THE BEHAVIOR OF SECTOR RETURN AND VOLATILITY AROUND BUDGET: EVIDENCE FROM COLOMBO STOCK MARKET

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Degree of Master of Science

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University of Moratuwa
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Declaration of the Candidate and Supervisor

The work submitted in this thesis is the results of my own investigation, except where otherwise stated.

It has not already been accepted for any degree, and is also not been concurrently submitted for any other degree.

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K.L.S.Bhashani Date

I endorse the declaration by the candidate,

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(Supervisor)

Senior Lecturer

Department of Mathematics

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Abstract

The study examines the behavior of stock returns and volatility in Diversified Holdings (DIV) sector of CSE around three annual government budget announcements. The daily returns of the sector over a period of three years from 1st April 2015 to 29th March 2018 are tested using three types of conditional time varying models, namely GARCH, EGARCH and GJR-GARCH. Three cases are considered using the dummy variable for n=5, 10 and 15 with three scenarios, n number of days on pre- budget, pre and post budget, post- budget for each case. Seven models are fitted except pre-budget with n=10 and pre-budget with n=15. This study finds strong evidence for the presence of budget announcement effect in stock returns and volatility of the sector. Returns during all considered windows are significantly negative and it implies that significant reduction in return. This reduction is increasing when getting closer to the budget date. Due to this effect investors can earn an abnormal return by buying stocks before five days of the budget announcement or after five days of the budget announcement and selling stocks after 15 days from the budget date.

Key Words: Volatility, Stock Return, All share price index, GJR-GARCH, Budget, pre, post

TABLE OF CONTENTS

Chapter 3: Methodology

Chapter 4: Data Analysis and Results

Chapter 5: Conclusions and Recommendations

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

Abbreviation	Description
ADF	Augmented Dickey-Fuller
AR	Auto Regressive
ARCH	Auto Regressive Conditional Heteroscedasticity
ASPI	All Share Price Index
BSE	Bombay Stock Exchange
CAAR	Cumulative Average Abnormal Returns
CSBA	Colombo Share Brokers' Association
CSE	Colombo Stock Exchange
DF	Dickey-Fuller
DFE	Dynamic Fixed Effects
DIV	Diversified holdings
DNB	Department of National Budget
EGARCH	Exponential Generalized Auto Regressive Conditional Heteroscedasticity
ETF	Exchange Traded Funds
GARCH	Generalized Auto Regressive Conditional Heteroscedasticity
GJR GARCH	Glosten Jagannathan Runkle Generalized Auto Regressive Conditional Heteroscedasticity
MA	Moving Average
MVRM	Multi Variate Regression Model
NSE	New York Stock Exchange
OLS	Ordinary Least Square

SBA	Share Brokers' Association
TGARCH	Threshold Generalized Auto Regressive Conditional Heteroscedasticity
WTC	World Trade Centre

CHAPTER 1
INTRODUCTION

1.1 Colombo Stock Exchange

From both the industry and investor's point of view, share trading is an important event of the economy of a country. Secondary shares are issued in a stock market to fulfill the capital necessities of public companies to ensure the continuity of the economic expansion and making opportunities for people to gain higher profits for their investments.

There is a long history in the establishment of the current stock market of Sri Lanka and it dates back to 19th century. In 1896 share trading in Sri Lanka was initiated under *share broker's association* (SBA) by British planters owing to find the financial needs for setting up the tea plantation in Sri Lanka. Share brokers association was renamed as *Colombo share broker's association* (CSBA) in 1904. In 1985, with the establishment of a formal stock exchange took place with incorporation of the Colombo security exchange which took over the stock market from the Colombo share broker's association. As a result, this venture was renamed as Colombo Stock Exchange (CSE) in 1990. Today there are 15 institutions, as members all of which are license to operate as stock brokers. Central deposition system was introduced by CSE and clearing was automated by that. CSE headquarters was opened at World Trade Centre (WTC) Colombo, in 1995.

CSE was considered to be one of the top performing stock markets in the world now. After the end of the civil war, it has attracted a lot of investors where all the uncontrolled factors like political stability were rapidly changing.

1.2 Stock Market Index

A stock index or stock market index is a mathematical construction, used to measure the value of a section of the stock market of all the market. From the prices of selected stocks (typically a weighted average), stock market index is computed. Investors and financial managers used it as a tool to describe the market, and to compare the return on specific investment.

The performance of the CSE comprises three stock market indexes in Sri Lanka:

1. All share price index (ASPI)
2. S & P Sri Lanka 20 (S & P SL20)
3. Colombo stock exchange sector indices (CSE sectors)

1.2.1 All Share Price Index (ASPI)

In Sri Lanka, all share price index is one of the principal stock indices of the CSE. The movement of ASPI measures the share prices of all listed companies. It is based on market capitalization. Valued at current market price (market capitalization) and weighting of shares is conducted in proportion to the issued ordinary capital if the listed companies. 1985 is the base year and the 100 is the base value of the index. This is the longest and the broadest measure of the Sri Lankan stock market. During the market day the ASPI indicates the price fluctuations of shares of all the listed companies and covers all the traded shares of companies.

The ASPI is calculated using the formula:

$$\text{All share price index} = \left(\frac{\text{Market capitalization all listed companies}}{\text{Base market capitalization}}\right) \times 100$$

Where,

$$\text{Market capitalization} = \sum (\text{current no of listed share of compani } y_i)(\text{Market price}_i)$$

i- No of companies

Base

$$\text{market capitalization} = \sum (\text{ No of listed share of compani } y_i)(\text{Market price}_i)$$

On year 1985, base values are established with average market value. Hence the base year becomes 1985.

$$\text{Opening base market capitalization} = \frac{\text{Total market capitalization in 1985}}{\text{No of trading days in 1985}}$$

ASPI increased 46 points or 0.76% to 6182 on Tuesday July 17 in 2018 from 6135 in the previous trading session. Historically, the CSE all share reached an all-time high of 7811.82 in February of 2011 and a record low of 4258.8 in June 2010.

1.2.2 S&P SL20 Index

On 18 June 2012, the S & P SL 20 index was initiated and on 26 June 2012, it was launched in Colombo. The S & P Sri Lanka 20 seeks to be comprised of liquid and tradable stocks for easy and cost effective replication as trading instruments, with possible application as index funds and Exchange Traded Funds (ETFs).On Colombo stock exchange , index constituents are the 20 largest blue chip companies chosen from the universe of all stocks listed. The indices are calculated using a capped market capitalization weighted scheme (capped at 15%). It is calculated in Sri Lankan rupee. December 17, 2004 is the base period of the S & P Sri Lanka 20 and 1000 is the base value.

1.2.3 Sector Indices

The listed companies of CSE are divided in to 20 sectors. The same formula is used to calculate the ASPI, on a daily basis for each sector to calculate price index. The price movement of the sector indicates the direction of each index. Investor can get an idea of the stock prices level of particular business sector by referring to these indices.

The 20 business sectors are as follows:

1) Bank Finance and Insurance – (BFI)
2) Beverage Food and Tobacco – (BFT)
3) Chemicals and Pharmaceuticals – (C & P)

4) Construction and Engineering – (C & E)
5) Diversified Holdings – (DIV)
6) Footwear and Textile – (F & T)
7) Health Care – (HLT)
8) Hotels and Travels – (H & T)
9) Information Technology – (IT)
10) Investment Trust – (INV)
11) Land and Property – (L & P)
12) Manufacturing – (MFG)
13) Motors – (MTR)
14) Oil Palms – (OIL)
15) Plantations – (PLT)
16) Power and Energy – (P & E)
17) Services – (SRV)
18) Stores Supplies – (S & S)
19) Telecommunication – (TLE)
20) Trading – (TRD)

1.3 Background of the study

Government budget announcement is a one of the most important event for many parties and people in a country. So it defines the financial guide of the country for the preceding year. Reaching economy stability and growth, the governing bodies of the country execute numerous policies to meet its objectives. In different sectors such as defense, administration, development and welfare involve humongous fund utilization by the policy implementation.

The annual budget is the formal announcement by the government on the tax policy changes and fund allocations as it is one of the main sources of government income. A budget is an influential instrument in the hands of the government to control the fiscal resources of the country. (Khannah K and Gogia N -2014)

In Sri Lanka, the authorized body to prepare the budget is Department of National Budget (DNB) by coordinating all the ministries of government under existing government. According to the budget calendar, in September the appropriation bill is presented to the parliament (first reading) and in November minister of finance declares the budget speech (second reading) in the parliament.(Action plan 2017 in ministry of finance). The budget speech day in parliament is one of the most awaiting political events in the country. So budget speech will illustrate the government income and expenditure for the preceding year. The policy decisions announced through the budget speech can be exciting and discouraging to companies listed on CSE.

The Sri Lankan stock market has local investors as well as foreign investors. They are either individuals or firms. The company can issue shares, if they want to raise funds for further expansion or setting up a new venture or instead of taking loans. When company issue shares, an investor can buy shares and get part ownership of the company. At annual shareholder meetings, this gives investor by a vote and right to a share of future profits. Investors have the ability to sell shares quickly and easily. Compared to other investments this is a good feature of investing in stocks, such as real estate. Most of the investors, especially foreign investors are more concerned with the market efficiency.

1.4 Research Problem

The stock market is a very important part in a country. If stock market is developed then economy of the country is developed. Stock market will be developed when investors invest more in the stock market. The political and economic changes are influence locally and globally the share price movements and exhibit the state stock market to the investors. The major problem faced by the investor in the stock market is the fluctuation from their expected returns due to the uncertainty in the market. Stock markets as an element which operate in the whole financial system are highly sensitive to the political environment in the country.

This study makes an effort to examine the behavior of stock returns and volatility around three annual government budget announcements on Diversified Holdings sector index of Colombo Stock Exchange.

1.5 Objective of the study

- Examine selected sector of Colombo Stock Exchange in Sri Lanka for the behavior of stock return and volatility around annual budget announcement.
- Examine the existence of Heteroscedasticity in selected sector.

1.6 Significance of the study

In Sri Lankan context most of the studies on finding the behavior of the stock return and volatility around government budget announcement in CSE are conducted using event study methodology. This study examines the same problem focusing the sectors of the CSE using multivariate regression model (MVRM model) with dummy variables for during the n days before, before and after, after the budget announcement date. This study will be the first study that focuses to use Time Series Analysis to examine the behavior of the stock market around national budget announcement.

1.7 Data Collection

This study used secondary data, which was obtained from the records at Colombo Stock Exchange. Data for the Three year period from 1st April 2015 to 29th March 2018 are collected. The data series is comprised of daily stock market closing prices (All share price index for sectors) of all the sectors which are listed at the CSE as at 23th March 2018.

1.8 Outline of the Thesis

The detailed literature review related to this study is given in chapter 2. The details of the methodology are provided in chapter 3.All theories which are related to each method that will be used to analyze data are given in this chapter. The result obtained from employing the fitted model for the data for selected sector is illustrated in chapter 4. The overall outcome of the data analysis is explained in the last part of the chapter. The major findings of the study are included in the last chapter of the thesis. The results are compared with previous studies and any differences and similarities are explained. The limitations of the study are also discussed and suggestions are provided for further research as well.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter analyses existing literature in behavior of stock returns and volatility around the government budget and covers, review of empirical studies and chapter summary.

2.2 Empirical Review

2.2.1 International studies on event study on budget announcement

Susan, T., & Ajay, S. (2002) investigate the response of the stock markets to the announcement of union budget in India. The study also examines the extent to which the stock market response to the Union Budget is consistent with the behavior that might expect in an efficient market. They construct a long time–series, consisting of 4673 observations of daily returns on the Indian stock market index from 4 April 1979 till 11 June 2001. The study was considered BSE Sensex returns data from 1979 to 1990 and NSE Nifty index data from 1990 to 2001. 26 budgets were considered as event dates for the study comparison of both interim and final budget respectively. An event window period of 45 days before and after the budget was followed by the event study methodology. The study finds Indian stock market to be fairly efficient at information processing about the union budget announcement date and it immediately suggests hedging strategies for equity investors, who could benefit by short–selling index futures on or near budget date. The study also finds that Union Budgets add 10% to the stock index, on average, and yield elevated volatility starting from the Budget date for the following 30 trading days or so. The study opinions that, as post-budget period is highly volatile in nature.

Varadharajan, P., & Dr.Vikkraman, P. (2011) examined the impact of pre and post budget on Indian stock market volatility from 2001 to 2011. The study period spans from 2nd April 2001 to 11th March 2010. 9 budgets were considered as event dates for the study and total of 60 trading days before and after the budget has been considered. The study finds the stock market has posted negative return post-budget except in the year 2005, 2007 and 2010. The study examined the extent to which the stock market responds to the Union Budget, it is during the post budget that the volatility in the stock market is higher in comparison to pre-budget since based on the budget people tend to buy or sell share accordingly so there is high volatility after the announcement of budget. Also Month of May showed highest volatility followed by October and March showed high volatility and the market capitalizations of NSE are slightly more volatile when compared to BSE.

Naveen Kumara R., Meghana Vittal B., Monica G. examined the impact of union budget on Bombay stock market & five sectorial indices such as Manufacturing and Services, Automobile, Real Estate, Banking, Information Technology. The study, the event date is considered as the date on which the Union Budget is announced for the past 3 years and measure indices of each sector 15 days pre-event period and 15 day post event period. And also consider medium event window using which the Impact of Union Budget on the indices of each sector to be determined. The study finds the market analyst felt that the budget might have an impact on Banking and Real Estate sectors but the impact of Union Budget was opposite in the year 2015 and 2017 and the Union Budget had impact in the year 2016. The other sectors that is Manufacturing and Services, Automobile and IT has no impact in all the three consecutive years but there was a chance for the investors to make a minimal abnormal returns in respect of increase and decrease in the Sectorial Indices in Manufacturing and Services during 2015 and 2016, Automobile sector during the year 2016, Real Estate sector during the year 2016, Information Technology sector during all the three years that is 2015, 2016 and 2017, Banking during 2016. And the study shows that there is no much impact of Union Budget on the five sectors except Banking and Real Estate sector in the year 2016. The study also observed that there was no significant impact on the Stock Market as available data of the BSE SENSEX confirmed the same.

Kabuga N.A. (2018) examined the dynamic relationship between budget deficits and stock market performance for a panel of 8 African countries (Nigeria, Ghana, South Africa, Kenya, Egypt, Botswana, Tunisia, and Morocco) over the period 2000-2016 using panel dynamic fixed effects (DFE) and panel VAR Granger causality test. the paper established that budget deficits and stock prices are not stationary at level but stationary at first difference using panel unit root tests. The study findings reported that the relationship between budget deficits and stock market performance is negative and statistically significant, it also reported that relationship is in the long run statistically significance. This point to the fact that, investors and other market participants are willing to invest for stock return even when in the long run fiscal deficit increases.

Kanyari L.W.(2015) investigate effect of national budget reading on sector returns at the Nairobi securities exchange covering the period from 2010 to 2014 included 5 budget readings. The study adopted event study methodology and examine stock returns for 58 companies listed at the Nairobi Securities Exchange. The event period was 10 days pre and post budget announcement. The study sought to compare sector returns and market returns prior to and subsequent to the budget to assess how abnormal returns vary with the event. The study found that national budget reading had an impact on the cross-sectional average sector returns. The impact was observed over the event period with different sectors reacting uniquely to the budget on different days within the event period. It was observed that opportunities to make abnormal gains existed just before, on and during the event period in some sectors dependent on the budget. Significant positive CARs were noted in the automobile sector, construction and manufacturing sectors over the 2013 budget period. However, statistical tests did not indicate significant differences between pre budget and post budget sector returns over the event periods studied. This indicates that investors had on average, anticipated the effects of the event days before the budget reading.

