SECTOR WISE COMPARATIVE STUDY ON STOCK PRICE INDICES USING TIME SERIES ANALYSIS: CASE STUDY OF COLOMBO STOCK EXCHANGE

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Abstract

The stock markets of the country play a vital role in its economy. Stock market indices are vital fragments of information for investors. It is very important to develop models that reflect the pattern of the stock price movements for different sectors since it becomes very significant to investors and policy makers. Therefore, the aim of this research study was to develop models to forecast different sector indices in Colombo Stock Exchange and to compare sector wise models. The investigation was performed using secondary data for sample of ten listed sectors in Colombo Stock Exchange (CSE) for the thirty-four years' time period from 2nd January 1985 to 31st December 2018. Data were collected by using data library maintain by Colombo Stock Exchange. In analyzing secondary data financial time series data analysis techniques were used. ARCH family models were applied including Autoregressive conditional heteroscedasticity model, Generalized Autoregressive conditional heteroscedasticity model, Threshold Autoregressive conditional heteroscedasticity model, Exponential generalized autoregressive conditional heteroscedastic model, Integrated Generalized Autoregressive conditional heteroscedasticity model and Power Autoregressive conditional heteroscedasticity model in this research study since the sector indices are financial time series. Findings revealed that appropriate model to forecast the sector indices of Oil Palms sector, Services sector and Stores & Supplies sector as PARCH (2,1) model, Beverage, Food & Tobacco sector as PARCH (1,1) model, Chemicals & Pharmaceuticals sector as PARCH (2,2) model, Banking Finance & Insurance sector and Investment Trusts sector as IGARCH (2,2) model, Footwear & Textiles sector as EGARCH (1,1) model, Manufacturing sector as EGARCH (1,3) model and Hotels & Travels sector as TARCH (1,1) model. The findings of this research study are useful to the policy makers and the investors for their decision making.

Keywords: Stock price indices, time series analysis, Colombo stock exchange

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LIST OF ABBREVIATIONS

Abbreviation	Description
ASPI	All Share Price Index
CSE	Colombo Stock Exchange
ADF	Augmented Dickey Fuller test
ACF	Auto correlation function
PACF	Partial autocorrelation function
ARCH	Autoregressive conditional heteroscedasticity
GARCH	Generalized Autoregressive conditional heteroscedasticity
TARCH	Threshold Autoregressive conditional heteroscedasticity
EGARCH	Exponential generalized autoregressive conditional heteroscedastic
IGARCH	Integrated Generalized Autoregressive conditional heteroscedasticity
PARCH	Power Autoregressive conditional heteroscedasticity
AIC	Akaike information criterion
SC	Schwarz criterion

CHAPTER ONE
INTRODUCTION

1.1. Introduction to the Chapter

Chapter one explains first the background to research, then the statement of problem. Thereafter it explains the questions for this study and research objectives which has been used in this research. Further it explains the significance of the research, research scope and coverage.

1.2. Background to the Study

The stock markets of the country play a significant role in the economy. The combination of buyers and sellers of stocks which represent ownership claims on businesses can be identified as a stock market. It includes the publicly listed securities on stock exchange and privately traded securities. Therefore, it can be identifying that the stock market is the best method for raising funds for the companies, where most probably debt markets do not trade publicly.

Stock marketplace offers a chance for the companies to trade shares publicly and to increase their financial ability by expanding the capital to enlarge their businesses. The companies can sell the ownership of shares in the public market. Investing in stock is a liquidness opportunity. It means that a securities exchange provides chance for their investors to who are holding securities to sell their securities as soon as possible. This is the most striking chance of investing in stocks with compared to other investments such as estates, gold and other non-moveable assets. Some of the companies themselves enthusiastically rise liquidness by trading their own shares.

Stock prices and the price of other properties are substantial part of the dynamic economic actions, and can impact or can be an indicator of societal moods. It is well-known that the economic strength and development of a country indicates by the stock market.

In accordance with the efficient market hypothesis by changing the essential factors, like the margins, profits or dividends, long term share prices, which casual sound in the system may overcome. Further it says that the hard efficient-market hypothesis does not explain some situation such as the crash in 1987.

Share prices can be decreased intensely without fixed reason. None of advance search able to perceive any rational expansion that might have caused for the crash. It says the Stock markets play a vital role in rising businesses which eventually touch the economy over moving existing capitals from the parties which have excess to those who are suffering from capital shortages (Padhi and Naik, 2012).

1.2.1. All Share Price Index (ASPI)

The Colombo Stock Exchange (CSE) is an authority party to computes and issues the ASPI, Sector wise Indices and Total Return Indices.

ASPI is the comprehensive marketplace index of CSE. It is calculated to amount the activities of the complete marketplace. The ASPI is designed weighted market capitalization indices that establish total elective and non-elective ordinary shares which are listed in Colombo Stock Exchange.

CSE has mentioned that the Elective Ordinary Shares and Non-Elective Ordinary Shares from 19th June 2017 listed on Colombo Stock Exchange are eligible for index calculation.

1.2.2. Index formula

The All Share Price Index is computed as follows:

$$\text{All Share Price Index} = \frac{\text{Market Capitalization of Total Listed Companies}}{\text{Base Market Capitalization}} \times 100$$

Where,

Market Capitalization = $\sum$ Current Number of Listed Shares of $\text{Company}_i \times \text{Market Price}_i$

Base Market Capitalization = $\sum$ Number of Listed Shares of $\text{Company}_i \times \text{Market Price}_i$

Base standards recognized by normal marketplace price on year 1985. Hereafter the base date is January 02, 1985 and base price is equal to 100.

1.2.3. Index maintenance

It has further mentioned by the CSE when upsurge or reduction in the present marketplace price because of fluctuations in the stock price activities, the Colombo Stock Exchange will do essential modifications to the Base Market Capitalization to remove all belongings other than price fluctuations. By altering the Base Market Capitalization, the index worth holds its steadiness previously and later the incident.

1.2.4. Sector wise indices

According the Colombo Stock Exchange, the CSE Sector Wise Indices contains of directories shaped by separating the residents of All Share Price Indices into twenty Sectors. Sector indices replicate price changes of businesses in twenty individual sectors. All the base values which are used to compute the sector wise indices are similar to the values used to compute the All Share Price Indices.

1.2.5. Forecasting

Simply forecasting can be introduced as an effort to estimate about future events. The key impartial of forecasting is to support for decision makers to end up with well conclusions. Theoretically here are two key tactics of forecasting, one is explanatory forecasting and other one is time series analysis. According to Explanatory forecasting, it accepts a cause and effect association among the contributions and production. Further, it emphasis the varying inputs will impact on production of the organization in foreseeable manner. Here it assumes the cause and effect association is as fixed. Time series forecasting is considered the organization as a black box and activities to determine the influences affecting the performance. According to the theory two motives influence to consider a scheme as a black box . Initial reason is the scheme may not be unstated and smooth if it were unspoken it may be tremendously hard to amount associations supposed to rule its behavior. Next reason is the chief consideration only for forecast what will occur and why not it occurs. Financial time series is a least stated method. Therefore, the attention of this research study is on time series forecasting.

1.3. Problem Statement

The Colombo Stock Exchange comprises with 290 listed business organizations as at 30th September 2019 which represent 20 business sectors. The prices of shares will change rapidly. The investors invest money in the capital market to earn profits. The stockholders purchase the shares of diverse business on the precedence base. Investors will select the shares of diverse business on the basis of the diverse aspects. Most investors have no information regarding the market investigation and regarding the appropriate forecast of the forthcoming prices of diverse kinds of shares existing in the market. Therefore, most probably investors employ their funds to buy shares of diverse corporations on the basis of error presumptions, deprived of any knowledge around data analysis and estimation. Most stockholders lose their investment in this unbalanced capital marketplace. Then, the universal investors will not pay their attention to capitalize their funds in the capital marketplace and it will cause to rise a disaster in the capital market. Changes in share prices of capital market are seized in price indices called stock indices. Stock market indexes are vital fragments of information for investors. Therefore, it is required to develop models that reflect the pattern of the stock price movements for different sectors listed in CSE since it becomes very significant to investors and policy makers. Therefore, in this research study the researcher developed models to forecast different sector indices and compared.

1.4. Research Objectives

To develop financial time series models to forecast Sector Indices for different sectors listed in CSE.

To identify the most suitable model for forecasting sector indices by comparing different sectors.

1.5. Research Questions

What are the financial time series models that can be developed to forecast the sector indices for different sectors listed in CSE?

What is the most suitable model to forecast the sector indices for different sectors listed in CSE?

1.6. Significance of the Research

Stock market of country is very crucial part of its economy. Most of the investors are gathering in stock market of a particular country to buy or sell their securities. Out of the buying and selling securities stock transactions are major in CSE and some other countries. When making a decision regarding stock transition stock prices and indices are most important factors to be concerned. Therefore, studying on stock indices is very important for the investors.

Investors most probably investing their money in any investment opportunity seeking a profit. They have to select suitable sector and suitable company or companies to investing their money. Stock prices are fluctuating with the time. Earnings of a particular investment will be depending on the future fluctuations of stock prices. Therefore, forecasting future stock prices and stock indices are very important for the investors to make their better decisions.

Some investors are familiar with stock transactions and they are engaging very frequently with stock transactions. Therefore, they have good experience and knowledge about behavior of stock market. But some of the investors are new to the stock market transactions and they have no sound knowledge and experience on it. Therefore, they will ask help from stock brokerage firms. Stock brokerage firms should have to obtain better knowledge about the behavior of stock market. Therefore, this study is also significant for the stock brokerage firms.

For the students or future researchers who are interesting in studying stock market, the behavior of stock prices and stock indices, financial time series modeling and forecasting techniques is also very important this research study.

1.7. Research Scope and Coverage

The scope of research was limited to develop financial time series models to forecast Sector Indices for different sectors listed in CSE and to identify the most suitable model for forecasting sector indices by comparing different sectors listed in Colombo Stock Exchange. Therefore, it will not be compared with other stock exchanges in the world.

The coverage of this research was only six models including ARCH model, GARCH model, TARCH model, EGARCH model, IGARCH model, PARCH model for forecasting sector indices.

1.8. Content of Thesis

The second chapter elaborates the empirical findings related with stock market. Therefore, chapter will be comprised with more details regarding the previous research studies which have done regarding stock market and financial time series analysis.

The methodology chapter explains the research method which researcher used in this research study. Therefore, this chapter comprises with the sample and population, data collection methods, data analysis tools and data analysis techniques.

Forth chapter presents and analyses the collected data. Charts and figures enhance the eminence of the data presentations. Time series analysis was used to analyses the data series of ten sectors. Tables are used to present the analyzed data.

The conclusion chapter will be explained the conclusion based on data analysis. It will address to the research objectives and questions which were included in chapter one. Finally based on the findings conclusion and recommendations will present.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction to the Chapter

This chapter elaborates empirical research findings related with stock market. Therefore, this chapter is comprised with more details regarding the previous research studies which have done with regarding stock market and financial time series analysis.

2.2 Empirical Findings

Many researchers have predicted the volatility of stock marketplace, and most of these researches carried out on overseas stock markets. Most of these findings inversely affect to the Sri Lankan stock market. Therefore, findings of these researches cannot be straight functional to Colombo Stock Exchange. Ng and McAleer in 2004 stated that the extrapolative estimating ability of GARCH (1,1) model introduced by Bollerslev in year 1986 and an asymmetry accommodating GJR (1,1) model presented by Glosten, Jagannathan, and Runkle for the S&P 500 indices and Nikkei 225 indices in year 1993. Ng and McAleer in 2004 observed predicting ability of each model GJR (1,1) and GARCH (1,1). They found that forecasting performance was reliant on the data applied. Further, Ng and McAleer in 2004 identified that to forecast the S&P 500 data the GJR (1,1) is mostly applicable and to predict the Nikkei 225 data the GARCH (1,1) model is more applicable.

Regularly evaluating the volatility of stock market and the projecting performance of the conditional movements of the stock marketplace is very much important. Stock market indices are change dynamically. DSE 20 and DSE general are two stock market indices in Bangladesh. Alam et al. in year 2013 investigate the Bangladesh stock indices by using five ARCH family models. They concluded that from their research findings historical changes significantly influenced on future changes when considering both stock indices mention above in Bangladesh with ARCH family models. The authors further identified that the EGARCH model has an asymmetric performance in volatility. Alam et al. in year 2013 assessed models grounded on within-sample and out-of-the - sample statistical as well as trading ability.

Alam et al. (2013) study was found mean absolute error, mean absolute percentage error, root mean squared error, and the inequality coefficient statistical performance from their research study. Based on the annual returns, annual volatility, the sharpe ratio, and maximum reductions it may depend on trading ability. Though research of Alam et al. (2013) submitted a tough model for measuring the ability of the conditional volatility models, its findings were rather inconclusive. Further less interpretation of research and more practical errors has provided plenty chances for further researches.

AL-Najjar in year 2016 focused on Stock Market movements of the Jordan. She has applied ARCH and GARCH Models on her research work. She modeled ARCH, GARCH, and EGARCH to examine the performance from Jan. 1 2005 to Dec.31 2014 time period of the Amman Stock Exchange. Further she found that the behavior of Amman Stock Exchange can be identified by ARCH and GARCH models. AL-Najjar (2016) further deliver more signals while EGARCH results discloses that for the survival of leverage effect it will not be reinforced by the stock indices of Jordan stock market. Mhmoud and Dawalbait in year 2015 measured the predicting ability of different conditional volatility models by using Saudi Arabia's Tadawul All Share Index daily data returns for twelve-year time period. They have considered GARCH(1,1), EGARCH(1,1) and GRJ-GARCH(1,1) models for predicting Saudi Arabia's Tadawul All Share Index. Ljung-Box Q statistics was functional to choice volatility model and both the standardized and squared standardized residuals and ARCH-LM test. Further Mhmoud and Dawalbait in year 2015 applied Akaike information criteria and maximum log-likelihood values to select best output. They have evaluated the performance of out-sample. For the purpose of measure, the statistical performance and find the best model they have used mean absolute error, the mean absolute percentage error, the root mean squared error and the Theil-U statistic in their research study.

Further to select the best model of forecasting the stock market changes Mhmoud and Dawalbait (2015) used Akaike information criteria and maximum log-likelihood values. They found that GRJ-GARCH(1,1) model as most suitable when the selection criteria is Akaike information. And also researcher found that EGARCH(1,1) is most suitable with LL value. They conclude that GRJ-GARCH(1,1) model is the best in forecasting volatility of the Saudi Arabia's Tadawul All Share Index for statistical forecasting performance.

Alam et al. (2013) investigated the stock indices of Bangaladesh it is different with the approach of Mhmoud and Dawalbait (2015). Alam et al. (2013) and Mhmoud and Dawalbait (2015) used equal statistically prediction performance assessments. Further Mhmoud and Dawalbait (2015) included extra appraisals through information criteria, though Alam et al. (2013) extended the assessment measures through trading performance procedures. The selection process of Mhmoud and Dawalbait (2015) promoted from out-of-sample trading ability assessments. That research can be further expand by increasing data. They have applied daily stock indices from January 1, 2005, to December 31, 2012. Mhmoud and Dawalbait (2015) applied 124 data points to out-of-sample prediction from total 2,317 data points.

Reid, Newbold and Granger (1969) used a large sample in their study to define post-sample predicting accuracy. Authors found that advanced statistical techniques as well as ordinary techniques perform well, but their conclusion was seriously criticized by many since it went in contradiction of conventional sense.

Predicting models have grown period from period. The complication of market increased and therefore complexity of the forecasting models has also increased. There are diverse models which applied by different researchers and some of the models are currently using and some of the models are still under research.

It is very difficult to make more accurate decisions with rapidly changing financial time series data. Various researchers and financial analysts found that the requirement of detection of non-linear changes in the financial markets [Abhyankar, Copel and Wong 1997]. Huge number of researches were evidenced that the nonlinear behavior of stock market. Normal distribution diagram well represents the behavior of the stock market. (e.g. see Ryden 1998, Terasvirta et al 1993 and the references therein). LeBaron; Hamilton and Susmel,; ; Ramchand et al 1998; Ryden et al1998, Susmel 1999 stated that the behavior of stock marketplace by the Markov switching model. Hamilton et al. in 1996 stated that Markov switching model can be used to fit the stock market data and also it can be used to predict the stock market.

It says that Non-linear methods are more complex than linear methods. So, non-linear models are very hard to develop. A person who is going to develop non-linear model has to select a suitable model among number of diverse models. More researches have established methods to identify non-linear methods like non-linear regression models, parametric models, non-linear volatility models and nonparametric models.

Climents, Franses and Swanson in year 2004 stated that application of nonlinear methods on financial time series data is a debatable consideration regarding the output and also no agreement with model selection of the nonlinear methods and evaluation process. Further, the Artificial intelligence methods and SVM models also with further examination level. More nonlinear methods are available to make more accurate estimation regarding stock market volatilities and most of these methods are model driven methods. Artificial intelligence methods are data driven methods. It is not required to specify models before developing the models. Artificial intelligence methods itself identify the inherent association of variables. Therefore, artificial intelligence techniques have ability to identify the association among the variables without any previous information.

Champbell in 1991 mentioned that artificial neural networks are being applied by analysists as a nonlinear technique. Schwert (1990) state that neural networks are able to establish relationships with scientific awareness of the stochastic procedure mentioned by the analyzed time series models is unidentified and hard to rationalize.

Mukherjee et al. (1997) stated that the suitability to apply support vector mechanism (SVM) in time series data predicting. Tay and Cao in 2001 studied the foreseeability of financial time series using time series data sets through support vector machines. Authors presented that support vector machines outpaced the Back Spread networks on the principles of normalized mean square error, mean absolute error, directional symmetry and weighted directional symmetry. Tay and Cao (2001) further estimated the future value by support vector machines in regression approximation. Mukherjee, Osuna and Girosi (1997) says that some applications of support vector mechanism to financial time series forecasting have been reported. Support vector mechanism as shown by Mills (1990) is better than other forecasting techniques to forecast the weekly changes of direction of NIKKEI 225 Index.

Fuzzy time-series were used by Chen et al to forecast the Taiwan stock market. Deboeck (1994) mentioned that to enhance the fruitfulness of artificial networks, fuzzy logic can be applied by integrating planned knowledge regarding financial markets which guidelines, explanations and recommendations providing by dealers.

According to the literature review, it shows that more researches have been conducted with regarding time series analysis and ended with inconsistent conclusions during past years. Many of the researches have been directed by traditional regression methods. It has implemented some researches with new techniques in very recently. It is clear more researches are essential on forecasting Stock markets. Stock markets are highly volatile. It is difficult to model stock market index returns. But using precise volatility predictions is extremely appreciated for financial time series. Forecasting stock market indices can be benefited for many of financial engagements. Stock market indices prediction may be appreciated by policy preparers, students and future researchers who are interested with understanding stock market fluctuations. Therefore, this research determines the most precise model for forecasting the stock market sector indices.

2.3 Chapter Summary

The literature review chapter has explained the empirical research findings related to stock market. Therefore, chapter comprises with more details regarding the previous research studies which have done on stock market and financial time series analysis.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction to the Chapter

The purpose of this methodology chapter is to explain the research method which researcher used in this research study. Therefore, this chapter comprises with the sample and population, data collection methods, data analysis tools and data analysis techniques.

3.2 Population & Sample

The Colombo Stock Exchange (CSE) has 290 companies which are representing 20 sectors as at 30th September 2019. Though the population of this research is 20 business sectors, sample was limited to 10 sectors because unavailability of data of six sectors including Diversified Holdings, Health Care, Information Technology, Plantations, Power & Energy and Telecommunications for the entire time period considered for this research study and another four sectors cannot apply the ARCH family models since they have not ARCH effect including Construction & Engineering, Motor, Land & Property and Trading. Therefore, the sample of this research was 10 sectors listed in CSE for the thirty-four years' time period from 2nd January 1985 to 31st December 2018 and for the purpose of forecasting 99 days used from 2nd January 2019 to 29th March 2019. This is the maximum time period that the researcher could finds secondary data archived from the Colombo Stock Exchange data library.

3.3 Data Collection

The secondary data collected for the study for the period of thirty-four years from 2nd January 1985 to 31st December 2018 using data library maintained by Colombo Stock Exchange.

3.4 Data Analysis

Since this research is based on financial time series to analysis the data it was used the conditional variance analysis techniques such as ARCH and GARCH models and the extensions of the ARCH and GARCH models. The collected data was analyzed in Eviews – 08 statistical package by using Time Series Analysis techniques.

3.5 Unit Root Test

Unit root test can be used to find whether to apply differencing or not for a time series. It is statistical hypothesis tests to test stationarity of a time series. Unit root test is intended to identify whether it is required to differentiate time series or not. There are many tests to select to check the unit root. In this research study to check the stationarity of the data series Augmented Dickey Fuller test (ADF) was used. The Augmented Dickey Fuller Test is one major test of unit root which can be used to check stationarity. If there are unit roots it is difficult to predict by using output of time series. Though there is serial correlation with series Augmented Dickey-Fuller test can be applied. The ADF test is better to use to test more complicated series than Dickey-Fuller test. Augmented Dickey Fuller test is more powerful. It is said Augmented Dickey Fuller test should be applied to test the stationary of series very carefully since it may include high Type I error rate like other tests. Time series has no unit root is the null hypothesis for Augmented Dickey Fuller test and the basic alternative hypothesis is that the time series is stationary or no unit root. The model is as follows:

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \cdots + \delta_{p-1} \Delta y_{t-p+1} + \varepsilon_t$$

Where;

α is a constant,

β coefficient of time trend

p lag order of autoregressive method

3.6 Autocorrelation

The series which values of the series can be forecasted grounded on previous data of time series, the series is supposed to display autocorrelation. It is denoted as serial correlation or serial dependence. If there is autocorrelation with residuals of a model that is not a symbol and that may be unreliable. Autocorrelation can be identified by using correlogram / Auto correlation function (ACF) plot and autocorrelation can be confirmed by Durbin-Watson test.

It is said that autocorrelation function is coefficient of correlation among two values within a series. For an example if we consider the autocorrelation function of time series "Y_t".

Y_t can be defined as like:

Correlation (Y_t, Y_t −k)

Here "k" represents the time gap and that is named as lag. If we consider a lag 1 autocorrelation, it is correlation among values of considered period. Here we can define lags k autocorrelation as correlation among data of "k" time period.

Auto correlation function is the mechanism to measure the linear association among data at time "t" and the data at preceding time period. Partial autocorrelation function (PACF) can be find after computing association of converted time series. By using the PACF, it can be identified order of an autoregressive model.

We can use ACF and PACF graphs to assess the lag of an autoregressive model. If the series is serially correlated, we can see large ACF amount and fixed pattern of lag values. Normally in PACF plot with lag values, we can see an arbitrary pattern. After confirming the stationary and the autocorrelation of the data series it has tested the ARCH effect.

3.7 ARCH Model and GARCH Model

3.7.1 ARCH model

Autoregressive conditional heteroscedasticity (ARCH) models are used if there are error terms of series in typical size or variance of the series. ARCH modes assume that the variance of existing error term of a series to be a function of the actual sizes of the error terms of prior period of a series. The ARCH model is a nonlinear model. It does not assume that the series has constant variance.

The basic model of linear ARCH is as follows:

$Y_t = \emptyset X_t + \varepsilon$

The error terms can be presented as follows and it divided into a stochastic sections and a standard deviation:

$$\varepsilon_t = \sigma_t z_t$$

The random variable and the series is changes over time can be modelled as follows:

$$\sigma_t^2 = a_0 + a_1 \varepsilon_{t-1}^2 + \cdots + a_q \varepsilon_{t-q}^2 = a_0 + \sum_{i=1}^{q} a_i \varepsilon_{t-i}^2$$

Where $a_0 > 0$ and $a_i > 0$

3.7.2 GARCH model

Bollerslev in 1986 and Taylor in 1986 independently recognized Generalized Autoregressive conditional heteroscedasticity (GARCH) model. It has presented a moving average term and fixed lag structure into the ARCH model. In GARCH (p, q) model p represent the order of the GARCH terms σ^2 and q denote the order of the ARCH terms ε^2.

$$\sigma_t^2 = w + a_1 \varepsilon_{t-1}^2 + \cdots + a_p \varepsilon_{t-p}^2 + \beta_1 \sigma_{t-1}^2 + \cdots + \beta_q \sigma_{t-q}^2$$

$$= w + \sum_{i=1}^{p} a_i \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2$$

The GARCH (1,1) can be presented as follows:

$$\sigma_t^2 = a_0 + a_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2$$

3.7.3 ARCH effect

To test the ARCH effect of the data series it has used the ARCH-LM test. Only if there was an ARCH effect of data series it has applied ARCH family models for analysis.

3.8 Extension of ARCH Models

3.8.1 EGARCH model

Nelson in 1991 introduced EGARCH model and it has developed to solve the problem of estimating negative variance parameter. Log form of the model confirms that the conditional variance as positive and sometimes parameters may take negative values. The EGARCH (p,q) can be presented as follows:

$$log\sigma_t^2 = w + \sum_{j=1}^{q} \beta_j \log(\sigma_{t-j}^2) + \sum_{i=1}^{p} \alpha_i \left|\frac{\varepsilon_{t-i}}{\sigma_{t-i}}\right| + \sum_{k=1}^{r} \gamma_k \frac{\varepsilon_{t-k}}{\sigma_{t-k}}$$

Engle and Ng. in 1993 permits from EGARCH model for positive and negative return shocks. Most of the previous studies prove that the coefficient γ is frequently negative and it proposes huge influence on return volatility by negative return shocks.

3.8.2 TARCH model / GJR GARCH model

Zakoïan in 1994 Threshold Autoregressive conditional heteroscedasticity (TARCH) model was presented. This is based on conditional standard deviation but not based on conditional variance. In TARCH model it identify the impact of good and bad news. It will identify independently by α and γ, coefficients correspondingly. TARCH model is presented as follows:

$$\sigma_t^2 = w + \sum_{i=1}^{p} a_i \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2 + \sum_{k=1}^{r} \gamma_k \varepsilon_{t-k}^2 \overline{I_{t-k}}$$

TARCH (1,1) model can be presented as follows:

$\sigma_t^2 = w + a_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2 + \gamma_1 \varepsilon_{t-1}^2 \overline{I_{t-1}}$

If $\gamma = 0$ the TARCH model converts as a linear Generalized Autoregressive conditional heteroscedasticity model. If $\gamma \neq 0$, there is an unbalanced effect.

