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Spillover from Global Volatility Index to Equity Markets of Selected Islamic Countries

by

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This work is dedicated to my beloved parents and family members who have encourage me to achieve this milestone. I would also like to dedicate this work to my respected supervisor "Dr. Arshad Hassan" for his support and guidance in each step of this study.

CERTIFICATE OF APPROVAL

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Abstract

The purpose of this study is to explore the spillover from global volatility Index (VIX) to the equity market of selected Islamic countries. The study employs the daily closing index of the VIX and eleven equity market of Islamic countries, while the time span is from 1st January 2000 to 30th September 2019.The study employs three methodologies; (a) ARMA GARCH model to analyze the return and volatility Spillover; (b) GJR GARCH model to capture the Asymmetric behavior; (c) DCC and ADCC model to explore the time varying conditional correlation and also to investegate the asymmetric effect on these correlations. The finding of the study shows the negative mean spillover from VIX to the all equity markets except Bursa Malaysia Exchange (KLSE) and Iraq stock exchange (ISX-60) which show insignificant result. However there is significant and positive volatility spillover for all equity markets except Pakistan stock exchange (KSE-100) which showing negative volatility spillover. The result of GJR GARCH shows the significant and positive asymmetric behavior from VIX to various equity markets which indicates bad news create more volatility than good news, whereas for Dubai Financial Market (DFM) and Iraq Stock Exchange (ISX-60) there is no influence of good or bad news. In addition, DCC GARCH reveals the time varying correlation for the various markets, while the asymmetric effect on these correlations is significant and positive for the Abu Dhabi Security Exchange (ADX) only.

Keywords: Return and Volatility Spillovers, Asymmetric behavior, Time Varying Correlation.

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Abbreviations

ADCC	Asymmetric Dynamic Conditional Correlations
ARMA-GARCH	Autoregressive Moving Averages GARCH
CBOE	Chicago Board Options Exchange
DCC	Dynamic Conditional Correlations
E-GARCH	Exponential Generalized Autoregressive Conditional Heteroscedastic
EMH	Efficient Market Hypothesis
GARCH	Generalized Autoregressive Conditional Heteroscedasticity
GJR-GARCH	Glosten-Jagannathan-Runkle GARCH
MV-GARCH	Multivariate GARCH
SPX	Standard & Poor's 500 Index
VIX	Volatility Index

Chapter 1

Introduction

Financial integration is a reality in which global financial markets are sharply connected. The Efficient Market Hypothesis (EMH) is one of the broadly discussed areas and that is the reason why it has received a lot of consideration in the field of finance. The acknowledged appearance is that markets act efficiently and stock prices rapidly reflect all available information. Meanwhile, all market players are concealed to the same information, as new information arrives into the market, stock prices fluctuate and respond rapidly to new information. As a result, investors do not earn above average or beat the overall market without taking an additional risk because the market is efficient.

Today world stock markets do not work in isolation due to highly risky environment and they operate according to the quick transmission of information available from any part of the world. The information from one market can positively or negatively affect the prices of another market in any part of the world, so it provides a path for the investors to invest in different securities at a time and make their portfolio and keep themselves on the safest side from the fluctuation of prices due to transmission of information from any part of the world.

Volatility is one of the fundamental tools for investors before making any investment decision in the financial market. In 1993, CBOE introduced Volatility Index (VIX) and declared it as a degree to capture the Standard and Poors 500

Index Volatility. Though again VIX is modified in 2003, which act as an unconventional of any model. VIX is calculated by using standard SPX option and weekly SPX option that are listed on the CBOE for trading. As VIX is introduced, it becomes a standard gauge of market fear because it has negative relationship with the global stock markets.

It has been observed during 2008 when 15% decline in the S&P 500 index lead to increase the value of VIX by 260% nearly. As VIX becomes popular, VIX option also attract the investors which result in the evolution of an appropriate pricing method for them. For S& P500 contract, VIX is the risk-neutral likely stock market variance which is calculated from a board of options prices. Whaley (2000) captures the variation of VIX from the period 1986 to 1999 and founds that VIX is the fear symbol for the investor rather than excitement as there is asymmetric behavior exist between VIX variation and stock market returns. Further results of his findings reveal, stock market show decline or move downward when the value of VIX goes up, while showing upward movement with the decline of VIX.

Globalization affects the global stock market co-movement as stock prices and their volatilities are seemed to be strongly correlated to each other. Especially, markets move more closely tighter during periods of crisis. The financial crisis of 2008 is evidence of market contagion. Market integration and market contagion are related to market efficiency. There is an about 50% drawdown in the S&P 500 Index and level of volatility from top to bottom in 2008, because VIX significantly increases at that time and frequently establish peakiest point for a first time since 1987 crash. The VIX progressively becomes a leading indicator of the U.S stock market volatility as it indicates the market direction for the investors. So, it has been seen Fluctuation in the VIX clearly, has a significant influence on domestic market return, as well as on the return of foreign market.

Traub et al. (2000) states that VIX is a best gauge for measuring risk level in US and international capital market. Variation in asset prices is determined and measured by the VIX as it is considered the simplest measure of risk or uncertainty. The results indicate significant negative relationship between implied volatility changes and stock return. Giot (2005) report a significant and negative

relationship between the return of stock (S&P100 and NASDAQ100) and implied volatility indices (VIX & VXN). Results indicate asymmetric relationship of VIX with the S&P100 index, as negative stock index return more influence the VIX than the positive return. While comparatively in case of the NASDAQ100 Index, weak asymmetric behavior is observed but the reply of VXN to index is also quiet to some extent in high volatility trading situations.

