIC is **22.95** and SIC is **23.26**. By comparing all these estimated models, the research found that GARCH (1,1) model is the best fitted because it has lower Akaike Information Criterion and Schwarz criterion.

Diagnostic Checking of best Fitted GARCH (1,1) model:

By comparing all ARCH family model and the researcher found that GARCH(1,1) model is best fitted with the values of AIC and SIC. Now need to check the diagnostic checking for the fitted model.

1. **Serial Correlation**

H_0: *There is no Serial Correlation*

Table 3

Serial Correlation Test for GARCH (1,1) Model

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |*. |	. |*. |	1	0.107	0.107	0.4507	0.502
.*| . |	.*| . |	2	-0.131	-0.144	1.1423	0.565
. | . |	. | . |	3	-0.063	-0.033	1.3091	0.727
. | . |	. | . |	4	-0.023	-0.031	1.3315	0.856
. |** |	. |** |	5	0.229	0.230	3.6544	0.600
. | . |	.*| . |	6	-0.013	-0.084	3.6622	0.722
.*| . |	.*| . |	7	-0.146	-0.083	4.6726	0.700
. | . |	. | . |	8	0.001	0.036	4.6726	0.792
. |*. |	. | . |	9	0.079	0.069	4.9907	0.835
. | . |	.*| . |	10	-0.047	-0.138	5.1062	0.884
. | . |	. | . |	11	-0.031	0.020	5.1592	0.923
.*| . |	. | . |	12	-0.083	-0.047	5.5544	0.937
.*| . |	.*| . |	13	-0.090	-0.101	6.0325	0.945
. | . |	.*| . |	14	-0.027	-0.085	6.0779	0.964
. | . |	. | . |	15	0.012	0.065	6.0874	0.978
. | . |	. | . |	16	-0.035	-0.064	6.1717	0.986

Source: Complied and Calculated

The table 3 shows the serial correlation for the GARCH(1,1) model for institutional investors and Crude oil energy commodity derivatives market in India. All the probability values are more than 0.05, meaning that can't reject the null hypothesis. So there is no serial correlation in the model with 5% level of significance.

2. ARCH Lm Test

H_0: *There is no ARCH effect*

Table 4

Heteroskedasticity Test: ARCH for GARCH (1,1) Model

F-statistic	0.390108	Prob. F(1,33)	0.5365
Obs*R-squared	0.408917	Prob. Chi-Square(1)	0.5225

Source: Complied and Calculated

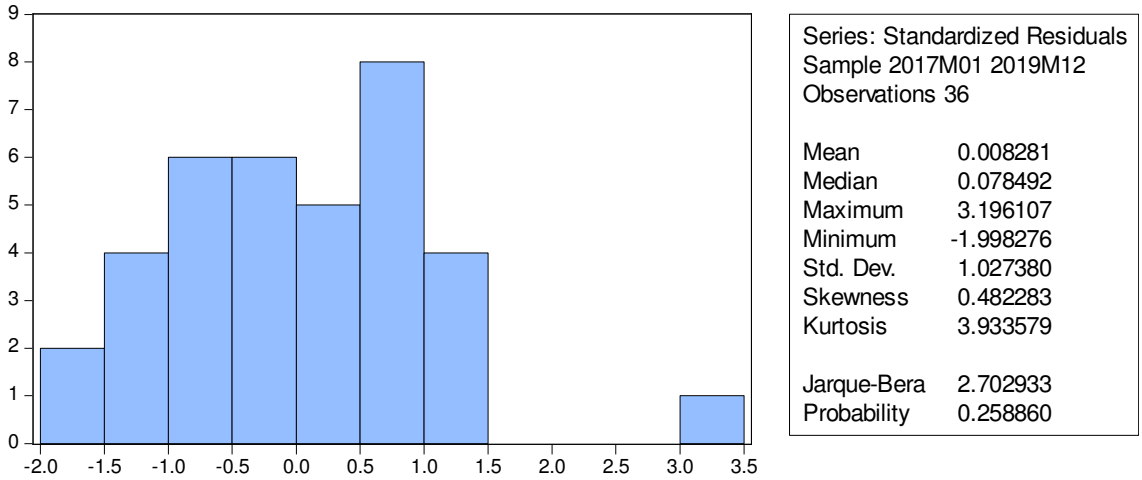
Table 4 demonstrates the Heteroskedasticity test for GARCH (1,) model. In that model probability value **(0.52)** is more than 5% level of significance. Hence, the null hypothesis is accepted. There is no ARCH effect in GARCH (1,1) model for the institutional investors and crude oil energy commodity derivatives in India.