3.8.3 IGARCH model

Integrated Generalized Autoregressive conditional heteroscedasticity (IGARCH) models are the unit root Generalized Autoregressive conditional heteroscedasticity models. IGARCH model is presented as follows:

$$\sigma_t^2 = w + \sum_{i=1}^{p} \alpha \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2$$

3.8.4 PARCH model

Power Autoregressive conditional heteroscedasticity (PARCH) model, parameter δ of the standard deviation can be projected. PARCH model is presented as follows:

$$\sigma_t^{\delta} = w + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^{\delta} + \sum_{i=1}^{p} \alpha_i \left(|\varepsilon_{t-i}| - \gamma_i \varepsilon_{t-i}^{2}\right)^{\delta}$$

3.9 Model Selection

After applying the six ARCH models including ARCH, GARCH, TARCH, EGARCH, IGARCH and PARCH it was selected the best model by using the Akaike information criterion (AIC) and Schwarz criterion (SC) values. According to the AIC and SC criteria the model which have lowest value of AIC and SC was recognized as appropriate model for the forecasting sector indices.

3.10 Residual analysis

After selecting a tentative model, it was done the residual analysis for the selected model for checking the autocorrelation, Heteroscedasticity and ARCH effect. To check the autocorrelation of the residuals it was used the correlogram of squired standardized residual and to check the ARCH effect of the residuals it was used the ARCH-LM test. To check the heteroscedasticity of the residuals Breusch – Pagan - Godfrey test was used.

3.11 Chapter Summary

The methodology chapter has explained the research method which researcher used in this research study. Therefore, this chapter was comprised with the techniques of sample design, methods of data collecting, tools and techniques of data analysis and finally data presentation methods. In this research study researcher used secondary data. To analyses the data EViews 8 statistical package was used. Time series Analysis were applied as the techniques of data analysis.

CHAPTER FOUR

DATA PRESENTATION AND ANALYSIS

4.1. Introduction to the Chapter

In this chapter the collected data are presented and analyzed. Charts and figures are enhanced the eminence of the data presentations. Time series analysis were used to analyses the data series of ten sectors. Tables and figures are used to present the analyzed data.

4.2. Banking Finance & Insurance Sector

4.2.1. Preliminary analysis

It is necessary to test the stationary conditions after collecting the data. By just looking at the time series plot it can be obtained an idea about the data series.

The Figure 4.1 shows the time series plot for daily index in Banking Finance & Insurance Sector which consists of 8190 observations.

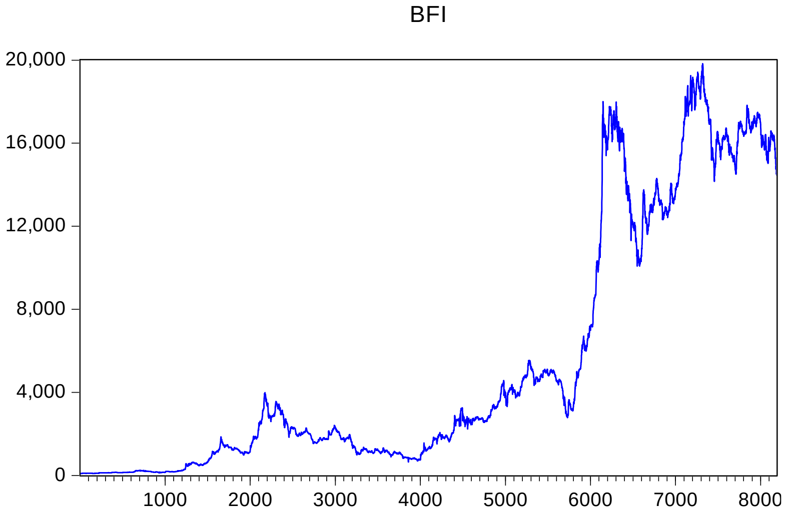


Figure 4.1: Time series plot for daily index in Banking Finance & Insurance Sector from 02nd Jan. 1985 to 29th Mar. 2019. The X axis denotes the year and Y axis denotes the Index.

4.2.2. Unit root test: Augmented dickey-fuller (ADF) test

Table 4.1 shows the test results of Unit Root Test, Augmented Dickey-Fuller (ADF) test with intercept to prove that data series is not stationary in statistically.

Table 4.1: ADF test for raw data series of Banking Finance & Insurance Sector

Null Hypothesis: BFI has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic - based on SIC, maxlag=36)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.251337	0.9295
Test critical values:	1% level	-3.430972	
	5% level	-2.861700	
	10% level	-2.566897	

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

According to the result of ADF it can be accepted null hypothesis and reject the alternative hypothesis said that the data series has unit root means that the time series data are not stationary. Thus it is necessary to make them stationary. To this purpose it can be checked the behavior of first difference of log data series.

To confirm the stationarity of the first difference of log data series Unit Root test, Augmented Dickey Fuller (ADF) tests have been carried out and the results for 5% of Significant level are shown the in the Table 4.2.

Table 4.2: ADF test values for the first difference of log data series of Banking Finance & Insurance Sector

Null Hypothesis: DLOGBFI has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=36)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-56.76858	0.0001
Test critical values:	1% level	-3.430972	
	5% level	-2.861700	
	10% level	-2.566897	

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

Though the result of ADF shows the probability as significant to reject the null hypothesis of the series has a unit root and accept the alternative hypothesis of the data series has not unit root. That means data series is stationary with mean but not with variance. It is confirmed by the autocorrelation (ACF) and partial autocorrelation (PACF) graphs.

Autocorrelation	Partial Correlation		AC	PAC	Q-Sta...	Prob
		1	0.153	0.153	193.02	0.000
		2	0.058	0.036	221.04	0.000
		3	0.038	0.025	233.16	0.000
		4	0.031	0.020	240.85	0.000
		5	0.034	0.025	250.35	0.000
		6	0.001	-0.01...	250.36	0.000
		7	0.009	0.007	251.05	0.000
		8	0.015	0.012	253.00	0.000
		9	0.020	0.015	256.18	0.000
		1...	0.000	-0.00...	256.18	0.000
		1...	0.014	0.014	257.84	0.000
		1...	0.041	0.036	271.33	0.000
		1...	0.020	0.007	274.57	0.000
		1...	0.045	0.038	291.19	0.000
		1...	-0.02...	-0.04...	297.01	0.000
		1...	-0.00...	-0.00...	297.23	0.000
		1...	-0.00...	-0.00...	297.29	0.000
		1...	0.000	0.002	297.30	0.000
		1...	0.018	0.017	299.93	0.000
		2...	0.014	0.010	301.43	0.000
		2...	-0.00...	-0.01...	301.76	0.000
		2...	0.001	0.001	301.76	0.000
		2...	0.024	0.023	306.58	0.000
		2...	0.031	0.024	314.23	0.000
		2...	0.009	-0.00...	314.85	0.000
		2...	0.004	-0.00...	315.02	0.000
		2...	0.018	0.017	317.65	0.000
		2...	0.017	0.009	320.10	0.000
		2...	0.000	-0.00...	320.10	0.000
		3...	0.030	0.029	327.59	0.000
		3...	0.008	-0.00...	328.06	0.000
		3...	0.009	0.002	328.75	0.000
		3...	0.004	-0.00...	328.87	0.000
		3...	0.013	0.012	330.26	0.000
		3...	-0.02...	-0.02...	333.57	0.000
		3...	-0.01...	-0.01...	334.96	0.000

Figure 4.2: The Correlogram of first difference series of Log index of Banking Finance & Insurance Sector

The Correlogram of first difference series of Log index of Banking Finance & Insurance Sector confirm that there is serial correlation with lag values.

4.2.3. Model identification and coefficient estimation

4.2.3.1 ARCH-LM test

To test the applicability of ARCH family model it can be checked the ARCH -LM test. The test results are shown in Table 4.3.

Table 4.3: ARCH-LM test results of Banking Finance & Insurance Sector

Heteroskedasticity Test: ARCH

F-statistic	934.2827	Prob. F(1,8186)	0.0000
Obs*R-squared	838.7796	Prob. Chi-Square(1)	0.0000

According to the Table 4.3, it can be reject the null hypothesis since the probability value is significant and can accept the alternative hypothesis. This means model has ARCH effect and therefore, ARCH family models can be applied.

4.2.3.2 ARCH

Table 4.4 Output of ARCH (2) model of Banking Finance & Insurance Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	8.48E-05	0.000252	0.336132	0.7368
AR(1)	0.923635	0.004434	208.2857	0.0000
MA(1)	-0.790556	0.006336	-124.7716	0.0000
		Variance Equation		
C	8.77E-05	2.22E-07	395.7884	0.0000
RESID(-1)^2	0.624089	0.009755	63.97690	0.0000
RESID(-2)^2	0.277836	0.008747	31.76376	0.0000

According to the Table 4.4, ARCH (2) model all the coefficients of both mean equation and variance equation are statistically significant under 1% significant level other than the C of mean equation. But the residual tests of this model is not satisfied. Therefore, ARCH (2) model was not considered to model comparison.

4.2.3.3 GARCH

Table 4.5 Output of GARCH (2,2) model of Banking Finance & Insurance Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	0.000457	0.000131	3.499291	0.0005
AR(1)	0.431916	0.021262	20.31409	0.0000
MA(1)	-0.120256	0.025821	-4.657338	0.0000
Variance Equation				
C	2.43E-05	4.72E-07	51.55027	0.0000
RESID(-1)^2	0.500582	0.007921	63.19984	0.0000
RESID(-2)^2	0.164344	0.005784	28.41139	0.0000
GARCH(-1)	-0.075036	0.002421	-30.99405	0.0000
GARCH(-2)	0.537147	0.002342	229.3552	0.0000

Table 4.5 shows that GARCH (2,2) model both mean equation and variance equation coefficients are statistically significant under 1% significant level.

4.2.3.4 TARCH

Table 4.6 Output of TARCH (2,2) model of Banking Finance & Insurance Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	0.000366	0.000180	2.036592	0.0417
AR(1)	0.691258	0.015319	45.12312	0.0000
MA(1)	-0.394941	0.021523	-18.34952	0.0000
Variance Equation				
C	-1.09E-10	5.04E-09	-0.021545	0.9828
RESID(-1)^2	0.269610	0.001238	217.8025	0.0000
RESID(-1)^2*(RESID(-1)<...	0.009647	0.000320	30.11186	0.0000
RESID(-2)^2	-0.269024	0.001249	-215.4512	0.0000
GARCH(-1)	1.570873	0.004528	346.9365	0.0000
GARCH(-2)	-0.575057	0.004449	-129.2574	0.0000

According to the Table 4.6, TARCH (2,2) model both mean equation and variance equation all the coefficients are statistically significant under 1% significant level other than C. The residual analysis of this model is not satisfied. Therefore, TARCH (2,2) model was not considered for model comparison.

4.2.3.5 EGARCH

Table 4.7 Output of EGARCH (1,2) model of Banking Finance & Insurance Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	5.87E-07	6.72E-05	0.008732	0.9930
AR(1)	0.347715	0.031893	10.90243	0.0000
MA(1)	-0.136222	0.034365	-3.963993	0.0001
Variance Equation				
C(4)	-1.216682	0.072799	-16.71293	0.0000
C(5)	0.464635	0.022466	20.68139	0.0000
C(6)	0.048685	0.012680	3.839659	0.0001
C(7)	0.637211	0.055763	11.42714	0.0000
C(8)	0.264378	0.053315	4.958756	0.0000
GED PARAMETER	0.854014	0.008196	104.2025	0.0000

Table 4.7 shows that the EGARCH (1,2) model both mean equation and variance equation all the coefficients are statistically significant under 1% significant level other than C.

4.2.3.6 IGARCH

Table 4.8 Output of IGARCH (2,2) model of Banking Finance & Insurance Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	9.01E-06	8.59E-05	0.104848	0.9165
AR(1)	0.500755	0.030511	16.41253	0.0000
MA(1)	-0.277170	0.034750	-7.976195	0.0000
Variance Equation				
RESID(-1)^2	0.338277	0.001700	199.0256	0.0000
RESID(-2)^2	-0.337221	0.001678	-200.9166	0.0000
GARCH(-1)	1.592963	0.005324	299.1902	0.0000
GARCH(-2)	-0.594019	0.005314	-111.7745	0.0000
T-DIST. DOF	3.104710	0.058535	53.03988	0.0000

According to the Table 4.8, IGARCH (2,2) model mean equation and variance equation all the coefficients are statistically significant under 1% significant level other than C.

4.2.3.7 PARCH

Table 4.9 Output of PARCH (1,1) model of Banking Finance & Insurance Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	0.000246	0.000201	1.225694	0.2203
AR(1)	0.430529	0.028781	14.95898	0.0000
MA(1)	-0.131863	0.032867	-4.011990	0.0001
		Variance Equation		
C(4)	1.40E-06	3.36E-07	4.180755	0.0000
C(5)	0.305682	0.007143	42.79738	0.0000
C(6)	-0.047362	0.010593	-4.471213	0.0000
C(7)	0.663537	0.005485	120.9816	0.0000
C(8)	2.547188	0.054583	46.66603	0.0000

Table 4.9 shows that PARCH (1,1) model both mean equation and variance equation all the coefficients are statistically significant under 1% significant level other than C. The residual analysis of this model is not satisfied. Therefore, PARCH (1,1) model was not considered for model comparison.

4.2.4. Model comparison by Akaike information criterion (AIC) and Schwarz criterion (SC) values

Table 4.10 AIC and SC values of ARCH models of Banking Finance & Insurance Sector Indices

Model	AIC Value	SC value
GARCH (2,2)	-6.042503	-6.035588
EGARCH (1,2)	-6.520517	-6.512738
IGARCH (2,2)	-6.520104	-6.514053

Table 4.10 shows that the lowest AIC & SC values are with the IGARCH (2,2) model. Therefore, by considering the AIC and SC values prove that the appropriate model for the forecasting Banking, Finance and Insurance sector indices is the IGARCH (2,2) model.

4.2.5. Residual analysis

After fitting tentative model to the data, we must examine its adequacy by analyzing its residuals.

4.2.5.1 Correlogram standard residuals squired

Autocorrelation	Partial Correlation		AC	PAC	Q-Sta...	Prob...
		1	0.001	0.001	0.0045	0.947
		2	-0.00...	-0.00...	0.0426	0.979
		3	-0.00...	-0.00...	0.0498	0.997
		4	-0.00...	-0.00...	0.0597	1.000
		5	-0.00...	-0.00...	0.0678	1.000
		6	-0.00...	-0.00...	0.0779	1.000
		7	-0.00...	-0.00...	0.0912	1.000
		8	-0.00...	-0.00...	0.1173	1.000
		9	-0.00...	-0.00...	0.1520	1.000
		1...	-0.00...	-0.00...	0.1762	1.000
		1...	-0.00...	-0.00...	0.1961	1.000
		1...	-0.00...	-0.00...	0.2166	1.000
		1...	-0.00...	-0.00...	0.2221	1.000
		1...	0.012	0.012	1.3268	1.000
		1...	-0.00...	-0.00...	1.3272	1.000
		1...	-0.00...	-0.00...	1.3307	1.000
		1...	0.000	0.000	1.3326	1.000
		1...	-0.00...	-0.00...	1.3567	1.000
		1...	0.012	0.012	2.5808	1.000
		2...	-0.00...	-0.00...	2.6038	1.000
		2...	-0.00...	-0.00...	2.6243	1.000
		2...	-0.00...	-0.00...	2.6244	1.000
		2...	-0.00...	-0.00...	2.6292	1.000
		2...	-0.00...	-0.00...	2.6414	1.000
		2...	0.000	0.000	2.6417	1.000
		2...	-0.00...	-0.00...	2.6454	1.000
		2...	-0.00...	-0.00...	2.6467	1.000
		2...	0.007	0.007	3.0223	1.000
		2...	-0.00...	-0.00...	3.0450	1.000
		3...	-0.00...	-0.00...	3.0695	1.000
		3...	-0.00...	-0.00...	3.0842	1.000
		3...	-0.00...	-0.00...	3.0928	1.000
		3...	-0.00...	-0.00...	3.1189	1.000
		3...	-0.00...	-0.00...	3.1371	1.000
		3...	-0.00...	-0.00...	3.1517	1.000
		3...	-0.00...	-0.00...	3.1569	1.000

Figure 4.3: The Correlogram of IGARCH (2,2) model of Banking Finance & Insurance Sector Indices

The ACF and PACF graphs in Figure 4.3 do not presence any structure and all the values lie between 95% of confidence interval. And their all probability values are greater than 5% of significance level. The ACF and PACF graphs are recommended that there is no serial correlation between each residual value.

4.2.5.2. ARCH- LM test

Table 4.11a Output of ARCH-LM test of IGARCH (2,2) model of Banking Finance & Insurance Sector Indices

Heteroskedasticity Test: ARCH

F-statistic	0.004485	Prob. F(1,8095)	0.9466
Obs*R-squared	0.004486	Prob. Chi-Square(1)	0.9466

Table shows that there is no ARCH effect of the residuals since the probability value is higher than 5%. The null hypothesis of no ARCH effect with residuals have to accept.

Table 4.11b Output of Breusch – Pagan - Godfrey test of IGARCH (2,2) model of Banking Finance & Insurance Sector Indices

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	206.6295	Prob. F(1,8096)	0.0000
Obs*R-squared	201.5368	Prob. Chi-Square(1)	0.0000
Scaled explained SS	1.04E+12	Prob. Chi-Square(1)	0.0000

Therefore, appropriate model for forecasting the Banking, Finance and Insurance sector indices is IGARCH (2,2) model.

Mean Equation

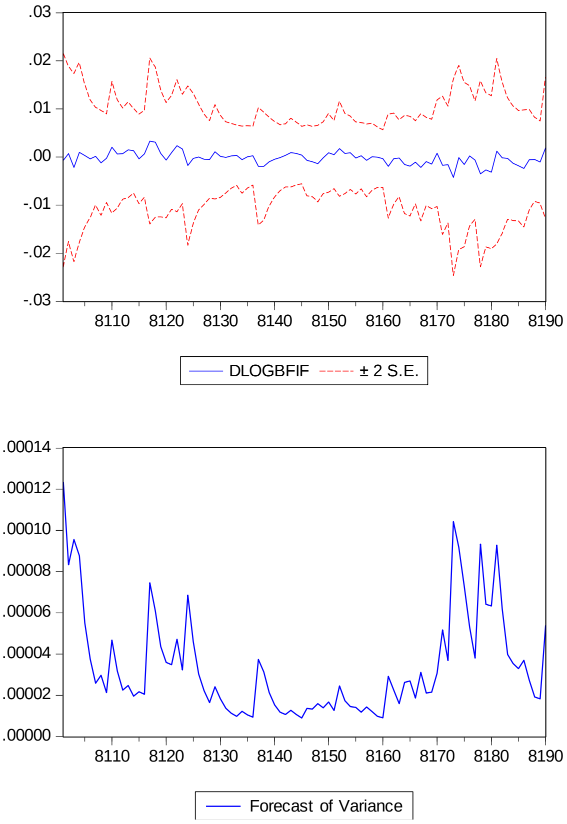
$$dlogbfi = 0.500755 dlogbfi_{\ t-1} - 0.277170 \varepsilon_{t-1}$$

Variance Equation

$$\sigma_t^2 = 0.338277\varepsilon_{t-1}^2 - 0.337221\varepsilon_{t-2}^2 + 1.592963\sigma_{t-1}^2 - 0.594019\sigma_{t-2}^2$$

4.2.6. Forecasting

Figure 4.4 show the forecasting results of Banking, Finance and Insurance sector indices for ninety days of 2019.



Forecast: DLOGBFIF	
Actual: DLOGBFI	
Forecast sample: 8101 8190	
Included observations: 90	
Root Mean Squared Error	0.005508
Mean Absolute Error	0.004235
Mean Abs. Percent Error	138.5445
Theil Inequality Coefficient	0.791635
Bias Proportion	0.008208
Variance Proportion	0.583870
Covariance Proportion	0.407923

Figure 4.4. Output of forecasting the Banking, Finance and Insurance sector index for ninety days in 2019

4.3. Beverage, Food & Tobacco Sector

4.3.1. Preliminary Analysis

It is necessary to test the stationary conditions after collecting the data. By just looking at the time series plot it can be obtained an idea about the data series.

The Figure 4.5 shows the time series plot for daily index in Beverage, Food & Tobacco Sector which consists of 8190 observations.

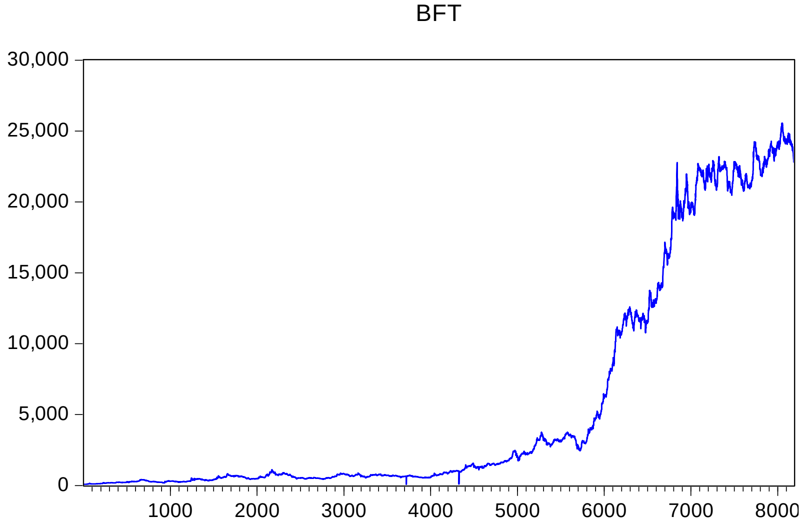


Figure 4.5: Time series plot for daily index in Beverage, Food & Tobacco Sector from 02nd Jan. 1985 to 29th Mar. 2019. The X axis denotes the year and Y axis denotes the Index.

4.3.2. Unit root test: Augmented dickey-fuller (ADF) test

Table 4.12 shows the test results of Unit Root Test, Augmented Dickey-Fuller (ADF) test with intercept to prove that data series is not stationary in statistically.

Table 4.12: ADF test for raw data series of Beverage, Food & Tobacco Sector

Null Hypothesis: BFT has a unit root
Exogenous: Constant
Lag Length: 11 (Automatic - based on SIC, maxlag=36)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.945533	0.9961
Test critical values:	1% level	-3.430973	
	5% level	-2.861700	
	10% level	-2.566897	

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

According to the result of ADF it can be accepted null hypothesis and reject the alternative hypothesis said that the data series has unit root means that the time series data are not stationary. Thus it is necessary to make them stationary. To this purpose it can be checked the behavior of first difference of log data series.

To confirm the stationarity of the first difference of log data series Unit Root test, Augmented Dickey Fuller (ADF) tests have been carried out and the results for 5% of Significant level are shown the in the Table 4.13.

Table 4.13: ADF test values for the first difference of log data series of Beverage, Food & Tobacco Sector

Null Hypothesis: DLOGBFT has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic - based on SIC, maxlag=36)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-54.87377	0.0001
Test critical values:	1% level	-3.430973	
	5% level	-2.861700	
	10% level	-2.566897	

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

Though the result of ADF shows the probability as significant to reject the null hypothesis of the series has a unit root and accept the alternative hypothesis of the data series has not unit root. That means data series is stationary with mean but not with variance. It is confirmed by the autocorrelation (ACF) and partial autocorrelation (PACF) graphs.

Autocorrelation	Partial Correlation		AC	PAC	Q-Sta...	Prob
		1	-0.44...	-0.44...	1647.6	0.000
		2	0.006	-0.24...	1647.9	0.000
		3	-0.00...	-0.14...	1648.0	0.000
		4	0.001	-0.08...	1648.0	0.000
		5	0.000	-0.05...	1648.0	0.000
		6	0.001	-0.02...	1648.0	0.000
		7	-0.00...	-0.02...	1648.1	0.000
		8	-0.00...	-0.02...	1648.2	0.000
		9	0.001	-0.01...	1648.2	0.000
		1...	-0.00...	-0.01...	1648.2	0.000
		1...	0.002	-0.00...	1648.3	0.000
		1...	-0.00...	-0.00...	1648.3	0.000
		1...	0.005	0.005	1648.5	0.000
		1...	-0.00...	-0.00...	1648.8	0.000
		1...	0.000	-0.00...	1648.8	0.000
		1...	0.003	0.001	1648.9	0.000
		1...	0.007	0.012	1649.3	0.000
		1...	-0.00...	0.011	1649.3	0.000
		1...	-0.00...	0.007	1649.3	0.000
		2...	0.002	0.007	1649.4	0.000
		2...	-0.00...	0.004	1649.4	0.000
		2...	-0.00...	-0.00...	1649.4	0.000
		2...	-0.00...	-0.00...	1649.4	0.000
		2...	-0.00...	-0.01...	1649.5	0.000
		2...	0.004	-0.00...	1649.7	0.000
		2...	-0.00...	-0.00...	1649.7	0.000
		2...	-0.00...	-0.00...	1649.7	0.000
		2...	-0.00...	-0.00...	1649.7	0.000
		2...	0.003	-0.00...	1649.8	0.000
		3...	0.002	0.004	1649.9	0.000
		3...	0.001	0.006	1649.9	0.000
		3...	0.002	0.008	1649.9	0.000
		3...	-0.00...	0.007	1649.9	0.000
		3...	0.001	0.008	1649.9	0.000
		3...	-0.00...	0.003	1650.0	0.000
		3...	0.001	0.003	1650.0	0.000

Figure 4.6: The Correlogram of first difference series of Log index of Beverage, Food & Tobacco Sector

The Correlogram of first difference series of Log index of Beverage, Food & Tobacco Sector confirm that there is serial correlation with lag values.

4.3.3. Model identification and coefficient estimation

4.3.3.1. ARCH-LM test

To test the applicability of ARCH family model it can be checked the ARCH -LM test. The test results are shown in Table 4.14.

Table 4.14: ARCH-LM test results of Beverage, Food & Tobacco Sector

Heteroskedasticity Test: ARCH

F-statistic	2722.421	Prob. F(1,8186)	0.0000
Obs*R-squared	2043.484	Prob. Chi-Square(1)	0.0000

According to the Table 4.14, it can be reject the null hypothesis since the probability value is significant and can accept the alternative hypothesis. This means model has ARCH effect and therefore, ARCH family models can be applied.

4.3.3.2. ARCH

Table 4.15 Output of ARCH (1) model of Beverage, Food & Tobacco Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-0.000142	0.001264	-0.112483	0.9104
AR(1)	0.113433	0.043342	2.617154	0.0089
		Variance Equation		
C	0.001725	1.82E-06	949.2895	0.0000
RESID(-1)^2	0.065816	0.007281	9.039775	0.0000

According to the Table 4.15, ARCH (1) model both mean equation and variance equation all the coefficients are statistically significant under 1% significant level other than C.