Khanna K. & Gogia N. (2014) considered the stock market behavior on pre and post announcements of Govt. budgets (India: Union Budget, US: Federal Budget and UK Govt. Budget) covering the period of study financial year September 2008 to November 2010.The study have been considered three countries' stock exchanges viz., Bombay Stock Exchange (India), New York Stock Exchange (USA), London Stock Exchange (UK) as a source of basic stock prices. The research has been used the Paired t Test and F test. The study defined three time periods as 3 days (short term), 15 days (medium term) and 30 days (long term) by pre and post budget announcement day. The study reveals that in India, the union budget mainly affects the stock market in short term mainly and medium term also. But in long term those budgets have not any significant impact on stock market trend as investors are adjusted with the announcements. The study reveals that in USA, the budget mainly affects the stock market in long term and medium term. The main reason of this type of impact was that the budget process takes much time in USA. The study reveals that in UK, budget mainly affects the stock market in short term mainly and medium term also. But in long term those budgets have not any significant impact on stock market trend. The anxiety about the Budget announcement of Government remains high during the period close to the Budget Day.

Deepak R. & Bhavya N.(2014) examined an event study thus reflects upon the perceptions of the markets especially considering the broader market and sectorial markets towards the announcements of budget by finance ministers from period 1993 to 2014. The study used the daily closing values of the twenty three market indices listed on Bombay/Mumbai Stock Exchange (BSE) and National Stock Exchange (NSE). The results obtained infer that budget announcement has no significant impact on the broader and sectorial indices over the years and trading strategies cannot be adopted by investors in making investment decisions during this shorter time frame as markets correct to any future expectations from the budget as time passes. The markets are observed to rally positively towards the budget announcements dates expecting good things from the finance ministers but it is found rare that the markets have reacted positively after the budget announcements. Except for the period 1993, where significant differences were observed in the returns after the announcement dates, the study observed any key changes in the returns statistically over the period 1994-2014. The study finds no ample evidence for long-term structuring of investments by retail and institutional investors based on the budget announcement news. But, short-term trading strategies can earn abnormal profits. The markets are semi-strong efficient in nature and no trading strategies can be adopted to get abnormal profits around the announcement date.

Singh G. & Kansal S. (2010) investigated the impact of Union budget announcements on stock markets represented by NSE Nifty index in Indian stock market for the period 1996-2009. The study examined a total of seventeen union budgets including three interim budgets, presented by finance ministers for a period of thirteen years from 1996 to 2009. The study was classified into 3 days (short term) 15 days (medium term) and 30 days (long-term) for the event window period. The authors examined the statistical changes in the returns and volatility of the indices by conducting T-test and Z-test. The study finds statistically significant changes in returns and volatility for short-term period and long-term period respectively. The study concludes that the impact of budget announcement is observed only in the short-term and medium-term on NSE Nifty returns and the differences are found to disappear with a longer period of time. The study also finds more volatility after the budget announcements in the returns of the index. Thus budget announcement was found to have significant impact on the stock market returns.

Anil Soni & Jalandhar (2010) examined the impact of the announcement of union budget and monetary policy on the stock market. The time period covered is 10 years i.e. from the year 2000-2009. All the union budgets presented and monetary policy announcements of this period have been considered. The BSE 30 share index Sensex has been taken as the indicator of the reaction of the stock market. Logarithmic daily returns have been calculated for the entire period. Average returns have been calculated during the pre and post 3 days (short term), 15 days (medium term) and 30 days (long term) around the announcements of union budget and monetary policy. Paired t-tests are carried out among different periods during announcement days. F-tests are also carried out to compare the last 30 days returns with post 3 days, 15 days and 30 days. The study found that the union budget and monetary policy announcements have no impact on the stock market in the long run. However, in the short run impact may be either way i.e. positive as well as negative.

Kutchu, Vishal. (2012) investigated the semi-strong form of efficiency of the Indian stock markets by analyzing the impact of union budget announcements for the period August 2011 to April 2012. The study, the event date was the March 16th 2012, the event window consisting of 7 pre-event days, the event day and 7 post event days. The comparison or pre-event window was 147 days prior to the event window. The study analyzed the impact of budget announcement on S&P CNX Nifty and companies belonging to major sectors mainly Fertilizers, Textiles, Hotels, Paper, Software and Pharmaceuticals. The study was approached an application of a multivariate regression model (MVRM model) with dummy variables for the event date in contrast to event study methodology. The study concluded that the results, there seems to be inconclusive evidence about overall impact of budget either on the stock market or a particular sector but the results seem to point in the direction that the effect of the Budget may be company-specific.

2.2.2 Local studies on event study

Ranjani, Sujeewa and Rathnasiri (2009) examined the impact of Sri Lankan government budget announcements on the Colombo stock exchange indices for the period 2005-2009. Event study methodology was followed in the study with an event window of 15 days before and after the first speech of budget announcement date to the Parliament. The indices considered for the study were mainly the All Share Price Index (ASPI) and Milanka Price Index (MPI) listed on Colombo stock exchange. The study finds significant negative trend in ASPI and Milanka price indices returns in the event window period across all the years except for 2007. The study concludes that continues imposition and concessions in tax may be one of the major reasons for negative and positive trend respectively in the index returns over the around the event date.

Edirisingha U.C. (2017) investigate the impact of Sri Lankan government budget announcements on five sector indexes of Colombo Stock Exchange, namely banks, finance & insurance; beverage, food & tobacco; manufacturing; motor; diversified holdings. The Event study methodology was used to analyze sector wise stock price behavior during the sample period of 2002 to 2013. The study was considered 12 budget speeches , 150 days as the estimation period and 60 days and the event period (30 days prior and 30 days post to the events) resulting with 181 days in the event window. The results show that all 5 sectors have increasing negative Cumulative

Average Abnormal Returns (CAAR) throughout the pre and post event windows but the proportions of these negative CAAR trends are different from one sector to another. Diversified holdings (DIV) are the least affected sector and Motor is the most affected sector. The study also concluded that although in all five sectors the general reaction to the budget announcement is negative the magnitude of these reactions are different from sector to sector.

Jayasinghe P. (2014) examined the behavior of stock returns and volatility of returns in CSE around both presidential and parliamentary elections. A univariate GARCH (1,1) model with dummy variables in both mean and variance equations has been employed for estimation using daily data of the sample period from January 1985 to September 2009. This study produces mixed results as for the abnormal returns and change in returns relative to the previous day's returns during election periods. The study finds strong evidence for the upward movement of the volatility around elections. This impact of election on stock market volatility is consistence for both type of elections with 5, 10, 15 and 20 day dummy periods before an election, after an election and both before and after an election. The degree of volatility increase becomes stronger when it gets close to election date from both directions.

CHAPTER 3
METHODOLOGY

3.1 Introduction

The steps and approaches which are followed in the proposed study are presented in this chapter. First, descriptive statistic terms are introduced in this section to provide a general understanding about the data sets. Then the research design, statistical models, tests and statistical techniques which are used to analyze the data are discussed.

3.2 Research Design

In this study, basic OLS model is fitted by taking dummy variables for during the n days before, before and after, after the budget announcement day as independent variables and return as the dependent variable. Then the fitted model is tested for ARCH effect. (See Figure 3.1) If the ARCH effect is not present in the data set then the fitted model is tested for auto correlation of the residuals and if residuals are not auto correlated then the fitted model is tested for normality of the residuals. If the residuals are normally distributed then accept the model as the best model that describes the data set.

If the residuals are auto correlated then the model will be modified until the residuals are not auto correlated by introducing lag values of the dependent variable into the regression model and then the fitted model is tested for normality of the residuals. If the residuals are normally distributed then accept the modified model as the best model that describes the data set.

If the ARCH effect is present in the data set then a model from GARCH, EGARCH or GJR-GARCH family are fitted until there is no ARCH effect and no auto correlation of the residuals and the residuals are normally distributed.

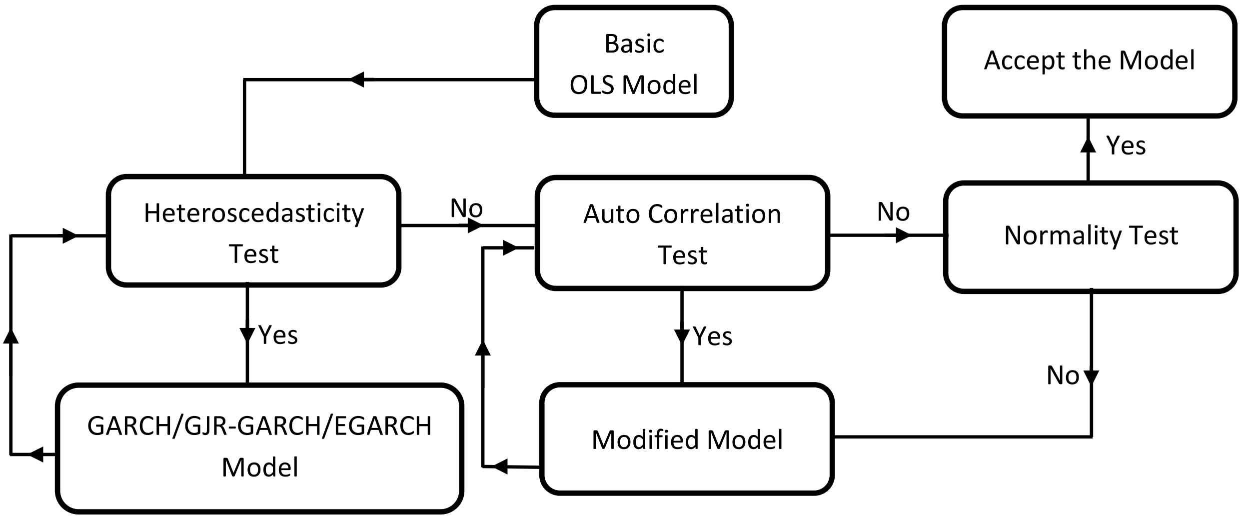


Figure 3.1: Algorithm of fitting the models

3.3 Augmented Dickey-Fuller (ADF) test

As clear from the name, this test is an augmented version of the Dickey-Fuller test for larger and more complex time series models. This test is useful if the series is correlated at higher order lags and the assumption of the white noise disturbance ε_t is violated.

A parametric correction for higher order correlation has been done by the ADF test in these situations by assuming that y series follows a AR (p) process. In this test p lagged difference terms of the dependent variable is added to the right hand side of the

$$\Delta y_t = c_t + \beta y_{t-1} + \sum_{i=1}^{p} \rho_i \Delta y_{t-i} + \varepsilon_t$$

where c_t is a deterministic function of the time index t and $\Delta y_t = y_t - y_{t-1}$ is the differenced series of y_t . In practice, c_t can be zero or a constant or $c_t = \omega_0 + \omega_1 t$.

Test Statistic:

t ratio of the least-squares (LS) estimate of β under the null hypothesis.

$i.e. ADF \equiv t\ ratio = \frac{\hat{\beta}-1}{std(\hat{\beta})}$

Hypothesis:

$H_0: \beta = 1$

$H_1: \beta < 1$

Conclusion:

If $ADF_{estimated} < ADF_{critical}$ reject the null hypothesis at α level of significance.

3.4 Testing the existence of Volatility Clusters

Volatility clustering is one of the main characteristics exist in volatility. This implies that the existence of the strong autocorrelation of the squared returns. Therefore, first order autocorrelation of the squared returns can be used to test the volatility clustering. Box-Pierce LM test is used for this purpose.

In this test,

1st order autocorrelation in squared returns is given by,

$$\hat{\gamma}_1 = \frac{\sum_{t=2}^{n} {r_t}^2 r_{t-1}^2}{\sum_{t=2}^{n} {r_t}^4}$$

Then the Box-Pierce test statistic is given by

$$Q(1) = n\hat{\gamma}_1$$

Where n is the number of observations.

Test Statistic:

$Q(1) \sim \chi_1^2$ (Chi-squared with 1 degrees of freedom)

Hypothesis:

H_0: There's no autocorrelation in squared returns (no volatility clusters)

H_1: There exist an autocorrelation in squared returns. (There exist volatility clusters)

Conclusion:

If $\chi_{estimated}^2 > \chi_{critical}^2$ reject the null hypothesis at α level of significance.

This is not a very robust test. But the results of the above test can be enhanced through some adjustments to the series. If the above test suggests that there exist no volatility clustering, then it needs to be checked whether the low volatility clustering is due to the large negative returns. This is because the above test checked for the chi-squared distribution (more suitable for large positive returns). This can be analysed using the skewness and kurtosis as well.

3.5 Testing the presence of asymmetry in volatility clusters

In some situations, some equity markets tend to show an asymmetry in volatility clustering. As mentioned above this will be happened due to the increase of volatility more, when stock prices are falling than the stock price decrease by the same amount. Therefore, depending on the symmetry/ asymmetry of the volatility clusters, an appropriate GARCH model (volatility model) needs to be selected in order to obtain the correct results. If a symmetric GARCH model is used in a place where there is asymmetric volatility clusters present, then it will lead to unreliable results. Therefore, testing asymmetric nature in volatility is very important.

The asymmetry of the volatility can be detected by the autocorrelation between the yesterday's return and the today's squared return. This is because when asymmetry present, the volatility will be higher following a negative return than following a positive return.

$$v = \frac{\sum_{t=2}^{n} r_t^2 r_{t-1}}{\sqrt{\sum_{t=2}^{n} {r_t}^4 * \sum_{t=2}^{n} r_{t-1}^2}}$$

If the above mentioned autocorrelation (v) is negative in value or the Box-Pierce test statistic corresponds to the above function is significantly different from zero, then it implies the existence of the asymmetry in volatility.

3.6 Basic OLS Model

First is employed the standard OLS methodology by regressing returns on dummy variable to investigate the behavior of returns as follows:

$$r_t \ = \ \mu D \ + \ \varepsilon_t \ ; \ \ \varepsilon_t \sim N(0, \sigma^2) - - - (1)$$

Where,

r_t - log return of the sector index (ASPI) of the day;

D - dummy variable;

$$D = \begin{cases} 1; \text{ if the observation is pre-event, pre and post event, post-event on n days} \\ 0; \text{ otherwise} \end{cases}$$

This methodology assumes the following assumptions on the residuals:

1) Residuals are not auto correlated
2) Residuals are homoscedastic
3) Residuals are normally distributed

If the above assumptions are not fulfilled then results obtained using this model may be invalid.