3. Normal Distribution Test

H_0: *Residual are normally distributed*

Table 5

Normal Distribution – Histogram Test for GARCH (1,1) Model



Source: Complied and Calculated

The table 5 illustrates the normal distribution histogram test for GARCH(1,) model. The Jarque-Bera probability value **(0.25)** is more than 5% level of significance. Hence, the null hypothesis is accepted. The residuals are normally distributed in GARCH (1,1) model for the institutional investors and crude oil energy commodity derivatives in India.

Overall results of ARCH family shows that volatility estimates are that institutional investors are influencing the crude oil energy commodity derivatives market in India. Hence the null hypothesis, so there is an ARCH Family effect in Institutional Investors and Crude oil Energy commodity Derivative Market in India.

ARCH family model on Natural Gas Energy Commodity:

Table 6

ARCH Family model and its corresponding Results for Institutional Investors and Natural Gas Energy Commodity Derivative Market in India for the period of January 2017 to December 2019

Variable	ARCH (5,0)	GARCH (1,1)	TGARCH (1,1)	EGARCH (1,1)
Mean Equation				
C	-2890.572 (0.61)	-1846.42 (0.42)	-2850.245 (0.10)	-137.5739 (0.94)
FII	0.371238 (0.61)	0.137031 (0.66)	0.222066 (0.23)	0.034093 (0.79)
DII	0.581765 (0.56)	0.328448 (0.42)	0.544593 (0.04)	0.161463 (0.47)

Variable Equation				
C	1.72E+08 (0.02)			
RESID(-1)^2	0.141458 (0.44)			
RESID(-2)^2	0.014935 (0.95)			
RESID(-3)^2	0.031006 (0.87)			
RESID(-4)^2	-0.048533 (0.75)			
RESID(-5)^2	-0.043904 (0.77)			
C		2.20E+08 (0.93)		
RESID(-1)^2		5.465419 (0.93)		
GARCH(-1)		0.064177 (0.60)		
C			2.20E+08 (0.53)	
RESID(-1)^2			0.931969 (0.54)	
RESID(-1)^2*(RESID(-1)<0)			0.588221 (0.06)	
GARCH(-1)			-0.038933 (0.89)	
C(4)				6.565212 (0.00)
C(5)				-0.275035 (0.54)
C(6)				1.157291 (0.00)
C(7)				0.652777 (0.00)
AIC	22.23001	21.771	21.82125	**21.23699**
SIC	22.62589	22.07891	22.12916	**21.54489**

Source: Complied and Calculated.

The above table depicts the ARCH family effects and corresponding results of institutional investors and Natural Gas energy commodity derivative market in India for the period from January 2017 to December 2019. In this analysis, estimated four models from the GARCH family. Contain the parameter estimates of ARCH (5,0), GARCH(1,1), TARCH(1,1) and EGARCH(1,1) respectively. All the estimated models can be compared according to the Akaike Information Criterion and Schwarz criterion with the normal guassian distribution method. Guideline is how to find the best model is that lower the value

of Akaike Information Criterion and Schwarz criterion better the model fitted. In this analysis for ARCH (5,0) AIC is **22.23** and SIC is **22.62,** GARCH(1,1) AIC is **21.77** and SIC is **22.07**, TGARCH(1,1) AIC is **22.82** and SIC is **22.12** and finally EGARCH (1,1) AIC is **21.23** and SIC is **21.54**. By comparing all these estimated models the research found that EGARCH (1,1) model is the best fitted because it has lower Akaike Information Criterion and Schwarz criterion.

Diagnostic Checking of best Fitted GARCH (1,1) model:

By comparing all ARCH family model and the researcher found that EGARCH(1,) model is best fitted with the values of AIC and SIC. Now need to check the diagnostic checking for the fitted model.

1. **Serial Correlation**

H_0: There is no Serial Correlation

Table 7

Serial Correlation Test for GARCH (1,1) Model

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. | . |	. | . |	1	-0.045	-0.045	0.0787	0.779
. | . |	. | . |	2	-0.044	-0.047	0.1582	0.924
. |** |	. |** |	3	0.314	0.311	4.2474	0.236
. | . |	. |* . |	4	0.073	0.106	4.4747	0.346
**| . |	**| . |	5	-0.316	-0.319	8.8942	0.113
. | . |	.*| . |	6	0.012	-0.137	8.9012	0.179
. | . |	.*| . |	7	-0.060	-0.138	9.0693	0.248
.*| . |	. |* . |	8	-0.108	0.097	9.6413	0.291
. | . |	. | . |	9	-0.063	0.052	9.8406	0.364
.*| . |	**| . |	10	-0.196	-0.295	11.853	0.295
. |* . |	. | . |	11	0.095	0.070	12.346	0.338
. | . |	. | . |	12	-0.003	-0.005	12.347	0.418
.*| . |	. | . |	13	-0.104	0.044	12.995	0.448
.*| . |	**| . |	14	-0.121	-0.253	13.913	0.456
. | . |	**| . |	15	0.065	-0.210	14.187	0.511
**| . |	**| . |	16	-0.235	-0.214	17.967	0.326

Source: Complied and Calculated

The table 7 shows the serial correlation for the EGARCH(1,1) model for institutional investors and Natural gas energy commodity derivatives market in India. All the probability values are more than 0.05, meaning that can't reject the null hypothesis. So there is no serial correlation in the model with 5% level of significance.