4.3.3.3. GARCH

Table 4.16 Output of GARCH (1,1) model of Beverage, Food & Tobacco Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-0.000260	0.002157	-0.120408	0.9042
AR(1)	0.090176	0.070499	1.279119	0.2009
		Variance Equation		
C	0.001871	0.000191	9.793645	0.0000
RESID(-1)^2	0.055588	0.008454	6.575570	0.0000
GARCH(-1)	0.318573	0.069747	4.567570	0.0000

Table 4.16 shows that GARCH (1,1) model mean equation is not statistically significant while all the variance equation coefficients are statistically significant.

4.3.3.4. TARCH

Table 4.17 Output of TARCH (1,1) model of Beverage, Food & Tobacco Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-0.001284	0.002727	-0.470805	0.6378
AR(1)	0.006477	0.014837	0.436536	0.6624
		Variance Equation		
C	0.001752	0.000142	12.31218	0.0000
RESID(-1)^2	-0.023101	0.000501	-46.09808	0.0000
RESID(-1)^2*(RESID(-1)<...	0.063324	0.002723	23.25287	0.0000
GARCH(-1)	0.571149	0.034761	16.43051	0.0000

According to the Table 4.17, TARCH (1,1) model mean equation is not statistically significant while the variance equation all the coefficients are statistically significant under 1% significant level. This model is not satisfied with residual analysis. Therefore, TARCH (1,1) model was not considered in model comparison.

4.3.3.5. EGARCH

Table 4.18 Output of EGARCH (1,2) model of Beverage, Food & Tobacco Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	1.83E-06	3.21E-05	0.057249	0.9543
AR(1)	0.699787	0.268012	2.611032	0.0090
MA(1)	-0.699630	0.268113	-2.609457	0.0091
		Variance Equation		
C(4)	-0.621040	0.045614	-13.61502	0.0000
C(5)	0.154744	0.007575	20.42839	0.0000
C(6)	0.116019	0.007141	16.24707	0.0000
C(7)	0.276976	0.049747	5.567720	0.0000
C(8)	0.664567	0.049145	13.52248	0.0000
GED PARAMETER	0.733156	0.003088	237.4202	0.0000

Table 4.18 shows that the EGARCH (1,2) model both mean equation and variance equation all the coefficients are statistically significant under 1% significant level except C.

4.3.3.6. IGARCH

Table 4.19 Output of IGARCH (1,2) model of Beverage, Food & Tobacco Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	0.000120	7.67E-05	1.566456	0.1172
AR(1)	0.737537	0.051351	14.36272	0.0000
MA(1)	-0.680218	0.056490	-12.04130	0.0000
		Variance Equation		
RESID(-1)^2	0.180441	0.012857	14.03493	0.0000
GARCH(-1)	0.628515	0.089467	7.025101	0.0000
GARCH(-2)	0.191044	0.077229	2.473720	0.0134
T-DIST. DOF	3.473384	0.061342	56.62327	0.0000

According to the Table 4.19, IGARCH (1,2) model both mean equation and variance equation all the coefficients are statistically significant except C.

4.3.3.7. PARCH

Table 4.20 Output of PARCH (1,1) model of Beverage, Food & Tobacco Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	0.000139	9.60E-05	1.447727	0.1477
AR(1)	0.715425	0.058309	12.26962	0.0000
MA(1)	-0.661127	0.063558	-10.40193	0.0000
		Variance Equation		
C(4)	0.001569	0.000203	7.725363	0.0000
C(5)	0.380192	0.044696	8.506191	0.0000
C(6)	-0.082423	0.036550	-2.255071	0.0241
C(7)	0.759004	0.011715	64.78962	0.0000
T-DIST. DOF	2.279873	0.069230	32.93165	0.0000

Table 4.20 shows that PARCH (1,1) model all the coefficients of mean equation and the variance equation are statistically significant except C.

4.3.4. Model comparison by Akaike information criterion (AIC) Schwarz criterion (SC) values

Table 4.21 AIC and SC values of ARCH models of Beverage, Food & Tobacco Sector Indices

Model	AIC Value	SC value
ARCH (1)	-3.607250	-3.603793
GARCH (1,1)	-3.475911	-3.471590
EGARCH (1,2)	-6.237918	-6.230139
IGARCH (1,2)	-6.189736	-6.184550
PARCH (1,1)	-6.297611	-6.290696

Table 4.21 shows that the lowest AIC & SC values are with the PARCH (1,1) model. Therefore, by considering the AIC and SC values prove that the appropriate model for the forecasting Beverage, Food & Tobacco sector indices is the PARCH (1,1) model.

4.3.5. Residual analysis

After fitting tentative model to the data, we must examine its adequacy by analyzing its residuals.

4.3.5.1. Correlogram of standardized residuals squared

Autocorrelation	Partial Correlation		AC	PAC	Q-Sta...	Prob...
		1	-0.00...	-0.00...	2.E-05	0.996
		2	-0.00...	-0.00...	0.0006	1.000
		3	-0.00...	-0.00...	0.0013	1.000
		4	-0.00...	-0.00...	0.0019	1.000
		5	-0.00...	-0.00...	0.0025	1.000
		6	-0.00...	-0.00...	0.0031	1.000
		7	-0.00...	-0.00...	0.0037	1.000
		8	-0.00...	-0.00...	0.0043	1.000
		9	-0.00...	-0.00...	0.0049	1.000
		1...	-0.00...	-0.00...	0.0056	1.000
		1...	-0.00...	-0.00...	0.0062	1.000
		1...	-0.00...	-0.00...	0.0068	1.000
		1...	-0.00...	-0.00...	0.0073	1.000
		1...	-0.00...	-0.00...	0.0078	1.000
		1...	-0.00...	-0.00...	0.0085	1.000
		1...	-0.00...	-0.00...	0.0091	1.000
		1...	-0.00...	-0.00...	0.0097	1.000
		1...	-0.00...	-0.00...	0.0103	1.000
		1...	-0.00...	-0.00...	0.0109	1.000
		2...	-0.00...	-0.00...	0.0115	1.000
		2...	-0.00...	-0.00...	0.0121	1.000
		2...	-0.00...	-0.00...	0.0127	1.000
		2...	-0.00...	-0.00...	0.0133	1.000
		2...	-0.00...	-0.00...	0.0139	1.000
		2...	-0.00...	-0.00...	0.0144	1.000
		2...	-0.00...	-0.00...	0.0150	1.000
		2...	-0.00...	-0.00...	0.0155	1.000
		2...	-0.00...	-0.00...	0.0160	1.000
		2...	-0.00...	-0.00...	0.0167	1.000
		3...	-0.00...	-0.00...	0.0173	1.000
		3...	-0.00...	-0.00...	0.0179	1.000
		3...	-0.00...	-0.00...	0.0184	1.000
		3...	-0.00...	-0.00...	0.0190	1.000
		3...	-0.00...	-0.00...	0.0196	1.000
		3...	-0.00...	-0.00...	0.0202	1.000
		3...	-0.00...	-0.00...	0.0209	1.000

Figure 4.7: The Correlogram of PARCH (1,1) model of Beverage, Food & Tobacco Sector Indices

The ACF and PACF graphs in Figure 4.7 do not presence any structure and all the values lie between 95% of confidence interval. And their all probability values are greater than 5% of significance level. The ACF and PACF graphs are recommended that there is no serial correlation between each residual value.

4.3.5.2. ARCH- LM test

Table 4.22a Output of ARCH-LM test of PARCH (1,1) model of Beverage, Food & Tobacco Sector Indices

Heteroskedasticity Test: ARCH

F-statistic	2.37E-05	Prob. F(1,8095)	0.9961
Obs*R-squared	2.37E-05	Prob. Chi-Square(1)	0.9961

Table shows that there is no ARCH effect of the residuals since the probability vale is higher than 5%. The null hypothesis of no ARCH effect with residuals have to accept.

Table 4.22b Output of Breusch – Pagan - Godfrey test of PARCH (1,1) model of Beverage, Food & Tobacco Sector Indices

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	6700.601	Prob. F(1,8096)	0.0000
Obs*R-squared	3667.158	Prob. Chi-Square(1)	0.0000
Scaled explained SS	7.81E+13	Prob. Chi-Square(1)	0.0000

Therefore, appropriate model for forecasting the Beverage, Food & Tobacco sector indices is PARCH (1,1) model.

Mean Equation

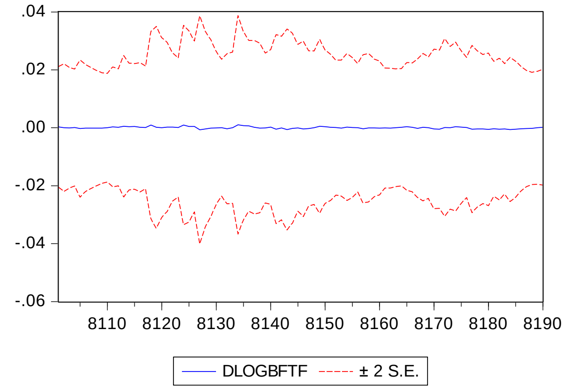
$$dlogbft = 0.715425 dlogbft_{t-1} - 0.661127 \varepsilon_{t-1}$$

Variance Equation

$$\sqrt{\sigma_t} = 0.001569 + 0.380192(|\varepsilon_{t-1}| + 0.082423\varepsilon_{t-1}) + 0.759004\sqrt{\sigma_{t-1}}$$

4.3.6. Forecasting

Figure 4.8 show the forecasting results of Beverage, Food & Tobacco sector indices for ninety days of 2019.



Forecast: DLOGBFTF	
Actual: DLOGBFT	
Forecast sample: 8101 8190	
Included observations: 90	
Root Mean Squared Error	0.005684
Mean Absolute Error	0.004059
Mean Abs. Percent Error	132.7969
Theil Inequality Coefficient	0.952624
Bias Proportion	0.017132
Variance Proportion	0.842102
Covariance Proportion	0.140766

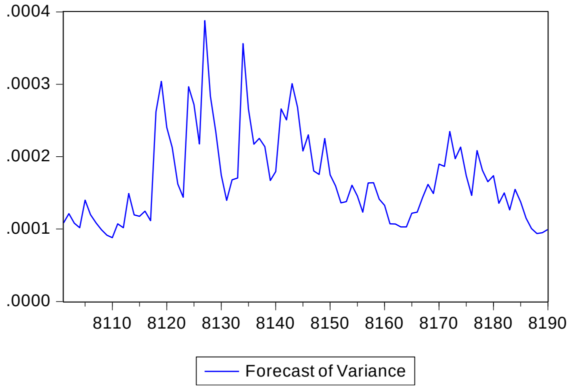


Figure 4.8. Output of forecasting the Beverage, Food & Tobacco sector index for ninety days in 2019

4.4. Chemicals & Pharmaceuticals Sector

4.4.1. Preliminary Analysis

It is necessary to test the stationary conditions after collecting the data. By just looking at the time series plot it can be obtained an idea about the data series.

The Figure 4.9 shows the time series plot for daily index in Chemicals & Pharmaceuticals sector which consists of 8190 observations.

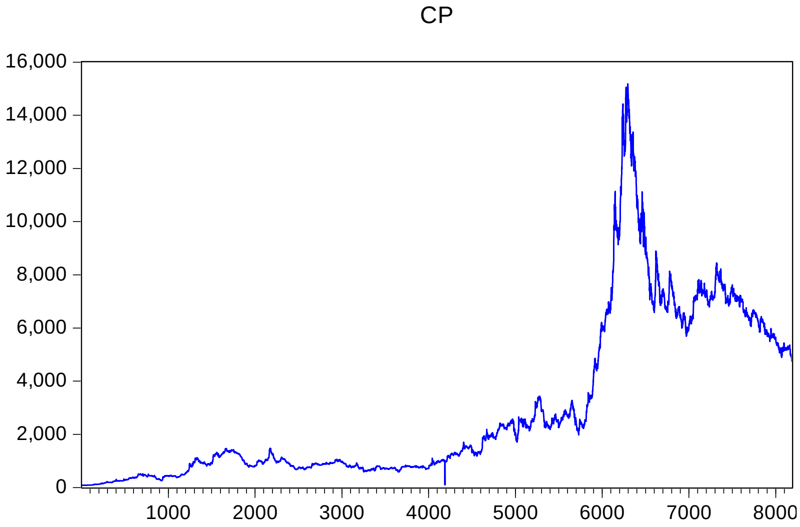


Figure 4.9: Time series plot for daily index in Chemicals & Pharmaceuticals Sector from 02nd Jan. 1985 to 29th Mar. 2019. The X axis denotes the year and Y axis denotes the Index.

4.4.2. Unit root test: Augmented dickey-fuller (ADF) test

Table 4.23 shows the test results of Unit Root Test, Augmented Dickey-Fuller (ADF) test with intercept to prove that data series is not stationary in statistically.

Table 4.23: ADF test for raw data series of Chemicals & Pharmaceuticals Sector

Null Hypothesis: CP has a unit root
Exogenous: Constant
Lag Length: 5 (Automatic - based on SIC, maxlag=36)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.169983	0.6896
Test critical values:	1% level	-3.430973	
	5% level	-2.861700	
	10% level	-2.566897	

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

According to the result of ADF it can be accepted null hypothesis and reject the alternative hypothesis said that the data series has unit root means that the time series data are not stationary. Thus it is necessary to make them stationary. To this purpose it can be checked the behavior of first difference of log data series.

To confirm the stationarity of the first difference of log data series Unit Root test, Augmented Dickey Fuller (ADF) tests have been carried out and the results for 5% of Significant level are shown the in the Table 4.24.

Table 4.24: ADF test values for the first difference of log data series of Chemicals & Pharmaceuticals Sector

Null Hypothesis: DLOGCP has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic - based on SIC, maxlag=36)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-58.84356	0.0001
Test critical values:	1% level	-3.430972	
	5% level	-2.861700	
	10% level	-2.566897	

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

Though the result of ADF shows the probability as significant to reject the null hypothesis of the series has a unit root and accept the alternative hypothesis of the data series has not unit root. That means data series is stationary with mean but not with variance. It is confirmed by the autocorrelation (ACF) and partial autocorrelation (PACF) graphs.

Autocorrelation	Partial Correlation		AC	PAC	Q-Sta...	Prob
		1	-0.40...	-0.40...	1368.4	0.000
		2	-0.00...	-0.20...	1368.4	0.000
		3	0.003	-0.10...	1368.5	0.000
		4	0.003	-0.04...	1368.6	0.000
		5	0.005	-0.01...	1368.8	0.000
		6	0.004	0.003	1368.9	0.000
		7	0.005	0.013	1369.1	0.000
		8	0.004	0.017	1369.3	0.000
		9	0.002	0.016	1369.3	0.000
		1...	0.003	0.015	1369.3	0.000
		1...	0.002	0.013	1369.4	0.000
		1...	0.005	0.015	1369.5	0.000
		1...	0.002	0.013	1369.6	0.000
		1...	-0.00...	0.006	1369.6	0.000
		1...	0.003	0.005	1369.7	0.000
		1...	-0.00...	-0.00...	1369.9	0.000
		1...	0.006	0.002	1370.2	0.000
		1...	-0.00...	0.000	1370.2	0.000
		1...	0.011	0.013	1371.2	0.000
		2...	-0.00...	0.007	1371.4	0.000
		2...	-0.00...	0.002	1371.4	0.000
		2...	-0.00...	-0.00...	1371.5	0.000
		2...	0.011	0.008	1372.6	0.000
		2...	-0.00...	0.006	1372.7	0.000
		2...	0.014	0.022	1374.2	0.000
		2...	-0.01...	0.006	1375.4	0.000
		2...	0.002	0.002	1375.4	0.000
		2...	-0.00...	-0.00...	1375.7	0.000
		2...	-0.00...	-0.00...	1375.7	0.000
		3...	0.003	-0.00...	1375.7	0.000
		3...	-0.00...	-0.00...	1375.8	0.000
		3...	0.003	-0.00...	1375.8	0.000
		3...	-0.00...	-0.00...	1375.9	0.000
		3...	-0.00...	-0.00...	1375.9	0.000
		3...	0.002	0.000	1375.9	0.000
		3...	-0.00...	-0.00...	1375.9	0.000

Figure 4.10: The Correlogram of first difference series of Log index of Chemicals & Pharmaceuticals Sector

The Correlogram of first difference series of Log index of Chemicals & Pharmaceuticals Sector confirm that there is serial correlation with lag values.

4.4.3. Model identification and coefficient estimation

4.4.3.1. ARCH-LM test

To test the applicability of ARCH family model it can be checked the ARCH -LM test. The test results are shown in Table 4.25.

Table 4.25: ARCH-LM test results of Chemicals & Pharmaceuticals Sector

Heteroskedasticity Test: ARCH

F-statistic	2725.374	Prob. F(1,8186)	0.0000
Obs*R-squared	2045.147	Prob. Chi-Square(1)	0.0000

According to the Table 4.25, it can be reject the null hypothesis since the probability value is significant and can accept the alternative hypothesis. This means model has ARCH effect and therefore, ARCH family models can be applied.

4.4.3.2. ARCH

Table 4.26 Output of ARCH (2) model of Chemicals & Pharmaceuticals Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	0.001468	6.68E-05	21.98297	0.0000
AR(1)	-0.803834	0.005916	-135.8735	0.0000
MA(1)	0.895860	0.003824	234.2774	0.0000
		Variance Equation		
C	0.000129	8.68E-07	148.9219	0.0000
RESID(-1)^2	3.443480	0.021435	160.6447	0.0000
RESID(-2)^2	0.054446	0.005879	9.261256	0.0000

According to the Table 4.26, ARCH (2) model all the coefficients of both mean equation and variance equation are statistically significant under 1% significant level.

4.4.3.3. GARCH

Table 4.27 Output of GARCH (1,1) model of Chemicals & Pharmaceuticals Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	0.001521	6.32E-05	24.06481	0.0000
AR(1)	-0.805040	0.005587	-144.1001	0.0000
MA(1)	0.896494	0.003539	253.3145	0.0000
		Variance Equation		
C	0.000126	9.66E-07	130.4096	0.0000
RESID(-1)^2	3.784528	0.022694	166.7601	0.0000
GARCH(-1)	0.014022	0.001559	8.992172	0.0000

Table 4.27 shows that GARCH (1,1) model both the mean equation and the variance equation coefficients are statistically significant under 1% significant level.

4.4.3.4. TARCH

Table 4.28 Output of TARCH (1,1) model of Chemicals & Pharmaceuticals Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-0.001531	8.60E-05	-17.81041	0.0000
AR(1)	-0.670004	0.006106	-109.7217	0.0000
MA(1)	0.788394	0.004442	177.4720	0.0000
		Variance Equation		
C	0.000151	8.95E-07	169.1618	0.0000
RESID(-1)^2	0.436099	0.010219	42.67713	0.0000
RESID(-1)^2*(RESID(-1)<...	8.506471	0.082830	102.6983	0.0000
GARCH(-1)	0.006246	0.000983	6.353005	0.0000

According to the Table 4.28, TARCH (1,1) model all the coefficient of the mean equation and the variance equation are statistically significant under 1% significant level.

4.4.3.5. EGARCH

Table 4.29 Output of EGARCH (1,3) model of Chemicals & Pharmaceuticals Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-2.80E-06	9.83E-05	-0.028475	0.9773
AR(1)	0.006902	0.007759	0.889585	0.3737
		Variance Equation		
C(3)	-1.589517	0.094376	-16.84239	0.0000
C(4)	0.111540	0.003792	29.41098	0.0000
C(5)	0.110796	0.003787	29.25588	0.0000
C(6)	0.486275	0.026173	18.57950	0.0000
C(7)	-0.173765	0.035584	-4.883203	0.0000
C(8)	0.516216	0.029988	17.21395	0.0000
GED PARAMETER	1.013831	0.002399	422.5449	0.0000

Table 4.29 shows that the EGARCH (1,3) model mean equation is not statistically significant while the variance equation coefficients are statistically significant under 1% significant level. Residual analysis was not satisfied with this model therefore it was not considered in model comparison.

4.4.3.6. IGARCH

Table 4.30 Output of IGARCH (1,2) model of Chemicals & Pharmaceuticals Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-5.76E-05	8.82E-05	-0.652949	0.5138
AR(1)	0.804631	0.048639	16.54291	0.0000
MA(1)	-0.767323	0.053206	-14.42162	0.0000
		Variance Equation		
RESID(-1)^2	0.155232	0.011345	13.68261	0.0000
GARCH(-1)	0.605833	0.093691	6.466305	0.0000
GARCH(-2)	0.238935	0.083083	2.875857	0.0040
T-DIST. DOF	2.940425	0.036729	80.05804	0.0000

According to the Table 4.30, IGARCH (1,2) model both mean equation and variance equation all the coefficient are statistically significant under 1% significant level except C.

4.4.3.7. PARCH

Table 4.31 Output of PARCH (2,2) model of Chemicals & Pharmaceuticals Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-5.56E-06	3.60E-05	-0.154493	0.8772
AR(1)	0.037023	0.006913	5.355491	0.0000
		Variance Equation		
C(3)	0.002686	0.000408	6.576828	0.0000
C(4)	0.308823	0.046044	6.707137	0.0000
C(5)	-0.181683	0.035977	-5.049997	0.0000
C(6)	0.297016	0.044578	6.662867	0.0000
C(7)	-0.128725	0.010365	-12.41967	0.0000
C(8)	0.773333	0.008780	88.07770	0.0000
T-DIST. DOF	2.201342	0.064686	34.03131	0.0000

Table 4.31 shows that PARCH (2,2) model all the coefficients of both mean equation and variance equation are statistically significant under 1% significant level except C.

4.4.4. Model comparison by Akaike information criterion (AIC) and Schwarz criterion (SC) values

Table 4.32 AIC and SC values of ARCH models of Chemicals & Pharmaceuticals Sector Indices

Model	AIC Value	SC value
ARCH (2)	-5.021614	-5.016428
GARCH (1,1)	-5.023121	-5.017935
TARCH (1,1)	-5.177166	-5.171115
IGARCH (1,2)	-6.073752	-6.068566
PARCH (2,2)	-6.169184	-6.161405

Table 4.32 shows that the lowest AIC & SC values are with the PARCH (2,2) model. Therefore, by considering the AIC and SC values prove that the appropriate model for the forecasting Chemicals & Pharmaceuticals sector indices is the PARCH (2,2) model.

4.4.5. Residual analysis

After fitting tentative model to the data, we must examine its adequacy by analyzing its residuals.

4.4.5.1 Correlagram standard residuals squired

Autocorrelation	Partial Correlation		AC	PAC	Q-Sta...	Prob...
		1	0.001	0.001	0.0079	0.929
		2	-0.00...	-0.00...	0.0082	0.996
		3	-0.00...	-0.00...	0.0085	1.000
		4	-0.00...	-0.00...	0.0086	1.000
		5	-0.00...	-0.00...	0.0089	1.000
		6	-0.00...	-0.00...	0.0091	1.000
		7	-0.00...	-0.00...	0.0094	1.000
		8	-0.00...	-0.00...	0.0097	1.000
		9	-0.00...	-0.00...	0.0100	1.000
		1...	-0.00...	-0.00...	0.0103	1.000
		1...	-0.00...	-0.00...	0.0106	1.000
		1...	-0.00...	-0.00...	0.0107	1.000
		1...	-0.00...	-0.00...	0.0109	1.000
		1...	-0.00...	-0.00...	0.0112	1.000
		1...	-0.00...	-0.00...	0.0115	1.000
		1...	-0.00...	-0.00...	0.0116	1.000
		1...	-0.00...	-0.00...	0.0119	1.000
		1...	-0.00...	-0.00...	0.0122	1.000
		1...	-0.00...	-0.00...	0.0125	1.000
		2...	-0.00...	-0.00...	0.0127	1.000
		2...	-0.00...	-0.00...	0.0129	1.000
		2...	-0.00...	-0.00...	0.0129	1.000
		2...	-0.00...	-0.00...	0.0130	1.000
		2...	-0.00...	-0.00...	0.0132	1.000
		2...	-0.00...	-0.00...	0.0135	1.000
		2...	-0.00...	-0.00...	0.0136	1.000
		2...	-0.00...	-0.00...	0.0139	1.000
		2...	-0.00...	-0.00...	0.0141	1.000
		2...	-0.00...	-0.00...	0.0144	1.000
		3...	-0.00...	-0.00...	0.0147	1.000
		3...	-0.00...	-0.00...	0.0150	1.000
		3...	-0.00...	-0.00...	0.0153	1.000
		3...	-0.00...	-0.00...	0.0154	1.000
		3...	-0.00...	-0.00...	0.0156	1.000
		3...	-0.00...	-0.00...	0.0157	1.000
		3...	-0.00...	-0.00...	0.0160	1.000

Figure 4.11: The Correlogram of PARCH (2,2) model of Chemicals & Pharmaceuticals Sector Indices

The ACF and PACF graphs in Figure 4.11 do not presence any structure and all the values lie between 95% of confidence interval. And their all probability values are greater than 5% of significance level. The ACF and PACF graphs are recommended that there is no serial correlation between each residual value.

4.4.5.2. ARCH- LM test

Table 4.33a Output of ARCH-LM test of PARCH (2,2) model of Chemicals & Pharmaceuticals Sector Indices

Heteroskedasticity Test: ARCH

F-statistic	0.007933	Prob. F(1,8095)	0.9290
Obs*R-squared	0.007934	Prob. Chi-Square(1)	0.9290

Table shows that there is no ARCH effect of the residuals since the probability vale is higher than 5%. The null hypothesis of no ARCH effect with residuals have to accept.

Table 4.33b Output of Breusch – Pagan - Godfrey test of PARCH (2,2) model model of Chemicals & Pharmaceuticals Sector Indices

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	5857.440	Prob. F(1,8096)	0.0000
Obs*R-squared	3399.416	Prob. Chi-Square(1)	0.0000
Scaled explained SS	1.70E+13	Prob. Chi-Square(1)	0.0000

Therefore, appropriate fitted model for forecasting the Chemicals & Pharmaceuticals sector indices is PARCH (2,2) model.