3.7 Modified OLS Model

Fail to meet the first assumption can be solved by introducing lagged values of the return variable in the regression equation as used in the studies conducted by Jayasinghe P. (2014). Then the model is expressed as:

$$r_t \ = \mu_0 + \mu_1 D \ + \mu_2 D \, r_{t-1} + \sum_{i=1}^{n} \theta_i \, r_{t-i} + \ \varepsilon_t \ ; \ \ \varepsilon_t \sim N(0, \sigma^2) - - - (2)$$

3.8 AR(p) Model

$$r_t \ = \phi_0 + \phi_1 \, r_{t-1} + \phi_2 \, r_{t-2} + \cdots + \phi_p \, r_{t-p} \ \ + \ \varepsilon_t \ ; \ \ \varepsilon_t \sim N(0, \sigma^2) - - - (3)$$

3.9 MA(q) Model

$$r_t \ = \phi_0 - \phi_1 \, \varepsilon_{t-1} - \phi_2 \, \varepsilon_{t-2} - \cdots - \phi_p \, \varepsilon_{t-q} \ \ ; \ \ \varepsilon_t \sim N(0, \sigma^2) - - - (4)$$

3.10 ARCH/GARCH Model

If the second assumption is not fulfilled, variance of the residuals is heteroscedastic. As a solution to that, Autoregressive Conditional Heterosecdasticity (ARCH) models are proposed by Engle (1982) and these models are built by expressing the conditional variance as a function of past squared errors in order to address the variability in the variance of the residuals. The generalized version of these models (GARCH) is introduced by Bollerslev (1986) and modeled the conditional variance as a linear function of past squared errors and lagged value of the variance itself. Then the model is expressed as:

$$r_t = \mu_0 + \mu_1 D + \mu_2 D\, r_{t-1} + \sum_{i=1}^{n} \theta_i\, r_{t-i} + \varepsilon_t - - - (5)$$

where $\varepsilon_t = \sigma_t e_t; e_t \sim N(0,1)$

and $\sigma_t^2 = \lambda_0 + \lambda_1 D + \sum_{j=1}^{q} \alpha_j\, \varepsilon_{t-j}^2 + \sum_{k=1}^{p} \beta_k\, \sigma_{t-k}^2 - - - (6)$

3.11 EGARCH Model

The exponential GARCH or EGARCH model was first developed by Nelson (1991) and the model is given by:

$$r_t = \mu_0 + \mu_1 D + \mu_2 D\, r_{t-1} + \sum_{i=1}^{n} \theta_i\, r_{t-i} + \varepsilon_t - - - (7)$$

where $\varepsilon_t = \sigma_t e_t; e_t \sim N(0,1)$

and $\ln \sigma_t^2 = \lambda_0 + \lambda_1 D + \sum_{j=1}^{p} \alpha_j \frac{|\varepsilon_{t-j}|}{|\sigma_{t-j}|} + \gamma_j \frac{\varepsilon_{t-j}}{\sigma_{t-j}} + \sum_{k=1}^{q} \beta_k \ln \sigma_{t-k}^2 - - - (8)$

3.12 GJR-GARCH Model

The GJR-GARCH model was introduced by, Glosten, Jagannathan and Runkle (1993). It extends the standard GARCH (p,q) and it is similar to EGARCH model.

Main GJR- GARCH model is also capable of capturing asymmetric volatility clusters in the conditional variance equation.

GJR- GARCH (p,q) model is defined as:

$$r_t = \mu_0 + \mu_1 D + \mu_2 D\, r_{t-1} + \sum_{i=1}^{n} \theta_i\, r_{t-i} + \varepsilon_t --- (9)$$

where $\varepsilon_t = \sigma_t e_t; e_t \sim N(0,1)$

$$\text{and } \sigma_t^2 = \lambda_0 + \lambda_1 D + \sum_{j=1}^{q} \alpha_j \varepsilon_{t-j}^2 + \gamma_j I_{t-j} \varepsilon_{t-j}^2 + \sum_{k=1}^{p} \beta_k\, \sigma_{t-k}^2 --- (10)$$

$$where\ I_{t-i} = \begin{cases} 1\ ;\ \varepsilon_{t-i} < 0 \\ 0\ ;\ \varepsilon_{t-i} \geq 0 \end{cases}.$$

3.13 Residual Analysis

3.13.1 Tests for Auto Correlation

Residuals obtained from OLS regression model is used to test the autocorrelation of the residuals. There are two tests which are widely used to test the autocorrelation. Fist is Durbin-Watson test and second is Ljung-Box Test. When the explanatory variables include a lagged dependent variable the Durbin-Watson test statistic is biased towards 2 and therefore it is not a valid test for autocorrelation. Therefore in this study Ljung-Box Test is used to test the autocorrelation.

3.13.2 Tests for Heteroscedasticity

Two tests are available to check for Conditional heteroscedasticity, which is also known as the *ARCH* effects. The first test is to apply White's test to the residuals. The second test for conditional heteroscedasticity is the Lagrange multiplier test of Engle (1984).

3.13.3 Test for Normality

The normality of the residuals is tested using the Jarque-Bera test for normality. This test measures the skewness and kurtosis of the residuals compared to the normal distribution.

3.14 Budget Announcement Effect

The mean equation (eq^n (2)) is a simple autoregressive structure augmented with dummy variable used for both the intercept and the slope. This study focus here would be to see whether there is an impact of budget related news on the stock returns and not to predict stock returns, hence the non- inclusion of the return on market portfolio or any other macroeconomic variables as regressors.

Due to the market responses to the arrival of various budget related news, during a certain period around the budget, the market tends to show returns and volatility of returns that are different from their normal. This is usually referred to as a period during which abnormal returns and abnormal volatility can be observed. The fitted model is able to capture this abnormal behavior of the market around the budget. Statistically significant μ_1 in equation (2) implies that the returns during pre-budget, pre and post budget, post-budget in n days are abnormal. A negative sign would imply a significant reduction in returns. μ_2 in equation (2) implies that change in returns relative to previous working day's returns during pre-budget, pre and post budget, post-budget in n days is significantly different from its usual value. A negative sign would suggest a reduction of this sensitivity.

Variance equation is also augmented with a dummy variable to check whether the volatility of stock returns is remarkably different the pre-budget, pre and post budget, post-budget in n days. More specially, λ_1 statistically significant and positive in variance equation, suggests that the degree to which the returns fluctuate during pre-budget, pre and post budget, post-budget in n days is significantly higher than the normal degree of fluctuations of returns. This implies increased volatility or uncertainty during those pre-budget, pre and post budget, post-budget in n days.

CHAPTER 4

DATA ANALYSIS AND RESULTS

4.1 Introduction

The study focuses on the behavior of stock returns and volatility around three budget speeches. Time series analysis method is used to reach the objective of the study. There are number of days in the budget calendar, the budget speech day (minister of the finance presenting the 2nd budget speech to the parliament) is the day which makes the budget published. This date has been considered as the event date. The sample period of the study is from 1st April 2015 to 29th March 2018. For the period 2015-2018, the union budget was put forth in the parliament 3 times by finance ministers under "yahapalana" government regimes. i.e. 3 events. The selected sample period consist of 722 daily observations. The list of 3 budget announcements dates is provided in Table 4.1.

Table 4.1: Year and date of budget announcement by finance ministers under government regimes for the period 2015-2018

Year	Date of Budget announcement	Finance minister proposing the budget
2015	20th November 2015	Hons. Ravi Karunanayaka
2016	10th November 2016	Hons. Ravi Karunanayaka
2017	9th November 2017	Hons. Mangala Samaraweera

There are 298 companies listed in the CSE as at 29th June 2018 representing 20 business sectors. Diversified Holdings (DIV) sector has been selected for the study.

The daily returns are calculated using the log difference of the ASPI index for selected sector, as follows;

$$r_t = \log\left(\frac{P_t}{P_{t-1}}\right) \times 100$$

Where r_t is the daily return on day t, P_t is the closing value of ASPI on day t, and P_{t-1} is the previous day closing value of ASPI.

4.2 Diversified Holding Sector

Under this sector there are 32 companies from the 296 companies registered at Colombo Stock Exchange.

As represented in Figure 4.1 around 20th November 2015, 10th November 2016 and 9th November 2017 there is rapid variations of daily stock prices exists.

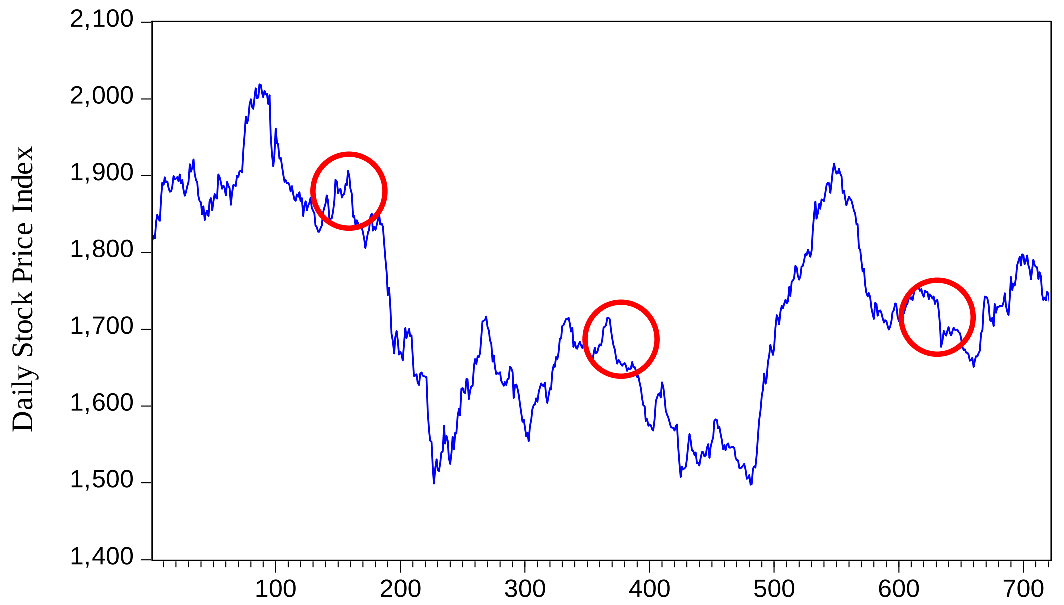


Figure 4.1: Plot of daily stock price index of Diversified Holding Sector

As represented in Figure 4.1 there are some up and downs in stock prices around budget announcement days. Further analysis of stock prices is needed to capture these variations.

Table 4.2: Descriptive Statistics of Stock Price and Stock Returns

Statistic	Stock Price	Stock Return
Mean	1729.908	-0.0000544
Median	1716.720	-0.000281
Maximum	2018.930	0.021619
Minimum	1497.640	-0.029005
Standard Deviation	124.9175	0.006680
Skewness	0.140927	-0.117529
Kurtosis	2.104709	4.110881
Jarque-Bera	26.50306	38.73299

Table 4.2 represents descriptive statistics of stock price and stock returns of Diversified Holding sector of Colombo stock market for the period from 1st April 2015 to 29th March 2018. The average daily returns are negative. In daily stock price, difference between maximum and minimum is 521.29. Stock price reflect positive skewness and return reflect negative skewness indicating that they are asymmetric. Stock return kurtosis is higher than that of a normal distribution showing the fat tails stylized fact of the empirical distributions. But stock price kurtosis is lower than that of a normal distribution showing spread of data over wider area.

4.2.1 ADF Unit Root Test: Evaluating Stationary Conditions

Unit root test is to check the stationary condition of a model. In order to consider a data series under time series assumptions that series should satisfy stationary conditions which are Mean constant, variance constant and covariance between two time periods is only depending on lag between two periods.

If only the aforesaid criteria are satisfied, data can be modeled with a time series model. Hence, the set is examined for stationary condition using unit root test with below hypothesis,

H_0 : Data set has a unit root

H_1 : Data set doesn’t have a unit root

First, ADF test is applied on level series including both intercept and trend parameters as the data set shows the existence of trend and intercept, respective results for the data set is as follow,

Table 4.3: ADF Unit Root Test – Diversified Holdings Sector index level series

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.386687	0.8643
Test critical values:	1% level	-3.970849	
	5% level	-3.416070	
	10% level	-3.130318	

According to Table 4.3, P value of the test is greater than 0.05. Hence null hypothesis is should be accepted and concluded that level series of ASPI has a unit root. Then ASPI level data series is non-stationary. Since level series is non-stationary, ADF test was carried out on first log differenced series of ASPI and results are shown below,

Table 4.4: ADF Unit Root Test – Diversified Holdings Sector index first differenced series

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-23.61105	0.0000
Test critical values:	1% level	-3.970849	
	5% level	-3.416070	
	10% level	-3.130318	

Table 4.4 represents P value of the first differenced series is lower than 0.05, therefore it can be concluded that null hypothesis is rejected and series doesn’t have a unit root. Therefore, first differenced series is stationary.

After applying ADF test on the dependent variable it was shown that the first differenced series of the data set is stationary. Therefore, differenced series of the dependent variable is used to build a time series model in order to capture the behavior of stock market return and volatility of this sector around the government budget announcement. Generally, return series is commonly considered in analyzing the volatility of the stocks as it provides a better view of volatility. Therefore, log returns of daily ASPI were taken in to consideration to model conditional returns and volatility.

4.2.2 Testing Volatility Clusters

Figure 4.2 represents daily return of ASPI over considered time period and it can be easily seen the fluctuations/volatility of returns based on factors, which prevailed during the same period. The impact on volatility due to bad and good news can be explained by analyzing the patterns of the graph. High fluctuations may be due to unexpected bad news, while lower volatilities represent expected good news. Similar scenario can be led to asymmetric scenario in volatility clusters.

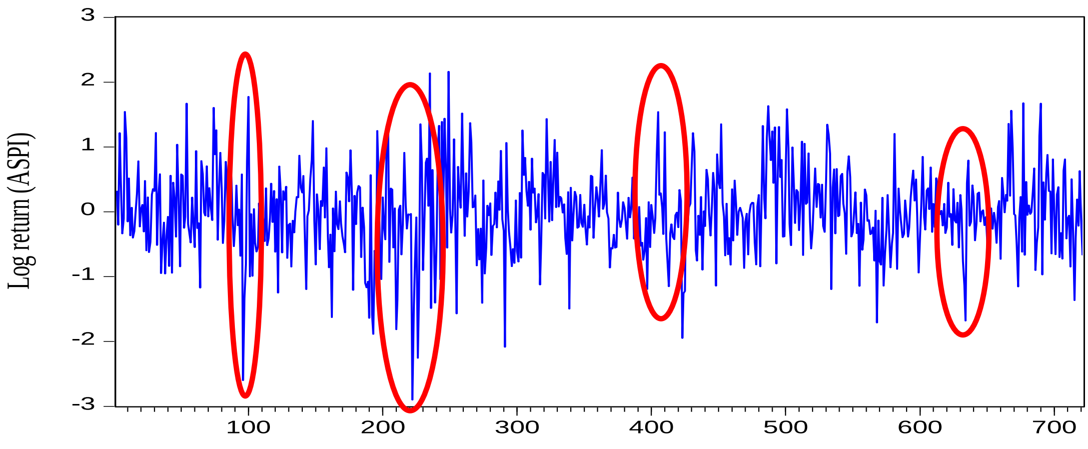


Figure 4.2: Time series Plot of daily returns of ASPI for Diversified Holding Sector

It is clear that there are multiple volatility clusters in the above graph. Moreover, high volatility is followed by another period high volatility and low volatility is followed by another period of low volatility and this pattern prolonged over a considerable amount of time. Clusters, which represent aforesaid properties, were highlighted in the above figures.

As volatility clustering represents a strong autocorrelation in squared returns, the same series of ASPI was obtained as Figure 4.3 to get a clear view of the volatility clusters.