2. **ARCH LM Test**

H_0: *There is no ARCH effect*

Table 8

Heteroskedasticity Test: ARCH for GARCH (1,1) Model

Heteroskedasticity Test: ARCH

F-statistic	0.067776	Prob. F(1,33)	0.7962
Obs*R-squared	0.071736	Prob. Chi-Square(1)	0.7888

Source: Complied and Calculated

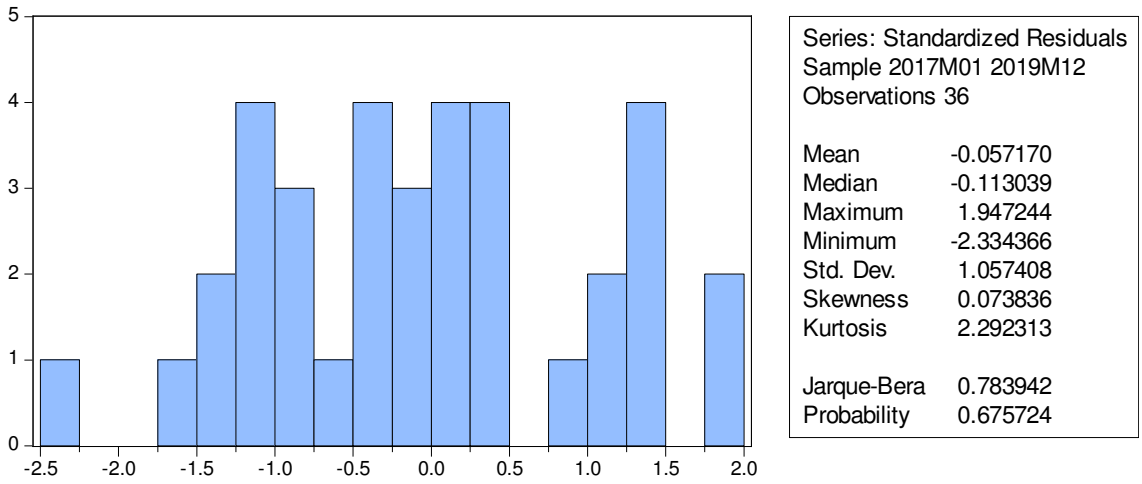
Table 8 demonstrates the Heteroskedasticity test for EGARCH (1,1) model. In that model probability value **(0.78)** is more than 5% level of significance. Hence, the null hypothesis is accepted. There is no ARCH effect in EGARCH (1,1) model for the institutional investors and Natural gas energy commodity derivatives in India.

3. Normal Distribution

H_0: *Residuals are normally distributed*

Table 9

Normal Distribution – Histogram Test for GARCH (1,1) Model



Source: Complied and Calculated

The table 9 illustrates the normal distribution histogram test for EGARCH(1,1) model. The Jarque-Bera probability value **(0.67)** is more than 5% level of significance. Hence, the null hypothesis is accepted. The residuals are normally distributed in EGARCH (1,1) model for the institutional investors and crude oil energy commodity derivatives in India.

Overall results of ARCH family shows that volatility estimates are that institutional investors are influencing the natural gas energy commodity derivatives market in India.

Hence the null hypothesis, so there is an ARCH Family effect in Institutional Investors and Natural Gas Energy commodity Derivative Market in India.

Conclusion

An analytical solution for volatility estimation which measures the normal distribution dispersion of data set has become a critical issue in many applications in business and finance. In this study the GARCH model, and some ARCH family models like ARCH (5,0), GARCH (1,1), TGARCH (1,1) and EGARCH (1,1) models are applied to analyze the data. These four models were applied to a monthly closing price of institutional investors and monthly total value of energy commodity derivative market in India covering the period from January 2017 to December 2019. By analyzing the volatility of crude oil energy commodity shows there is a influence on institutional investors by applying the GARCH (1,1) model; Natural Gas energy commodity proves there is a influence on institutional investors with the proof of EGARCH (1,1) model were applied. Overall the study found that there is an influence of energy commodity market on institutional investors investment pattern by adopting the ARCH family models with Normal Gaussian error distribution.

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