Mean Equation

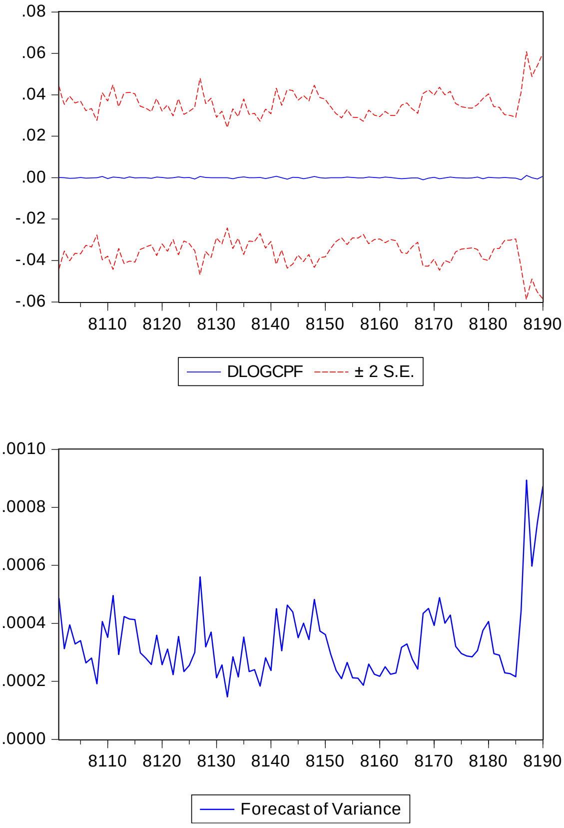
$$dlogcp = -0.00000556 + 0.037023 dlogcp_{t-1}$$

Variance Equation

$$\sqrt{\sigma_t} = 0.002686 + 0.308823(|\varepsilon_{t-1}| + 0.181683\varepsilon_{t-1}) + 0.297016|\varepsilon_{t-2}| - 0.128725\sqrt{\sigma_{t-1}} + 0.773333\sqrt{\sigma_{t-2}}$$

4.4.6. Forecasting

Figure 4.12 show the forecasting results of Chemicals & Pharmaceuticals sector indices for ninety days of 2019.



Forecast: DLOGCPF	
Actual: DLOGCP	
Forecast sample: 8101 8190	
Included observations: 90	
Root Mean Squared Error	0.009210
Mean Absolute Error	0.006432
Mean Abs. Percent Error	97.46353
Theil Inequality Coefficient	0.972036
Bias Proportion	0.006601
Variance Proportion	0.905985
Covariance Proportion	0.087413

Figure 4.12: Output of forecasting the Chemicals & Pharmaceuticals sector index for ninety days in 2019

4.5. Footwear & Textile Sector

4.5.1. Preliminary Analysis

It is necessary to test the stationary conditions after collecting the data. By just looking at the time series plot it can be obtained an idea about the data series.

The Figure 4.13 shows the time series plot for daily index in Footwear & Textile sector which consists of 8190 observations.

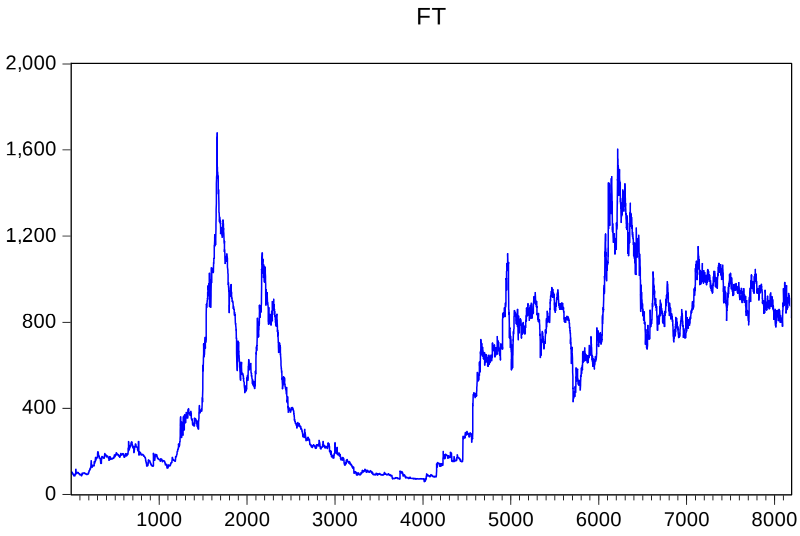


Figure 4.13: Time series plot for daily index in Footwear & Textile sector from 02nd Jan. 1985 to 29th Mar. 2019. The X axis denotes the year and Y axis denotes the Index.

4.5.2. Unit root test: Augmented dickey-fuller (ADF) test

Table 4.34 shows the test results of Unit Root Test, Augmented Dickey-Fuller (ADF) test with intercept to prove that data series is not stationary in statistically.

Table 4.34: ADF test for raw data series of Footwear & Textile sector

Null Hypothesis: FT has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=36)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.879203	0.3425
Test critical values:	1% level	-3.430972	
	5% level	-2.861699	
	10% level	-2.566897	

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

According to the result of ADF it can be accepted null hypothesis and reject the alternative hypothesis said that the data series has unit root means that the time series data are not stationary. Thus it is necessary to make them stationary. To this purpose it can be checked the behavior of first difference of log data series.

To confirm the stationarity of the first difference of log data series Unit Root test, Augmented Dickey Fuller (ADF) tests have been carried out and the results for 5% of Significant level are shown the in the Table 4.35.

Table 4.35: ADF test values for the first difference of log data series of Footwear & Textile sector

Null Hypothesis: DLOGFT has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=36)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-88.78371	0.0001
Test critical values:	1% level	-3.430972	
	5% level	-2.861699	
	10% level	-2.566897	

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

Though the result of ADF shows the probability as significant to reject the null hypothesis of the series has a unit root and accept the alternative hypothesis of the data series has not unit root. That means data series is stationary with mean but not with variance. It is confirmed by the autocorrelation (ACF) and partial autocorrelation (PACF) graphs.

Autocorrelation	Partial Correlation		AC	PAC	Q-Sta...	Prob
		1	0.019	0.019	2.8431	0.092
		2	0.012	0.012	4.0296	0.133
		3	-0.00...	-0.00...	4.6395	0.200
		4	0.005	0.005	4.8054	0.308
		5	-0.00...	-0.00...	5.0583	0.409
		6	-0.02...	-0.02...	10.547	0.103
		7	0.001	0.002	10.551	0.159
		8	0.017	0.017	12.826	0.118
		9	0.032	0.031	21.412	0.011
		1...	0.005	0.004	21.610	0.017
		1...	-0.00...	-0.00...	21.873	0.025
		1...	-0.00...	-0.00...	21.947	0.038
		1...	-0.01...	-0.01...	24.281	0.029
		1...	0.014	0.016	25.940	0.026
		1...	0.001	0.002	25.947	0.039
		1...	0.010	0.010	26.837	0.043
		1...	0.020	0.018	29.959	0.027
		1...	-0.00...	-0.00...	30.244	0.035
		1...	-0.00...	-0.00...	30.277	0.048
		2...	0.010	0.012	31.123	0.054
		2...	0.012	0.012	32.312	0.054
		2...	0.004	0.004	32.413	0.071
		2...	-0.01...	-0.02...	35.457	0.047
		2...	0.014	0.014	37.101	0.043
		2...	-0.00...	-0.00...	37.294	0.054
		2...	-0.00...	-0.00...	37.294	0.070
		2...	-0.00...	-0.00...	37.600	0.084
		2...	-0.02...	-0.02...	41.845	0.045
		2...	-0.00...	-0.00...	42.065	0.055
		3...	0.015	0.016	44.020	0.047
		3...	-0.00...	-0.00...	44.047	0.060
		3...	0.003	0.004	44.135	0.075
		3...	0.012	0.011	45.261	0.076
		3...	0.002	-0.00...	45.285	0.093
		3...	-0.00...	-0.00...	45.524	0.110
		3...	0.006	0.007	45.833	0.126

Figure 4.14: The Correlogram of first difference series of Log index of Footwear & Textile sector

The Correlogram of first difference series of Log index of Footwear & Textile sector confirm that there is serial correlation with lag values.

4.5.3. Model identification and coefficient estimation

4.5.3.1. ARCH-LM test

To test the applicability of ARCH family model it can be checked the ARCH -LM test. The test results are shown in Table 4.36.

Table 4.36: ARCH-LM test results of Footwear & Textile sector

Heteroskedasticity Test: ARCH

F-statistic	10.48876	Prob. F(1,8186)	0.0012
Obs*R-squared	10.47790	Prob. Chi-Square(1)	0.0012

According to the Table 4.36, it can be reject the null hypothesis since the probability value is significant and can accept the alternative hypothesis. This means model has ARCH effect and therefore, ARCH family models can be applied.

4.5.3.2. ARCH

Table 4.37 Output of ARCH (2) model of Footwear & Textile sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-0.000284	0.000225	-1.265428	0.2057
AR(1)	0.037770	0.016639	2.269926	0.0232
Variance Equation				
C	0.000425	1.20E-06	355.6331	0.0000
RESID(-1)^2	0.228942	0.006336	36.13198	0.0000
RESID(-2)^2	0.055511	0.005410	10.26057	0.0000

According to the Table 4.37, ARCH (2) model both mean equation and variance equation coefficients are statistically significant under except C.

4.5.3.3. GARCH

Table 4.38 Output of GARCH (1,2) model of Footwear & Textile sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-0.000468	0.000204	-2.296206	0.0217
AR(1)	0.026878	0.016494	1.629569	0.1032
Variance Equation				
C	0.000157	2.48E-06	63.10801	0.0000
RESID(-1)^2	0.221850	0.005476	40.51333	0.0000
GARCH(-1)	0.391397	0.026999	14.49690	0.0000
GARCH(-2)	0.146556	0.023258	6.301264	0.0000

Table 4.38 shows that GARCH (1,2) model both mean equation and all the variance equation coefficients are statistically significant except AR (1).

4.5.3.4. TARCH

Table 4.39 Output of TARCH (1,2) model of Footwear & Textile sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-1.04E-05	0.000368	-0.028171	0.9775
AR(1)	0.989237	0.007406	133.5775	0.0000
MA(1)	-0.984251	0.009322	-105.5831	0.0000
Variance Equation				
C	0.000147	2.50E-06	58.53087	0.0000
RESID(-1)^2	0.350881	0.010856	32.32251	0.0000
RESID(-1)^2*(RESID(-1)<...	-0.262959	0.012562	-20.93361	0.0000
GARCH(-1)	0.353877	0.020461	17.29527	0.0000
GARCH(-2)	0.201137	0.018663	10.77762	0.0000

According to the Table 4.39, TARCH (1,2) model mean equation and variance equation all the coefficients are statistically significant under 1% significant level except C.

4.5.3.5. EGARCH

Table 4.40 Output of EGARCH (1,1) model of Footwear & Textile sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-1.30E-06	5.47E-05	-0.023771	0.9810
AR(1)	0.990503	0.002266	437.0785	0.0000
MA(1)	-0.990502	0.002253	-439.6987	0.0000
Variance Equation				
C(4)	-1.057854	0.093230	-11.34674	0.0000
C(5)	0.192010	0.011830	16.23027	0.0000
C(6)	-0.023769	0.008582	-2.769487	0.0056
C(7)	0.885735	0.010859	81.56910	0.0000
GED PARAMETER	0.807565	0.008709	92.73092	0.0000

Table 4.40 shows that the EGARCH (1,1) model both mean and all the variance equation coefficients are statistically significant other than C.

4.5.3.6. IGARCH

Table 4.41 Output of IGARCH (1,1) model of Footwear & Textile sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-0.000402	0.000131	-3.060612	0.0022
AR(1)	0.613079	0.129860	4.721091	0.0000
MA(1)	-0.615323	0.129340	-4.757416	0.0000
		Variance Equation		
RESID(-1)^2	0.000593	4.72E-05	12.55725	0.0000
GARCH(-1)	0.999407	4.72E-05	21154.88	0.0000
T-DIST. DOF	2.413641	0.016544	145.8885	0.0000

According to the Table 4.41, IGARCH (1,1) model both mean equation and variance equation all the coefficients are statistically significant. This model is not satisfied with residual analysis therefore it was not considered in model comparison.

4.5.3.7. PARCH

Table 4.42 Output of PARCH (1,1) model of Footwear & Textile sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-0.000324	0.000114	-2.844677	0.0044
AR(1)	0.992133	0.002364	419.6300	0.0000
MA(1)	-0.992013	0.002334	-425.0998	0.0000
		Variance Equation		
C(4)	0.011254	0.013771	0.817258	0.4138
C(5)	2.607560	3.175555	0.821135	0.4116
C(6)	-0.112437	0.031952	-3.518872	0.0004
C(7)	0.754446	0.010699	70.51675	0.0000
T-DIST. DOF	2.005429	0.013234	151.5389	0.0000

Table 4.42 shows that PARCH (1,1) model mean equation and variance equation coefficients are statistically significant under 1% significant level except C (4) and C (5). This model is not satisfied with residual analysis therefore it was not considered in model comparison.

4.5.4. Model comparison by Akaike information criterion (AIC) and Schwarz criterion (SC) values

Table 4.43 AIC and SC values of ARCH models of Footwear & Textile sector Indices

Model	**AIC Value**	**SC value**
ARCH (2)	-4.738264	-4.733942
GARCH (1,2)	-4.772248	-4.767062
TARCH (1,2)	-4.785997	-4.779083
EGARCH (1,1)	-5.588103	-5.581188

Table 4.43 shows that the lowest AIC & SC values are with the EGARCH (1,1) model. Therefore, by considering the AIC and SC values prove that the appropriate model for the forecasting Footwear & Textile sector indices is the EGARCH (1,1) model.

4.5.5. Residual analysis

After fitting tentative model to the data, we must examine its adequacy by analyzing its residuals.

4.5.5.1 Correlogram standard residuals squired

Autocorrelation	Partial Correlation		AC	PAC	Q-Sta...	Prob...
		1	0.002	0.002	0.0486	0.826
		2	-0.00...	-0.00...	0.1125	0.945
		3	-0.00...	-0.00...	0.1974	0.978
		4	0.006	0.006	0.5249	0.971
		5	0.008	0.008	1.0804	0.956
		6	-0.00...	-0.00...	1.1324	0.980
		7	-0.00...	-0.00...	1.2345	0.990
		8	-0.00...	-0.00...	1.4006	0.994
		9	-0.00...	-0.00...	1.4032	0.998
		1...	-0.00...	-0.00...	1.5119	0.999
		1...	-0.00...	-0.00...	1.6033	0.999
		1...	-0.00...	-0.00...	1.6432	1.000
		1...	0.009	0.009	2.3506	0.999
		1...	-0.00...	-0.00...	2.4678	1.000
		1...	-0.00...	-0.00...	2.5868	1.000
		1...	-0.00...	-0.00...	2.5907	1.000
		1...	-0.00...	-0.00...	2.6322	1.000
		1...	-0.00...	-0.00...	2.6593	1.000
		1...	0.002	0.003	2.7094	1.000
		2...	-0.00...	-0.00...	2.7996	1.000
		2...	-0.00...	-0.00...	2.8654	1.000
		2...	-0.00...	-0.00...	2.9796	1.000
		2...	-0.00...	-0.00...	3.0597	1.000
		2...	0.000	0.000	3.0599	1.000
		2...	-0.00...	-0.00...	3.0600	1.000
		2...	0.011	0.011	4.0131	1.000
		2...	0.001	0.001	4.0170	1.000
		2...	0.002	0.002	4.0605	1.000
		2...	0.005	0.005	4.2566	1.000
		3...	0.002	0.002	4.2921	1.000
		3...	-0.00...	-0.00...	4.3302	1.000
		3...	-0.00...	-0.00...	4.3924	1.000
		3...	-0.00...	-0.00...	4.4861	1.000
		3...	0.002	0.002	4.5070	1.000
		3...	-0.00...	-0.00...	4.5451	1.000
		3...	-0.00...	-0.00...	4.5720	1.000

Figure 4.15: The Correlogram of EGARCH (1,1) model of Footwear & Textile sector Indices

The ACF and PACF graphs in Figure 4.15 do not presence any structure and all the values lie between 95% of confidence interval. And their all probability values are greater than 5% of significance level. The ACF and PACF graphs are recommended that there is no serial correlation between each residual value.

4.5.5.2. ARCH- LM test

Table 4.44a Output of ARCH-LM test of EGARCH (1,1) model of Footwear & Textile sector Indices

Heteroskedasticity Test: ARCH

F-statistic	0.048518	Prob. F(1,8095)	0.8257
Obs*R-squared	0.048530	Prob. Chi-Square(1)	0.8256

Table shows that there is no ARCH effect of the residuals since the probability vale is higher than 5%. The null hypothesis of no ARCH effect with residuals have to accept.

Table 4.44b Output of Breusch – Pagan - Godfrey test of EGARCH (1,1) model of Footwear & Textile sector Indices

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1312.851	Prob. F(1,8096)	0.0000
Obs*R-squared	1129.943	Prob. Chi-Square(1)	0.0000
Scaled explained SS	5.88E+11	Prob. Chi-Square(1)	0.0000

Therefore, appropriate model for forecasting the Footwear & Textile sector indices is EGARCH (1,1) model.

Mean Equation

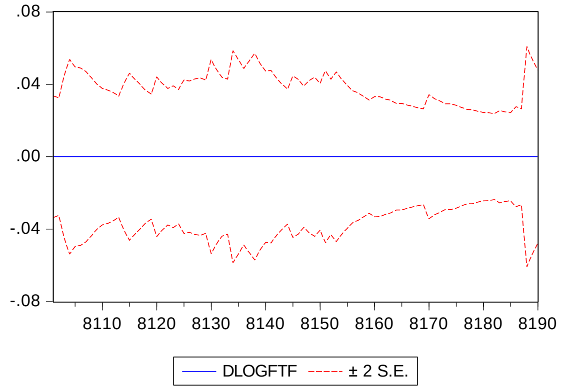
$$dlogft = 0.990503 dlogft_{t-1} - 0.990502\varepsilon_{t-1}$$

Variance Equation

$$log\sigma_t^2 = -1.057854 + 0.192010\left|\frac{\varepsilon_{t-1}}{\sqrt{\sigma_{t-1}}}\right| - 0.023769\frac{\varepsilon_{t-1}}{\sqrt{\sigma_{t-1}}} + 0.885735 log\sigma_{t-1}^2$$

4.5.6. Forecasting

Figure 4.16 show the forecasting results of Footwear & Textile sector indices for ninety days of 2019.



Forecast: DLOGFTF	
Actual: DLOGFT	
Forecast sample: 8101 8190	
Included observations: 90	
Root Mean Squared Error	0.027109
Mean Absolute Error	0.015533
Mean Abs. Percent Error	82.22216
Theil Inequality Coefficient	0.999954
Bias Proportion	0.000096
Variance Proportion	0.999898
Covariance Proportion	0.000006

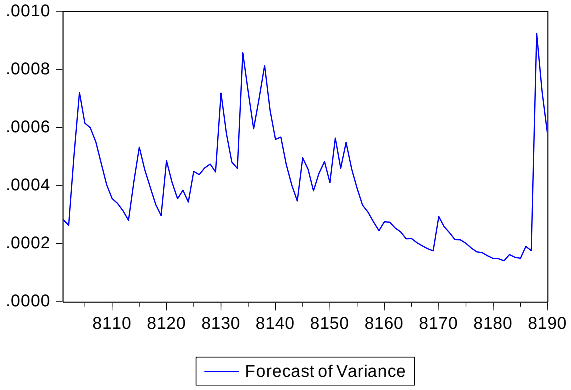


Figure 4.16. Output of forecasting the Footwear & Textile sector index for ninety days in 2019

4.6. Hotels & Travel Sector

4.6.1. Preliminary Analysis

It is necessary to test the stationary conditions after collecting the data. By just looking at the time series plot it can be obtained an idea about the data series.

The Figure 4.17 shows the time series plot for daily index in Hotels & Travel sector which consists of 8190 observations.

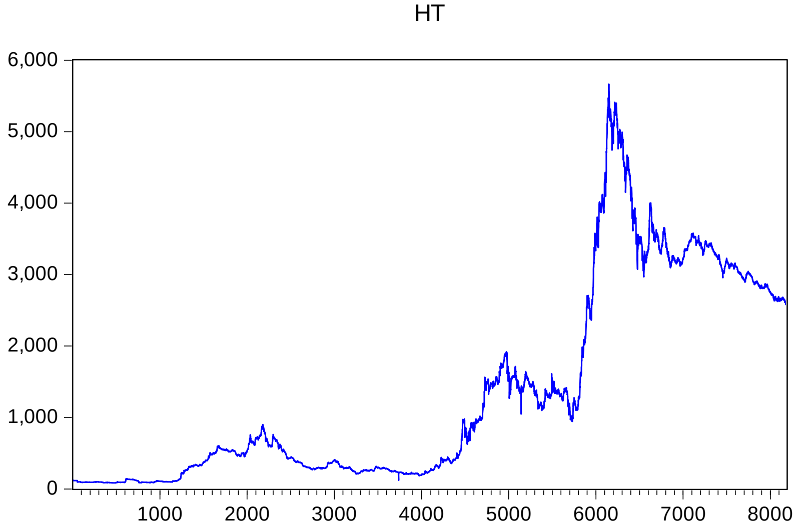


Figure 4.17: Time series plot for daily index in Hotels & Travel Sector from 02nd Jan. 1985 to 29th Mar. 2019. The X axis denotes the year and Y axis denotes the Index.

4.6.2. Unit root test: Augmented dickey-fuller (ADF) test

Table 4.45 shows the test results of Unit Root Test, Augmented Dickey-Fuller (ADF) test with intercept to prove that data series is not stationary in statistically.

Table 4.45: ADF test for raw data series of Hotels & Travel Sector

Null Hypothesis: HT has a unit root
Exogenous: Constant
Lag Length: 5 (Automatic - based on SIC, maxlag=36)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.805787	0.8170
Test critical values:	1% level	-3.430973	
	5% level	-2.861700	
	10% level	-2.566897	

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

According to the result of ADF it can be accepted null hypothesis and reject the alternative hypothesis said that the data series has unit root means that the time series data are not stationary. Thus it is necessary to make them stationary. To this purpose it can be checked the behavior of first difference of log data series.

To confirm the stationarity of the first difference of log data series Unit Root test, Augmented Dickey Fuller (ADF) tests have been carried out and the results for 5% of Significant level are shown the in the Table 4.46.

Table 4.46: ADF test values for the first difference of log data series of Hotels & Travel Sector

Null Hypothesis: DLOGHT has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=36)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-103.6048	0.0001
Test critical values:	1% level	-3.430972	
	5% level	-2.861699	
	10% level	-2.566897	

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

Though the result of ADF shows the probability as significant to reject the null hypothesis of the series has a unit root and accept the alternative hypothesis of the data series has not unit root. That means data series is stationary with mean but not with variance. It is confirmed by the autocorrelation (ACF) and partial autocorrelation (PACF) graphs.

Autocorrelation	Partial Correlation		AC	PAC	Q-Sta...	Prob
		1	-0.13...	-0.13...	148.58	0.000
		2	0.009	-0.00...	149.23	0.000
		3	0.025	0.025	154.35	0.000
		4	0.034	0.041	163.59	0.000
		5	0.017	0.027	165.85	0.000
		6	0.016	0.021	167.84	0.000
		7	0.002	0.005	167.87	0.000
		8	0.031	0.030	175.66	0.000
		9	0.007	0.012	176.00	0.000
		1...	0.010	0.011	176.84	0.000
		1...	0.017	0.017	179.11	0.000
		1...	0.016	0.018	181.25	0.000
		1...	0.031	0.034	189.29	0.000
		1...	0.021	0.027	192.88	0.000
		1...	-0.01...	-0.01...	194.96	0.000
		1...	0.003	-0.00...	195.04	0.000
		1...	0.008	0.002	195.60	0.000
		1...	0.003	0.001	195.70	0.000
		1...	0.007	0.006	196.16	0.000
		2...	0.016	0.016	198.23	0.000
		2...	0.007	0.009	198.63	0.000
		2...	0.001	-0.00...	198.63	0.000
		2...	0.009	0.007	199.36	0.000
		2...	-0.00...	-0.00...	199.37	0.000
		2...	0.017	0.013	201.76	0.000
		2...	0.008	0.009	202.29	0.000
		2...	-0.01...	-0.01...	203.27	0.000
		2...	0.010	0.005	204.03	0.000
		2...	0.011	0.011	204.98	0.000
		3...	-0.00...	-0.00...	205.03	0.000
		3...	-0.01...	-0.02...	207.58	0.000
		3...	-0.00...	-0.01...	208.03	0.000
		3...	0.026	0.020	213.78	0.000
		3...	-0.00...	0.001	213.92	0.000
		3...	0.023	0.025	218.20	0.000
		3...	0.012	0.019	219.45	0.000

Figure 4.18: The Correlogram of first difference series of Log index of Hotels & Travel Sector

The Correlogram of first difference series of Log index of Hotels & Travel Sector confirm that there is serial correlation with lag values.

4.6.3. Model identification and coefficient estimation

4.6.3.1. ARCH-LM test

To test the applicability of ARCH family model it can be checked the ARCH -LM test. The test results are shown in Table 4.47.

Table 4.47: ARCH-LM test results of Hotels & Travel Sector

Heteroskedasticity Test: ARCH

F-statistic	2595.234	Prob. F(1,8186)	0.0000
Obs*R-squared	1970.997	Prob. Chi-Square(1)	0.0000

According to the Table 4.47, it can be reject the null hypothesis since the probability value is significant and can accept the alternative hypothesis. This means model has ARCH effect and therefore, ARCH family models can be applied.

4.6.3.2. ARCH

Table 4.48 Output of ARCH (6) model of Hotels & Travel Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-0.001476	7.87E-05	-18.76750	0.0000
AR(1)	-0.372936	0.032208	-11.57912	0.0000
MA(1)	0.589471	0.024536	24.02500	0.0000
Variance Equation				
C	5.17E-05	5.29E-07	97.65451	0.0000
RESID(-1)^2	1.245901	0.015340	81.21834	0.0000
RESID(-2)^2	0.202390	0.011582	17.47418	0.0000
RESID(-3)^2	0.210220	0.005137	40.92568	0.0000
RESID(-4)^2	0.015538	0.003136	4.954909	0.0000
RESID(-5)^2	0.034090	0.005876	5.801365	0.0000
RESID(-6)^2	0.223415	0.007137	31.30402	0.0000

According to the Table 4.48, ARCH (6) model both mean equation and the variance equation coefficients are statistically significant under 1% significant level.

4.6.3.3. GARCH

Table 4.49 Output of GARCH (1,1) model of Hotels & Travel Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-0.001271	9.30E-05	-13.66664	0.0000
AR(1)	-0.281310	0.029701	-9.471527	0.0000
MA(1)	0.569313	0.019829	28.71081	0.0000
Variance Equation				
C	3.80E-05	4.37E-07	87.04054	0.0000
RESID(-1)^2	1.087334	0.014120	77.00699	0.0000
GARCH(-1)	0.377695	0.003693	102.2801	0.0000

Table 4.49 shows that GARCH (1,1) model all the coefficients of both mean equation and the variance equation are statistically significant.

4.6.3.4. TARCH

Table 4.50 Output of TARCH (1,1) model of Hotels & Travel Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-0.000327	0.000111	-2.946310	0.0032
AR(1)	-0.315544	0.026190	-12.04813	0.0000
MA(1)	0.577610	0.018081	31.94557	0.0000
		Variance Equation		
C	4.11E-05	4.54E-07	90.46964	0.0000
RESID(-1)^2	1.800594	0.032233	55.86266	0.0000
RESID(-1)^2*(RESID(-1)<...	-1.385955	0.039954	-34.68899	0.0000
GARCH(-1)	0.354888	0.003350	105.9521	0.0000

According to the Table 4.50, TARCH (1,1) model both mean equation and variance equation all the coefficients are statistically significant under 1% significant level.