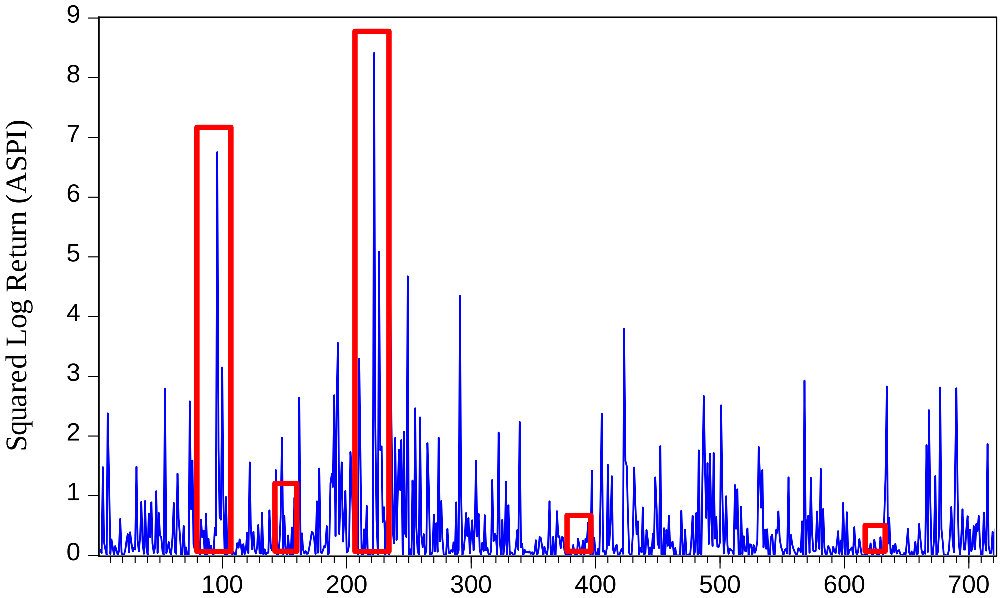


Figure 4.3: Time series Plot of squared daily returns of ASPI for Diversified Holding Sector

It can be considered that daily values of ASPI comprise volatility clusters with low and high volatilities. In order to assure that existence of volatility clusters ASPI return series was tested against statistical significance using Box- Pierce LM test.

Volatility clustering is one of the main characteristics exist in volatility. This implies that the existence of the strong autocorrelation of the squared returns. Therefore,

first order autocorrelation of the squared returns can be used to test the volatility clustering. Box-Pierce LM test is used for this purpose.
In this test,

1st order autocorrelation in squared returns is given by,

$$\hat{\gamma}_1 = \frac{\sum_{t=2}^{n} {r_t}^2 r_{t-1}^2}{\sum_{t=2}^{n} {r_t}^4} = 0.350482348$$

Then the Box-Pierce test statistic is given by
Test statistic: $\chi_1^2 = 3.84$

$$Q(1) = n\hat{\gamma}_1 = 253.0482549$$

Where $n = 722$

As per the results respective Q statistic value is greater than test statistic criterion χ_1^2 of 3.84, at 5% significant level. Hence this provided clear evidence to reject null hypothesis and it reassured non-existence of autocorrelation in squared return at 5% significance level. Similarly, this provided a sufficient evidence to prove that there exists a conditional heteroscedasticity in daily returns of ASPI. Now it is clear that the existence of significant volatility clusters in ASPI log return series, therefore it is safe to conclude that there is an ARCH effect in the data set during the considered time period. Hence, this can be considered as the entry criteria to use ARCH model in order to capture the existence of the behavior of stock return and volatility of this sector.

4.2.3 Asymmetric/Symmetric Nature of the volatility

Prior to apply GARCH/ EGARCH/ GJR GARCH models, it is required to analyze symmetricity of the volatility clusters. In case, there is asymmetry in volatility, fitting ARCH model doesn't produce accurate outcomes as ARCH model is incapable of capturing asymmetric volatility.

Asymmetry in volatility occurs due to significant increase in volatility when stock prices fall, compared to rise of the same. As mentioned in the methodology, below test can be used to identify the asymmetric volatility.

$$v = \frac{\sum_{t=2}^{n} {r_t}^2 \, r_{t-1}}{\sqrt{\sum_{t=2}^{n} {r_t}^4 \sum_{t=2}^{n} r_{t-1}^2}}$$

As per the above formula, if autocorrelation between yesterday's return and today's square returns are negative, it can be concluded the existence of asymmetric volatility. In order to calculate the above v value, test was carried out on Microsoft excel and the result is as below,

$$\sum_{t=2}^{n} {r_t}^2 \, r_{t-1} = -3.3414$$

$$\sqrt{\sum_{t=2}^{n} {r_t}^4 \sum_{t=2}^{n} r_{t-1}^2} = 35.6103$$

$$v = \frac{\sum_{t=2}^{n} {r_t}^2 \, r_{t-1}}{\sqrt{\sum_{t=2}^{n} {r_t}^4 \sum_{t=2}^{n} r_{t-1}^2}} = -0.0938$$

Result of the above test is negative hence, it provides sufficient grounds to conclude that volatility in ASPI returns is asymmetric. Therefore, EGARCH and GJR GARCH models can be used to derive a model which is used to examine the behavior of stock return and volatility.

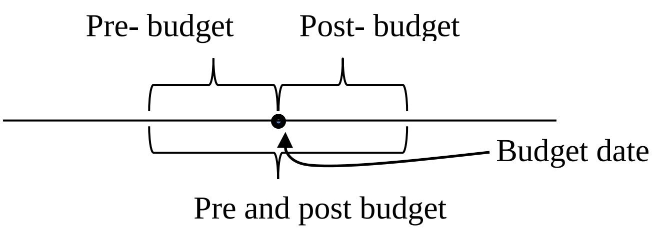
4.3 Time Series Analysis

Secondary data is used to examine the behavior of stock return and volatility in this sector. Diversified Holdings sector index from 1st April 2015 to 29th March 2018 used to derive models that are used to examine the behavior of stock return and volatility. Aforesaid period contains 722 data points.

In measuring the impact of budget related news on stock returns and volatility, attention to below factors:

a) The length of the period, during which abnormal returns and volatilities are assumed to exist(i.e. the length of time period, for which the dummy variable is used or the value of n) $n = 5, 10, 15$

b) Whether the abnormal returns and volatilities are assumed to exist during pre- budget period, both pre and post budget period and post budget periods (i.e. whether the dummy variable is applied to pre-budget period, both pre and post budget period and post budget period)



Model fitting was carried out on Eviews, as the first step, log return of ASPI modeled using GJR-GARCH method taking dummy variable for budget announcement date as the independent variable. Error distribution is modeled using normal distribution. AR (1) and MA (1) terms are included in the mean equations for fitted models.

4.3.1 Model for pre-budget period with n=5

Table 4.5: Mean and variance equation of GJR-GARCH (1, 3) model

Variable	Coefficient	Std.Error	Z-statistic	Probability
Conditional Mean Equation				
D	-0.087	0.039	-2.204	0.027
C	0.001	0.002	0.425	0.671
D*r_{t-1}	-0.161	0.116	-1.381	0.167
r_{t-1}	0.899	0.034	26.006	0.000
AR(1)	0.026	0.037	0.706	0.479
MA(1)	-0.825	0.050	-16.227	0.000

Conditional Variance Equation				
C	0.021	0.013	1.677	0.093
ε_{t-1}^2	0.038	0.008	4.883	0.000
$I_{t-1}\varepsilon_{t-1}^2$	0.019	0.024	0.781	0.434
$I_{t-2}\varepsilon_{t-2}^2$	-0.001	0.016	-0.039	0.968
$I_{t-3}\varepsilon_{t-3}^2$	0.026	0.024	1.084	0.278
σ_{t-1}^2	1.549	0.029	51.761	0.000
σ_{t-2}^2	-1.599	0.020	-79.005	0.000
σ_{t-3}^2	0.934	0.029	31.347	0.000
D	0.004	0.018	0.203	0.838

Using the coefficients represented in the Table 4.5 mean and variance equations of GJR-GARCH (1, 3) model can be written as follows,

Mean Equation:

$$r_t = -0.087\,D + 0.899\ r_{t-1} - 0.825\,\varepsilon_{t-1} + \varepsilon_t$$

Variance Equation:

$$\sigma_t^2 = 0.038\,\varepsilon_{t-1}^2 + 1.549\,\sigma_{t-1}^2 - 1.599\,\sigma_{t-2}^2 + 0.934\,\sigma_{t-3}^2$$

According to above mean equation, return on pre- budget period with n=5 is reduce by 8.7% compared to other days and according to the variance equation, current volatility is influence by lag one of the residuals, lag one, two and three of the volatility.

Diagnostic testing for the model

The model finalized under the above section represented a sufficient capability in capturing the behavior of stock return and volatility of the sector. Therefore, it was decided to run below diagnostic test on the model to check the adequacy of the model,

1. Ljung-Box Q-statistics for standardized residuals
2. Ljung-Box Q-statistics for squared standardized residuals
3. ARCH LM test
4. Normality test

Ljung-Box Q-statistics for standardized residuals

Ljung-Box Q-statistics test is carried out on standardized residual series in order to measure the adequacy of the model and result is as follows,

Table 4.6: Q-statistics and P value of Ljung-Box test on standard residuals of the Model

Lag	**Model–GJR- GARCH (1,3)**	
	Q-statistic	**Probability**
1	0.962	0.327
2	0.963	0.618
3	3.539	0.316
4	7.954	0.093
5	8.633	0.125
6	9.604	0.142
7	10.354	0.169
8	10.354	0.241
9	10.613	0.303
10	10.613	0.388

Main objective of the test is to analyze whether there is a pattern in the residual terms. If there is a pattern in the error terms, the fitted model is not adequate as model hasn't been captured the trend in the data set. However, in Table 4.6, all other P values in subsequent lags are insignificant because respective P values are higher than 0.05 at 5% significant level. Therefore, it represented suitable evidence to conclude that there is no serial autocorrelation in squared standard residuals. Hence, it provides sufficient evidence on adequacy of the model accordingly to the test statistics of Ljung-Box Q-statistics.

Ljung-Box Q-statistics for squared standardized residuals

Similar to the above test, main objective of the squared standardized residual test is to ensure whether fitted model captures the trend in the data set. However, it has a different approach as it uses return series instead of residuals which were used in the first test. To create a squared return series, firstly GARCH variance series should be created, thereafter ASPI log return series is divided by GARCH variance series. Finally, the squares of the results were calculated which were obtained by dividing ASPI log returns by GARCH series.

Table 4.7 depicts the correlogram results of the squared returns,

Table 4.7: Q-statistics and P value of Ljung-Box test on squared standard residuals of the Model

Lag	**Model –GJR- GARCH (1,3)**	
	Q-statistic	**Probability**
1	0.088	0.766
2	0.483	0.785
3	1.224	0.747
4	1.241	0.871
5	1.265	0.938
6	2.452	0.874
7	2.603	0.919
8	2.604	0.957
9	2.628	0.977
10	2.823	0.985

ARCH - LM test

In order to test the presence of additional autoregressive conditional heteroscedasticity, ARCH- LM test is used.

Table 4.8: ARCH LM test statistic values and P values of the Model

	Model –GJR- GARCH (1,3)	
	Test Statistic	**Probability**
F- Statistic	0.014	0.905
Obs*R- squared	0.014	0.905

According to the Table 4.8, it is clear that two test statistics do not reject the null hypothesis, of non-existence of autoregressive conditional heteroscedasticity (ARCH) in the residuals at 5% significant level. This means residuals of the model do not contain autoregressive conditional heteroscedasticity. Thus, these tests provide further assurance on adequacy of the model.

Normality test

If this model is well specified, error distribution should behave in random manner, in other words Skewness and Kurtosis of residuals tend to represent properties of normality by representing values 0 for Skewness and 3 for Kurtosis. Hence, the normality of errors is checked for the model as below.

Table 4.9: Normality test for residuals

Description	**Model – GJR-GARCH(1,3)**
Skewness	-0.001
Kurtosis	3.516
Jarque-Bera	7.977
Probability	0.018

It is clear that error distribution of the model depict properties of normality conditions as kurtosis and skewness of errors approximately satisfy normality condition. As per the results Jarque-Bera value is lower than test statistic criterion $\chi^2_{2,1-\alpha}$ of 9.21, at 1% significant level. Hence this provided clear evidence to accept null hypothesis and it is safe to consider that errors are normally distributed.

In above model statistically significant μ_1 in Table 4.5 suggest that there is abnormality in returns during pre-budget period with n=5. The negative sign implies a significant reduction in returns. Statistically insignificant μ_2 in the model suggest that there is no abnormality in the change in returns relative to the previous working day's return around the budget. The coefficient of the dummy variable λ_1 in the variance equation of the model is insignificant.

4.3.2 Model for pre and post budget period with n=5

Table 4.10: Mean and variance equation of GJR- GARCH (3,3) model

Variable	Coefficient	Std.Error	Z-statistic	Probability
Conditional Mean Equation				
D	-0.115	0.044	-2.600	0.009
C	-0.006	0.003	-1.551	0.120
D*r_{t-1}	-0.217	0.113	-1.919	0.055
r_{t-1}	0.851	0.059	14.201	0.000
AR(1)	0.118	0.040	2.949	0.003
MA(1)	-0.807	0.077	-10.451	0.000
Conditional Variance Equation				
C	0.019	0.014	1.366	0.171
ε^2_{t-1}	0.098	0.023	4.251	0.000
$I_{t-1}\varepsilon^2_{t-1}$	0.008	0.024	0.332	0.739
ε^2_{t-2}	0.077	0.020	3.754	0.000

$I_{t-2}\varepsilon_{t-2}^2$	0.003	0.019	0.178	0.858
ε_{t-3}^2	0.009	0.022	0.402	0.687
$I_{t-3}\varepsilon_{t-3}^2$	0.025	0.023	1.082	0.279
σ_{t-1}^2	0.026	0.023	1.127	0.259
σ_{t-2}^2	-0.207	0.019	-10.478	0.000
σ_{t-3}^2	0.924	0.023	38.576	0.000
D	0.033	0.027	1.236	0.216

Using the coefficients represented in Table 4.10 mean and variance equations of GJR-GARCH (3,3) model can be written as follows,

Mean Equation:

$$r_t - 0.115\, D + 0.970\, r_{t-1} - 0.807\varepsilon_{t-1} + \varepsilon_t$$

Variance Equation:

$$\sigma_t^2 = 0.098\, \varepsilon_{t-1}^2 + 0.077\, \varepsilon_{t-2}^2 - 0.207\, \sigma_{t-2}^2 + 0.924\, \sigma_{t-3}^2$$

According to above mean equation, return on pre and post budget period with n=5 is reduce by 11.5 % compared to other days and according to the variance equation, current volatility is influence by lag one and two of the residuals, lag two and three of the volatility.

Diagnostic testing for the Model

Ljung-Box Q-statistics for standardized residuals

Ljung-Box Q-statistics test is carried out on standardized residual series in order to measure the adequacy of the model and results are as follows,

Table 4.11: Q-statistics and P value of Ljung-Box test on standard residuals of the model

Lag	Model–GJR- GARCH (3,3)	
	Q-statistic	**Probability**
1	3.038	0.081
2	3.058	0.217
3	5.880	0.118
4	7.621	0.106
5	7.727	0.172
6	7.921	0.244
7	8.584	0.284
8	9.012	0.341
9	9.015	0.436
10	9.028	0.529

According to Table 4.11, all P values in subsequent lags are insignificant. Therefore, it represented suitable evidence to conclude that there is no serial autocorrelation in squared standard residuals. Hence, it provides sufficient evidence on adequacy of the model accordingly to the test statistics of Ljung-Box Q-statistics.