Bardgett et al. (2019) investigate and link the information contained in the S&P 500 index and VIX market and found that when there is a calm situation in the market, derivatives prices of S&P 500 and VIX are constant but during market distress, inconsistent information had been observed. Cheuathonghua et al. (2019) investigate the spillover effect from VIX to 42 equity markets, at the time of market crisis. Finding of the study conclude that any small variation in VIX greatly affects the global market activities at time when market is in worst condition. Further asymmetric relationship is found from VIX which is extremely unstable and result in low trading in the markets. Return of developed market, while volatility of emerging markets is greatly affected by the VIX. Whereas in terms of geographical location, spillover from VIX to Europe is extra definite in terms of returns, while for Latin America VIX showing effect in term of volatility.

Pan et al. (2019) use a GARCH model to perceive the usefulness of the VIX for the performance improvement of option pricing and volatility forecasting. The findings of the study conclude that VIX has the significant ability to forecast stock volatility in a sample and out of sample and also information provided by VIX helps significantly to shorten the option pricing error. Bekaert and Hoerova (2014) examine that stock returns are predicted by variance premium but economic activity is predicted by conditional stock market variance and is simultaneously linked with financial anxiety than the variance premium.

Qadan et al. (2019) argue that cumulative market volatility risk, captured by VIX, plays a significant role in the relationship among idiosyncratic volatility and return of the stock. Respectively, an extension (recession) in the VIX tends to be chase by a bad (good) relationship between future returns and idiosyncratic volatility, even including other risk factors. The result further concludes and

preserves the statement that increases in VIX is the fear symbol for the investors, may show an increase in investors risk repulsion, and encouraging them to make their portfolio by investing in different securities by increasing the diversification of their investment.

So VIX providing a strong path for a useful research to study the relationship among the markets, which can provide investors direction and supervision before making any decision in the financial markets such as when going for the diversification.

1.1 Theoretical Background

1.1.1 Efficient Market Hypothesis

Market efficiency is one of the fundamental concepts in finance and seems in many pretexts. There is an important debate among stock market investors whether there is efficiency in the market and whether it absorb all the incoming information in shape of unpredictable stock prices. The EMH states that market always quickly respond to the arrival any information from any part of the world and stock prices behave or adjusted according to the available information as all market players possess it equally. In simple words, stock prices in the financial market are the result of available information to the investor.

Market efficiency theory has been the subject of severe academic research and concentrated debate over the past 50 years. It has leaded finance and economics as the vital theory explaining movements in asset prices. The base of Efficient Market hypothesis is set by the pioneer papers of King and Cootner (1965) and Samuelson (1965) but the formation of theory is done by the Fama (1965). According to Fama (1965) efficient market exist in three forms weak, semi and strong form.

Fama et al. (1969) observe how stock prices adjusted according to the arrival of new information. Evidence indicates that any market decision including information has a great influence on the prices of share slightly at the end of the split month but more rapidly after the announcement date. The result of the study

strongly supports that the market is efficient and stock prices rapidly adjusted according to the arrival of any information in the market.

Malkiel and Fama (1970) states that for resource allocation market should be efficient and it is possible when asset prices fully reflect the available information. Fama (1998) conduct a study in support of EMH, and found that anomalies showing causal result as it adjusted according to the arrival of information, is approximately as common as under-reaction and current-event persistence of past-event unusual returns is approximately as common as current-event turnaround. As with reasonable changes in the technique, mostly anomalies with long term tend to vanish showing consistency with Market Efficiency Theory.

According to Samuelson (1965) and Mandelbrot (1966) asset prices behave according to any new happening in the market, so the market is always efficient. Chavannavar and Patel (2016) conduct a study to find the relationship between NSE 50 stock and Nifty to check whether stock prices variate according to the new arrival of information in the market and past prices influences today's return. The result shows stock prices fluctuate as any information arrives, which indicates Indian stock markets showing consistency with Market Efficiency Theory in both weak and semi-strong form.

This study strongly supports the Efficient Market Theory. In global Financial market stock market is one of the important components which plays an important role for the overall economy of any country and provides the opportunity to the investors for investment. Injection of Information from any market has a great impact on the prices of stock as well as on the wealth of the investor. Asymmetry information is also common in the financial market and has an impact on investor return. This study focusses on the VIX and equity markets of the Islamic countries. The VIX which is known as a sign of fear for all global investors, so any change in the VIX has a great impact on the prices of stock markets worldwide, and also it is the main focus of the study to capture the spillover from VIX to the stock markets of Islamic countries.

1.2 Gap Analysis

Firstly, most of the study discuss global indices effect on the local market or it discusses intermarket spillover but there is little work done which discuss the effect of VIX on indices, so this study capture VIX spillover on indices. Secondly, most of the study focus on developed and emerging market background or it focuses on regional effect as Islamic countries as a group is less considered, so this study focus on Islamic countries. Thirdly in this study spillover is not only ARMA GARCH based model but it also includes time-varying effect investigation, which will capture integration between the indices.

1.3 Research Questions

Keeping in view research gap following questions are raised and answered:

Research Question 1

Is there any spillover between VIX and stock market of Islamic countries?

Research Question 2

Is there spillover between VIX and the equity market of Islamic countries considering the asymmetric behavior?

Research Question 3

Does there exist time varying correlation among the markets?

Research Question 4

Does the correlation among VIX and Equity markets of Islamic countries show asymmetric behavior?

1.4 Research Objectives

Objectives of the study are as follows:

Research Objective 1

To find the spillover between VIX and the equity market of Islamic countries.

Research Objective 2

To capture the spillover from VIX to equity markets considering the asymmetric behavior.

Research Objective 3

To explore the time-varying correlation among VIX and the equity market of Islamic countries.

Research Objective 4

To explore the asymmetric behavior of conditional correlation among VIX and the equity market of Islamic countries.

1.5 Significance of the Study

Several studies are there which discusses index to index spillover and only discuss interdependency between the markets but this study focuses on the spillover of VIX on stock markets indices and also captures time-varying correlation among the markets. A number of studies capture regional effect but this study focusses on Islamic countries as a group which is before less considered.