4.6.3.5. EGARCH

Table 4.51 Output of EGARCH (1,1) model of Hotels & Travel Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	5.55E-08	3.81E-05	0.001457	0.9988
AR(1)	0.023463	0.005613	4.180292	0.0000
		Variance Equation		
C(3)	-0.371115	0.018395	-20.17469	0.0000
C(4)	0.078838	0.003587	21.97882	0.0000
C(5)	0.072453	0.003443	21.04077	0.0000
C(6)	0.966390	0.001756	550.2013	0.0000
GED PARAMETER	0.843149	0.004689	179.8055	0.0000

Table 4.51 shows that the EGARCH (1,1) model all the coefficient of both mean equation and variance equation are statistically significant under 1% significant level except C.

4.6.3.6. IGARCH

Table 4.52 Output of IGARCH (1,1) model of Hotels & Travel Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-0.000204	7.12E-05	-2.861460	0.0042
AR(1)	0.776652	0.046258	16.78970	0.0000
MA(1)	-0.745302	0.049520	-15.05049	0.0000
		Variance Equation		
RESID(-1)^2	0.001808	7.14E-05	25.30461	0.0000
GARCH(-1)	0.998192	7.14E-05	13973.79	0.0000
T-DIST. DOF	2.294902	0.008477	270.7258	0.0000

According to the Table 4.52, IGARCH (1,1) model both mean equation and variance equation all the coefficients are statistically significant under 1% significant level.

4.6.3.7. PARCH

Table 4.53 Output of PARCH (1,1) model of Hotels & Travel Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-3.32E-05	4.04E-05	-0.822913	0.4106
AR(1)	0.038973	0.009257	4.209958	0.0000
		Variance Equation		
C(3)	0.000209	0.000124	1.683296	0.0923
C(4)	1.201814	0.629386	1.909502	0.0562
C(5)	-0.018744	0.027587	-0.679466	0.4968
C(6)	0.841897	0.005896	142.7903	0.0000
T-DIST. DOF	2.022237	0.023491	86.08414	0.0000

Table 4.53 shows that PARCH (1,1) model mean equation and variance equation all the coefficients are not statistically significant except AR (1) and C (6).

4.6.4. Model comparison by Akaike information criterion (AIC) Schwarz criterion (SC) values

Table 4.54 AIC and SC values of ARCH models of Hotels & Travel Sector Indices

Model	**AIC Value**	**SC value**
ARCH (6)	-5.816166	-5.807523
GARCH (1,1)	-5.802212	-5.797026
TARCH (1,1)	-5.834313	-5.828262

Table 4.54 shows that the lowest AIC & SC values are with the TARCH (1,1) model. Therefore, by considering the AIC and SC values prove that the appropriate model for the forecasting Hotels & Travel sector indices is the TARCH (1,1) model.

4.6.5. Residual analysis

After fitting tentative model to the data, we must examine its adequacy by analyzing its residuals.

4.6.5.1. Correlogram standard residuals squired

Autocorrelation	Partial Correlation		AC	PAC	Q-Sta...	Prob...
		1	0.001	0.001	0.0034	0.954
		2	-0.00...	-0.00...	0.0414	0.980
		3	-0.00...	-0.00...	0.0662	0.996
		4	-0.00...	-0.00...	0.0977	0.999
		5	-0.00...	-0.00...	0.1199	1.000
		6	-0.00...	-0.00...	0.1199	1.000
		7	-0.00...	-0.00...	0.1433	1.000
		8	-0.00...	-0.00...	0.1637	1.000
		9	0.001	0.001	0.1689	1.000
		1...	-0.00...	-0.00...	0.1776	1.000
		1...	-0.00...	-0.00...	0.2007	1.000
		1...	-0.00...	-0.00...	0.2161	1.000
		1...	-0.00...	-0.00...	0.2165	1.000
		1...	-0.00...	-0.00...	0.2226	1.000
		1...	-0.00...	-0.00...	0.2505	1.000
		1...	-0.00...	-0.00...	0.2540	1.000
		1...	-0.00...	-0.00...	0.2771	1.000
		1...	0.002	0.002	0.3035	1.000
		1...	-0.00...	-0.00...	0.3343	1.000
		2...	0.000	0.000	0.3361	1.000
		2...	-0.00...	-0.00...	0.3498	1.000
		2...	-0.00...	-0.00...	0.3680	1.000
		2...	0.000	0.000	0.3683	1.000
		2...	-0.00...	-0.00...	0.3856	1.000
		2...	-0.00...	-0.00...	0.4003	1.000
		2...	-0.00...	-0.00...	0.4257	1.000
		2...	0.000	0.000	0.4270	1.000
		2...	-0.00...	-0.00...	0.4662	1.000
		2...	-0.00...	-0.00...	0.4663	1.000
		3...	-0.00...	-0.00...	0.4733	1.000
		3...	-0.00...	-0.00...	0.5069	1.000
		3...	-0.00...	-0.00...	0.5080	1.000
		3...	0.004	0.004	0.6188	1.000
		3...	-0.00...	-0.00...	0.6190	1.000
		3...	0.006	0.006	0.8760	1.000
		3...	0.001	0.001	0.8845	1.000

Figure 4.19: The Correlogram of TARCH (1,1) model of Hotels & Travel Sector Indices

The ACF and PACF graphs in Figure 4.19 do not presence any structure and all the values lie between 95% of confidence interval. And their all probability values are greater than 5% of significance level. The ACF and PACF graphs are recommended that there is no serial correlation between each residual value.

4.6.5.2. ARCH- LM test

Table 4.55a Output of ARCH-LM test of TARCH (1,1) model of Hotels & Travel Sector Indices

Heteroskedasticity Test: ARCH

F-statistic	0.003365	Prob. F(1,8095)	0.9537
Obs*R-squared	0.003365	Prob. Chi-Square(1)	0.9537

Table shows that there is no ARCH effect of the residuals since the probability vale is higher than 5%. The null hypothesis of no ARCH effect with residuals have to accept.

Table 4.55b Output of Breusch – Pagan - Godfrey test of TARCH (1,1) model of Hotels & Travel Sector Indices

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1239.775	Prob. F(1,8096)	0.0000
Obs*R-squared	1075.401	Prob. Chi-Square(1)	0.0000
Scaled explained SS	8.06E+11	Prob. Chi-Square(1)	0.0000

Therefore, appropriate fitted model for forecasting the Hotels & Travel sector indices is TARCH (1,1) model.

Mean Equation

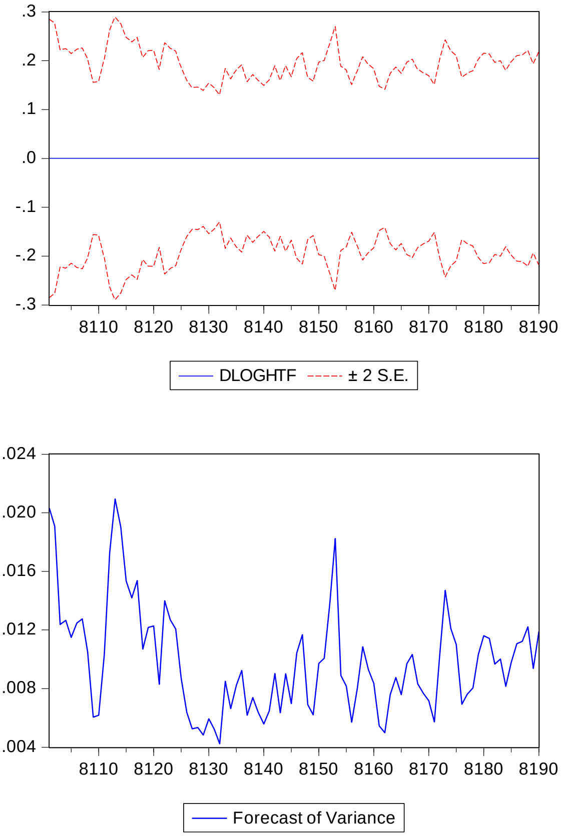
$$dloght = -0.000327 - 0.315544 dloght_{t-1} + 0.577610 \varepsilon_{t-1}$$

Variance Equation

$$\sigma_t^2 = 0.0000411 + 1.800594 \varepsilon_{t-1}^2 - 1.385955 \varepsilon_{t-1}^2 (\varepsilon_{t-1} < 0) + 0.354888 \sigma_{t-1}^2$$

4.6.6. Forecasting

Figure 4.20 show the forecasting results of Hotels & Travel sector indices for ninety days of 2019.



Forecast: DLOGHTF	
Actual: DLOGHT	
Forecast sample: 8101 8190	
Included observations: 90	
Root Mean Squared Error	0.002820
Mean Absolute Error	0.002087
Mean Abs. Percent Error	99.99997
Theil Inequality Coefficient	1.000000
Bias Proportion	0.003249
Variance Proportion	NA
Covariance Proportion	NA

Figure 4.20: Output of forecasting the Hotels & Travel sector index for ninety days in 2019

4.7. Investment Trusts Sector

4.7.1. Preliminary Analysis

It is necessary to test the stationary conditions after collecting the data. By just looking at the time series plot it can be obtained an idea about the data series.

The Figure 4.21 shows the time series plot for daily index in Investment Trusts sector which consists of 8190 observations.

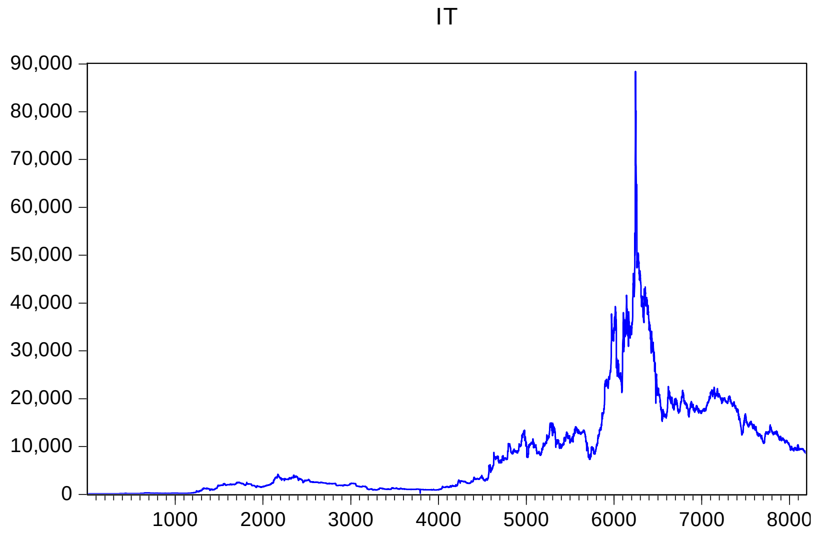


Figure 4.21: Time series plot for daily index in Investment Trusts Sector from 02nd Jan. 1985 to 29th Mar. 2019. The X axis denotes the year and Y axis denotes the Index.

4.7.2. Unit root test: Augmented dickey-fuller (ADF) test

Table 4.56 shows the test results of Unit Root Test, Augmented Dickey-Fuller (ADF) test with intercept to prove that data series is not stationary in statistically.

Table 4.1: ADF test for raw data series of Investment Trusts Sector

Null Hypothesis: IT has a unit root
Exogenous: Constant
Lag Length: 28 (Automatic - based on SIC, maxlag=36)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.057395	0.2624
Test critical values:	1% level	-3.430975	
	5% level	-2.861701	
	10% level	-2.566897	

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

According to the result of ADF it can be accepted null hypothesis and reject the alternative hypothesis said that the data series has unit root means that the time series data are not stationary. Thus it is necessary to make them stationary. To this purpose it can be checked the behavior of first difference of log data series.

To confirm the stationarity of the first difference of log data series Unit Root test, Augmented Dickey Fuller (ADF) tests have been carried out and the results for 5% of Significant level are shown the in the Table 4.57.

Table 4.57: ADF test values for the first difference of log data series of Investment Trusts Sector

Null Hypothesis: DLOGIT has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=36)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-64.18308	0.0001
Test critical values:	1% level	-3.430972	
	5% level	-2.861700	
	10% level	-2.566897	

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

Though the result of ADF shows the probability as significant to reject the null hypothesis of the series has a unit root and accept the alternative hypothesis of the data series has not unit root. That means data series is stationary with mean but not with variance. It is confirmed by the autocorrelation (ACF) and partial autocorrelation (PACF) graphs.

Autocorrelation	Partial Correlation		AC	PAC	Q-Sta...	Prob
		1	-0.34...	-0.34...	998.22	0.000
		2	0.011	-0.12...	999.15	0.000
		3	0.006	-0.03...	999.44	0.000
		4	-0.01...	-0.02...	1000.6	0.000
		5	0.016	0.004	1002.7	0.000
		6	-0.00...	0.002	1002.9	0.000
		7	0.003	0.004	1003.0	0.000
		8	0.011	0.016	1004.0	0.000
		9	0.006	0.019	1004.3	0.000
		1...	0.004	0.016	1004.4	0.000
		1...	-0.00...	0.009	1004.4	0.000
		1...	0.002	0.006	1004.4	0.000
		1...	0.000	0.004	1004.4	0.000
		1...	-0.00...	0.002	1004.4	0.000
		1...	0.008	0.010	1005.0	0.000
		1...	0.005	0.013	1005.2	0.000
		1...	0.002	0.010	1005.3	0.000
		1...	-0.00...	-0.00...	1005.5	0.000
		1...	-0.00...	-0.00...	1005.6	0.000
		2...	-0.00...	-0.00...	1005.6	0.000
		2...	-0.00...	-0.01...	1005.8	0.000
		2...	-0.00...	-0.01...	1005.8	0.000
		2...	0.003	-0.00...	1005.9	0.000
		2...	-0.00...	-0.00...	1005.9	0.000
		2...	0.004	0.004	1006.0	0.000
		2...	0.004	0.008	1006.1	0.000
		2...	0.001	0.007	1006.1	0.000
		2...	-0.00...	0.003	1006.1	0.000
		2...	0.004	0.006	1006.3	0.000
		3...	0.001	0.005	1006.3	0.000
		3...	0.007	0.011	1006.7	0.000
		3...	0.003	0.012	1006.8	0.000
		3...	0.006	0.014	1007.1	0.000
		3...	0.006	0.016	1007.4	0.000
		3...	0.001	0.012	1007.4	0.000
		3...	-0.00...	-0.00...	1007.8	0.000

Figure 4.22: The Correlogram of first difference series of Log index of Investment Trusts Sector

The Correlogram of first difference series of Log index of Investment Trusts Sector confirm that there is serial correlation with lag values.

4.7.3. Model identification and coefficient estimation

4.7.3.1. ARCH-LM test

To test the applicability of ARCH family model it can be checked the ARCH -LM test. The test results are shown in Table 4.58.

Table 4.58: ARCH-LM test results of Investment Trusts Sector

Heteroskedasticity Test: ARCH

F-statistic	2719.160	Prob. F(1,8186)	0.0000
Obs*R-squared	2041.647	Prob. Chi-Square(1)	0.0000

According to the Table 4.58, it can be reject the null hypothesis since the probability value is significant and can accept the alternative hypothesis. This means model has ARCH effect and therefore, ARCH family models can be applied.

4.7.3.2. ARCH

Table 4.59 Output of ARCH (1) model of Investment Trusts Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-0.000778	0.000877	-0.887826	0.3746
AR(1)	0.873122	0.061274	14.24942	0.0000
MA(1)	-0.827041	0.070656	-11.70512	0.0000
		Variance Equation		
C	0.001079	1.69E-06	638.4184	0.0000
RESID(-1)^2	0.138162	0.009623	14.35686	0.0000

According to the Table 4.59, ARCH (1) model both mean equation and variance equation all the coefficients are statistically significant under 1% significant level except C.

4.7.3.3. GARCH

Table 4.60 Output of GARCH (1,2) model of Investment Trusts Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-0.000477	0.001811	-0.263535	0.7921
AR(1)	0.934372	0.067427	13.85764	0.0000
MA(1)	-0.905588	0.077171	-11.73488	0.0000
		Variance Equation		
C	0.001422	4.23E-05	33.62214	0.0000
RESID(-1)^2	0.041121	0.003402	12.08904	0.0000
GARCH(-1)	0.416679	0.025931	16.06881	0.0000
GARCH(-2)	-0.085882	0.006369	-13.48513	0.0000

Table 4.60 shows that GARCH (1,2) model all the coefficients of mean equation and variance equation are statistically significant under 1% significant level except C.

4.7.3.4. TARCH

Table 4.61 Output of TARCH (1,1) model of Investment Trusts Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	0.000639	0.001405	0.454621	0.6494
AR(1)	0.002471	0.020323	0.121608	0.9032
Variance Equation				
C	0.001101	6.12E-05	17.98972	0.0000
RESID(-1)^2	-0.020123	0.000932	-21.58749	0.0000
RESID(-1)^2*(RESID(-1)<...	0.053206	0.002845	18.70438	0.0000
GARCH(-1)	0.592816	0.022597	26.23400	0.0000

According to the Table 4.61, TARCH (1,1) model mean equation is not statistically significant while the variance equation all the coefficients are statistically significant under 1% significant level.

4.7.3.5. EGARCH

Table 4.62 Output of EGARCH (1,1) model of Investment Trusts Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	3.41E-05	0.000124	0.274111	0.7840
AR(1)	0.654636	0.327573	1.998442	0.0457
MA(1)	-0.648542	0.330159	-1.964334	0.0495
Variance Equation				
C(4)	-0.876941	0.032191	-27.24155	0.0000
C(5)	0.076242	0.002253	33.84597	0.0000
C(6)	0.077123	0.002252	34.24366	0.0000
C(7)	0.903152	0.003670	246.0987	0.0000
GED PARAMETER	1.043361	0.002741	380.6191	0.0000

Table 4.62 shows that the EGARCH (1,1) model all the coefficients of both mean equation and the variance equation are statistically significant except C. This model is not satisfied with the residual analysis. Therefore, it was not considered in model comparison.

4.7.3.6. IGARCH

Table 4.63 Output of IGARCH (2,2) model of Investment Trusts Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	4.62E-07	1.04E-07	4.448020	0.0000
AR(1)	0.571702	0.110382	5.179302	0.0000
MA(1)	-0.531030	0.114373	-4.642990	0.0000
		Variance Equation		
RESID(-1)^2	0.189203	0.010200	18.54904	0.0000
RESID(-2)^2	-0.089555	0.014745	-6.073425	0.0000
GARCH(-1)	1.371560	0.020911	65.59071	0.0000
GARCH(-2)	-0.471209	0.014866	-31.69642	0.0000
T-DIST. DOF	2.642131	0.020535	128.6636	0.0000

According to the Table 4.63, IGARCH (2,2) model both mean equation and variance equation all the coefficients are statistically significant under 1% significant level.

4.7.3.7. PARCH

Table 4.64 Output of PARCH (1,1) model of Investment Trusts Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-8.88E-08	2.75E-05	-0.003223	0.9974
AR(1)	0.001763	0.008440	0.208865	0.8346
		Variance Equation		
C(3)	3.51E-06	2.36E-05	0.148523	0.8819
C(4)	0.819414	0.208815	3.924115	0.0001
C(5)	-0.011305	0.019526	-0.578953	0.5626
C(6)	0.821974	0.003043	270.0869	0.0000
T-DIST. DOF	2.049894	0.026196	78.25123	0.0000

Table 4.64 shows that PARCH (1,1) model mean equation, C (2) & C (5) coefficients of variance equation is not statistically significant while all other coefficients of the variance equation are statistically significant under 1% significant level. This model was not considered in model comparison.

4.7.4. Model comparison by Akaike information criterion (AIC) Schwarz criterion (SC) values

Table 4.65 AIC and SC values of ARCH models of Investment Trusts Sector Indices

Model	**AIC Value**	**SC value**
ARCH (1)	-3.992654	-3.988333
GARCH (1,2)	-3.786784	-3.786784
IGARCH (2,2)	-6.040602	-6.034552

Table 4.65 shows that the lowest AIC & SC values are with the IGARCH (2,2) model. Therefore, by considering the AIC and SC values prove that the appropriate model for the forecasting Investment Trusts sector indices is the IGARCH (2,2) model.

4.7.5. Residual analysis

After fitting tentative model to the data, we must examine its adequacy by analyzing its residuals.

4.7.5.1. Correlogram standard residuals squired

Autocorrelation	Partial Correlation		AC	PAC	Q-Sta...	Prob...
		1	-0.00...	-0.00...	0.0002	0.989
		2	-0.00...	-0.00...	0.0004	1.000
		3	-0.00...	-0.00...	0.0005	1.000
		4	-0.00...	-0.00...	0.0007	1.000
		5	-0.00...	-0.00...	0.0009	1.000
		6	-0.00...	-0.00...	0.0011	1.000
		7	-0.00...	-0.00...	0.0012	1.000
		8	-0.00...	-0.00...	0.0014	1.000
		9	-0.00...	-0.00...	0.0016	1.000
		1...	-0.00...	-0.00...	0.0018	1.000
		1...	-0.00...	-0.00...	0.0020	1.000
		1...	-0.00...	-0.00...	0.0022	1.000
		1...	-0.00...	-0.00...	0.0023	1.000
		1...	-0.00...	-0.00...	0.0025	1.000
		1...	-0.00...	-0.00...	0.0027	1.000
		1...	-0.00...	-0.00...	0.0029	1.000
		1...	-0.00...	-0.00...	0.0031	1.000
		1...	-0.00...	-0.00...	0.0033	1.000
		1...	-0.00...	-0.00...	0.0034	1.000
		2...	-0.00...	-0.00...	0.0036	1.000
		2...	-0.00...	-0.00...	0.0038	1.000
		2...	-0.00...	-0.00...	0.0040	1.000
		2...	-0.00...	-0.00...	0.0042	1.000
		2...	-0.00...	-0.00...	0.0044	1.000
		2...	-0.00...	-0.00...	0.0046	1.000
		2...	-0.00...	-0.00...	0.0047	1.000
		2...	-0.00...	-0.00...	0.0049	1.000
		2...	-0.00...	-0.00...	0.0051	1.000
		2...	-0.00...	-0.00...	0.0053	1.000
		3...	-0.00...	-0.00...	0.0055	1.000
		3...	-0.00...	-0.00...	0.0057	1.000
		3...	-0.00...	-0.00...	0.0058	1.000
		3...	-0.00...	-0.00...	0.0060	1.000
		3...	-0.00...	-0.00...	0.0062	1.000
		3...	-0.00...	-0.00...	0.0064	1.000
		3...	-0.00...	-0.00...	0.0066	1.000

Figure 4.23: The Correlogram of IGARCH (2,2) model of Investment Trusts Sector Indices

The ACF and PACF graphs in Figure 4.23 do not presence any structure and all the values lie between 95% of confidence interval. And their all probability values are greater than 5% of significance level.

The ACF and PACF graphs are recommended that there is no serial correlation between each residual value.

4.7.5.2. ARCH- LM test

Table 4.66a Output of ARCH-LM test of IGARCH (2,2) model of Investment Trusts Sector

Heteroskedasticity Test: ARCH

F-statistic	0.000182	Prob. F(1,8095)	0.9892
Obs*R-squared	0.000182	Prob. Chi-Square(1)	0.9892

Table shows that there is no ARCH effect of the residuals since the probability vale is higher than 5%. The null hypothesis of no ARCH effect with residuals have to accept.

Table 4.66b Output of Breusch – Pagan - Godfrey test of IGARCH (2,2) model of Investment Trusts Sector

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	4653.085	Prob. F(1,8097)	0.0000
Obs*R-squared	2955.693	Prob. Chi-Square(1)	0.0000
Scaled explained SS	4.80E+13	Prob. Chi-Square(1)	0.0000

Therefore, appropriate fitted model for forecasting the Investment Trusts sector indices is IGARCH (2,2) model.

Mean Equation

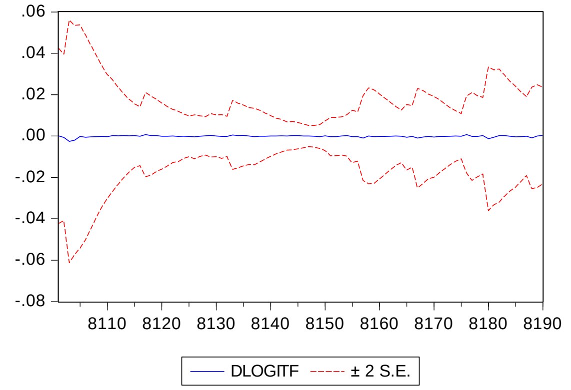
$$dlogit = 0.000000462 + 0.571702dlogit_{t-1} - 0.531030\varepsilon_{t-1}$$

Variance Equation

$$\sigma_t^2 = 0.189203\varepsilon_{t-1}^2 - 0.089555\varepsilon_{t-2}^2 + 1.371560\sigma_{t-1}^2 - 0.471209\sigma_{t-2}^2$$

4.7.6. Forecasting

Figure 4.24 show the forecasting results of Investment Trusts sector indices for ninety days of 2019.



Forecast: DLOGITF	
Actual: DLOGIT	
Forecast sample: 8101 8190	
Included observations: 90	
Root Mean Squared Error	0.010429
Mean Absolute Error	0.006597
Mean Abs. Percent Error	109.8567
Theil Inequality Coefficient	0.958814
Bias Proportion	0.019736
Variance Proportion	0.884795
Covariance Proportion	0.095469

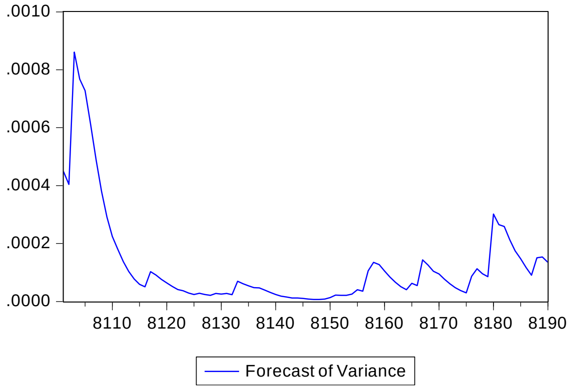


Figure 4.24: Output of forecasting the Investment Trusts sector index for ninety days in 2019

4.8. Manufacturing Sector

4.8.1. Preliminary Analysis

It is necessary to test the stationary conditions after collecting the data. By just looking at the time series plot it can be obtained an idea about the data series.

The Figure 4.25 shows the time series plot for daily index in Manufacturing sector which consists of 8190 observations.