Ljung-Box Q-statistics for squared standardized residuals

Table 4.12 represents the correlogram results of the squared returns,

Table 4.12: Q-statistics and P value of Ljung-Box test on squared standard residuals of the model

Lag	Model–GJR- GARCH (3,3)	
	Q-statistic	**Probability**
1	0.648	0.421

2	0.735	0.692
3	0.781	0.854
4	1.152	0.886
5	1.414	0.923
6	2.904	0.821
7	3.029	0.882
8	4.676	0.792
9	4.897	0.843
10	4.937	0.895

ARCH - LM test

In order to test the presence of additional autoregressive conditional heteroscedasticity, ARCH- LM test is used.

Table 4.13: ARCH LM test statistic values and P values of the Model

	Model–GJR- GARCH (3,3)	
	Test Statistic	**Probability**
F- Statistic	0.209	0.647
Obs*R- squared	0.210	0.646

According to Table 4.13, it is clear that two test statistics do not reject the null hypothesis, of non-existence of ARCH in the residuals at 5% significant level. This means residuals of the model do not contain ARCH effect. Thus, these tests provide further assurance on adequacy of the models.

Normality test

Normality of the errors is checked using Jarque-Bera test as below,

Table 4.14: Normality test for residuals

Description	**Model– GJR-GARCH(3,3)**
Skewness	-0.124
Kurtosis	3.488
Jarque-Bera	9.012
Probability	0.011

It is clear that error distribution of the model depict properties of normality conditions as kurtosis and skewness of errors approximately satisfy normality condition. Jarque-Bera value is lower than test statistic criterion $\chi^2_{2,1-\alpha}$ of 9.21, at 1% significant level. Hence this provided clear evidence to accept null hypothesis and it is safe to consider that errors are normally distributed.

In above model statistically significant μ_1 in Table 4.10 suggest that there is abnormality in returns during pre and post budget period with n=5. The negative sign implies a significant reduction in returns. Statistically insignificant μ_2 in the model suggest that there is no abnormality in the change in returns relative to the previous working day's return around the budget. The coefficient of the dummy variable λ_1 in the variance equation of the model is insignificant.

4.3.3 Model for post-budget period with n=5

Table 4.15: Mean and variance equation of GJR-GARCH (2, 3) model

Variable	Coefficient	Std.Error	Z-statistic	Probability
Conditional Mean Equation				
D	-0.115	0.057	-2.021	0.043
C	0.000	0.004	0.003	0.997

D*r_{t-1}	-0.194	0.141	-1.376	0.168
r_{t-1}	0.887	0.061	14.328	0.000
AR(1)	0.043	0.052	0.843	0.398
MA(1)	-0.819	0.083	-9.843	0.000
Conditional Variance Equation				
C	0.012	0.009	1.266	0.205
ε_{t-1}^2	0.072	0.013	5.259	0.000
$I_{t-1}\varepsilon_{t-1}^2$	-0.010	0.024	-0.418	0.675
ε_{t-2}^2	-0.018	0.014	-1.241	0.214
$I_{t-2}\varepsilon_{t-2}^2$	0.035	0.013	2.651	0.008
$I_{t-3}\varepsilon_{t-3}^2$	0.029	0.020	1.443	0.149
σ_{t-1}^2	1.052	0.021	49.186	0.000
σ_{t-2}^2	-1.087	0.009	-112.019	0.000
σ_{t-3}^2	0.923	0.021	43.684	0.000
D	0.032	0.019	1.681	0.092

Using the coefficients represented in Table 4.15, mean and variance equations of GJR-GARCH (2, 3) model can be written as follows,

Mean Equation:

$$r_t = -0.115\, D + 0.887\, r_{t-1} - 0.819\, \varepsilon_{t-1} + \varepsilon_t$$

Variance Equations:

$$\sigma_t^2 = 0.072\, \varepsilon_{t-1}^2 + 0.035\, \varepsilon_{t-2}^2 + 1.052\, \sigma_{t-1}^2 - 1.087\, \sigma_{t-2}^2 + 0.923\, \sigma_{t-3}^2 \;\; ; \varepsilon_{t-2} < 0$$

$$\sigma_t^2 = 0.072\, \varepsilon_{t-1}^2 + 1.052\, \sigma_{t-1}^2 - 1.087\, \sigma_{t-2}^2 + 0.923\, \sigma_{t-3}^2 \quad ; \varepsilon_{t-2} \geq 0$$

According to above mean equation, return on post- budget with n=5 is reduce by 11.5% compared to other days and according to the variance equations, current volatility is influence by lag one and two of the residuals, lag one, two and three of the volatility.

Diagnostic testing for the model

Ljung-Box Q-statistics for standardized residuals

Ljung-Box Q-statistics test is carried out on standardized residual series in order to measure the adequacy of the model and results are as follows,

Table 4.16: Q-statistics and P value of Ljung-Box test on standard residuals of the Model

Lag	**Model–GJR- GARCH (2,3)**	
	Q-statistic	**Probability**
1	1.341	0.247
2	1.367	0.505
3	3.882	0.274
4	7.059	0.133
5	7.544	0.183
6	8.603	0.197
7	9.054	0.249
8	9.264	0.320
9	9.265	0.413
10	9.265	0.507

Table 4.16 represents, all P values in subsequent lags are insignificant because respective P values are higher than 0.05 at 5% significant level. Therefore there enough evidence to conclude that there is no serial autocorrelation in squared standard residuals. Hence, it provides sufficient evidence on suitability of the model accordingly to the test statistics of Ljung-Box Q-statistics.

Ljung-Box Q-statistics for squared standardized residuals

Table 4.17 depicts the correlogram results of the squared returns.

Table 4.17: Q-statistics and P value of Ljung-Box test on squared standard residuals of the model

Lag	Model–GJR- GARCH (2,3)	
	Q-statistic	**Probability**
1	0.200	0.654
2	0.474	0.789
3	0.591	0.898
4	1.000	0.910
5	1.150	0.950
6	2.394	0.880
7	2.434	0.932
8	2.786	0.947
9	3.797	0.924
10	4.049	0.945

ARCH - LM test

In order to test the presence of additional autoregressive conditional heteroscedasticity, ARCH- LM test is used.

Table 4.18: ARCH LM test statistic values and P values of the model

	Model–GJR- GARCH (2,3)	
	Test Statistic	**Probability**
F- Statistic	0.003	0.954
Obs*R- squared	0.003	0.954

According to Table 4.18, it is clear that two test statistics do not reject the null hypothesis, of non-existence of autoregressive conditional heteroscedasticity in the residuals at 5% significant level. This means residuals of the model do not contain autoregressive conditional heteroscedasticity. Thus, these tests provide further assurance on adequacy of the model.

Normality test

Table 4.19 represents the results of the normality test.

Table 4.19: Normality test for residuals

Description	**Model– GJR-GARCH(2,3)**
Skewness	-0.029
Kurtosis	3.496
Jarque-Bera	7.482
Probability	0.023

It is clear that error distribution of the model represent properties of normality conditions as kurtosis and skewness of errors approximately satisfy normality condition. As per the results Jarque-Bera value is lower than test statistic criterion $\chi^2_{2,1-\alpha}$ of 9.21. At 1% significance level accept the null of that the errors are normally distributed.

In above model statistically significant μ_1 in Table 4.15 suggest that there is abnormality in returns during post-budget period with n=5. The negative sign implies a significant reduction in returns. Statistically insignificant μ_2 in the model suggest that there is no abnormality in the change in returns relative to the previous working day's return around the budget. The coefficient of the dummy variable λ_1 in the variance equation of the model is insignificant.

4.3.4 Model for pre-post budget period with n=10

Table 4.20: Mean and variance equation of GJR-GARCH (1,3) model

Variable	Coefficient	Std.Error	Z-statistic	Probability
Conditional Mean Equation				
D	-0.066	0.032	-2.057	0.039
C	-0.005	0.004	-1.140	0.254
D*r_{t-1}	-0.197	0.075	-2.599	0.009
r_{t-1}	0.826	0.067	12.314	0.000
AR(1)	0.083	0.039	2.089	0.036
MA(1)	-0.774	0.080	-9.603	0.000
Conditional Variance Equation				
C	0.011	0.012	0.909	0.363
ε_{t-1}^2	0.081	0.012	6.488	0.000
$I_{t-1}\varepsilon_{t-1}^2$	-0.016	0.006	-2.359	0.018
$I_{t-2}\varepsilon_{t-2}^2$	0.001	0.006	0.164	0.869
σ_{t-1}^2	0.078	0.014	5.515	0.000
σ_{t-2}^2	-0.160	0.010	-15.341	0.000
σ_{t-3}^2	0.974	0.012	76.585	0.000
D	0.020	0.015	1.331	0.182

Using the coefficients represented in Table 4.20 mean and variance equations of GJR-GARCH (1, 3) model can be written as follows;

Mean Equation:

$$r_t = -0.066\ D - 0.197\, D * r_{t-1} + 0.909\, r_{t-1} - 0.774\, \varepsilon_{t-1} + \varepsilon_t$$

Variance Equations:

$$\sigma_t^2 = 0.065\, \varepsilon_{t-1}^2 + 0.078\, \sigma_{t-1}^2 - 0.160\, \sigma_{t-2}^2 + 0.974\, \sigma_{t-3}^2 \ ; \varepsilon_{t-1} < 0$$

$$\sigma_t^2 = 0.081\, \varepsilon_{t-1}^2 + 0.078\, \sigma_{t-1}^2 - 0.160\, \sigma_{t-2}^2 + 0.974\, \sigma_{t-3}^2 \ ; \ \varepsilon_{t-1} \geq 0$$

According to above mean equation, return on pre and post budget with n=10 is reduce by 6.6% compared to other days and according to variance equations, current volatility is influence by lag one of the residuals, lag one, two and three of the volatility.

Diagnostic testing for the model

Ljung-Box Q-statistics for standardized residuals

Ljung-Box Q-statistics test is carried out on standardized residual series in order to measure the adequacy of model and result is as follows,

Table 4.21: Q-statistics and P value of Ljung-Box test on standard residuals of the Model

Lag	**Model–GJR- GARCH (1,3)**	
	Q-statistic	**Probability**
1	3.828	0.051
2	4.043	0.132
3	7.409	0.060
4	9.224	0.056
5	9.445	0.093
6	9.858	0.131
7	10.353	0.169
8	10.595	0.226
9	10.599	0.304
10	10.740	0.378

Table 4.21 represent all P values in subsequent lags are insignificant. Therefore, it represented suitable evidence to conclude that there is no serial autocorrelation in squared standard residuals. Hence, it provides sufficient evidence on adequacy of the model accordingly to the test statistics of Ljung-Box Q-statistics.

Ljung-Box Q-statistics for squared standardized residuals

Table 4.22 depicts the correlogram result of the squared returns.

Table 4.22: Q-statistics and P value of Ljung-Box test on squared standard residuals of the Model

Lag	**Model–GJR- GARCH (1,3)**	
	Q-statistic	**Probability**
1	4.181	0.071
2	4.715	0.095
3	6.569	0.087
4	7.142	0.129
5	7.323	0.198
6	7.360	0.289
7	8.232	0.313
8	9.607	0.294
9	11.727	0.229
10	12.012	0.284

ARCH - LM test

In order to test the presence of additional autoregressive conditional heteroscedasticity, ARCH- LM test is used.

Table 4.23: ARCH LM test statistic values and P values of the Model

	Model–GJR- GARCH (1,3)	
	Test Statistic	**Probability**
F- Statistic	0.370	0.543
Obs*R- squared	0.370	0.542

According to Table 4.23, it is clear that test statistics do not reject the null hypothesis, of non-existence of ARCH in the residuals at 5% significant level. This means residual of this model does not contain ARCH effect. Thus, this test provides further assurance on adequacy of the model.

Normality test

Table 4.24 represents the results of the normality test.

Table 4.24: Normality test for residuals

Description	**Model– GJR-GARCH(1,3)**
Skewness	-0.041
Kurtosis	3.525
Jarque-Bera	8.481
Probability	0.014

It is clear that error distributions of the model represent properties of normality conditions and kurtosis and skewness of errors approximately satisfy normality condition. According to Table 4.24 Jarque-Bera value is lower than test statistic criterion $\chi^2_{2,1-\alpha}$ of 9.21, at 1% significant level. Hence test statistics accept the null hypothesis and it is safe to consider that errors are normally distributed.

In above model statistically significant μ_1 and μ_2 in Table 4.20 suggest that there is abnormality in returns and the change in returns relative to the previous working day's return during pre and post budget with n=10 respectively. The negative sign implies a significant reduction in returns and reduction of the change in returns relative to the previous working day's return around the budget. The coefficient of the dummy variable λ_1 in the variance equation of above model is insignificant.

4.3.5 Model for post budget period with n=10

Table 4.25: Mean and variance equation of GJR-GARCH (1,3) model

Variable	Coefficient	Std.Error	Z-statistic	Probability
Conditional Mean Equation				
D	-0.067	0.034	-1.973	0.048
C	0.000	0.003	0.104	0.916
D*r_{t-1}	-0.187	0.123	-1.519	0.128
r_{t-1}	0.898	0.054	16.375	0.000
AR(1)	0.047	0.044	1.075	0.282
MA(1)	-0.857	0.068	-12.436	0.000
Conditional Variance Equation				
C	0.108	0.040	2.669	0.007
ε_{t-1}^2	0.018	0.003	5.737	0.000
$I_{t-1}\varepsilon_{t-1}^2$	0.067	0.023	2.905	0.003
$I_{t-2}\varepsilon_{t-2}^2$	0.123	0.044	2.771	0.005
$I_{t-3}\varepsilon_{t-3}^2$	0.042	0.022	1.872	0.061
σ_{t-1}^2	-1.068	0.028	-37.370	0.000
σ_{t-2}^2	0.767	0.058	13.011	0.000
σ_{t-3}^2	0.910	0.031	28.594	0.000
D	-0.021	0.025	-0.839	0.401

Using the coefficients represented in Table 4.25 mean and variance equations of GJR-GARCH (1, 3) model can be written as follows,

Mean Equation:

$$r_t = -0.067\ D + 0.898\, r_{t-1} - 0.857\, \varepsilon_{t-1} + \varepsilon_t$$

Variance Equations:

$$\sigma_t^2 = 0.108 + 0.085\, \varepsilon_{t-1}^2 + 0.123\, \varepsilon_{t-2}^2 - 1.068\, \sigma_{t-1}^2 + 0.767\, \sigma_{t-2}^2 + 0.910\, \sigma_{t-3}^2 \ ;$$

$$\varepsilon_{t-1} < 0\ , \qquad \varepsilon_{t-2} < 0$$

$$\sigma_t^2 = 0.108 + 0.018\,\varepsilon_{t-1}^2 + 0.123\,\varepsilon_{t-2}^2 - 1.068\,\sigma_{t-1}^2 + 0.767\,\sigma_{t-2}^2 + 0.910\,\sigma_{t-3}^2\,;$$

$$\varepsilon_{t-1} \geq 0\ , \qquad \varepsilon_{t-2} < 0$$

$$\sigma_t^2 = 0.108 + 0.085\,\varepsilon_{t-1}^2 - 1.068\,\sigma_{t-1}^2 + 0.767\,\sigma_{t-2}^2 + 0.910\,\sigma_{t-3}^2\,;$$

$$\varepsilon_{t-1} < 0\ , \varepsilon_{t-2} \geq 0$$

$$\sigma_t^2 = 0.108 + 0.018\,\varepsilon_{t-1}^2 - 1.068\,\sigma_{t-1}^2 + 0.767\,\sigma_{t-2}^2 + 0.910\,\sigma_{t-3}^2\,;$$

$$\varepsilon_{t-1} \geq 0\,, \varepsilon_{t-2} \geq 0$$

According to above mean equation, return on post-budget with n=10 is reduce by 6.7% compared to other days and according to the variance equations, current volatility is influence by lag one and two of the residuals, lag one, two and three of the volatility.