Traders use VIX to forecast market swing. VIX is traded by the investors by using a variety of options and exchange-traded products, or values of VIX are used to price derivatives. It helps the investor to determine when there is too much confidence or fear in the market. The market typically reverses back when the sentiment of the investors reaches one extreme or the other. Portfolio managers, investors as well as research analyst looked at the values of VIX, as it provides way to measure market risk and pressure before making any investment decisions.

The investor, portfolio manager, and risk manager use the securities linked with the VIX for portfolio diversification, as historical record reflect a strong negative correlation of volatility to the equity market returns that is, when stock

market return moves upward the value of VIX moves downward and vice versa. For portfolio restructuring an investors should keep in mind that VIX strongly negatively connected with the stock market, while past record shows its positive relationship with the gold market, so it is considered as safest investment at time of stock market decline.

When the VIX moves downward, the negative linkage of the highly volatile VIX to the equity markets makes it possible to use VIX options as a hedge to protect a portfolio against a market decline. For the implementation of such a hedging strategy, the risk manager buys near term slightly out of the money VIX calls while at the same time, to reduce the total cost of the hedge, sells slightly out-of-the-money VIX puts of the same expiration month. The idea of this strategy is that, during stock market decline, it is expected that the VIX will move upward, so that the VIX call options gain sufficient value to balance the losses in the portfolio.

1.6 Plan of Study

Chapter 1 covers the Introduction, Theoretical Background, Gap Analysis, Research Questions and Objectives and at the end Significance of the Study. Chapter 2 includes the literature review regarding past studies in context of spillover from VIX to different financial markets across the world and hypothesis of the study. Various methodologies are employed in the study that is covered in chapter 3. Data Analysis and interpretation are briefly discussed in chapter 4. In last, conclusion, recommendations, limitation and future directions of the study are covered in chapter 5.

Chapter 2

Literature Review

Formation of efficient portfolios depends upon the nature of relationship between the financial markets in the world. The benefit of diversification comes from the addition of international stocks depends upon comparatively low levels of correlation among global equity markets. During the crisis period, when the correlation among the markets fluctuate then investors face a huge uncertainty that can lead them in to a huge financial loss.

It is the fact that variations in the VIX occurs with the Stock market decline that is why it is known as fear symbol for the investors and caught a great attention by the market players before making any investment decision or going for a diversification in different asset classes. There are two forces which drives the investors expectations, if VIX increase (decrease) investors expectations also fall (rise) on the stock market return as stock prices fall (rise) in response to variation in VIX level. This concludes that the connection between variation in VIX should be related to the return on international stock market return.

2.1 Spillover from VIX to the Different Financial Markets Across the World

Shu and Chang (2019) use the daily stock market indexes from January 2004 to June 2014 by applying generalized VAR approach, to explore the relationship

between the VIX and the return of stock market of US and non-US. The result reveal that variation in VIX significantly influence the return of both US and non-US stock markets, indicating VIX play a leading role in the international market. Simlai (2010) use weekly time series data of VIX from 1995 to 1993 to examine the information spillover between VIX fluctuations and S&P 500 returns. The result of the study shows that when the value of VIX goes up it results in the falling of prices of the stock market, indicating both markets are negatively correlated.

For three subperiods from 1992 to 2011 the study done by Sarwar (2012a) to investigate the impact of VIX on the return of S&P 100, 500 and 600. The findings of the study shows negative relationship between the daily fluctuation in VIX and the return of the S&P 100, 500 and 600. The result of the study suggest stability of simultaneous VIX return base on the establishment of mean and volatility of VIX and this relation show more strength at that time when VIX is peak and highly volatile. Further result of the study shows strong asymmetric behavior between VIX variation and the stock market return, indicating VIX act as fear signal for the investor rather than investors happiness.

The study of Wang (2019) investigate the relationship between the VIX and volatility of the thirteen stock markets of G20 countries by using daily data of realized volatility from 2000 to 2018. The result of the study conclude in two directions, firstly VIX and its elements show significant effect for mostly countries and can result in higher volatility of the stock market, while when VIX is analyzed to R- square it is found that peak value of VIX has greater ability to explain the volatility of the international stock market. Secondly, when result is analyzed out of sample it indicate that forecasts accuracy can increase through VIX and specifically the peak value of VIX.

Chang et al. (2018) examine the relationship between the VIX and return of the Exchange Traded Fund (ETF) that follow the stock market of US and Europe by using daily data for three sub periods. This study includes two techniques, firstly VAR model to explore the impact of any change in daily VIX value on the ETF run, Secondly Diagonal BEKK model is used to quarter the multivariate conditional heteroskedasticity in the estimation of VAR for ETF returns. The

result indicates: (a) In short run the ETF returns are significantly and negatively influenced by the VIX returns; (b) The return of the VIX, show significant and high response to the ETF return in case of single market as compared to the return of Europe ETF; (c) The return of VIX showing less response to the return of European ETF in contrast with the return of S&P 500 index.

Further the estimation of mean equations for the markets of European is different among the overall sample and sub periods, but in Diagonal BEKK model the estimation of A and B matrices are relatively same for the overall sample period and partially for the two of the three sub periods. Whereas, the estimation of mean equations for the markets of US is also different among the overall sample and sub periods, but in Diagonal BEKK model the estimation of A and B matrices are very identical for the overall sample period and for also three sub periods (Chang et al., 2018).

Using monthly data from 1980 to 2010 of eleven industrialized countries, a study conducted by Rapach et al. (2013) explore the lead lag relationship between the stock returns and examine the importance of US market. Three techniques are used for the study (1) predictive regression model which describes excess return of a country to its lagged dividend yield and interest rate (2) Granger causality test is applied pairwise to capture the lead lag effect among the markets (3) news diffusion model is used to examine how the return of one country effect the return of other country. The finding of the study concludes that lagged return of the U.S significantly forecast the return of the several countries stock markets. However lagged return of the non-US stock market shows partial forecast ability with the returns of the US market. Further the result of the news diffusion model show that any shocks arise in the market of US fully absorbed in the stock markets outside US with an effect of lag showing consistency with slow transmission of information, indicating US stock market play a leading role for the world stock markets.