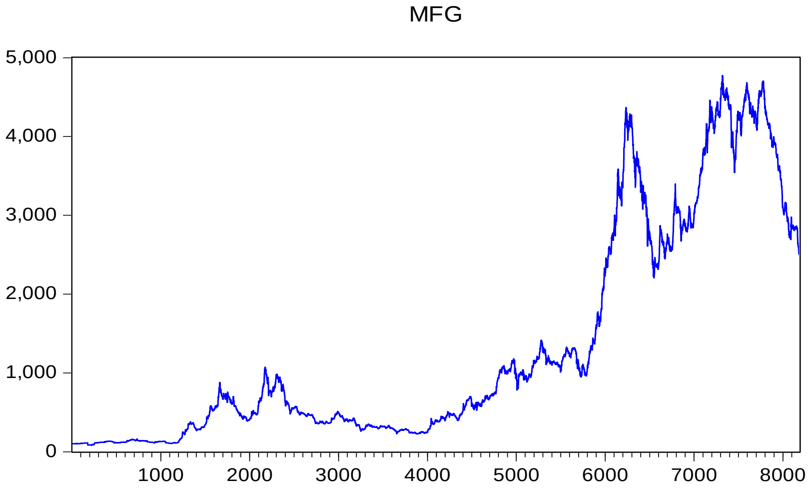


Figure 4.25: Time series plot for daily index in Manufacturing Sector from 02nd Jan. 1985 to 29th Mar. 2019. The X axis denotes the year and Y axis denotes the Index.

4.8.2. Unit root test: Augmented dickey-fuller (ADF) test

Table 4.67 shows the test results of Unit Root Test, Augmented Dickey-Fuller (ADF) test with intercept to prove that data series is not stationary in statistically.

Table 4.67: ADF test for raw data series of Manufacturing Sector

Null Hypothesis: MFG has a unit root
Exogenous: Constant
Lag Length: 9 (Automatic - based on SIC, maxlag=36)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.883037	0.7942
Test critical values:	1% level	-3.430973	
	5% level	-2.861700	
	10% level	-2.566897	

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

According to the result of ADF it can be accepted null hypothesis and reject the alternative hypothesis said that the data series has unit root means that the time series data are not stationary. Thus it is necessary to make them stationary. To this purpose it can be checked the behavior of first difference of log data series.

To confirm the stationarity of the first difference of log data series Unit Root test, Augmented Dickey Fuller (ADF) tests have been carried out and the results for 5% of Significant level are shown the in the Table 4.68.

Table 4.68: ADF test values for the first difference of log data series of Manufacturing Sector

Null Hypothesis: DLOGMFG has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic - based on SIC, maxlag=36)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-38.92115	0.0000
Test critical values:	1% level	-3.430972	
	5% level	-2.861700	
	10% level	-2.566897	

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

Though the result of ADF shows the probability as significant to reject the null hypothesis of the series has a unit root and accept the alternative hypothesis of the data series has not unit root. That means data series is stationary with mean but not with variance. It is confirmed by the autocorrelation (ACF) and partial autocorrelation (PACF) graphs.

Autocorrelation	Partial Correlation		AC	PAC	Q-Sta...	Prob
		1	0.196	0.196	314.29	0.000
		2	0.059	0.022	343.07	0.000
		3	0.062	0.048	374.27	0.000
		4	0.063	0.042	406.38	0.000
		5	0.045	0.022	422.71	0.000
		6	0.001	-0.01...	422.71	0.000
		7	0.009	0.006	423.45	0.000
		8	0.022	0.015	427.30	0.000
		9	0.029	0.021	434.38	0.000
		1...	0.003	-0.00...	434.46	0.000
		1...	0.036	0.035	444.89	0.000
		1...	0.026	0.009	450.25	0.000
		1...	0.047	0.038	468.50	0.000
		1...	0.013	-0.00...	469.95	0.000
		1...	-0.00...	-0.01...	470.02	0.000
		1...	0.021	0.016	473.64	0.000
		1...	0.018	0.007	476.21	0.000
		1...	-0.00...	-0.01...	476.51	0.000
		1...	0.000	0.003	476.51	0.000
		2...	0.027	0.024	482.37	0.000
		2...	0.003	-0.01...	482.43	0.000
		2...	0.010	0.008	483.30	0.000
		2...	0.003	-0.00...	483.39	0.000
		2...	0.010	0.004	484.17	0.000
		2...	0.032	0.026	492.39	0.000
		2...	0.009	-0.00...	493.06	0.000
		2...	0.002	-0.00...	493.08	0.000
		2...	0.019	0.016	496.13	0.000
		2...	0.022	0.011	500.14	0.000
		3...	0.017	0.008	502.50	0.000
		3...	0.014	0.007	504.07	0.000
		3...	0.007	-0.00...	504.51	0.000
		3...	0.015	0.006	506.24	0.000
		3...	0.022	0.016	510.27	0.000
		3...	0.015	0.006	512.03	0.000
		3...	0.019	0.010	514.85	0.000

Figure 4.26: The Correlogram of first difference series of Log index of Manufacturing Sector

The Correlogram of first difference series of Log index of Manufacturing Sector confirm that there is serial correlation with lag values.

4.8.3. Model identification and coefficient estimation

4.8.3.1. ARCH-LM test

To test the applicability of ARCH family model it can be checked the ARCH -LM test. The test results are shown in Table 4.69.

Table 4.69: ARCH-LM test results of Manufacturing Sector

Heteroskedasticity Test: ARCH

F-statistic	29.06468	Prob. F(1,8186)	0.0000
Obs*R-squared	28.96893	Prob. Chi-Square(1)	0.0000

According to the Table 4.69, it can be reject the null hypothesis since the probability value is significant and can accept the alternative hypothesis. This means model has ARCH effect and therefore, ARCH family models can be applied.

4.8.3.2. ARCH

Table 4.70 Output of ARCH (4) model of Manufacturing Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-0.000236	0.000117	-2.009254	0.0445
AR(1)	0.710005	0.017672	40.17729	0.0000
MA(1)	-0.547651	0.022971	-23.84096	0.0000
		Variance Equation		
C	6.25E-05	5.91E-07	105.6457	0.0000
RESID(-1)^2	0.412098	0.009818	41.97581	0.0000
RESID(-2)^2	0.088301	0.006938	12.72749	0.0000
RESID(-3)^2	0.024665	0.006247	3.948072	0.0001
RESID(-4)^2	0.324278	0.009622	33.70065	0.0000

According to the Table 4.70, ARCH (4) model both mean equation and the variance equation all the coefficients are statistically significant. The residual analysis of this model is not satisfied. Therefore, this model was not considered for model comparison.

4.8.3.3. GARCH

Table 4.71 Output of GARCH (2,1) model of Manufacturing Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-0.000323	0.000101	-3.186838	0.0014
AR(1)	0.429319	0.044189	9.715505	0.0000
MA(1)	-0.220239	0.050182	-4.388845	0.0000
		Variance Equation		
C	1.48E-05	6.29E-07	23.52575	0.0000
RESID(-1)^2	0.439696	0.012173	36.12048	0.0000
RESID(-2)^2	-0.275017	0.012971	-21.20181	0.0000
GARCH(-1)	0.773422	0.009008	85.85994	0.0000

Table 4.71 shows that GARCH (2,1) model all the coefficients of both mean equation is and the variance equation are statistically significant.

4.8.3.4. TARCH

Table 4.72 Output of TARCH (1,3) model of Manufacturing Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-0.000337	0.000253	-1.334519	0.1820
AR(1)	0.212116	0.017677	11.99938	0.0000
Variance Equation				
C	0.000124	4.22E-06	29.41136	0.0000
RESID(-1)^2	0.249167	0.014615	17.04911	0.0000
RESID(-1)^2*(RESID(-1)<...	-0.054722	0.018041	-3.033190	0.0024
GARCH(-1)	0.240536	0.028245	8.516051	0.0000
GARCH(-2)	-0.083392	0.012985	-6.422199	0.0000
GARCH(-3)	0.125049	0.014639	8.542005	0.0000

According to the Table 4.72, TARCH (1,3) model both mean equation and variance equation all the coefficients are statistically significant under 1% significant level except C of mean equation. The residual analysis of this model is not satisfied. Therefore, this model was not considered for model comparison.

4.8.3.5. EGARCH

Table 4.73 Output of EGARCH (1,3) model of Manufacturing Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	7.35E-07	3.59E-05	0.020483	0.9837
AR(1)	0.361102	0.049577	7.283640	0.0000
MA(1)	-0.263043	0.052623	-4.998610	0.0000
Variance Equation				
C(4)	-1.117555	0.079300	-14.09282	0.0000
C(5)	0.464428	0.021852	21.25324	0.0000
C(6)	0.061227	0.013123	4.665433	0.0000
C(7)	0.387869	0.053180	7.293496	0.0000
C(8)	0.185518	0.062277	2.978913	0.0029
C(9)	0.337846	0.047204	7.157181	0.0000
GED PARAMETER	0.775825	0.010123	76.63994	0.0000

Table 4.73 shows that the EGARCH (1,3) model both mean equation and variance equation all the coefficients are statistically significant under 1% significant level except C.

4.8.3.6. IGARCH

Table 4.74 Output of IGARCH (2,2) model of Manufacturing Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	1.05E-05	7.16E-05	0.147034	0.8831
AR(1)	0.177469	0.010171	17.44904	0.0000
		Variance Equation		
RESID(-1)^2	0.297690	0.000227	1309.311	0.0000
RESID(-2)^2	-0.297501	0.000227	-1312.024	0.0000
GARCH(-1)	1.550492	0.011982	129.3970	0.0000
GARCH(-2)	-0.550681	0.011983	-45.95549	0.0000
T-DIST. DOF	3.175582	0.059336	53.51875	0.0000

According to the Table 4.74, IGARCH (2,2) model both mean equation and variance equation all the coefficients are statistically significant under 1% significant level except C.

4.8.3.7. PARCH

Table 4.75 Output of PARCH (2,2) model of Manufacturing Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	5.77E-06	5.81E-05	0.099382	0.9208
AR(1)	0.130218	0.009677	13.45597	0.0000
		Variance Equation		
C(3)	-1.44E-07	2.95E-07	-0.488635	0.6251
C(4)	0.316665	0.025697	12.32308	0.0000
C(5)	-0.002880	0.000551	-5.227413	0.0000
C(6)	-0.315616	0.025626	-12.31610	0.0000
C(7)	1.651083	0.019565	84.38825	0.0000
C(8)	-0.651622	0.019523	-33.37726	0.0000
T-DIST. DOF	2.452516	0.072436	33.85776	0.0000

Table 4.75 shows that PARCH (2.2) model mean equation and variance equation coefficients are statistically significant under 1% significant level except C and C (3). The residual analysis of this model is not satisfied. Therefore, this model was not considered for model comparison.

4.8.4. Model comparison by Akaike information criterion (AIC) Schwarz criterion (SC) values

Table 4.76 AIC and SC values of ARCH models of Manufacturing Sector Indices

Model	AIC Value	SC value
GARCH (2,1)	-6.143782	-6.137732
EGARCH (1,3)	-6.615324	-6.606681
IGARCH (2,2)	-6.608206	-6.603020

Table 4.76 shows that the lowest AIC & SC values are with the EGARCH (1,3) model. Therefore, by considering the AIC and SC values prove that the appropriate model for the forecasting Manufacturing sector indices is the EGARCH (1,3) model.

4.8.5. Residual analysis

After fitting tentative model to the data, we must examine its adequacy by analyzing its residuals.

4.8.5.1. Correlogram standard residuals squired

Autocorrelation	Partial Correlation		AC	PAC	Q-Sta...	Prob...
		1	-0.00...	-0.00...	0.0075	0.931
		2	-0.00...	-0.00...	0.0223	0.989
		3	-0.00...	-0.00...	0.0417	0.998
		4	0.003	0.003	0.0993	0.999
		5	-0.00...	-0.00...	0.1261	1.000
		6	-0.00...	-0.00...	0.1718	1.000
		7	-0.00...	-0.00...	0.1734	1.000
		8	-0.00...	-0.00...	0.1889	1.000
		9	-0.00...	-0.00...	0.2263	1.000
		1...	-0.00...	-0.00...	0.2459	1.000
		1...	-0.00...	-0.00...	0.2491	1.000
		1...	-0.00...	-0.00...	0.2819	1.000
		1...	-0.00...	-0.00...	0.3244	1.000
		1...	-0.00...	-0.00...	0.3699	1.000
		1...	-0.00...	-0.00...	0.3723	1.000
		1...	-0.00...	-0.00...	0.4091	1.000
		1...	0.003	0.003	0.5022	1.000
		1...	-0.00...	-0.00...	0.5215	1.000
		1...	-0.00...	-0.00...	0.5480	1.000
		2...	-0.00...	-0.00...	0.5554	1.000
		2...	-0.00...	-0.00...	0.5900	1.000
		2...	0.003	0.003	0.6507	1.000
		2...	-0.00...	-0.00...	0.6785	1.000
		2...	-0.00...	-0.00...	0.7033	1.000
		2...	-0.00...	-0.00...	0.7169	1.000
		2...	-0.00...	-0.00...	0.7208	1.000
		2...	-0.00...	-0.00...	0.7318	1.000
		2...	0.006	0.006	0.9812	1.000
		2...	-0.00...	-0.00...	1.0062	1.000
		3...	0.000	0.000	1.0062	1.000
		3...	-0.00...	-0.00...	1.0208	1.000
		3...	-0.00...	-0.00...	1.0268	1.000
		3...	-0.00...	-0.00...	1.0516	1.000
		3...	-0.00...	-0.00...	1.0783	1.000
		3...	-0.00...	-0.00...	1.1120	1.000
		3...	-0.00...	-0.00...	1.1352	1.000

Figure 4.27: The Correlogram of EGARCH (1,3) model of Manufacturing Sector Indices

The ACF and PACF graphs in Figure 4.27 do not presence any structure and most of the values lie between 95% of confidence interval. And their all probability values are greater than 5% of significance level. The ACF and PACF graphs are recommended that there is no serial correlation between each residual value.

4.8.5.2. ARCH- LM test

Table 4.77a Output of ARCH-LM test of EGARCH (1,3) model of Manufacturing Sector Indices

Heteroskedasticity Test: ARCH

F-statistic	0.007477	Prob. F(1,8095)	0.9311
Obs*R-squared	0.007479	Prob. Chi-Square(1)	0.9311

Table shows that there is no ARCH effect of the residuals since the probability vale is higher than 5%. The null hypothesis of no ARCH effect with residuals have to accept.

Table 4.77b Output of Breusch – Pagan - Godfrey test of EGARCH (1,3) model of Manufacturing Sector Indices

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	366.4741	Prob. F(1,8096)	0.0000
Obs*R-squared	350.6903	Prob. Chi-Square(1)	0.0000
Scaled explained SS	2.56E+12	Prob. Chi-Square(1)	0.0000

Therefore, appropriate fitted model for forecasting the Manufacturing sector indices is EGARCH (1,3) model.

Mean Equation

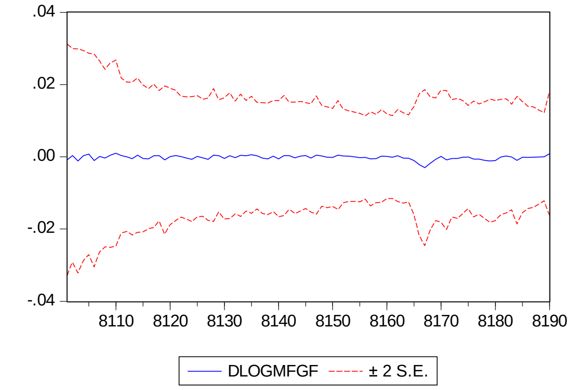
$$dlogmfg = 0.361102 dlogmfg_{t-1} - 0.263043\varepsilon_{t-1}$$

Variance Equation

$$log\sigma_t^2 = -1.117555 + 0.464428\left|\frac{\varepsilon_{t-1}}{\sqrt{\sigma_{t-1}}}\right| + 0.061227\frac{\varepsilon_{t-1}}{\sqrt{\sigma_{t-1}}} + 0.387869 log\sigma_{t-1}^2 + 0.185518 log\sigma_{t-2}^2 + 0.337846 log\sigma_{t-3}^2$$

4.8.6. Forecasting

Figure 4.28 show the forecasting results of Manufacturing sector indices for ninety days of 2019.



Forecast: DLOGMFGF	
Actual: DLOGMFG	
Forecast sample: 8101 8190	
Included observations: 90	
Root Mean Squared Error	0.005872
Mean Absolute Error	0.004538
Mean Abs. Percent Error	103.4897
Theil Inequality Coefficient	0.883521
Bias Proportion	0.040629
Variance Proportion	0.785545
Covariance Proportion	0.173825

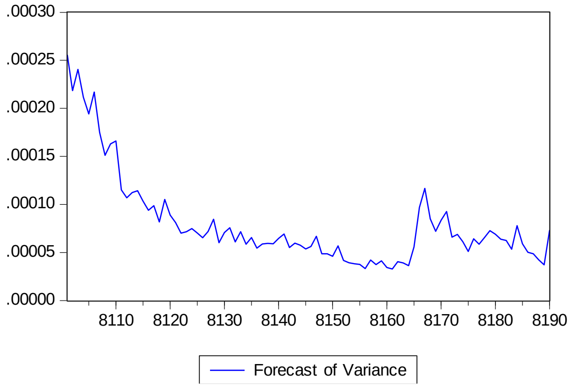


Figure 4.28: Output of forecasting the Manufacturing sector index for ninety days in 2019

4.9. Oil Palms Sector

4.9.1. Preliminary Analysis

It is necessary to test the stationary conditions after collecting the data. By just looking at the time series plot it can be obtained an idea about the data series.

The Figure 4.29 shows the time series plot for daily index in Oil Palms sector which consists of 8190 observations.

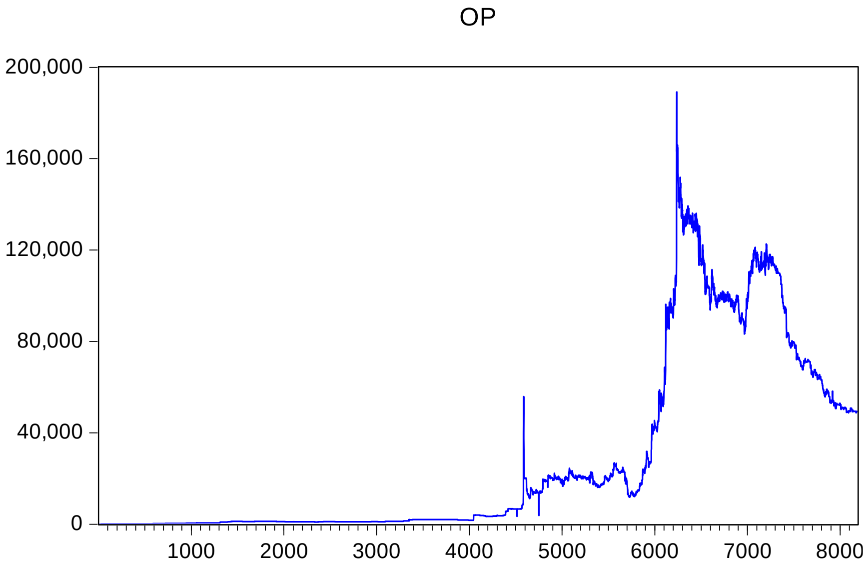


Figure 4.29: Time series plot for daily index in Oil Palms sector from 02nd Jan. 1985 to 29th Mar. 2019. The X axis denotes the year and Y axis denotes the Index.

4.9.2. Unit root test: Augmented dickey-fuller (ADF) test

Table 4.78 shows the test results of Unit Root Test, Augmented Dickey-Fuller (ADF) test with intercept to prove that data series is not stationary in statistically.

Table 4.78: ADF test for raw data series of Oil Palms sector

Null Hypothesis: OP has a unit root
Exogenous: Constant
Lag Length: 7 (Automatic - based on SIC, maxlag=36)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.090061	0.7220
Test critical values:	1% level	-3.430973	
	5% level	-2.861700	
	10% level	-2.566897	

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

According to the result of ADF it can be accepted null hypothesis and reject the alternative hypothesis said that the data series has unit root means that the time series data are not stationary. Thus it is necessary to make them stationary. To this purpose it can be checked the behavior of first difference of log data series.

To confirm the stationarity of the first difference of log data series Unit Root test, Augmented Dickey Fuller (ADF) tests have been carried out and the results for 5% of Significant level are shown the in the Table 4.79.

Table 4.79: ADF test values for the first difference of log data series of Oil Palms sector

Null Hypothesis: DLOGOP has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=36)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-105.7354	0.0001
Test critical values:	1% level	-3.430972	
	5% level	-2.861699	
	10% level	-2.566897	

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

Though the result of ADF shows the probability as significant to reject the null hypothesis of the series has a unit root and accept the alternative hypothesis of the data series has not unit root. That means data series is stationary with mean but not with variance. It is confirmed by the autocorrelation (ACF) and partial autocorrelation (PACF) graphs.

Autocorrelation	Partial Correlation		AC	PAC	Q-Sta...	Prob
		1	-0.15...	-0.15...	195.80	0.000
		2	0.039	0.015	208.26	0.000
		3	0.001	0.010	208.28	0.000
		4	-0.03...	-0.03...	218.23	0.000
		5	-0.03...	-0.04...	227.90	0.000
		6	-0.02...	-0.03...	232.33	0.000
		7	-0.02...	-0.03...	236.95	0.000
		8	-0.00...	-0.01...	237.17	0.000
		9	0.007	0.003	237.63	0.000
		1...	-0.00...	-0.00...	237.99	0.000
		1...	0.019	0.012	240.86	0.000
		1...	0.019	0.021	243.76	0.000
		1...	0.007	0.011	244.20	0.000
		1...	0.005	0.006	244.43	0.000
		1...	0.010	0.012	245.28	0.000
		1...	0.004	0.010	245.40	0.000
		1...	0.000	0.005	245.40	0.000
		1...	0.007	0.011	245.76	0.000
		1...	0.001	0.007	245.76	0.000
		2...	0.009	0.012	246.39	0.000
		2...	-0.02...	-0.01...	249.53	0.000
		2...	-0.00...	-0.00...	249.53	0.000
		2...	-0.00...	-0.00...	249.58	0.000
		2...	-0.00...	-0.00...	249.62	0.000
		2...	0.004	0.003	249.74	0.000
		2...	0.003	0.003	249.83	0.000
		2...	0.011	0.010	250.76	0.000
		2...	0.003	0.004	250.84	0.000
		2...	-0.00...	-0.00...	251.13	0.000
		3...	0.024	0.023	256.05	0.000
		3...	-0.01...	-0.00...	256.94	0.000
		3...	-0.01...	-0.01...	259.28	0.000
		3...	-0.00...	-0.01...	259.57	0.000
		3...	-0.00...	-0.00...	260.06	0.000
		3...	-0.00...	-0.00...	260.08	0.000
		3...	-0.00...	-0.00...	260.09	0.000

Figure 4.30: The Correlogram of first difference series of Log index of Oil Palms sector

The Correlogram of first difference series of Log index of Oil Palms sector confirm that there is serial correlation with lag values.

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4.9.3. Model identification and coefficient estimation

4.9.3.1. ARCH-LM test

To test the applicability of ARCH family model it can be checked the ARCH -LM test. The test results are shown in Table 4.80.

Table 4.80: ARCH-LM test results of Oil Palms sector

Heteroskedasticity Test: ARCH

F-statistic	2211.908	Prob. F(1,8186)	0.0000
Obs*R-squared	1741.803	Prob. Chi-Square(1)	0.0000

According to the Table 4.80, it can be reject the null hypothesis since the probability value is significant and can accept the alternative hypothesis. This means model has ARCH effect and therefore, ARCH family models can be applied.

4.9.3.2. ARCH

Table 4.81 Output of ARCH (2) model of Oil Palms Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-0.002141	4.75E-05	-45.10170	0.0000
AR(1)	-0.972671	0.000240	-4058.339	0.0000
MA(1)	0.994635	3.27E-05	30423.53	0.0000
		Variance Equation		
C	0.000232	6.00E-07	386.3446	0.0000
RESID(-1)^2	3.249541	0.070459	46.11933	0.0000
RESID(-2)^2	0.186205	0.009063	20.54494	0.0000

According to the Table 4.81, ARCH (2) model both mean equation and the variance equation coefficients are statistically significant under 1% significant level. The residual analysis of this model is not satisfied. Therefore, this model was not considered for model comparison.

4.9.3.3. GARCH

Table 4.82 Output of GARCH (1,1) model of Oil Palms Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-0.004812	7.99E-05	-60.23240	0.0000
AR(1)	0.077992	0.004357	17.89961	0.0000
		Variance Equation		
C	0.000167	4.58E-06	36.52607	0.0000
RESID(-1)^2	9.485261	0.096123	98.67800	0.0000
GARCH(-1)	0.007077	0.000637	11.10450	0.0000

Table 4.82 shows that GARCH (1,1) model all the coefficients of both mean equation and variance equation are statistically significant under 1% significant

level. The residual analysis of this model is not satisfied. Therefore, this model was not considered for model comparison.

4.9.3.4. TARCH

Table 4.83 Output of TARCH (2,1) model of Oil Palms Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-0.000502	0.000717	-0.699996	0.4839
AR(1)	-0.069152	0.031298	-2.209483	0.0271
Variance Equation				
C	0.001518	5.35E-06	283.6985	0.0000
RESID(-1)^2	0.206169	0.005777	35.68948	0.0000
RESID(-1)^2*(RESID(-1)<...	-0.180995	0.007039	-25.71159	0.0000
RESID(-2)^2	0.060079	0.003761	15.97521	0.0000
GARCH(-1)	-0.023401	0.002469	-9.476065	0.0000

According to the Table 4.83, TARCH (2,1) model all the coefficients of both mean equation and the variance equation are statistically significant except C of mean equation. The residual analysis of this model is not satisfied. Therefore, this model was not considered for model comparison.

4.9.3.5. EGARCH

Table 4.84 Output of EGARCH (1,1) model of Oil Palms Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-1.75E-05	0.000162	-0.107841	0.9141
AR(1)	-0.101257	0.002995	-33.80623	0.0000
Variance Equation				
C(3)	-7.596112	0.027129	-279.9987	0.0000
C(4)	0.030881	0.000379	81.38462	0.0000
C(5)	0.035071	0.000387	90.71178	0.0000
C(6)	0.139917	0.003137	44.60024	0.0000
GED PARAMETER	1.428124	0.001777	803.5828	0.0000

Table 4.84 shows that the EGARCH (1,1) model both mean equation and variance equation coefficients are statistically significant under 1% significant level except C. The residual analysis of this model is not satisfied. Therefore, this model was not considered for model comparison.