Diagnostic testing for the model

Ljung-Box Q-statistics for standardized residuals

Ljung-Box Q-statistics test is carried out on standardized residual series in order to measure the adequacy of model and result is as follows,

Table 4.26: Q-statistics and P value of Ljung-Box test on standard residuals of the Model

Lag	**Model–GJR- GARCH (1,3)**	
	Q-statistic	**Probability**
1	3.050	0.081
2	3.052	0.217
3	5.360	0.147
4	9.280	0.054
5	10.124	0.072
6	10.365	0.110
7	10.803	0.147
8	10.871	0.209
9	11.529	0.241
10	11.547	0.316

According to Table 4.26, all other P values in subsequent lags are insignificant. Therefore, it represented suitable evidence to conclude that there is no serial autocorrelation in squared standard residuals. Hence, it provides sufficient evidence on adequacy of the model accordingly to the test statistics of Ljung-Box Q-statistics.

Ljung-Box Q-statistics for squared standardized residuals

Table 4.27 depicts the correlogram result of the squared returns,

Table 4.27: Q-statistics and P value of Ljung-Box test on squared standard residuals of the Model

Lag	**Model–GJR- GARCH (1,3)**	
	Q-statistic	**Probability**
1	1.548	0.213
2	3.896	0.143
3	3.906	0.272
4	4.773	0.311
5	5.130	0.400
6	5.160	0.523
7	5.578	0.590
8	5.747	0.675
9	5.747	0.765
10	7.121	0.714

ARCH - LM test

In order to test the presence of additional autoregressive conditional heteroscedasticity, ARCH- LM test is used.

Table 4.28: ARCH LM test statistic values and P values of Model

	Model–GJR- GARCH (1,3)	
	Test Statistic	**Probability**
F- Statistic	1.422	0.233
Obs*R- squared	1.423	0.232

According to Table 4.28, it is clear that test statistics accept the null hypothesis, of non-existence of autoregressive conditional heteroscedasticity (ARCH) in the residuals at 5% significant level. This means residual of this model does not contain autoregressive conditional heteroscedasticity. Thus, this test provides further assurance on adequacy of the model.

Normality test

Table 4.29 represents the results of the normality test.

Table 4.29: Normality test for residuals

Description	**Model– GJR-GARCH(1,3)**
Skewness	-0.063
Kurtosis	3.528
Jarque-Bera	8.851
Probability	0.011

According to Table 4.29 Jarque-Bera value is lower than test statistic criterion $\chi^2_{2,1-\alpha}$ of 9.21, at 1% significant level. Hence this provided clear evidence to accept null hypothesis. Error distributions of model depict properties of normality conditions and kurtosis and skewness of errors approximately satisfy normality condition. Hence, it is safe to consider that errors are normally distributed.

In above model statistically significant μ_1 in Table 4.25 suggest that there is abnormality in returns during post-budget period with n=10. The negative sign implies a significant reduction in returns. Statistically insignificant μ_2 in above model suggest that there is no abnormality in the change in returns relative to the previous working day's return around the budget. The negative sign suggest a reduction of the change in returns relative to the previous working day's return around the budget. The coefficient of the dummy variable λ_1 in the variance equation of above model is insignificant.

4.3.6 Model for pre- post budget period with n=15

Table 4.30: Mean and variance equation of GJR-GARCH (1,3) model

Variable	Coefficient	Std.Error	Z-statistic	Probability
Conditional Mean Equation				
D	-0.032	0.013	-2.309	0.020
C	-0.005	0.004	-1.319	0.187
D*r_{t-1}	-0.117	0.075	-1.554	0.120
r_{t-1}	0.857	0.045	18.794	0.000
AR(1)	0.075	0.040	1.836	0.066
MA(1)	-0.803	0.061	-13.067	0.000
Conditional Variance Equation				
C	0.034	0.021	1.621	0.104
ε_{t-1}^2	0.074	0.014	5.264	0.000
$I_{t-1}\varepsilon_{t-1}^2$	0.015	0.019	0.802	0.422
$I_{t-2}\varepsilon_{t-2}^2$	0.022	0.015	1.418	0.156
$I_{t-3}\varepsilon_{t-3}^2$	0.036	0.018	2.034	0.041
σ_{t-1}^2	0.047	0.024	1.907	0.056
σ_{t-2}^2	-0.191	0.020	-9.175	0.000
σ_{t-3}^2	0.949	0.021	44.243	0.000
D	0.001	0.013	0.103	0.917

Using the coefficients represented in Table 4.30 mean and variance equations of GJR-GARCH (1, 3) model can be written as follows,

Mean Equation:

$$r_t = -0.032\ D + 0.857\, r_{t-1} - 0.803\, \varepsilon_{t-1} + \varepsilon_t$$

Variance Equations:

$$\sigma_t^2 = 0.074\, \varepsilon_{t-1}^2 + 0.036\, \varepsilon_{t-3}^2 - 0.191\, \sigma_{t-2}^2 + 0.949\, \sigma_{t-3}^2\ ;\ \ \varepsilon_{t-3} < 0$$
$$\sigma_t^2 = 0.074\, \varepsilon_{t-1}^2 - 0.191\, \sigma_{t-2}^2 + 0.949\, \sigma_{t-3}^2\ ;\ \varepsilon_{t-3} \geq 0$$

According to above mean equation, return on pre and post budget with n=15 is reduce by 3.2% compared to other days and according to variance equations, current volatility is influence by lag one and three of the residuals, lag two and three of the volatility.

Diagnostic testing for the model

Ljung-Box Q-statistics for standardized residuals

Ljung-Box Q-statistics test is carried out on standardized residual series in order to measure the adequacy of model and result is as follows,

Table 4.31: Q-statistics and P value of Ljung-Box test on standard residuals of the Model

Lag	**Model–GJR- GARCH (1,3)**	
	Q-statistic	**Probability**
1	3.149	0.076
2	3.183	0.204
3	5.899	0.117

4	8.425	0.077
5	8.860	0.115
6	9.535	0.146
7	9.666	0.208
8	9.788	0.280
9	9.899	0.359
10	9.932	0.446

According to table 4.31, all other P values in subsequent lags are insignificant. Therefore, it is conclude that there is no serial autocorrelation in squared standard residuals. Hence, it provides sufficient evidence on adequacy of the model accordingly to the test statistics of Ljung-Box Q-statistics.

Ljung-Box Q-statistics for squared standardized residuals

Table 4.32 depicts the correlogram result of the squared returns,

Table 4.32: Q-statistics and P value of Ljung-Box test on squared standard residuals of Model

Lag	**Model–GJR- GARCH (1,3)**	
	Q-statistic	**Probability**
1	1.761	0.184
2	1.761	0.415
3	2.910	0.406
4	2.914	0.572
5	3.861	0.570
6	4.109	0.662
7	4.159	0.761
8	5.747	0.675
9	7.566	0.578
10	7.567	0.671

ARCH - LM test

In order to test the presence of additional autoregressive conditional heteroscedasticity, ARCH- LM test is used.

Table 4.33: ARCH LM test statistic values and P values of the Model

	Model–GJR- GARCH (1,3)	
	Test Statistic	**Probability**
F- Statistic	0.028	0.866
Obs*R- squared	0.028	0.865

According to Table 4.33, it is clear that test statistics accept the null hypothesis, of non-existence of ARCH effect in the residuals at 5% significant level. This means residual of this model does not contain ARCH effect. Thus, this test provides further assurance on adequacy of the model.

Normality test

Table 4.34 represents the results of the normality test.

Table 4.34: Normality test for residuals

Description	**Model– GJR-GARCH(1,3)**
Skewness	-0.059
Kurtosis	3.445
Jarque-Bera	9.002
Probability	0.011

According to Table 4.34 Jarque-Bera value is lower than test statistic criterion $\chi^2_{2,1-\alpha}$ of 9.21, at 1% significant level. Hence this provided clear evidence to accept null hypothesis. Error distributions of model depict properties of normality conditions and kurtosis and skewness of errors approximately satisfy normality condition. Hence, it is safe to consider that errors are normally distributed.

In above model statistically significant μ_1 in Table 4.30 suggest that there is abnormality in returns during pre and post budget with n=15. The negative sign implies a significant reduction in returns. Statistically insignificant μ_2 in above model suggest that there is no abnormality in the change in returns relative to the previous working day's return around the budget. The negative sign suggest a reduction of the change in returns relative to the previous working day's return around the budget. The coefficient of the dummy variable λ_1 in the variance equation of above model is insignificant.

4.3.7 Models for post budget period with n=15

Table 4.35: Mean and variance equation of GJR-GARCH (2,3) model

Variable	Coefficient	Std.Error	Z-statistic	Probability
Conditional Mean Equation				
D	-0.042	0.020	-2.075	0.037
C	0.001	0.002	0.499	0.617
D*r_{t-1}	-0.157	0.081	-1.917	0.055
r_{t-1}	0.920	0.041	22.356	0.000
AR(1)	0.051	0.040	1.274	0.202
MA(1)	-0.867	0.054	-16.053	0.000

Conditional Variance Equation				
C	0.028	0.010	2.791	0.005
ε_{t-1}^2	0.065	0.003	18.732	0.000
$I_{t-1}\varepsilon_{t-1}^2$	-0.018	0.000	-273.561	0.000
ε_{t-2}^2	0.049	0.003	16.340	0.000
σ_{t-1}^2	-1.020	0.007	-144.450	0.000
σ_{t-2}^2	0.866	0.013	66.657	0.000
σ_{t-3}^2	0.965	0.006	145.889	0.000
D	0.021	0.010	2.074	0.038

Using the coefficients represented in Table 4.35 mean and variance equations of GJR-GARCH (2, 3) model can be written as follows,

Mean Equation:

$$r_t = -0.042\ D + 0.920\, r_{t-1} - 0.867\, \varepsilon_{t-1} + \varepsilon_t$$

Variance Equations:

$$\sigma_t^2 = 0.028 + 0.021\, D + 0.047\, \varepsilon_{t-1}^2 + 0.049\, \varepsilon_{t-2}^2 - 1.020\, \sigma_{t-1}^2 + 0.866\, \sigma_{t-2}^2 + 0.965\, \sigma_{t-3}^2\ ;\ \varepsilon_{t-1} < 0$$

$$\sigma_t^2 = 0.028 + 0.021\, D + 0.065\, \varepsilon_{t-1}^2 + 0.049\, \varepsilon_{t-2}^2 - 1.020\, \sigma_{t-1}^2 + 0.866\, \sigma_{t-2}^2 + 0.965\, \sigma_{t-3}^2\ ;\ \varepsilon_{t-2} \geq 0$$

According to above mean equation, return on post-budget with n=15 is reduce by 4.2% compared to other days and according to variance equations, current volatility is influence by lag one and two of the residuals, lag one, two and three of the volatility.

Diagnostic testing for model

Ljung-Box Q-statistics for standardized residuals

Ljung-Box Q-statistics test is carried out on standardized residual series in order to measure the adequacy of model and result is as follows,

Table 4.36: Q-statistics and P value of Ljung-Box test on standard residuals of the Model

Lag	**Model–GJR- GARCH (2,3)**	
	Q-statistic	**Probability**
1	3.489	0.062
2	3.637	0.162
3	5.340	0.148
4	10.174	0.058
5	11.636	0.060
6	12.208	0.087
7	12.495	0.085
8	12.496	0.130
9	13.917	0.125
10	13.932	0.176

Table 4.36 depicts, all other P values in subsequent lags are insignificant because respective P values are higher than 0.05 at 5% significant level. Therefore, it conclude that there is no serial autocorrelation in squared standard residuals. Hence, it provides sufficient evidence on adequacy of the model accordingly to the test statistics of Ljung-Box Q-statistics.

Ljung-Box Q-statistics for squared standardized residuals

Table 4.37 depicts the correlogram result of the squared returns,

Table 4.37: Q-statistics and P value of Ljung-Box test on squared standard residuals of the Model

Lag	**Model–GJR- GARCH (2,3)**	
	Q-statistic	**Probability**
1	3.225	0.073
2	5.740	0.057
3	6.436	0.092
4	6.878	0.142
5	7.292	0.200
6	7.328	0.292
7	8.468	0.293
8	8.481	0.388
9	8.542	0.481
10	8.830	0.548

ARCH - LM test

In order to test the presence of additional autoregressive conditional heteroscedasticity, ARCH- LM test is used.

Table 4.38: ARCH LM test statistic values and P values of Model

	Model–GJR- GARCH (1,3)	
	Test Statistic	**Probability**
F- Statistic	2.402	0.121
Obs*R- squared	2.401	0.121

According to Table 4.38, it is clear that test statistics do not reject the null hypothesis, of non-existence of ARCH in the residuals at 5% significant level. This means residual of this model does not contain autoregressive conditional heteroscedasticity. Thus, this test provides further assurance on adequacy of the model.

Normality test

Table 4.39 represents the results of the normality test.

Table 4.39: Normality test for residuals

Description	Model– GJR-GARCH(1,3)
Skewness	-0.106
Kurtosis	3.481
Jarque-Bera	8.296
Probability	0.015

It is clear that error distributions of model depict properties of normality conditions and kurtosis and skewness of errors approximately satisfy normality condition. According to Table 4.39 Jarque-Bera value is lower than test statistic criterion $\chi^2_{2,1-\alpha}$ of 9.21, at 1% significant level. Hence this provided clear evidence to accept null hypothesis and it is safe to consider that errors are normally distributed.

In above model statistically significant μ_1 in Table 4.35 suggest that there is abnormality in returns during post- budget with n=15. The negative sign implies a significant reduction in returns. Statistically insignificant μ_2 in above model suggest that there is no abnormality in the change in returns relative to the previous working day's return around the budget. The negative sign suggest a reduction of the change in returns relative to the previous working day's return around the budget. The coefficient of the dummy variable λ_1 in the variance equation of above model is significant and positive, it indicates that there is an increase in the degree of fluctuations in stock returns during post-budget with n=15. In simple terms, this implies an increase in risk of the investments in CSE during post- budget with n=15.

4.4. Chapter summary

This study examined the behavior of stock returns and volatility around budget announcement for the Diversified Holdings sector for the period from 1st April 2015 to 29th March 2018. Three cases are considered using the dummy variable for 5, 10 and 15 days with three scenarios n no of days on pre- budget, pre and post budget, post- budget for each case. Seven models are fitted except pre-budget with n=10 and pre-budget with n=15.