To describe the relationship between the return of the stock market and VIX a study done by Ruan (2018) by using ST-Vcopula model which depend upon the idea of STCC model. The result indicates that VIX significantly influence the

relationship among the stock markets. The overall finding of the study reveals that VIX can easily be obtained which can provide a way for a research among the markets, also can provide investors direction before making any decision in the financial markets such as when going for the diversification.

Cohen and Qadan (2010) using the daily data of VIX and gold prices from 2004 to 2009 to find the relationship between the gold prices and VIX by applying simple linear regression model and to avoid the issue of autocorrelation, in the mean equation lagged regressor is included and variance is allowed to vary over time to avoid the issue of unstable variance, so maximum likelihood function is employed for the estimation of model. The result of study show that return of the gold positively translates in to value of the VIX, which provides the evidence that any positive change in the gold prices, increases the VIX level.

Further the findings of the study show that during stable market condition when value of VIX move about 10 to 20, a significant bi-directional causality is observed between the VIX and the prices of the gold. Whereas during unstable market condition when VIX value move above 20, the return of gold drives the VIX changes. So, during instability in the market an investor can dare to invest in gold stock as it provides shield against the fear in the market (Cohen and Qadan, 2010).

Cochran et al. (2012) use the daily return of silver, platinum, gold, silver from 1999 to 2009 to explore (a) the persistence of volatility in these 4 metals returns (b) to explore whether return and conditional volatility is effected by the market instability during 2008 (c) to examine the effect of VIX on the returns of the metals, by applying FIGARCH model. The results show that VIX play a significant role in explaining the return of the metals and volatility. In addition, common risk factor influencing the return of metal and equity, showing clear failure to model as less optimal portfolio diversification will be achieved through this factor. Return volatility for numerous metals has increased during events in post September 2008. However, the collaboration effect is found to be significant between dummy variable of financial crisis and VIX. The results strongly reveal that for any upcoming modeling of return volatility and metal returns, VIX must

be considered. Also FIGARCH (1,d,1) properly defines the volatility procedures as parameter of all persistence of volatility showing significant result.

Another study done by Sari et al. (2011) analyze the information spillover between gold, silver, world oil, us dollar/euro exchange rate and VIX, by using daily time series data from 2003 to 2009 as only five days were considered in a week. The analysis of the study reveals that; VIX index, gold and silver prices, and exchange rate seems to be driving variables of the prices of oil in long run. The result discovers that in long run, VIX strongly effects the prices of oil, while in short run weakest relationship has been found in describing the predicted error variance of oil prices other than the prices in the substitute investment markets. Further result concludes that any change in the behavior of global investors regarding risk have negative but limited initial effect on the prices of oil.

Using the daily and weekly data from the period of 1990 to 2006 a research done by Kanas (2013) to analyze the risk and return linkage of S&P 500 Index by applying GARCH (1,1)-M model. It is observed during findings that in the conditional variance equation, when squared VIX is permitted as an exogenous variable, significant and positive risk and return linkage is found for the S&P 500 Index. The result of the study are significant for both daily and weekly observations for widen conditional mean and variance, showing its strength towards sub samples. Further conditional variance with the addition of VIX makes a strong forecast capability for the realized volatility than without the addition of VIX, as Volatility Index containing an important information for the conditional variance. The result can be concluded as a mark that strong risk and return linkage is found by the addition of volatility index squared in the conditional variance which result in strong degree of conditional variance.

Smales (2019) examine the linkage between the global stock markets, through VAR model by using the implied volatility of each country stock market. The study contains daily data from 2003 to 2015 including daily changes in G7 countries stock market and BRIC countries stock market to measure the implied volatility for each market. The result of the study indicates that risk in the U.S market play vital role in the overall world stock market risk. If any uncertainty or fear is

found in the U.S stock market, the information directly transmitted to the stock market of the world. However, risk innovation in the U.S market is not determined by the world markets. The result of the study also explores that there is some indication of market risk relationship among the European markets, as politically and economically they are closely interconnected with each other. The result of the study provide encouragement to the investors in mean of, that relationship among the markets does not change during market distress period 2008-2009.

Banerjee et al. (2007) use the daily data from June of 1986 to June of 2005 and create 12 portfolio and use the excess return to explore (a) the connection between the future return and level of VIX with changes (b) the predicting ability of the VIX for future portfolio returns which is gathered by book to market equity, size and beta (c) control the factors including market return, size premium, value premium and momentum factor. The result of the study reveals that most portfolios returns are significantly influenced by the VIX, as this relationship is showing more strength for those portfolios which contains high beta. It is also observed VIX showing stronger results after 60 day return as compared to 30 days returns as VIX takes almost 60 days to come back to its mean. Further result reveals that VIX might be priced risk factor, as its weaker response to the portfolios with low beta provides the evidence of market inefficiency. The findings conclude that variables related to the VIX has a greater ability to predict about the future return.

To investigate the impact of VIX on the return of stock market of U.S as well European stock market return before and during the crisis in the European market a work done by Sarwar (2014) by using daily closing data of the VIX, S&P 500 index and 7 main stock markets of the Europe from 1998 to 2013 time period. The result of the study indicates that daily variation in the VIX has stronger negative simultaneous linkage with the return of 7 stock markets of Europe and also this relationship showing persistency as compared to U.S stock markets, indicating market resistance and limited market information processing abilities of the investors. Whereas during the time of crisis in European stock market this

relationship is double and large as compare to, before the crisis period and it is stronger for Belgium, German, and British equity market.

It has been also observed that VIX rapidly response to the return of U.S stock market, at time of crisis in the European stock market. Further, asymmetric behavior is found between the VIX fluctuation and return of the European stock market providing the evidence that VIX act as fear signal for the European market. The finding of the study concludes that VIX has a stronger predictive role for the European market as its rapidly absorb all the changes in the VIX (Sarwar, 2014).