4.9.3.6. IGARCH

Table 4.85 Output of IGARCH (2,1) model of Oil Palms Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-3.37E-07	1.31E-08	-25.69325	0.0000
AR(1)	-0.818948	0.051538	-15.89024	0.0000
MA(1)	0.820309	0.051542	15.91546	0.0000
Variance Equation				
RESID(-1)^2	1.71E-08	3.37E-09	5.074267	0.0000
RESID(-2)^2	0.143213	0.000496	288.6865	0.0000
GARCH(-1)	0.856787	0.000496	1727.102	0.0000
T-DIST. DOF	6.184996	0.028173	219.5364	0.0000

According to the Table 4.85, IGARCH (2,1) model both mean equation and variance equation all the coefficients are statistically significant under 1% significant level.

4.9.3.7. PARCH

Table 4.86 Output of PARCH (2,1) model of Oil Palms Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	1.82E-08	5.75E-09	3.159523	0.0016
AR(1)	-0.656569	0.197295	-3.327865	0.0009
MA(1)	0.655339	0.199702	3.281585	0.0010
Variance Equation				
C(4)	9.43E-08	1.40E-08	6.735888	0.0000
C(5)	0.893621	0.167869	5.323310	0.0000
C(6)	0.088837	0.024473	3.630002	0.0003
C(7)	0.391437	0.081195	4.820974	0.0000
C(8)	0.641324	0.004331	148.0632	0.0000
T-DIST. DOF	2.034811	0.013318	152.7853	0.0000

Table 4.86 shows that PARCH (2,1) model both mean equation and variance equation coefficients are statistically significant under 1% significant level.

4.9.4. Model comparison by Akaike information criterion (AIC) and Schwarz criterion (SC) values

Table 4.87 AIC and SC values of ARCH models of Oil Palms Sector Indices

Model	AIC Value	SC value
IGARCH (2,1)	-9.964241	-9.959055
PARCH (2,1)	-16.27446	-16.26668

Table 4.87 shows that the lowest AIC & SC values are with the PARCH (2,1) model. Therefore, by considering the AIC and SC values prove that the appropriate model for the forecasting Oil Palms sector indices is the PARCH (2,1) model.

4.9.5. Residual analysis

After fitting tentative model to the data, we must examine its adequacy by analyzing its residuals.

4.9.5.1. Correlogram standard residuals squired

Autocorrelation	Partial Correlation		AC	PAC	Q-Sta...	Prob...
		1	-0.00...	-0.00...	0.0016	0.968
		2	-0.00...	-0.00...	0.0031	0.998
		3	-0.00...	-0.00...	0.0047	1.000
		4	-0.00...	-0.00...	0.0063	1.000
		5	-0.00...	-0.00...	0.0078	1.000
		6	-0.00...	-0.00...	0.0094	1.000
		7	-0.00...	-0.00...	0.0110	1.000
		8	-0.00...	-0.00...	0.0126	1.000
		9	-0.00...	-0.00...	0.0141	1.000
		1...	-0.00...	-0.00...	0.0157	1.000
		1...	-0.00...	-0.00...	0.0173	1.000
		1...	-0.00...	-0.00...	0.0189	1.000
		1...	-0.00...	-0.00...	0.0204	1.000
		1...	-0.00...	-0.00...	0.0220	1.000
		1...	-0.00...	-0.00...	0.0236	1.000
		1...	-0.00...	-0.00...	0.0252	1.000
		1...	-0.00...	-0.00...	0.0267	1.000
		1...	-0.00...	-0.00...	0.0283	1.000
		1...	-0.00...	-0.00...	0.0299	1.000
		2...	-0.00...	-0.00...	0.0315	1.000
		2...	-0.00...	-0.00...	0.0331	1.000
		2...	-0.00...	-0.00...	0.0346	1.000
		2...	-0.00...	-0.00...	0.0362	1.000
		2...	-0.00...	-0.00...	0.0378	1.000
		2...	-0.00...	-0.00...	0.0394	1.000
		2...	-0.00...	-0.00...	0.0410	1.000
		2...	-0.00...	-0.00...	0.0425	1.000
		2...	-0.00...	-0.00...	0.0441	1.000
		2...	-0.00...	-0.00...	0.0457	1.000
		3...	-0.00...	-0.00...	0.0473	1.000
		3...	-0.00...	-0.00...	0.0488	1.000
		3...	-0.00...	-0.00...	0.0504	1.000
		3...	-0.00...	-0.00...	0.0520	1.000
		3...	-0.00...	-0.00...	0.0536	1.000
		3...	-0.00...	-0.00...	0.0549	1.000
		3...	-0.00...	-0.00...	0.0563	1.000

Figure 4.31: The Correlogram of PARCH (2,1) model of Oil Palms Sector Indices

The ACF and PACF graphs in Figure 4.31 do not presence any structure and all the values lie between 95% of confidence interval. And their all probability values are greater than 5% of significance level. The ACF and PACF graphs are recommended that there is no serial correlation between each residual value.

4.9.5.2. ARCH- LM test

Table 4.88a Output of ARCH-LM test of PARCH (2,1) model of Oil Palms Sector Indices

Heteroskedasticity Test: ARCH

F-statistic	0.001567	Prob. F(1,8095)	0.9684
Obs*R-squared	0.001567	Prob. Chi-Square(1)	0.9684

Table shows that there is no ARCH effect of the residuals since the probability vale is higher than 5%. The null hypothesis of no ARCH effect with residuals have to accept.

Table 4.88b Output of Breusch – Pagan - Godfrey test of PARCH (2,1) model of Oil Palms Sector Indices

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	209.3727	Prob. F(1,8096)	0.0000
Obs*R-squared	204.1450	Prob. Chi-Square(1)	0.0000
Scaled explained SS	2.07E+29	Prob. Chi-Square(1)	0.0000

Therefore, appropriate fitted model for forecasting the Oil Palms sector indices is PARCH (2,1) model.

Mean Equation

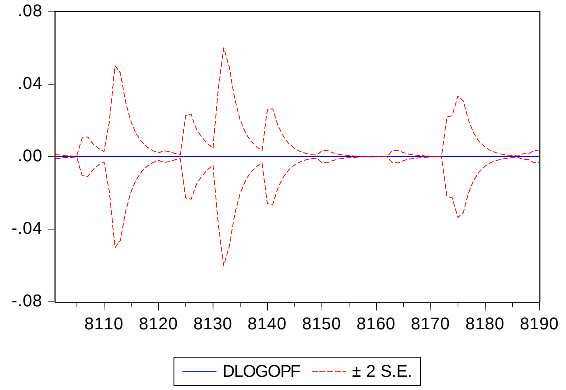
$$dlogop = 0.0000000182 - 0.656569dlogop_{t-1} + 0.655339\varepsilon_{t-1}$$

Variance Equation

$$\sqrt{\sigma_t} = 0.000000094 + 0.893621(|\varepsilon_{t-1}| - 0.088837\varepsilon_{t-1}) + 0.391437|\varepsilon_{t-2}| + 0.641324\sqrt{\sigma_{t-1}}$$

4.9.6. Forecasting

Figure 4.32 show the forecasting results of Oil Palms sector indices for ninety days of 2019.



Forecast: DLOGOPF	
Actual: DLOGOP	
Forecast sample: 8101 8190	
Included observations: 90	
Root Mean Squared Error	0.004103
Mean Absolute Error	0.001336
Mean Abs. Percent Error	17.79223
Theil Inequality Coefficient	0.998406
Bias Proportion	0.000196
Variance Proportion	0.996544
Covariance Proportion	0.003260

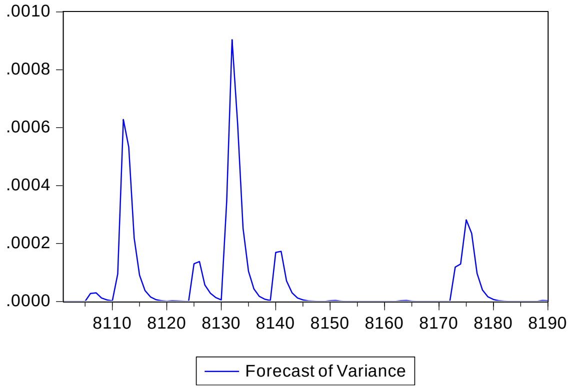


Figure 4.32. Output of forecasting the Oil Palms sector index for ninety days in 2019

4.10. Service Sector

4.10.1. Preliminary Analysis

It is necessary to test the stationary conditions after collecting the data. By just looking at the time series plot it can be obtained an idea about the data series.

The Figure 4.33 shows the time series plot for daily index in Service sector which consists of 8190 observations.

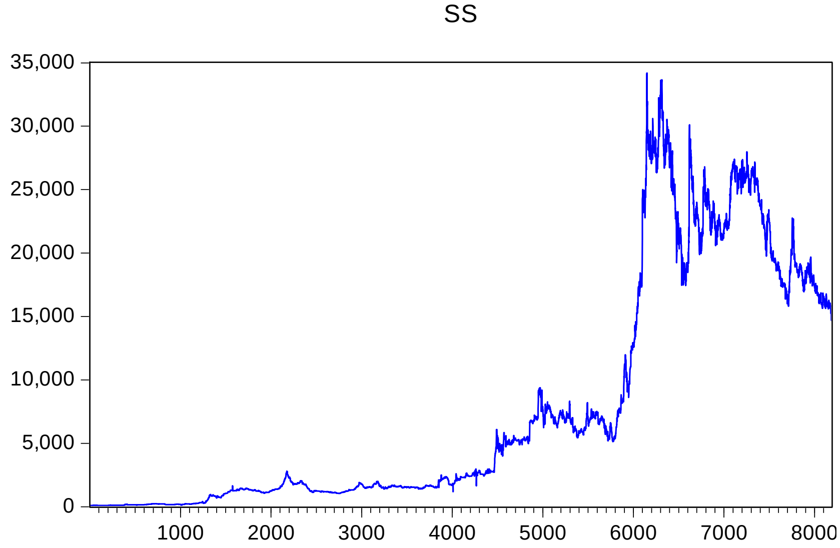


Figure 4.33: Time series plot for daily index in Service sector from 02nd Jan. 1985 to 29th Mar. 2019. The X axis denotes the year and Y axis denotes the Index.

4.10.2. Unit root test: Augmented dickey-fuller (ADF) test

Table 4.1 shows the test results of Unit Root Test, Augmented Dickey-Fuller (ADF) test with intercept to prove that data series is not stationary in statistically.

Table 4.33: ADF test for raw data series of Service sector

Null Hypothesis: SS has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=36)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.165297	0.6916
Test critical values:	1% level	-3.430972	
	5% level	-2.861699	
	10% level	-2.566897	

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

According to the result of ADF it can be accepted null hypothesis and reject the alternative hypothesis said that the data series has unit root means that the time series data are not stationary. Thus it is necessary to make them stationary. To this purpose it can be checked the behavior of first difference of log data series.

To confirm the stationarity of the first difference of log data series Unit Root test, Augmented Dickey Fuller (ADF) tests have been carried out and the results for 5% of Significant level are shown the in the Table 4.2.

Table 4.90: ADF test values for the first difference of log data series of Service sector

Null Hypothesis: DLOGSS has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=36)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-100.1268	0.0001
Test critical values:	1% level	-3.430972	
	5% level	-2.861699	
	10% level	-2.566897	

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

Though the result of ADF shows the probability as significant to reject the null hypothesis of the series has a unit root and accept the alternative hypothesis of the data series has not unit root. That means data series is stationary with mean but not with variance. It is confirmed by the autocorrelation (ACF) and partial autocorrelation (PACF) graphs.

Autocorrelation	Partial Correlation		AC	PAC	Q-Sta...	Prob
		1	-0.10...	-0.10...	83.571	0.000
		2	-0.01...	-0.03...	86.532	0.000
		3	-0.02...	-0.03...	92.895	0.000
		4	0.003	-0.00...	92.947	0.000
		5	0.008	0.006	93.426	0.000
		6	0.002	0.002	93.451	0.000
		7	-0.02...	-0.02...	99.715	0.000
		8	0.008	0.002	100.18	0.000
		9	0.032	0.032	108.45	0.000
		1...	-0.00...	0.004	108.45	0.000
		1...	0.015	0.017	110.22	0.000
		1...	0.022	0.028	114.17	0.000
		1...	-0.02...	-0.02...	121.11	0.000
		1...	0.017	0.013	123.44	0.000
		1...	-0.00...	-0.00...	123.66	0.000
		1...	0.023	0.023	127.97	0.000
		1...	0.014	0.020	129.69	0.000
		1...	-0.00...	-0.00...	130.09	0.000
		1...	-0.01...	-0.01...	131.39	0.000
		2...	0.021	0.016	134.88	0.000
		2...	-0.01...	-0.00...	135.77	0.000
		2...	0.011	0.010	136.72	0.000
		2...	0.010	0.012	137.49	0.000
		2...	-0.00...	0.002	137.50	0.000
		2...	-0.01...	-0.01...	138.93	0.000
		2...	-0.01...	-0.01...	140.48	0.000
		2...	-0.01...	-0.02...	143.36	0.000
		2...	0.013	0.005	144.82	0.000
		2...	-0.01...	-0.01...	145.59	0.000
		3...	0.019	0.018	148.53	0.000
		3...	0.020	0.023	151.85	0.000
		3...	0.032	0.035	160.37	0.000
		3...	0.001	0.010	160.37	0.000
		3...	-0.02...	-0.02...	164.28	0.000
		3...	-0.01...	-0.01...	165.90	0.000
		3...	-0.00...	-0.00...	166.13	0.000

Figure 4.34: The Correlogram of first difference series of Log index of Service sector

The Correlogram of first difference series of Log index of Service sector confirm that there is serial correlation with lag values.

4.10.3. Model identification and coefficient estimation

4.10.3.1. ARCH-LM test

To test the applicability of ARCH family model it can be checked the ARCH -LM test. The test results are shown in Table 4.3.

Table 4.91: ARCH-LM test results of Service sector

Heteroskedasticity Test: ARCH

F-statistic	909.9314	Prob. F(1,8186)	0.0000
Obs*R-squared	819.1045	Prob. Chi-Square(1)	0.0000

According to the Table 4.91, it can be reject the null hypothesis since the probability value is significant and can accept the alternative hypothesis. This means model has ARCH effect and therefore, ARCH family models can be applied.

4.10.3.2. ARCH

Table 4.92 Output of ARCH (5) model of Service Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	0.000566	9.39E-05	6.024885	0.0000
AR(1)	0.856006	0.012929	66.20998	0.0000
MA(1)	-0.919857	0.007764	-118.4750	0.0000
Variance Equation				
C	0.000279	8.38E-07	332.2298	0.0000
RESID(-1)^2	0.173658	0.006027	28.81482	0.0000
RESID(-2)^2	0.255086	0.005503	46.35206	0.0000
RESID(-3)^2	0.048314	0.003281	14.72374	0.0000
RESID(-4)^2	0.200109	0.007847	25.50168	0.0000
RESID(-5)^2	0.032736	0.003522	9.295544	0.0000

According to the Table 4.92, ARCH (5) model both mean equation and the variance equation coefficients are statistically significant under 1% significant level. The residual analysis of this model is not satisfied. Therefore, ARCH (5) model was not considered for model comparison.

4.10.3.3. GARCH

Table 4.93 Output of GARCH (5,1) model of Service Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	0.000373	0.000200	1.866398	0.0620
AR(1)	-0.758566	0.092091	-8.237172	0.0000
MA(1)	0.720546	0.097855	7.363413	0.0000
		Variance Equation		
C	1.56E-05	3.62E-07	43.15436	0.0000
RESID(-1)^2	0.116319	0.004699	24.75535	0.0000
RESID(-2)^2	0.102464	0.004846	21.14579	0.0000
RESID(-3)^2	-0.144980	0.005001	-28.99231	0.0000
RESID(-4)^2	0.097129	0.005909	16.43696	0.0000
RESID(-5)^2	-0.110564	0.004965	-22.26773	0.0000
GARCH(-1)	0.921750	0.001687	546.2782	0.0000

Table 4.93 shows that GARCH (5,1) model all the coefficients of both mean equation and variance equation are statistically significant under 1% significant level except C of mean equation. The residual analysis of this model is not satisfied. Therefore, GARCH (5,1) model was not considered for model comparison.

4.10.3.4. TARCH

Table 4.94 Output of TARCH (1,1) model of Service Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	0.000328	0.000212	1.551772	0.1207
AR(1)	-0.854693	0.079997	-10.68403	0.0000
MA(1)	0.832510	0.086506	9.623751	0.0000
		Variance Equation		
C	2.56E-05	2.60E-07	98.20483	0.0000
RESID(-1)^2	0.103639	0.001995	51.96211	0.0000
RESID(-1)^2*(RESID(-1)<...	-0.019906	0.002796	-7.119759	0.0000
GARCH(-1)	0.873387	0.001074	813.2780	0.0000

According to the Table 4.94, TARCH (1,1) model mean equation and variance equation all the coefficients are statistically significant under 1% significant level except C of mean equation. The residual analysis of this model is not satisfied. Therefore, TARCH (1,1) model was not considered for model comparison.

4.10.3.5. EGARCH

Table 4.95 Output of EGARCH (3,1) model of Service Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-5.12E-06	0.000138	-0.037247	0.9703
AR(1)	-0.906099	0.290917	-3.114624	0.0018
MA(1)	0.906016	0.291078	3.112619	0.0019
		Variance Equation		
C(4)	-7.506222	0.286774	-26.17473	0.0000
C(5)	0.088822	0.006578	13.50274	0.0000
C(6)	0.120303	0.006963	17.27738	0.0000
C(7)	0.069700	0.006913	10.08264	0.0000
C(8)	0.111957	0.006472	17.29915	0.0000
C(9)	0.143741	0.032974	4.359281	0.0000
GED PARAMETER	1.115308	0.004944	225.5765	0.0000

Table 4.95 shows that the EGARCH (3,1) model all the coefficients of mean equation and variance equation are statistically significant under 1% significant level except C. The residual analysis of this model is not satisfied. Therefore, this model was not considered for model comparison.

4.10.3.6. IGARCH

Table 4.96 Output of IGARCH (2,2) model of Service Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-4.48E-06	4.63E-05	-0.096767	0.9229
AR(1)	-0.013194	0.007584	-1.739759	0.0819
		Variance Equation		
RESID(-1)^2	0.197551	0.005319	37.14077	0.0000
RESID(-2)^2	0.198059	0.003952	50.10999	0.0000
GARCH(-1)	-0.059362	0.005525	-10.74420	0.0000
GARCH(-2)	0.663752	0.007429	89.34576	0.0000
T-DIST. DOF	2.342669	0.009618	243.5648	0.0000

According to the Table 4.96, IGARCH (2,2) model mean equation is not statistically significant while variance equation all the coefficients are statistically significant under 1% significant level.

4.10.3.7. PARCH

Table 4.97 Output of PARCH (2,1) model of Service Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	5.71E-08	5.64E-05	0.001013	0.9992
AR(1)	0.794241	0.037463	21.20047	0.0000
MA(1)	-0.794239	0.037253	-21.31993	0.0000
		Variance Equation		
C(4)	7.93E-05	2.12E-05	3.750836	0.0002
C(5)	0.274587	0.040404	6.795992	0.0000
C(6)	-0.089843	0.026396	-3.403631	0.0007
C(7)	0.039670	0.020455	1.939411	0.0525
C(8)	0.874119	0.003467	252.1441	0.0000
T-DIST. DOF	2.124786	0.036175	58.73563	0.0000

Table 4.97 shows that PARCH (2,1) model all the coefficients of mean equation and variance equation are statistically significant under 1% significant level except C & C(7)

4.10.4. Model comparison by Akaike information criterion (AIC) and Schwarz criterion (SC) values

Table 4.98 AIC and SC values of ARCH models of Service Sector Indices

Model	AIC Value	SC value
IGARCH (2,2)	-6.113642	-6.108456
PARCH (2,1)	-6.271048	-6.263269

Table 4.98 shows that the lowest AIC & SC values are with the PARCH (2,1) model. Therefore, by considering the AIC and SC values prove that the appropriate model for the forecasting Service Sector Indices is the PARCH (2,1) model.

4.10.5. Residual analysis

After fitting tentative model to the data, we must examine its adequacy by analyzing its residuals.

4.10.5.1 Correlogram standard residuals squired

Autocorrelation	Partial Correlation		AC	PAC	Q-Sta...	Prob...
		1	-0.00...	-0.00...	0.0013	0.971
		2	-0.00...	-0.00...	0.0024	0.999
		3	-0.00...	-0.00...	0.0038	1.000
		4	-0.00...	-0.00...	0.0052	1.000
		5	-0.00...	-0.00...	0.0066	1.000
		6	-0.00...	-0.00...	0.0074	1.000
		7	-0.00...	-0.00...	0.0086	1.000
		8	-0.00...	-0.00...	0.0096	1.000
		9	-0.00...	-0.00...	0.0109	1.000
		1...	-0.00...	-0.00...	0.0122	1.000
		1...	-0.00...	-0.00...	0.0129	1.000
		1...	0.002	0.002	0.0330	1.000
		1...	0.011	0.011	0.9635	1.000
		1...	-0.00...	-0.00...	0.9648	1.000
		1...	-0.00...	-0.00...	0.9659	1.000
		1...	-0.00...	-0.00...	0.9673	1.000
		1...	-0.00...	-0.00...	0.9684	1.000
		1...	-0.00...	-0.00...	0.9697	1.000
		1...	-0.00...	-0.00...	0.9706	1.000
		2...	-0.00...	-0.00...	0.9709	1.000
		2...	-0.00...	-0.00...	0.9723	1.000
		2...	-0.00...	-0.00...	0.9727	1.000
		2...	-0.00...	-0.00...	0.9734	1.000
		2...	-0.00...	-0.00...	0.9744	1.000
		2...	-0.00...	-0.00...	0.9747	1.000
		2...	-0.00...	-0.00...	0.9758	1.000
		2...	0.000	0.000	0.9776	1.000
		2...	-0.00...	-0.00...	0.9787	1.000
		2...	-0.00...	-0.00...	0.9799	1.000
		3...	-0.00...	-0.00...	0.9813	1.000
		3...	0.000	0.000	0.9814	1.000
		3...	-0.00...	-0.00...	0.9821	1.000
		3...	-0.00...	-0.00...	0.9834	1.000
		3...	-0.00...	-0.00...	0.9845	1.000
		3...	0.000	0.000	0.9845	1.000
		3...	-0.00...	-0.00...	0.9858	1.000

Figure 4.35: The Correlogram of PARCH (2,1) model of Service Sector Indices

The ACF and PACF graphs in Figure 4.35 do not presence any structure and all the values lie between 95% of confidence interval. And their all probability values are greater than 5% of significance level. The ACF and PACF graphs are recommended that there is no serial correlation between each residual value.

4.10.5.2. ARCH- LM test

Table 4.99a Output of ARCH-LM test of PARCH (2,1) model of Service Sector Indices

Heteroskedasticity Test: ARCH

F-statistic	0.001341	Prob. F(1,8095)	0.9708
Obs*R-squared	0.001342	Prob. Chi-Square(1)	0.9708

Table shows that there is no ARCH effect of the residuals since the probability vale is higher than 5%. The null hypothesis of no ARCH effect with residuals have to accept.

Table 4.99b Output of Breusch – Pagan - Godfrey test of PARCH (2,1) model of Service Sector Indices

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	209.1880	Prob. F(1,8096)	0.0000
Obs*R-squared	203.9694	Prob. Chi-Square(1)	0.0000
Scaled explained SS	1.93E+13	Prob. Chi-Square(1)	0.0000

Therefore, appropriate fitted model for forecasting the Service sector indices is PARCH (2,1) model.

Mean Equation

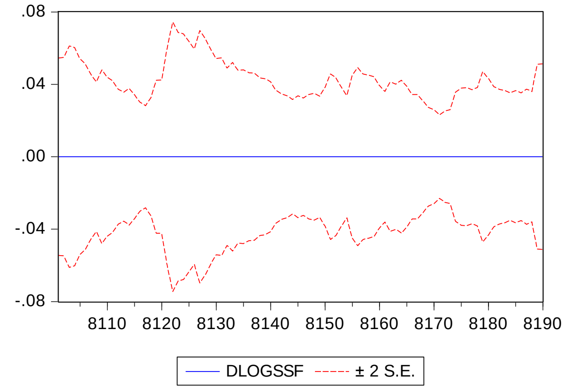
$$dlogss = 0.794241 dlogss_{t-1} - 0.794239 \varepsilon_{t-1}$$

Variance Equation

$$\sqrt{\sigma_t} = 0.0000793 + 0.274587(|\varepsilon_{t-1}| + 0.089843\varepsilon_{t-1}) + 0.874119\sqrt{\sigma_{t-1}}$$

4.10.6. Forecasting

Figure 4.36 show the forecasting results of Service sector indices for ninety days of 2019.



Forecast: DLOGSSF	
Actual: DLOGSS	
Forecast sample: 8101 8190	
Included observations: 90	
Root Mean Squared Error	0.011891
Mean Absolute Error	0.008309
Mean Abs. Percent Error	86.66680
Theil Inequality Coefficient	0.999996
Bias Proportion	0.005743
Variance Proportion	0.994249
Covariance Proportion	0.000008

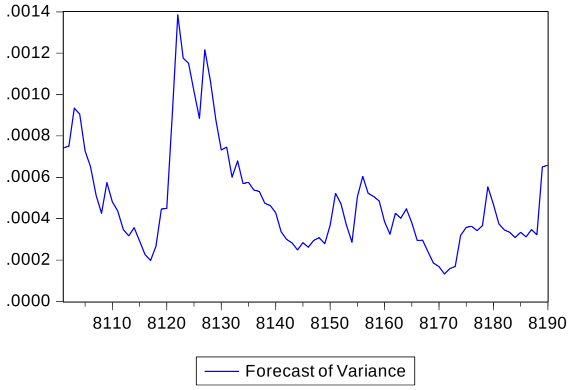


Figure 4.36. Output of forecasting the Service sector index for ninety days in 2019

4.11. Stores & Supplies Sector

4.11.1. Preliminary Analysis

It is necessary to test the stationary conditions after collecting the data. By just looking at the time series plot it can be obtained an idea about the data series.

The Figure 4.37 shows the time series plot for daily index in Stores & Supplies Sector which consists of 8190 observations.