Table 4.40: Summary of the models

n \ Window	**Pre-budget**	**Pre and post budget**	**Post-budget**
5	μ_1 -Significant and negative Return is reduced by 8.7%	μ_1 -Significant and negative Return is reduced by 11.5%	μ_1 -Significant and negative Return is reduced by 11.5%
10	-	μ_1 , μ_2 -Significant and negative Return is reduced by 6.6%	μ_1 -Significant and negative Return is reduced by 6.7%
15	-	μ_1 -Significant and negative Return is reduced by 3.2%	μ_1 -Significant and negative λ_1 -Significant and positive Return is reduced by 4.2%

Returns on all considered windows are negative and statistically significant at 5% significance level. This negative sign implies a significant reduction in return. This reduction is increasing when getting closer to the budget date.

In the window pre and post budget with n=10, change in return relative to the previous working day's return around the budget is negative and statistically significant at 1% significance level. This negative sign implies a significant reduction of the change in returns relative to the previous working day's return around the budget.

The coefficient of the dummy variable λ_1 in the variance equation of the model fitted for the window post-budget with n=15 is significant and positive. It indicates that there is an increase in the degree of fluctuations in stock returns during 15 days after the budget.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter displays the conclusions from the empirical studies conducted to examine the behavior of stock returns and volatility around budget announcement for the Diversified Holdings sector. The results are compared with previous studies and any differences and similarities are explained and suggestions are provided for further research as well.

5.2 Summary of findings

This study examined the behavior of stock returns and volatility of Diversified Holdings sector in Colombo Stock Exchange around budget for the period from 1st April 2015 to 29th March 2018.

In the Diversified Holding sector, returns are significant and negative at 5% confidence level for all considered windows. That is abnormality in returns and negative sign implies a significant reduction in returns. Change of returns relative to the previous working day's return is significant at 1% confidence level in pre and post budget with n=10. In terms of volatility, coefficient of the dummy variable of the model is statistically significant at 5% significance level and positive, it indicates that there is an increase in the degree of fluctuations in stock returns during post-budget with n=15. In simple terms, this implies an increase in risk of the investments in CSE during 15 days after the budget.

5.3 Conclusion of the study

In conclusion, budget day effect is present in both return and volatility of Diversified Holdings sector in Colombo Stock market. According to this study, Returns on all considered windows are negative and statistically significant at 5% significance level. This negative sign implies a significant reduction in return. This reduction is increasing when getting closer to the budget date. Therefore investors can earn an abnormal return by buying stocks before five working days of the budget announcement or after five working days of the budget announcement and selling stocks after 15 working days from the budget date.

5.4 Discussion and Recommendations for Further Research

This study focused only one sector of the Colombo stock exchange. There is an opportunity for future researchers to analyze other sectors of the Colombo Stock Exchange. Also future researchers can do further research on this area not only sector wise but also company wise by using more sophisticated methods such as the GARCH-EVT method.

REFERENCES

Action plan 2017 - Department of national budget, Ministry of Finance.

Anil Soni and Jalandhar. (2010). Reaction of the stock market to Union Budget and Monetary policy announcements, *APJRBM, Vol. 1, No. 2, pp. 155-175.*

Bollerslev, T. (1986). Generalized autoregressive conditional heteroskedasticity. *Journal of econometrics, 31(3), 307-327.*

Deepak R. & Bhavya N.(2014). An Event Study Analysis of Union Budget Announcement on Broad and Sectoral Indices of Indian Stock Market, *International Journal of Innovative Research & Development, Vol. 3 Issue 12 November, 2014 (Special Issue)*

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American statistical association*, *74*(366a), 427-431.

Dickey, D. A., & Fuller, W. A. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica: Journal of the Econometric Society*, 1057-1072.

Engle, R. F. (1982). Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation. *Econometrica: Journal of the Econometric Society*, 987-1007.

Engle, R. F. (1984). Wald, likelihood ratio, and Lagrange multiplier tests in econometrics. *Handbook of econometrics*, *2*, 775-826.

Edirisingha U.C. (2017). Impact of Government Budget Announcement on Stock Market Sector Indices: Evidence from Colombo Stock Exchange. *Journal of Finance and Accounting 2017; Vol. 5(6): pp 214-218*

Jayasinghe P. (2014). The behavior of stock returns and volatility around elections: Evidence from Colombo Stock Exchange, *Journal of Multidisciplinary Research, vol.I, No.1, 2014*

Kabuga N.A. (2018) .Budget Deficits and Stock Market Performance in Selected African Countries: A Dynamic Panel estimation Approach, *UMYUK Journal of Economics and Development (UJED) Vol. 1 No. 1 January, 2018 pp 65-77*

Kanyari L.W.(2015). Effect Of National Budget Reading On Sector Returns At The Nairobi Securities Exchange,

Khanna K. & Gogia N.(2014). A Pragmatic Study Of Budget Announcements & Stock Market Performance: India, US & UK Panorama, *VSRD International Journal of Business and Management Research, Vol. IV Issue II February 2014: pp 35-38*

Kutchu, Vishal. (2012). Testing Semi-Strong efficiency of Indian Stock market- A study of effect of Union Budget 2012 on six select sectoral stocks, *Journal of Arts, Science and commerce, Vol. 3, No. 2, pp. 74-81*

Ljung, G. M., & Box, G. E. (1978). On a measure of lack of fit in time series models. *Biometrika*, *65*(2), 297-303.

Naveen Kumara R., Meghana Vittal B., Monica G.(2017). Impact of union budget on market & sectorial indices, *International journal of research culture society ISSN: 2456-6683 Volume - 1, Issue -09, Nov– 2017.*

Nelson, D. B. (1991). Conditional heteroskedasticity in asset returns: A new approach. *Econometrica: Journal of the Econometric Society*, 347-370.

Ranjani, R.P.C., Sujeewa, Mudith and Rathnasiri, U.A.H.A. (2009), The impact of the government budget announcement on Colombo Stock Exchange, *Proceedings of the Annual Research Symposium-Faculty of general studies, University of Kelaniya.*

Singh, G. & Kansal, S. (2010). Impact of Union Budget on Indian Stock market-A case study of NSE, *Asia-Pacific Journal of Social Sciences, Vol. 2, No. 1, pp. 148-160.*

Susan, T., & Ajay, S. (2002). Stock Market Response to Union Budget. *Economic and Political Weekly, Volume XXXVII, No 5, February 2–8, 2002, pp. 455-458.*

Varadharajan, P., & Dr.Vikkraman, P. (2011). Impact of Pre and Post Budget on Stock Market Volatility Between 2001 to 2011. *Journal Of Contemporary Research In Management, October - December, 2011. 49-64.*

Appendix

Diversified Holdings Sector

Date	Index	Date	Index	Date	Index
1-Apr-15	1,816.09	3-Jun-15	1,865.15	29-Jul-15	1,992.43
2-Apr-15	1,821.98	4-Jun-15	1,849.57	30-Jul-15	1,999.52
6-Apr-15	1,818.32	5-Jun-15	1,859.92	3-Aug-15	1,989.83
7-Apr-15	1,840.56	8-Jun-15	1,842.44	4-Aug-15	1,987.09
8-Apr-15	1,849.31	9-Jun-15	1,850.80	5-Aug-15	2,002.53
9-Apr-15	1,843.09	10-Jun-15	1,854.59	6-Aug-15	2,013.61
10-Apr-15	1,841.12	11-Jun-15	1,847.44	7-Aug-15	2,000.62
15-Apr-15	1,869.75	12-Jun-15	1,866.71	10-Aug-15	2,002.09
16-Apr-15	1,891.07	15-Jun-15	1,870.60	11-Aug-15	2,018.93
17-Apr-15	1,888.20	16-Jun-15	1,854.89	12-Aug-15	2,018.15
20-Apr-15	1,898.00	17-Jun-15	1,865.67	13-Aug-15	2,007.44
21-Apr-15	1,891.08	18-Jun-15	1,876.12	14-Aug-15	2,002.23
22-Apr-15	1,892.31	19-Jun-15	1,871.46	17-Aug-15	2,010.39
23-Apr-15	1,884.75	22-Jun-15	1,870.03	18-Aug-15	2,006.14
24-Apr-15	1,879.14	23-Jun-15	1,901.53	19-Aug-15	2,006.90
27-Apr-15	1,879.79	24-Jun-15	1,897.93	20-Aug-15	1,993.29
28-Apr-15	1,884.92	25-Jun-15	1,892.02	21-Aug-15	2,004.90
29-Apr-15	1,899.75	26-Jun-15	1,883.02	24-Aug-15	1,953.47
30-Apr-15	1,895.43	29-Jun-15	1,887.24	25-Aug-15	1,927.57
5-May-15	1,896.19	30-Jun-15	1,884.68	26-Aug-15	1,912.15
6-May-15	1,898.30	2-Jul-15	1,874.37	27-Aug-15	1,927.00
7-May-15	1,892.47	3-Jul-15	1,892.05	28-Aug-15	1,961.50
8-May-15	1,901.54	6-Jul-15	1,887.28	31-Aug-15	1,941.99
11-May-15	1,890.20	7-Jul-15	1,884.04	1-Sep-15	1,941.33
12-May-15	1,894.46	8-Jul-15	1,862.10	2-Sep-15	1,922.19
13-May-15	1,882.65	9-Jul-15	1,876.77	3-Sep-15	1,923.04
14-May-15	1,873.96	10-Jul-15	1,887.80	4-Sep-15	1,913.91
15-May-15	1,878.97	13-Jul-15	1,887.60	7-Sep-15	1,902.18
18-May-15	1,885.64	14-Jul-15	1,886.47	8-Sep-15	1,891.93
19-May-15	1,891.66	15-Jul-15	1,899.83	9-Sep-15	1,894.48
20-May-15	1,914.89	16-Jul-15	1,898.39	10-Sep-15	1,889.82
21-May-15	1,905.06	17-Jul-15	1,905.41	11-Sep-15	1,890.39
22-May-15	1,910.01	20-Jul-15	1,906.52	14-Sep-15	1,888.15
25-May-15	1,921.17	21-Jul-15	1,904.05	15-Sep-15	1,879.57
26-May-15	1,903.04	22-Jul-15	1,934.88	16-Sep-15	1,886.45
27-May-15	1,894.48	23-Jul-15	1,952.03	17-Sep-15	1,876.69
28-May-15	1,891.36	24-Jul-15	1,976.80	18-Sep-15	1,868.99
29-May-15	1,873.39	27-Jul-15	1,968.24	21-Sep-15	1,867.33
1-Jun-15	1,866.54	28-Jul-15	1,974.30	22-Sep-15	1,875.49

Date	Index
23-Sep-15	1,872.49
25-Sep-15	1,878.58
28-Sep-15	1,866.99
29-Sep-15	1,870.70
30-Sep-15	1,847.50
1-Oct-15	1,860.49
2-Oct-15	1,866.58
5-Oct-15	1,854.82
6-Oct-15	1,860.78
7-Oct-15	1,864.20
8-Oct-15	1,871.47
9-Oct-15	1,858.16
12-Oct-15	1,854.47
13-Oct-15	1,851.14
14-Oct-15	1,835.50
15-Oct-15	1,833.04
16-Oct-15	1,827.16
19-Oct-15	1,827.18
20-Oct-15	1,831.41
21-Oct-15	1,835.47
22-Oct-15	1,851.49
23-Oct-15	1,858.38
26-Oct-15	1,863.86
28-Oct-15	1,874.27
29-Oct-15	1,867.30
30-Oct-15	1,845.09
2-Nov-15	1,843.84
3-Nov-15	1,844.25
4-Nov-15	1,853.47
5-Nov-15	1,868.31
6-Nov-15	1,894.75
9-Nov-15	1,892.20
11-Nov-15	1,876.85
12-Nov-15	1,881.98
13-Nov-15	1,882.53
16-Nov-15	1,871.63
17-Nov-15	1,874.81
18-Nov-15	1,876.43
19-Nov-15	1,889.36
20-Nov-15	1,887.60
23-Nov-15	1,906.30

Date	Index
24-Nov-15	1,899.39
26-Nov-15	1,883.14
27-Nov-15	1,876.60
30-Nov-15	1,846.33
1-Dec-15	1,847.35
2-Dec-15	1,836.09
3-Dec-15	1,841.90
4-Dec-15	1,838.51
7-Dec-15	1,833.52
8-Dec-15	1,836.60
9-Dec-15	1,833.21
10-Dec-15	1,826.23
11-Dec-15	1,817.15
14-Dec-15	1,805.76
15-Dec-15	1,816.79
16-Dec-15	1,826.32
17-Dec-15	1,829.22
18-Dec-15	1,846.74
21-Dec-15	1,850.76
22-Dec-15	1,828.56
23-Dec-15	1,833.13
28-Dec-15	1,829.60
29-Dec-15	1,835.02
30-Dec-15	1,842.43
31-Dec-15	1,849.41
4-Jan-16	1,836.49
5-Jan-16	1,837.76
6-Jan-16	1,833.39
7-Jan-16	1,813.36
8-Jan-16	1,792.27
11-Jan-16	1,773.15
12-Jan-16	1,744.34
13-Jan-16	1,754.26
14-Jan-16	1,726.67
18-Jan-16	1,694.41
19-Jan-16	1,684.30
20-Jan-16	1,668.44
21-Jan-16	1,689.40
22-Jan-16	1,697.57
25-Jan-16	1,684.61
26-Jan-16	1,667.16

Date	Index
27-Jan-16	1,670.91
28-Jan-16	1,666.55
29-Jan-16	1,659.45
1-Feb-16	1,681.45
2-Feb-16	1,701.71
3-Feb-16	1,688.55
5-Feb-16	1,694.67
8-Feb-16	1,700.53
9-Feb-16	1,691.17
10-Feb-16	1,692.13
11-Feb-16	1,661.70
12-Feb-16	1,639.19
15-Feb-16	1,639.73
16-Feb-16	1,641.35
17-Feb-16	1,630.53
18-Feb-16	1,627.38
19-Feb-16	1,642.31
23-Feb-16	1,643.87
24-Feb-16	1,639.56
25-Feb-16	1,638.98
26-Feb-16	1,638.20
29-Feb-16	1,637.73
1-Mar-16	1,590.91
2-Mar-16	1,567.03
3-Mar-16	1,554.91
4-Mar-16	1,553.61
8-Mar-16	1,518.97
9-Mar-16	1,498.93
10-Mar-16	1,519.34
11-Mar-16	1,530.81
14-Mar-16	1,517.09
15-Mar-16	1,515.35
16-Mar-16	1,526.93
17-Mar-16	1,539.56
18-Mar-16	1,540.94
21-Mar-16	1,574.26
23-Mar-16	1,551.00
24-Mar-16	1,561.10
28-Mar-16	1,554.12
29-Mar-16	1,532.45
30-Mar-16	1,524.62

Date	Index
31-Mar-16	1,539.48
1-Apr-16	1,560.11
4-Apr-16	1,543.88
5-Apr-16	1,565.49
6-Apr-16	1,564.30
7-Apr-16	1,587.00
8-Apr-16	1,596.65
11-Apr-16	1,587.80
12-Apr-16	1,622.50
15-Apr-16	1,623.32
18-Apr-16	1,618.08
19-Apr-16	1,617.25
20-Apr-16	1,635.47
22-Apr-16	1,634.71
25-Apr-16	1,609.24
26-Apr-16	1,620.49
27-Apr-16	1,625.52
28-Apr-16	1,626.47
29-Apr-16	1,651.39
3-May-16	1,661.16
4-May-16	1,654.96
5-May-16	1,664.91
6-May-16	1,663.60
9-May-16	1,668.75
10-May-16	1,691.79
11-May-16	1,710.03
12-May-16	1,711.13
13-May-16	1,712.44
16-May-16	1,716.84
17-May-16	1,702.67
18-May-16	1,698.20
19-May-16	1,685.74
20-May-16	1,681.44
24-May-16	1,657.97
25-May-16	1,666.10
26-May-16	1,650.26
27-May-16	1,641.35
30-May-16	1,642.95
31-May-16	1,642.02
1-Jun-16	1,644.21
2-Jun-16	1,633.24