Kanas (2012) using 970 observation for VIX and S&P 100 Index from 1989 to 2007 to explore the role of VIX in explaining risk and return linkage for the S&P 100 by applying GARCH-M models. The study reveals that there exist significant positive risk and return linkage for the S&P 500 Index, if in the conditional variance equation VIX is added as an exogenous variable. In addition, Monte Carlo indicates that it is more possible that risk and return relationship will be weak if VIX is not included as an exogenous variable and if it is included there is 99% chance of risk and return will be significant and will show positive value. The result concludes that VIX contains an important information which results in the accuracy in the estimation of conditional variance and showing significant positive linkage.

Lei et al. (2012) use daily data from 1997 to 2010 by including the variables related to market return to examine the impact of VIX fluctuation on the trading volume of the stock market through applying regression analysis. The variables related to market return included in the study are quality spread, short term interest rate, holiday dummy and GDP, weekday dummies, unemployment rate and CPI declaration date dummies. The result of the study shows that high value of VIX has ability to determine the increase in trading volume, as peak level of VIX is possibly linked with the uncertainty in the trading volume. Liquidity in the market increases as investors continuously start trading in the market due to noise traders which decreases the return of the investors. Result conclude that noise traders not only deviate prices from the central value but also results in fast liquidation in the market.

Smales (2016b) use daily observation for the period of 2000 to 2010 to find the relationship among the variation in the VIX, S&P 500 Index, and cumulative news sentiments. The result of the study indicates significant negative contemporaneous linkage between the VIX fluctuation and the news sentiments and return of the stock market. The asymmetric linkage is found, whereas variations in the VIX is the result of bad news and decline in the stock market. In addition, VAR model is applied which shows strong positive connection between the past and current time variation in the VIX and stock market return, while current period and lagged news sentiments showing significant good (bad) connection with stock returns (changes in VIX). The result concludes that VIX perform well as a fear signal for the investors as compared with any news sentiment measures in predicting the future return.

Using daily data of VIX and VIX futures a study conducted by Shu and Zhang (2012) from the period of 2004 to 2009 and utilizing the linear as well as nonlinear Granger causality technique to explore the lead and lag relationship between the VIX and VIX future prices and timeline. The result reveals that during complete sample period the linear Granger test with an error correction mechanism show that VIX future prices predict the VIX Index, which indicates the price discovery ability of the VIX future market. However nonlinear test shows the bi-directional relationship among the VIX and VIX future prices, indicating both react contemporaneously to the arrival of new information. Further quarter by quarter results indicate that on average projected parameters are equal to 0 which provides the evidence that VIX futures market is efficient.

To examine the relationship between the change in the VIX and the gold prices or stock related to gold during and before the financial crisis period a study done by Boscaljon and Clark (2013) and use daily data from 1990 to 2008 . They study find that there exists significant positive relationship between the VIX changes and the prices of the gold, as large value of VIX lead to abnormal return for the gold, silver, ore industries, SPDR gold shares and exchange traded fund. The finding of the study provides the evidence that return of the gold related stock is strongly connected with the up and down movement in VIX, as it is observed

during result that when there is 25% rise in the VIX or during the financial crisis, the return of gold, also move upward. The finding concludes that investment in the gold related stock is the safest market for the investors at time when there is uncertainty in the markets and VIX values showing upward movement.

Copeland and Copeland (1999) use monthly data from 1981 to 1997 to examine the relationship between the VIX and portfolios of the various sizes and styles. The study found that portfolios returns are significantly enhanced through the VIX. The finding indicates that variation in the VIX leads to market timing signal. Further result of the study indicates that by rotation of style the portfolio returns can be improved, while value portfolios depends upon the variation in the VIX level. It is also observed that value stock portfolio depends upon the behavior of the VIX level, as VIX increases it outperform the portfolio of growth stocks, while it underperforms in case of low level of VIX. The result of the study concludes that preference of investor to value stock and growth stock strongly depends upon the Level of VIX.

Including 5 developed countries (UK, France, Germany, Japan, and US) and using monthly data from the period of 2000 to 2017 by applying simple linear auto regressive technique a study conducted by Dai et al. (2020) to investigate the predictability power of the implied volatility for the volatility of the stock return,. The implied volatility taken from each country are VIX (US), VXJ (Japan), VDAX (Germany), VCAC (France) and VFTSE (UK). In sample result indicates significant relationship among the implied volatility and volatility of the stock return, while this relationship is stronger in case of out of sample as compared with the volatility of oil price in the following countries. The findings reveal that implied volatility has the significant and strong predictability power to the volatility of the stock return.

Blair et al. (1999) use daily VIX, index return, and five-minute index return from 1987 to 1999 to explore the impact of VIX and intraday return to predict the index volatility from 1 to 20 days by applying ARCH model. The study includes in sample period from 1987 to 1992 including 1519 observations, while out of sample

period from 1993 to 1999 including 1768 observations. The result show that in-sample investigation of low frequency data, daily index does not show additional information, while high frequency data show slight additional information.

However, evidence indicate that in-sample investigation VIX providing additional information to predict the index volatility in high as well as low frequency data. The out of sample findings also indicate that VIX has a greater forecasting ability for the volatility of index than the low as well as high frequency index return. In addition, the combination of VIX prediction and prediction from the index return indicate that there exists additional predicting information in daily return when predicting one day forward. The study concludes that VIX has a ability to predict the index volatility (Blair et al., 1999).

By choosing the time frame from the period of 1990 to 2010 including daily data another work done by Jubinski and Lipton (2013) to examine the impact of VIX and contemporaneous stock market volatility on the return of oil, silver and gold by applying exponentially weighted moving average (EWMA). The study found that there exist significant and positive relationship between the VIX and the gold and silver, as any change in the VIX, positively reflect in the prices of gold and silver, indicating investment in the metal commodity is safest place during market uncertainty, while this relationship is found to be insignificant for contemporaneous stock market volatility. Oil return is also influenced by the variation in the VIX but showing negative relationship, indicating demand is decreasing, while also it is not affected by volatility of the stock market.