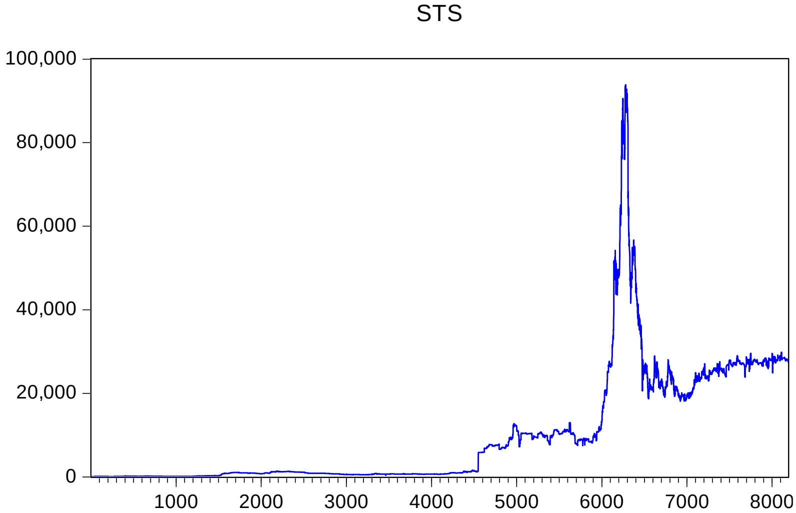


Figure 4.37: Time series plot for daily index in Stores & Supplies Sector from 02nd Jan. 1985 to 29th Mar. 2019. The X axis denotes the year and Y axis denotes the Index.

4.11.2. Unit root test: Augmented dickey-fuller (ADF) test

Table 4.100 shows the test results of Unit Root Test, Augmented Dickey-Fuller (ADF) test with intercept to prove that data series is not stationary in statistically.

Table 4.100: ADF test for raw data series of Stores & Supplies Sector

Null Hypothesis: STS has a unit root
Exogenous: Constant
Lag Length: 36 (Automatic - based on SIC, maxlag=36)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.848048	0.3574
Test critical values:	1% level	-3.430976	
	5% level	-2.861701	
	10% level	-2.566897	

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

According to the result of ADF it can be accepted null hypothesis and reject the alternative hypothesis said that the data series has unit root means that the time series data are not stationary. Thus it is necessary to make them stationary. To this purpose it can be checked the behavior of first difference of log data series.

To confirm the stationarity of the first difference of log data series Unit Root test, Augmented Dickey Fuller (ADF) tests have been carried out and the results for 5% of Significant level are shown the in the Table 4.2.

Table 4.101: ADF test values for the first difference of log data series of Stores & Supplies Sector

Null Hypothesis: DLOGSTS has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=36)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-96.84962	0.0001
Test critical values:	1% level	-3.430972	
	5% level	-2.861699	
	10% level	-2.566897	

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

Though the result of ADF shows the probability as significant to reject the null hypothesis of the series has a unit root and accept the alternative hypothesis of the data series has not unit root. That means data series is stationary with mean but not with variance. It is confirmed by the autocorrelation (ACF) and partial autocorrelation (PACF) graphs.

Autocorrelation	Partial Correlation		AC	PAC	Q-Sta...	Prob
		1	-0.06...	-0.06...	37.873	0.000
		2	0.009	0.004	38.475	0.000
		3	0.012	0.013	39.592	0.000
		4	-0.00...	-0.00...	40.184	0.000
		5	0.018	0.017	42.828	0.000
		6	-0.00...	-0.00...	43.321	0.000
		7	0.005	0.004	43.491	0.000
		8	0.019	0.019	46.498	0.000
		9	-0.00...	0.001	46.517	0.000
		1...	0.026	0.025	51.861	0.000
		1...	0.006	0.009	52.118	0.000
		1...	0.002	0.003	52.168	0.000
		1...	-0.00...	-0.01...	52.892	0.000
		1...	0.018	0.017	55.499	0.000
		1...	0.010	0.011	56.292	0.000
		1...	0.010	0.011	57.094	0.000
		1...	0.009	0.009	57.744	0.000
		1...	-0.01...	-0.01...	58.622	0.000
		1...	0.002	-0.00...	58.644	0.000
		2...	0.003	0.003	58.728	0.000
		2...	0.003	0.003	58.793	0.000
		2...	0.012	0.012	60.042	0.000
		2...	-0.01...	-0.01...	62.153	0.000
		2...	0.017	0.013	64.459	0.000
		2...	-0.01...	-0.01...	66.044	0.000
		2...	-0.00...	-0.00...	66.050	0.000
		2...	-0.00...	-0.00...	66.077	0.000
		2...	0.013	0.014	67.400	0.000
		2...	0.000	0.001	67.400	0.000
		3...	0.001	0.001	67.415	0.000
		3...	0.006	0.005	67.694	0.000
		3...	0.022	0.022	71.593	0.000
		3...	0.002	0.005	71.614	0.000
		3...	-0.01...	-0.01...	73.588	0.000
		3...	-0.00...	-0.00...	73.632	0.000
		3...	-0.02...	-0.02...	77.219	0.000

Figure 4.38: The Correlogram of first difference series of Log index of Stores & Supplies Sector

The Correlogram of first difference series of Log index of Stores & Supplies Sector confirm that there is serial correlation with lag values.

4.11.3. Model identification and coefficient estimation

4.11.3.1. ARCH-LM test

To test the applicability of ARCH family model it can be checked the ARCH -LM test. The test results are shown in Table 4.102.

Table 4.102: ARCH-LM test results of Stores & Supplies Sector

Heteroskedasticity Test: ARCH

F-statistic	4.205932	Prob. F(1,8186)	0.0403
Obs*R-squared	4.204800	Prob. Chi-Square(1)	0.0403

According to the Table 4.102, it can be reject the null hypothesis since the probability value is significant and can accept the alternative hypothesis. This means model has ARCH effect and therefore, ARCH family models can be applied.

4.11.3.2. ARCH

Table 4.103 Output of ARCH (1) model of Stores & Supplies Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	0.000640	0.000311	2.056961	0.0397
AR(1)	-0.033307	0.017529	-1.900076	0.0574
Variance Equation				
C	0.000609	4.16E-07	1462.884	0.0000
RESID(-1)^2	0.058953	0.005474	10.76868	0.0000

According to the Table 4.103, ARCH (1) model mean equation AR (1) is not statistically significant while all other coefficients of both mean equation and variance equation are statistically significant.

4.11.3.3. GARCH

Table 4.104 Output of GARCH (1,1) model of Stores & Supplies Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	0.000625	0.000587	1.064941	0.2869
AR(1)	-0.029730	0.027975	-1.062738	0.2879
Variance Equation				
C	0.001185	4.52E-06	262.0890	0.0000
RESID(-1)^2	0.028187	0.002939	9.591833	0.0000
GARCH(-1)	-0.019870	0.003673	-5.409166	0.0000

Table 4.104 shows that GARCH (1,1) model mean equation is not statistically significant while all the coefficients of variance equation are statistically significant.

4.11.3.4. TARCH

Table 4.105 Output of TARCH (1,2) model of Stores & Supplies Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	0.003371	0.000400	8.435620	0.0000
AR(1)	-0.007230	2.082763	-0.003471	0.9972
MA(1)	0.015616	2.085912	0.007487	0.9940
Variance Equation				
C	3.47E-05	2.37E-06	14.63138	0.0000
RESID(-1)^2	-0.000437	6.85E-05	-6.377253	0.0000
RESID(-1)^2*(RESID(-1)<...	0.100555	0.008414	11.95085	0.0000
GARCH(-1)	0.272661	0.079062	3.448713	0.0006
GARCH(-2)	0.658900	0.075319	8.748174	0.0000

According to the Table 4.105, TARCH (1,2) model both mean equation and the variance equation all the coefficients are statistically significant under 1% significant level except AR (1) and MA (1) of mean equation.

4.11.3.5. EGARCH

Table 4.106 Output of EGARCH (1,3) model of Stores & Supplies Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-3.65E-06	1.20E-06	-3.047986	0.0023
AR(1)	0.011000	0.001651	6.662687	0.0000
Variance Equation				
C(3)	-0.960175	0.007864	-122.0899	0.0000
C(4)	0.064885	0.000626	103.6119	0.0000
C(5)	0.012129	0.000456	26.59824	0.0000
C(6)	1.626309	0.000665	2445.882	0.0000
C(7)	-1.582526	0.000767	-2062.606	0.0000
C(8)	0.870462	0.000800	1088.650	0.0000
GED PARAMETER	0.670984	0.001484	452.2630	0.0000

Table 4.106 shows that the EGARCH (1,3) model both mean equation and variance equation all the coefficients are statistically significant under 1% significant level.

4.11.3.6. IGARCH

Table 4.107 Output of IGARCH (2,1) model of Stores & Supplies Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	-2.60E-05	6.89E-05	-0.377581	0.7057
AR(1)	-0.891125	0.014516	-61.39036	0.0000
MA(1)	0.891868	0.014194	62.83371	0.0000
		Variance Equation		
RESID(-1)^2	-4.88E-05	1.51E-06	-32.28583	0.0000
RESID(-2)^2	0.087772	0.000901	97.38455	0.0000
GARCH(-1)	0.912277	0.000901	1012.023	0.0000
T-DIST. DOF	9.064194	0.089520	101.2528	0.0000

According to the Table 4.107, IGARCH (2,1) model both mean equation and variance equation all the coefficients are statistically significant under 1% significant level except C. This model is not satisfied with residual analysis. Therefore, it is not considered for model comparison.

4.11.3.7. PARCH

Table 4.108 Output of PARCH (2,1) model of Stores & Supplies Sector Indices

Variable	Coefficien...	Std. Error	z-Statistic	Prob.
C	4.71E-10	2.71E-07	0.001737	0.9986
AR(1)	-0.933461	0.001770	-527.3678	0.0000
MA(1)	0.933461	0.001777	525.4020	0.0000
		Variance Equation		
C(4)	1.05E-06	2.48E-07	4.230919	0.0000
C(5)	0.935005	0.219012	4.269186	0.0000
C(6)	-0.410339	0.015876	-25.84644	0.0000
C(7)	0.250160	0.061640	4.058428	0.0000
C(8)	0.611487	0.002293	266.6212	0.0000
T-DIST. DOF	2.022073	0.010523	192.1485	0.0000

Table 4.108 shows that PARCH (2,1) model both mean equation and variance equation are statistically significant under 1% significant level except C.

4.11.4. Model comparison by Akaike information criterion (AIC) and Schwarz criterion (SC) values

Table 4.109 AIC and SC values of ARCH models of Stores & Supplies Sector

Model	AIC Value	SC value
ARCH (1)	-4.413492	-4.410035
GARCH (1,1)	-4.308365	-4.304044
TARCH (1,2)	-4.514740	-4.507825
EGARCH (1,3)	-7.273141	-7.265362
PARCH (2,1)	-8.446055	-8.438276

Table 4.109 shows that the lowest AIC & SC values are with the PARCH (2,1) model. Therefore, by considering the AIC and SC values prove that the appropriate model for the forecasting Stores & Supplies sector indices is the PARCH (2,1) model.

4.11.5. Residual analysis

After fitting tentative model to the data, we must examine its adequacy by analyzing its residuals.

4.11.5.1 Correlogram standard residuals squired

Autocorrelation	Partial Correlation		AC	PAC	Q-Sta...	Prob...
		1	-0.00...	-0.00...	0.0027	0.959
		2	-0.00...	-0.00...	0.0054	0.997
		3	-0.00...	-0.00...	0.0080	1.000
		4	-0.00...	-0.00...	0.0107	1.000
		5	-0.00...	-0.00...	0.0134	1.000
		6	-0.00...	-0.00...	0.0161	1.000
		7	-0.00...	-0.00...	0.0188	1.000
		8	-0.00...	-0.00...	0.0215	1.000
		9	-0.00...	-0.00...	0.0241	1.000
		1...	-0.00...	-0.00...	0.0268	1.000
		1...	-0.00...	-0.00...	0.0295	1.000
		1...	-0.00...	-0.00...	0.0322	1.000
		1...	-0.00...	-0.00...	0.0349	1.000
		1...	-0.00...	-0.00...	0.0373	1.000
		1...	-0.00...	-0.00...	0.0396	1.000
		1...	-0.00...	-0.00...	0.0423	1.000
		1...	0.004	0.004	0.1505	1.000
		1...	-0.00...	-0.00...	0.1532	1.000
		1...	-0.00...	-0.00...	0.1559	1.000
		2...	-0.00...	-0.00...	0.1586	1.000
		2...	-0.00...	-0.00...	0.1613	1.000
		2...	-0.00...	-0.00...	0.1639	1.000
		2...	-0.00...	-0.00...	0.1666	1.000
		2...	-0.00...	-0.00...	0.1690	1.000
		2...	-0.00...	-0.00...	0.1690	1.000
		2...	-0.00...	-0.00...	0.1715	1.000
		2...	-0.00...	-0.00...	0.1742	1.000
		2...	-0.00...	-0.00...	0.1742	1.000
		2...	-0.00...	-0.00...	0.1769	1.000
		3...	-0.00...	-0.00...	0.1796	1.000
		3...	-0.00...	-0.00...	0.1823	1.000
		3...	-0.00...	-0.00...	0.1850	1.000
		3...	-0.00...	-0.00...	0.1876	1.000
		3...	-0.00...	-0.00...	0.1903	1.000
		3...	-0.00...	-0.00...	0.1928	1.000
		3...	-0.00...	-0.00...	0.1956	1.000

Figure 4.39: The Correlogram of PARCH (2,1) model of Stores & Supplies Sector

The ACF and PACF graphs in Figure 4.39 do not presence any structure and all the values lie between 95% of confidence interval. And their all probability values are greater than 5% of significance level. The ACF and PACF graphs are recommended that there is no serial correlation between each residual value.

4.11.5.2. ARCH- LM test

Table 4.110a Output of ARCH-LM test of PARCH (2,1) model of Stores & Supplies Sector

Heteroskedasticity Test: ARCH

F-statistic	0.002679	Prob. F(1,8095)	0.9587
Obs*R-squared	0.002679	Prob. Chi-Square(1)	0.9587

Table shows that there is no ARCH effect of the residuals since the probability vale is higher than 5%. The null hypothesis of no ARCH effect with residuals have to accept.

Table 4.110b Output of Breusch – Pagan - Godfrey test of PARCH (2,1) model of Stores & Supplies Sector

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	11.31235	Prob. F(1,8096)	0.0008
Obs*R-squared	11.29936	Prob. Chi-Square(1)	0.0008
Scaled explained SS	2.87E+20	Prob. Chi-Square(1)	0.0000

Therefore, appropriate model for forecasting the Stores & Supplies sector indices is PARCH (2,1) model.

Mean Equation

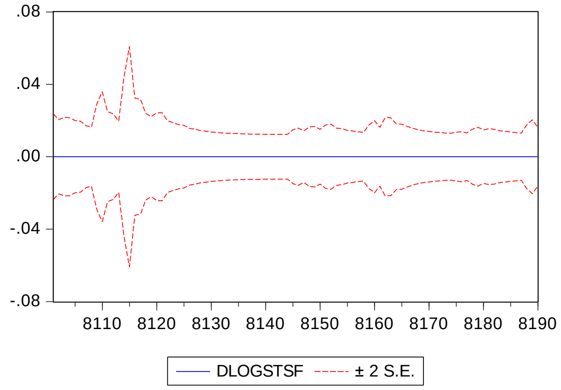
$$dlogsts = -0.933461dlogsts_{t-1} + 0.933461\varepsilon_{t-1}$$

Variance Equation

$$\sqrt{\sigma_t} = 0.00000105 + \ 0.935005(|\varepsilon_{t-1}| + 0.410339\varepsilon_{t-1}) + 0.250160|\varepsilon_{t-2}| + 0.611487\sqrt{\sigma_{t-1}}$$

Forecasting

Figure 4.40 show the forecasting results of Stores & Supplies sector indices for ninety days of 2019.



Forecast: DLOGSTSF	
Actual: DLOGSTS	
Forecast sample: 8101 8190	
Included observations: 90	
Root Mean Squared Error	0.008664
Mean Absolute Error	0.002676
Mean Abs. Percent Error	21.11104
Theil Inequality Coefficient	0.999988
Bias Proportion	0.001130
Variance Proportion	NA
Covariance Proportion	NA

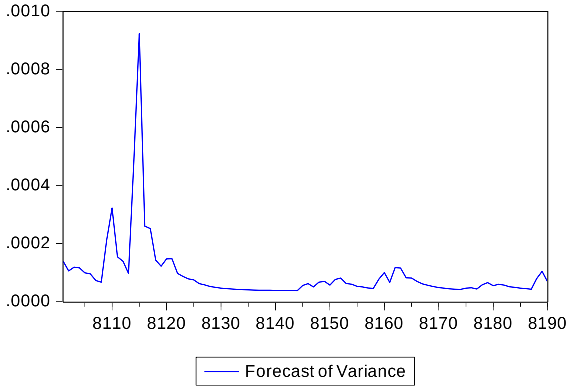


Figure 4.40: Output of forecasting the Stores & Supplies sector index for ninety days in 2019

4.12. Sector Wise Comparison

Table 4.111 Sector wise appropriate forecasting models

Sector	**Appropriate forecasting model**
Banking Finance & Insurance	IGARCH (2,2)
Beverage, Food & Tobacco	PARCH (1,1)
Chemicals & Pharmaceuticals	PARCH (2,2)
Footwear & Textiles	EGARCH (1,1)
Hotels & Travels	TARCH (1,1)
Investment Trusts	IGARCH (2,2)
Manufacturing	EGARCH (1,3)
Oil Palms	PARCH (2,1)
Services	PARCH (2,1)
Stores & Supplies	PARCH (2,1)

According to the Table 111 for the Oil Palms sector, Services sector and Stores & Supplies sector the appropriate model for forecasting sector indices is PARCH (2,1) model while for the Beverage, Food & Tobacco sector the appropriate model for forecasting sector indices is PARCH (1,1) model and for Chemicals & Pharmaceuticals sector is PARCH (2,2) model. Banking Finance & Insurance sector and Investment Trusts sector the appropriate model for forecasting sector indices is IGARCH (2,2) model. To forecast sector indices of Footwear & Textiles sector the appropriate model is EGARCH (1,1) model while for the Manufacturing sector is EGARCH (1,3) model. The appropriate model to forecast sector indices of Hotels & Travels sector is TARCH (1,1) model.

4.13. Chapter Summary

This chapter has shown the presentation of the data collected from ten sectors. Time series analysis was used to analyses the data for the sector indices. From the different time series models it was selected the appropriate model for forecasting sector indices.

CHAPTER FIVE
CONCLUSION

5.1. Introduction to the Chapter

This chapter will present the conclusions and recommendations. The conclusions are based on the findings of this research. It will address to the research problem and to the research questions which are included in the chapter one. Based on the research findings and conclusion, recommendations will be presented.

5.2. Conclusion

Stock market of a country is very crucial part of the economy. Developing models which reflect the pattern of the stock price movements for different sectors listed in CSE is very significant to investors and policy makers. Therefore, in this research study the researcher developed models to forecast different sector indices and compared them. The forecasting models comprise with ARCH, GARCH, TARCH, EGARCH, IGARCH and PARCH. Out of these ARCH family models researcher selected appropriate model to forecast the sector indices by using Akaike information criterion (AIC) Schwarz criterion (SC) values.

Banking Finance & Insurance sector

According to the finding of the research study it can conclude that to forecast the Banking Finance & Insurance sector indices the appropriate model is IGARCH (2,2) model. IGARCH (2,2) model is as follows:

Mean Equation

$$dlogbfi = 0.500755 dlogbfi_{\ t-1} - 0.277170 \varepsilon_{t-1}$$

Variance Equation

$$\sigma_t^2 = 0.338277 \varepsilon_{t-1}^2 - 0.337221 \varepsilon_{t-2}^2 + 1.592963 \sigma_{t-1}^2 - 0.594019 \sigma_{t-2}^2$$

Beverage, Food & Tobacco sector

For the Beverage, Food & Tobacco sector, PARCH (1,1) model is suitable model to predict the sector indices. PARCH (1,1) model is as follows:

Mean Equation

$$dlogbft = 0.715425dlogbft_{t-1} - 0.661127\varepsilon_{t-1}$$

Variance Equation

$$\sqrt{\sigma_t} = 0.001569 + 0.380192(|\varepsilon_{t-1}| + 0.082423\varepsilon_{t-1}) + 0.759004\sqrt{\sigma_{t-1}}$$

Chemicals & Pharmaceuticals sector

PARCH (2,2) model is the appropriate model to forecast the Chemicals & Pharmaceuticals sector indices. PARCH (2,2) model is as follows:

Mean Equation

$$dlogcp = -0.00000556 + 0.037023dlogcp_{t-1}$$

Variance Equation

$$\sqrt{\sigma_t} = 0.002686 + 0.308823(|\varepsilon_{t-1}| + 0.181683\varepsilon_{t-1}) + 0.297016|\varepsilon_{t-2}| - 0.128725\sqrt{\sigma_{t-1}} + 0.773333\sqrt{\sigma_{t-2}}$$

Footwear & Textile sector

According to the results of the research it reveals that to forecast the Footwear & Textile sector indices the appropriate model is as the EGARCH (1,1) model. EGARCH (1,1) model is as follows:

Mean Equation

$$dlogft = 0.990503dlogft_{t-1} - 0.990502\varepsilon_{t-1}$$

Variance Equation

$$log\sigma_t^2 = -1.057854 + 0.192010\left|\frac{\varepsilon_{t-1}}{\sqrt{\sigma_{t-1}}}\right| - 0.023769\frac{\varepsilon_{t-1}}{\sqrt{\sigma_{t-1}}} + 0.885735log\sigma_{t-1}^2$$

Hotels & Travel sector

For the Hotels & Travel sector, TARCH (1,1) model is the appropriate model to forecast the sector indices. TARCH (1,1) model is as follows:

Mean Equation

$$dloght = -0.000327 - 0.315544dloght_{t-1} + 0.577610\varepsilon_{t-1}$$

Variance Equation

$$\sigma_t^2 = 0.0000411 + 1.800594\varepsilon_{t-1}^2 - 1.385955\varepsilon_{t-1}^2(\varepsilon_{t-1} < 0) + 0.354888\sigma_{t-1}^2$$

Investment Trusts sector

IGARCH (2,2) model is the appropriate model to forecast the Investment Trusts sector indices. IGARCH (2,2) model is as follows:

Mean Equation

$$dlogit = 0.000000462 + 0.571702dlogit_{t-1} - 0.531030\varepsilon_{t-1}$$

Variance Equation

$$\sigma_t^2 = 0.189203\varepsilon_{t-1}^2 - 0.089555\varepsilon_{t-2}^2 + 1.371560\sigma_{t-1}^2 - 0.471209\sigma_{t-2}^2$$

Manufacturing sector

To forecast the sector indices of the Manufacturing sector, the appropriate model is EGARCH (1,3) model. EGARCH (1,3) model is as follows:

Mean Equation

$$dlogmfg = 0.361102dlogmfg_{t-1} - 0.263043\varepsilon_{t-1}$$

Variance Equation

$$log\sigma_t^2 = -1.117555 + 0.464428\left|\frac{\varepsilon_{t-1}}{\sqrt{\sigma_{t-1}}}\right| + 0.061227\frac{\varepsilon_{t-1}}{\sqrt{\sigma_{t-1}}} + 0.387869log\sigma_{t-1}^2 + 0.185518log\sigma_{t-2}^2 + 0.337846log\sigma_{t-3}^2$$

Oil Palms sector

Findings of the research study show that to forecast the Oil Palms sector indices, the appropriate model is as the PARCH (2,1) model. PARCH (2,1) model is as follows:

Mean Equation

$$dlogop = 0.0000000182 - 0.656569dlogop_{t-1} + 0.655339\varepsilon_{t-1}$$

Variance Equation

$$\sqrt{\sigma_t} = 0.000000094 + 0.893621(|\varepsilon_{t-1}| - 0.088837\varepsilon_{t-1}) + 0.391437|\varepsilon_{t-2}| + 0.641324\sqrt{\sigma_{t-1}}$$

Service sector

To forecast the Service sector indices, the appropriate model is the PARCH (2,1) model. PARCH (2,1) model is as follows:

Mean Equation

$$dlogss = 0.794241dlogss_{t-1} - 0.794239\varepsilon_{t-1}$$

Variance Equation

$$\sqrt{\sigma_t} = 0.0000793 + \ 0.274587(|\varepsilon_{t-1}| + 0.089843\varepsilon_{t-1}) + 0.874119\sqrt{\sigma_{t-1}}$$

Stores & Supplies sector

PARCH (2,1) model is the appropriate model to forecast the sector indices of Stores & Supplies sector. PARCH (2,1) model is as follows:

Mean Equation

$$dlogsts = -0.933461dlogsts_{t-1} + 0.933461\varepsilon_{t-1}$$

Variance Equation

$$\sqrt{\sigma_t} = 0.00000105 + \ 0.935005(|\varepsilon_{t-1}| + 0.410339\varepsilon_{t-1}) + 0.250160|\varepsilon_{t-2}| + 0.611487\sqrt{\sigma_{t-1}}$$

It can be concluded that PARCH model is appropriate to forecast five sectors out of ten sectors. Oil Palms sector, Services sector and Stores & Supplies sector the appropriate model for forecasting sector indices is PARCH (2,1) model while for the Beverage, Food & Tobacco sector the appropriate model for forecasting sector indices is PARCH (1,1) model and for Chemicals & Pharmaceuticals sector is PARCH (2,2) model. For two sectors including Banking Finance & Insurance sector and Investment Trusts sector the appropriate model for forecasting sector indices is IGARCH (2,2) model. To forecast sector indices of Footwear & Textiles sector the appropriate model is EGARCH (1,1) model while for the Manufacturing sector is EGARCH (1,3) model. The appropriate model to forecast sector indices of Hotels & Travels sector is TARCH (1,1) model.

5.3. Recommendations & Limitations

It can be recommended that the most appropriate model to forecast the sector indices of Oil Palms sector, Services sector and Stores & Supplies sector as PARCH (2,1) model, Beverage, Food & Tobacco sector as PARCH (1,1) model, Chemicals & Pharmaceuticals sector as PARCH (2,2) model, Banking Finance & Insurance sector and Investment Trusts sector as IGARCH (2,2) model and Manufacturing sector as EGARCH (1,3) model. These findings are contradicted with Ng and McAleer (2004), Mhmoud and Dawalbait (2015) and AL-Najjar (2016). Further it can be recommended that the most appropriate model to forecast the Footwear & Textiles sector indices as EGARCH (1,1) model. This is similar with the findings of Mhmoud and Dawalbait (2015). TARCH (1,1) model is more appropriate to forecast the Hotels & Travels sector. This is similar with the findings of Ng and McAleer (2004), Mhmoud and Dawalbait (2015) and contradict with the findings of AL-Najjar (2016).

This research study was carried out with some limitations therefore future researchers can further develop this. It has selected only the Colombo Stock Exchange for this research study and other stock markets in foreign countries has not been considered. This research study was limited only for thirty-four years time period from 2nd January 1985 to 29th a March 2019. The sample of this research was limited only to daily market indices. All the previous studies on forecasting market indices have not been considered.

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