Date	Index
3-Jun-16	1,629.70
6-Jun-16	1,626.58
7-Jun-16	1,631.46
8-Jun-16	1,627.47
9-Jun-16	1,635.17
10-Jun-16	1,635.62
13-Jun-16	1,651.11
14-Jun-16	1,649.19
15-Jun-16	1,644.31
16-Jun-16	1,610.38
17-Jun-16	1,627.60
20-Jun-16	1,628.32
21-Jun-16	1,623.36
22-Jun-16	1,614.65
23-Jun-16	1,601.10
24-Jun-16	1,591.99
27-Jun-16	1,579.44
28-Jun-16	1,582.25
29-Jun-16	1,572.67
30-Jun-16	1,560.61
1-Jul-16	1,565.23
4-Jul-16	1,554.15
5-Jul-16	1,573.84
7-Jul-16	1,582.78
8-Jul-16	1,596.08
11-Jul-16	1,601.13
12-Jul-16	1,602.57
13-Jul-16	1,610.07
14-Jul-16	1,605.59
15-Jul-16	1,618.86
18-Jul-16	1,623.60
20-Jul-16	1,629.50
21-Jul-16	1,626.77
22-Jul-16	1,625.94
25-Jul-16	1,630.45
26-Jul-16	1,612.23
27-Jul-16	1,604.36
28-Jul-16	1,614.07
29-Jul-16	1,623.26
1-Aug-16	1,621.52
2-Aug-16	1,644.96

Date	Index
3-Aug-16	1,653.62
4-Aug-16	1,651.07
5-Aug-16	1,663.89
8-Aug-16	1,661.67
9-Aug-16	1,668.97
10-Aug-16	1,687.63
11-Aug-16	1,688.77
12-Aug-16	1,704.33
15-Aug-16	1,705.66
16-Aug-16	1,709.67
18-Aug-16	1,713.28
19-Aug-16	1,713.05
22-Aug-16	1,715.11
23-Aug-16	1,708.14
24-Aug-16	1,697.01
25-Aug-16	1,702.23
26-Aug-16	1,676.95
29-Aug-16	1,683.25
30-Aug-16	1,675.74
31-Aug-16	1,674.56
1-Sep-16	1,679.81
2-Sep-16	1,683.78
5-Sep-16	1,679.59
6-Sep-16	1,675.72
7-Sep-16	1,680.18
8-Sep-16	1,677.33
9-Sep-16	1,673.38
13-Sep-16	1,675.25
14-Sep-16	1,671.22
15-Sep-16	1,662.76
19-Sep-16	1,661.68
20-Sep-16	1,657.60
21-Sep-16	1,666.89
22-Sep-16	1,676.01
23-Sep-16	1,669.25
26-Sep-16	1,669.94
27-Sep-16	1,676.38
28-Sep-16	1,680.27
29-Sep-16	1,678.99
30-Sep-16	1,686.31
3-Oct-16	1,702.47

Date	Index
4-Oct-16	1,703.20
5-Oct-16	1,705.34
6-Oct-16	1,714.94
7-Oct-16	1,714.84
10-Oct-16	1,713.05
11-Oct-16	1,698.36
12-Oct-16	1,688.93
13-Oct-16	1,679.36
14-Oct-16	1,673.48
17-Oct-16	1,664.19
18-Oct-16	1,655.09
19-Oct-16	1,660.09
20-Oct-16	1,658.45
21-Oct-16	1,654.49
24-Oct-16	1,652.58
25-Oct-16	1,655.08
26-Oct-16	1,656.07
27-Oct-16	1,652.63
28-Oct-16	1,645.73
31-Oct-16	1,649.37
1-Nov-16	1,647.89
2-Nov-16	1,648.56
3-Nov-16	1,657.36
4-Nov-16	1,650.48
7-Nov-16	1,650.99
8-Nov-16	1,646.20
9-Nov-16	1,637.93
10-Nov-16	1,639.21
11-Nov-16	1,630.60
15-Nov-16	1,622.89
16-Nov-16	1,610.89
17-Nov-16	1,601.20
18-Nov-16	1,599.71
21-Nov-16	1,580.75
22-Nov-16	1,583.17
23-Nov-16	1,574.51
24-Nov-16	1,576.24
25-Nov-16	1,575.09
28-Nov-16	1,569.88
29-Nov-16	1,568.31
30-Nov-16	1,582.25

Date	Index
1-Dec-16	1,606.83
2-Dec-16	1,610.97
5-Dec-16	1,615.62
6-Dec-16	1,616.65
7-Dec-16	1,611.06
8-Dec-16	1,631.04
9-Dec-16	1,624.32
14-Dec-16	1,612.52
15-Dec-16	1,594.04
16-Dec-16	1,588.74
19-Dec-16	1,585.70
20-Dec-16	1,579.59
21-Dec-16	1,572.89
22-Dec-16	1,572.06
23-Dec-16	1,571.94
27-Dec-16	1,568.15
28-Dec-16	1,573.47
29-Dec-16	1,576.12
30-Dec-16	1,545.70
2-Jan-17	1,526.37
3-Jan-17	1,507.80
4-Jan-17	1,520.97
5-Jan-17	1,517.86
6-Jan-17	1,518.96
9-Jan-17	1,520.86
10-Jan-17	1,530.28
11-Jan-17	1,548.99
13-Jan-17	1,563.47
16-Jan-17	1,554.21
17-Jan-17	1,542.49
18-Jan-17	1,541.64
19-Jan-17	1,536.11
20-Jan-17	1,539.68
23-Jan-17	1,525.94
24-Jan-17	1,526.11
25-Jan-17	1,522.72
26-Jan-17	1,532.67
27-Jan-17	1,540.45
30-Jan-17	1,540.03
31-Jan-17	1,534.37
1-Feb-17	1,535.80

Date	Index
2-Feb-17	1,545.12
3-Feb-17	1,550.49
6-Feb-17	1,532.86
7-Feb-17	1,546.56
8-Feb-17	1,553.81
9-Feb-17	1,559.41
13-Feb-17	1,580.67
14-Feb-17	1,582.89
15-Feb-17	1,581.72
16-Feb-17	1,571.08
17-Feb-17	1,573.08
20-Feb-17	1,562.79
21-Feb-17	1,556.51
22-Feb-17	1,543.84
23-Feb-17	1,549.27
27-Feb-17	1,542.37
28-Feb-17	1,549.86
1-Mar-17	1,551.61
2-Mar-17	1,546.04
3-Mar-17	1,546.06
6-Mar-17	1,547.07
7-Mar-17	1,547.06
8-Mar-17	1,545.58
9-Mar-17	1,532.23
10-Mar-17	1,529.83
13-Mar-17	1,529.40
14-Mar-17	1,519.32
15-Mar-17	1,518.86
16-Mar-17	1,520.52
17-Mar-17	1,522.68
20-Mar-17	1,524.80
21-Mar-17	1,517.54
22-Mar-17	1,505.21
23-Mar-17	1,506.40
24-Mar-17	1,510.34
27-Mar-17	1,497.64
28-Mar-17	1,498.52
29-Mar-17	1,518.54
30-Mar-17	1,521.51
31-Mar-17	1,519.92
3-Apr-17	1,537.41

Date	Index
4-Apr-17	1,562.74
5-Apr-17	1,581.34
6-Apr-17	1,593.97
7-Apr-17	1,613.90
11-Apr-17	1,621.05
12-Apr-17	1,642.36
17-Apr-17	1,629.26
18-Apr-17	1,635.76
19-Apr-17	1,657.35
20-Apr-17	1,666.19
21-Apr-17	1,679.61
24-Apr-17	1,673.11
25-Apr-17	1,666.74
26-Apr-17	1,674.75
27-Apr-17	1,701.51
28-Apr-17	1,718.40
2-May-17	1,715.16
3-May-17	1,706.30
4-May-17	1,723.40
5-May-17	1,730.50
8-May-17	1,727.48
9-May-17	1,733.35
12-May-17	1,738.65
15-May-17	1,733.70
16-May-17	1,736.12
17-May-17	1,755.07
18-May-17	1,743.37
19-May-17	1,761.83
22-May-17	1,763.95
23-May-17	1,766.42
24-May-17	1,782.49
25-May-17	1,779.85
26-May-17	1,769.77
29-May-17	1,764.75
30-May-17	1,769.47
31-May-17	1,781.42
1-Jun-17	1,782.68
2-Jun-17	1,790.43
5-Jun-17	1,798.00
6-Jun-17	1,796.35
7-Jun-17	1,803.95

Date	Index
9-Jun-17	1,800.01
12-Jun-17	1,794.39
13-Jun-17	1,803.19
14-Jun-17	1,827.68
15-Jun-17	1,849.51
16-Jun-17	1,866.15
19-Jun-17	1,843.96
20-Jun-17	1,850.82
21-Jun-17	1,863.05
22-Jun-17	1,856.82
23-Jun-17	1,869.20
27-Jun-17	1,867.85
28-Jun-17	1,866.80
29-Jun-17	1,877.16
30-Jun-17	1,888.27
3-Jul-17	1,890.57
4-Jul-17	1,890.05
5-Jul-17	1,877.75
6-Jul-17	1,889.38
7-Jul-17	1,905.70
10-Jul-17	1,915.94
11-Jul-17	1,908.63
12-Jul-17	1,902.70
13-Jul-17	1,903.34
14-Jul-17	1,909.11
17-Jul-17	1,902.75
18-Jul-17	1,899.30
19-Jul-17	1,877.69
20-Jul-17	1,880.44
21-Jul-17	1,869.42
24-Jul-17	1,861.35
25-Jul-17	1,867.82
26-Jul-17	1,872.62
27-Jul-17	1,869.95
28-Jul-17	1,867.60
31-Jul-17	1,861.11
1-Aug-17	1,854.96
2-Aug-17	1,850.53
3-Aug-17	1,836.58
4-Aug-17	1,836.95
8-Aug-17	1,805.77

Date	Index
9-Aug-17	1,803.43
10-Aug-17	1,789.83
11-Aug-17	1,775.25
14-Aug-17	1,779.15
15-Aug-17	1,758.96
16-Aug-17	1,747.73
17-Aug-17	1,742.67
18-Aug-17	1,747.26
21-Aug-17	1,742.45
22-Aug-17	1,727.56
23-Aug-17	1,719.17
24-Aug-17	1,713.55
25-Aug-17	1,734.33
28-Aug-17	1,733.10
29-Aug-17	1,717.88
30-Aug-17	1,724.14
31-Aug-17	1,724.51
4-Sep-17	1,721.53
6-Sep-17	1,714.74
7-Sep-17	1,708.87
8-Sep-17	1,711.92
11-Sep-17	1,710.61
12-Sep-17	1,704.00
13-Sep-17	1,699.81
14-Sep-17	1,703.30
15-Sep-17	1,711.28
18-Sep-17	1,722.24
19-Sep-17	1,725.16
20-Sep-17	1,733.84
21-Sep-17	1,732.80
22-Sep-17	1,716.60
25-Sep-17	1,710.59
26-Sep-17	1,712.04
27-Sep-17	1,726.66
28-Sep-17	1,725.21
29-Sep-17	1,720.42
2-Oct-17	1,726.12
3-Oct-17	1,732.47
4-Oct-17	1,733.14
6-Oct-17	1,745.11
9-Oct-17	1,739.67

Date	Index
10-Oct-17	1,741.84
11-Oct-17	1,737.70
12-Oct-17	1,746.79
13-Oct-17	1,753.50
16-Oct-17	1,754.19
17-Oct-17	1,753.53
19-Oct-17	1,753.85
20-Oct-17	1,750.10
23-Oct-17	1,752.30
24-Oct-17	1,746.51
25-Oct-17	1,742.30
26-Oct-17	1,750.21
27-Oct-17	1,748.79
30-Oct-17	1,748.26
31-Oct-17	1,739.29
1-Nov-17	1,745.44
2-Nov-17	1,743.07
6-Nov-17	1,740.11
7-Nov-17	1,742.58
8-Nov-17	1,732.98
9-Nov-17	1,737.52
10-Nov-17	1,738.23
13-Nov-17	1,725.04
14-Nov-17	1,705.56
15-Nov-17	1,677.11
16-Nov-17	1,684.57
17-Nov-17	1,698.01
20-Nov-17	1,694.34
21-Nov-17	1,691.68
22-Nov-17	1,698.64
23-Nov-17	1,702.68
24-Nov-17	1,695.14
27-Nov-17	1,692.14
28-Nov-17	1,696.92
29-Nov-17	1,702.05
30-Nov-17	1,699.45
4-Dec-17	1,699.38
5-Dec-17	1,699.82

Date	Index
6-Dec-17	1,696.27
7-Dec-17	1,694.98
8-Dec-17	1,688.07
11-Dec-17	1,676.80
12-Dec-17	1,672.96
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15-Dec-17	1,669.33
18-Dec-17	1,667.01
19-Dec-17	1,659.02
20-Dec-17	1,660.24
21-Dec-17	1,663.04
22-Dec-17	1,650.97
26-Dec-17	1,659.71
27-Dec-17	1,664.97
28-Dec-17	1,664.77
29-Dec-17	1,669.18
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3-Jan-18	1,694.87
4-Jan-18	1,698.99
5-Jan-18	1,725.71
8-Jan-18	1,742.71
9-Jan-18	1,742.03
10-Jan-18	1,741.14
11-Jan-18	1,732.33
12-Jan-18	1,712.46
16-Jan-18	1,710.89
17-Jan-18	1,714.85
18-Jan-18	1,704.26
19-Jan-18	1,733.09
22-Jan-18	1,721.59
23-Jan-18	1,729.61
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25-Jan-18	1,730.49
26-Jan-18	1,729.87
29-Jan-18	1,729.78
30-Jan-18	1,735.05
1-Feb-18	1,746.76

Date	Index
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6-Feb-18	1,722.79
7-Feb-18	1,718.65
8-Feb-18	1,738.88
9-Feb-18	1,768.21
12-Feb-18	1,751.17
14-Feb-18	1,759.23
15-Feb-18	1,757.03
16-Feb-18	1,767.53
19-Feb-18	1,783.15
20-Feb-18	1,788.81
21-Feb-18	1,794.49
22-Feb-18	1,782.96
23-Feb-18	1,797.48
26-Feb-18	1,796.32
27-Feb-18	1,784.57
28-Feb-18	1,789.38
2-Mar-18	1,796.24
5-Mar-18	1,783.66
6-Mar-18	1,777.86
7-Mar-18	1,764.99
8-Mar-18	1,776.28
9-Mar-18	1,790.78
12-Mar-18	1,783.40
13-Mar-18	1,781.48
14-Mar-18	1,780.49
15-Mar-18	1,765.44
16-Mar-18	1,774.39
19-Mar-18	1,769.28
20-Mar-18	1,745.28
21-Mar-18	1,738.11
22-Mar-18	1,741.48
23-Mar-18	1,737.70
26-Mar-18	1,748.69
27-Mar-18	1,746.53
28-Mar-18	1,735.00
29-Mar-18	1,746.30