Cochran et al. (2015) use Double Threshold GARCH (1,1) to explore the ability of the VIX in explaining the returns and volatility of the return of natural Gas gasoline, oil, and heating oil by choosing frame from period of 1999 to 2003 including daily data. Their study also includes a sub period investigation, which covers the market decline period from 2007 to 2009. Their finding of the study indicate, that the shift in the commodities is specific according to the level of VIX, also threshold value of VIX are time varying. Further they find that natural gas prices significantly survive with the increase in VIX as compared with the prices of other energy commodities, as this relationship become more stronger during the

market decline period. The result further explore that estimated coefficient of the study shows asymmetric behavior about 50% to 70% because of variation during the overall sample period and crisis period.

The study of Fleming et al. (1995) includes daily and weekly data from the period of 1986 to 1992 to analyze (a) the VIX statistical properties (b) the relationship between the VIX behavior and return of the S&P100 index (c) the ability of the VIX to predict the volatility of the future stock market.

The result of the study shows (a) variation in the daily and weekly VIX perform very well. Daily variation of VIX with first autocorrelation is significantly negative, while its size is small and considerably lower than the OEX implied volatilities. Variation in weekly VIX with first order autocorrelation is greatly captured, showing mean return in index over this longer time period. (b) Variation in the VIX shows strong and negative relationship with the S&P 100 index return, indicating return of the market decreases with the increase in the level of VIX. Further relationship among them showing asymmetric behavior, indicating negative return are the result of the large changes in the VIX. (C) VIX has a stronger ability to predict the volatility of the stock market Fleming et al. (1995)

Employing symmetric thermal optimal path a work done by Yang and Shao (2020) to explain the linkage between the VIX and VIX future markets based on daily prices from 2004 to 2017 including 3331 observations. The study found that many times there exist lead and lag relationship between VIX and VIX futures depending upon the different time intervals, as in first few years VIX leads to the VIX futures exclusively before VIX option introduction. Further the result concludes that in price discovery, VIX play significant role at time of introduction of some VIX ETPS.

Fernandes et al. (2014) using daily index from 1992 to 2013 and the heterogeneous autoregressive (HAR) technique in which parametric and semiparametric is included to explore the time series properties of the VIX at daily frequency. The result of the study shows that VIX is negatively translated into the return of S&P 500 index, while positive contemporaneous relationship is found with S&P 500 index volume. Further, when multicollinearity and endogeneity is controlled the

response of term spread to VIX is somewhat negative as well as long in run. The overall finding of the study concludes that, it is very difficult to beat the pure HAR process because VIX is very persistence in nature. Guo and Wohar (2006) uses daily data of VIX and VXN from 1990 to 2003 to examine the multiple structural breaks in mean level of market volatility and to find the period in which these means turn out. The study find eidence in three separate period, before 1992, from 1992 to 1997 and after 1997. The result show that lowest mean volatility and standard deviation (average volatility) is observed from the period 1992 to 1997. The findings of the study indicate that volatility of the market change over time.

To determine the volatility spillover effect between the VIX and the RISE index (risk indicator in turkey) a research is done by Akdag et al. (2020) by choosing a time frame from the period of 2010 to 2018 including weekly observations. They employ Granger causality and Breitung and Candelon frequency domain causality methodology to explore this relationship. The result of the study indicates that there exists uni-directional linkage between the VIX and RISE index, as this relationship is moving from VIX to RISE index. RISE index shows no response to the VIX. The relationship among these two measures is also noticed distinctly in short, medium as well as long run, showing permanent causal linkage moving from VIX to RISE index. So, their results reveal the existence of volatility spillover effect between two fear indices, providing path and guidance to the investors, stakeholders before making any investment decision.

Erdoğdu and Baykut (2016) use daily data from the period of 1998 to 2015 to explore the relationship among the BIST Banking Index (XBANK) and VIX and MOVE (Merrill Lynchs Treasury Option Volatility Expectations Index). They use two techniques, firstly ARDL and secondly, Toda and Yamamoto (1995). The result of the study shows that there is no persistence linkage between the VIX and XBANK and MOVE, as CUSUM and CUSUMSQ tests graph also provides the evidence of no relationship among the variables. Further Granger causality test show that there is significant relationship exist from VIX to the XBANK index, whereas this relationship is found to be insignificant from MOVE to the XBANK index.

The study of Adhikari and Hilliard (2014) examine the lagged and contemporaneous relationship between realized volatility and VIX and VXO by choosing the time framework from the period of 1990 to 2008 including daily closing data. The study, use Granger causality approach to find a such relationship. The result of the study indicates that realized volatility effect the VIX, as realized volatility is lagged by VIX around 1 month. However, no evidence is found that VIX causes the realized volatility. The result of the study showing consistency with the idea that participants depends more upon the objective probabilities which results from a past observation and less depends upon subjective probabilities of the future.

Akdağ et al. (2019a) employ three methodologies, Granger causality, Breitung and Candelon frequency causality and Johansen cointegration to explore the effect of VIX on the various financial indicators in Turkey. The result of the study can be discussed in three points (a) Granger causality investigation indicates that fluctuation in VIX is due to fluctuation in BIST 100 index, industrial production index, dollar and Euro exchange rate, purchasing managers index, real sector and consumer confidence index, and RISE index (b) Frequency causality result provides the evidence of permanent connection from the variation in VIX to the variation in BIST 100 index, interest rate, industrial production index, industrial production index, Dollar and Euro exchange rate, purchasing managers index, real sector confidence index, and RISE index, while this relationship is found to be temporary in case of consumer confidence index (c) Long term connection is found among the related variables and VIX index as measured by the Cointegration test.

Huynh (2020) use daily spot prices from the period of 1990 to 2019 to determine the causal relationship between the VIX and Economic Policy Uncertainty (EPU) and four precious metals including platinum, palladium, silver, gold. The study utilizes two methodologies, firstly Multilayer Perceptron Neural Network Non-linear Granger causality, secondly Transfer Entropy to explore the such relationship. His study reveals that gold is still the leading safest stock for the investors against the uncertainty in the market. The findings of the result also

show that all the metals significantly effect the EPU and VIX index, whereas they are resistant to shocks from EPU but not from VIX.

Another study conducted by the Ozair, 2014 to examine the causality linkage between S&P 500 index and VIX by employing Granger causality test. The result of the study shows that (a) Impact of S&P 500 index to VIX is significant as well showing persistency; (b) The sequential pattern of convincing reversal (in first lag) is followed by a VIX, which is then again followed by momentum in succeeding lags (after the first 10 minutes); (c) The VIX showing permanent impact on the market, while S&P 500 index bears a temporary one; (d) the effect of S&P 500 index on the VIX is long enough to results in 70% of VIX variance, showing that S&P 500 index has predictable ability to the present variation of the VIX.

Using daily time series data from a period of 1995 to 2014, a study conducted by Kaya and Çoşkun (2015) find the relationship between VIX (fear index) and Istanbul Stock Exchange (BIST-100) by employing Granger causality and regression analysis. The result of the study shows that there is significant relationship found from VIX to Istanbul Stock Exchange (BIST-100). However, the result of regression investigation provides the evidence of negative relation among the VIX and BIST-100 index, indicating any change in VIX negatively affect the return of BIST-100. The findings of the study conclude that VIX has a stronger forecasting ability for the future returns of the stock market as well as providing guidance to the investors before investing in the stock market.

Another study conducted by the Başarır (2019) explore the linkage between the VIX and BIST-100 for the time frame from 2000 to 2018 using daily data. The frequency domain causality test is applied to measure the relationship. According to the result of the study there is no temporary and permanent causality linkage from BIST-100 to VIX. However, this relationship is found to be significant in both cases, temporary and permanent from VIX to BIST-100. Overall study reveals that information provided by the VIX is used by the investors in effective manners to predict the prices of stock markets in short as well as long period.

The study of Esqueda et al. (2015) explain the response of VIX on the American depository receipt (ADR) by using daily prices from 1995 to 2009 and employing the GARCH-M framework. The result indicates that variation from law of one price (LOP) in ARD market is moderately because in non frictionless markets there is limit of arbitrage. The VIX is significantly negatively translated in to ARD premium, as investors thinks when the level of VIX increases there is decrease in ARD premium. In addition, it is observed that variation from law of one price in ARD can be forecasted by the lagged VIX. The authors provide the evidence that increase in the volatility of ARD market tend to increase variation from law of one price. Their overall study concludes that diversification strategy of ARD investors can be improved by keeping information of the VIX Index.

Neffelli and Resta (2018) use daily data from the period of 2007 to 2018 to explore the relationship between the VIX Index and US and BRIC stock markets including China (SHSEC), Russia (IMOEX), India (BSESN), Brazil (IBOV) and USA (S&P500 index) by applying the GMM methodology. The result shows the regular structural break in the VIX as during 2008 when there is a market decline and market moves negatively, the level of VIX significantly goes up in response to such crisis period. This relationship is stronger for the US even after the crisis, whereas BRIC countries stock markets move negatively to pre-crisis period.

Öner et al. (2018) using time framework from 2006 to 2017 to study the short and long-term relationship between VIX and equity market of developing countries i.e. South Africa (JALSH Index), Thailand (SETI Index), Argentina (MERVAL Index), Turkey (BIST 100 Index), Taiwan (TWII Index), Chile (IPSA Index), Russia (MICEX Index), South Korea (KS11 Index), Mexico (MXSE Index), while Poland (WIG20 Index) has been selected as a representative of developing countries equity market. The study employs Engel-Granger Cointegration and Granger Causality test, while relationship between the variables are measured through Vector Error Correction Model (VECM). The result indicates there is minimum one short or long-term connection is found between VIX and developing countries equity markets except Argentina.

Sarwar (2012b) use daily closing values from 1993 to 2007 to study the effect of VIX on the stock market return of BRIC countries i.e. China, Brazil, Russia, and India, also effect of VIX is examined on the US stock market return. The multivariate regression analysis is used to explore the relationship between VIX and stock market return. The results show that daily variation in VIX significantly and negatively influence the return of U.S, china, Brazil and India stock market, as this relationship is stronger for U.S and Brazilian stock market at time of peak level of VIX. Further result indicates that there exists asymmetric behavior between variation in VIX and China, Brazil, U.S stock market return, while this relationship is stronger when VIX value goes up, indicating VIX act as a fear signal for the investors rather than good news. Overall result of the study concludes that VIX index is not only a fear symbol for U.S. equity market but also for equity market of India, Brazil, and China.

Another study conducted by the Sarwar (2017) investigate the flight to safety fact by exploring the relationship between VIX and volatilities of the gold, silver and treasury note market by using data from 2004 to 2014 including pre-crisis period, crisis period and post-crisis period. The multivariate regression is used in the study to find the relationship between the variables. The result show that rise in VIX result in contemporaneous and late rise in the volatilities of gold, silver and treasury note prices but these late volatilities do not forecast the volatility of the stock market. It has been also observed that increase of volatilities in gold and treasury note prices is more explained by the VIX during the crisis period as compared to other periods. The result shows that VIX has a leading role in the financial market and also investment in gold stock is the safest investment during market decline period.

Using daily data from the period of 2011 to 2015, a study done by Badshah (2018) examine volatility spillover from VIX to the developed (VXEFA) and emerging (VXEEM) stock markets VIX. The study apply vector autoregressive (VAR) frame work in first part, while secondly Asymmetric dynamic conditional correlation (ADCC). His findings show that VIX play a leading role and contain important information that reflect in both developed and emerging markets. The

unexpected volatility shocks of developed and emerging markets are about 57.07% and 63.77% is explained by the VIX, as these shocks showing persistency around 7 days. Further findings of the study show that there is time varying correlation among the market, as both developed and emerging markets are strongly interconnected with the VIX. The correlation dynamic of emerging markets are drived by the VIX, while it increases in crisis period and decreases in good market condition periods.

Akdağ et al. (2019b) daily data of tourism indices of 11 countries i.e. Turkey, USA, China, Britain, Sweden, Greece, Spain, Finland, Denmark, Italy, and Srilanka along with VIX from the period of 2013 to 2017 to study the effect of VIX on the return of tourism indices. The study employ Granger causality and cointegration test to explore the relationship between the variables. They find that change in VIX significantly effect the return of tourism indices of all countries except USA and Srilanka. The frequency causality investigation result concludes that variation in VIX permanently effect the variation in tourism indices of Turkey, Italy, Denmark, Spain, Sweden, UK, China, Greece, but this relationship is found to be temporary for Finland.

However, for USA and Srilanka this relationship is also found to be insignificant. Further cointegration result shows long term linkage between the variables as rise in VIX negatively translate in the return of tourism indices. Their study result provides the evidence that VIX has a stronger ability to predict the return of tourism indices and provide the guidance to the investors before making investment in tourism sector Akdağ et al. (2019b).

Using daily data from 2007 to 2015 and utilizing ARDL model a study done by KULA and BAYKUT (2017) to find the short and long run linkage between the VIX and Borsa Istanbul corporate Governance Index (XKURY). The result of the study reveals that there exist long run relationship between the VIX and Borsa Istanbul corporate Governance Index (XKURY). Result provides the evidence of long-term capability of the VIX in predicting the future return. Chiang (2012) use daily time series data from 2001 to 2011 and employ bivariate GARCH and TAR model to explore the transmission of volatility and return between NASDAQ 100,

S&P 500, VXN and VIX, at time when VIX and VXN was introduced. The author argues that during the complete sample period, VIX performance is best among the all four indices and also high VIX volatility is observed as compared to other index. VIX has stronger influence on the prices of S&P 500 index. Result indicate that negative lagged return showing bidirectional causal relationship with SP500 index/VIX series during low fear period, while there is no lead lag relationship is observed between NASDAQ100 and VXN index. Further, return and volatility connection to high and low fear gauge is asymmetric.

Chen et al. (2017) use daily data from 2003 to 2013 to explain the predictability power of 7 international fear indices for the cumulative Chinese stock market return by utilizing standard predictive regression framework. The international fear indices include; VIX (USA), VXJ (Japan), VCAC (France), VFTSE (UK), VDAX (Germany), VSHI (Hongkong), VSTOXX (Euro zone), while Shanghai stock exchange (SSE) and Shenzhen stock market represent Chinese stock market. The findings reveal that international fear indices negatively influence contemporaneous daily overnight Chinese stock returns, while this relationship is found to be positive for day time stock return. It has been also observed by them that variation in VIX is powerful in predicting daytime return and play main role among the all other international fear indices, while VIX predicting power remains strong after controlling the volatility of Chinese domestic. In addition, highest domestic volatility of Chinese market, low trading and liquidity in the market are predicted by the peak VIX index, indicating the predictive power of the VIX for Chinese stock return.

Using daily closing data from 2008 to 2016 and employing E-GARCH and GARCH (1,1) model a study conducted by a Pati et al. (2018) explore the effect of Implied volatility Index in predicting the volatility of the stock market of Australia, India, and Hongkong. These authors argue that persistence of volatility is reduced and model fitness is improved through the addition of implied volatility index in the conditional variance. The result showing significant and positive implied volatility index in GARCH model, which indicates that it holds related information in explaining the volatility process. Their study concludes that VIX

is a prejudiced forecast but it contains related information in describing future realized volatility, while it has been observed through encompassing regression that there exists additional information in the implied volatility index for stock market volatility prediction as compared to information exist in the GARCH model.

Dutta (2018) use daily data values from the period of 2011 to 2016 and apply autoregressive distributed lag (ARDL), Granger causality test and bivariate VAR-GARCH model to explore the linkage between the stock market of US and emerging markets i.e. China and Brazil by using their implied volatility indexes. The result showing strong evidence of long-term relationship between VIX and emerging markets. The bivariate VAR-GARCH model shows high correlation between the equity markets, which can reduce the advantage of portfolio diversification among the U.S. and China, Brazil markets. The final Granger causality analysis also explain significant connections among the volatility indices.

Using daily data of VIX, KSE-100 index, PKR exchange rate from 2004 to 2016 except China Exchange Traded Funds VXFXI from 2011 onward a study conducted by Ishfaq et al. (2018) to examine the spillover effect from VIX and VXFXI to the KSE-100 Index and foreign exchange rate of Pakistan. The study employ VAR model and impulse response function (IRF) to explore the relationship between the variables. Their findings conclude that rise in VIX and VXFXI index leads to decrease the prices of KSE-100 index and also crumble the exchange rate market, indicating the sensitivity of currency and stock market against the fear index. Overall findings show important role of VIX and VXFXI index for the financial market of Pakistan as rise in VIX leads to outflow of investment from Pakistan.

Sarwar (2020) use daily values from 2004 to 2019 to describe the interdependencies between VIX and implied volatilities of five European countries i.e. France (VCAC), German (VDAX), Eurozone (VSTOXX), U.K. (VFTSE) and Swiss (VSMI) by employing VARMAX-DCC-QGARCH model. The result of the study shows significant connection between VIX and volatilities of the European markets that persist and enable risk spillover, while this relationship is more stronger during financial crisis period. It also observe that variations in VIX

and VSTOXX index play important role of risk transmission in European Markets. Further VIX and European volatilities exhibiting response to each other, while shocks of VIX significantly contribute to the forecast error of European risk shocks but this relationship is not observed from European Indexes. In addition, during Brexit vote the risk spillover is strengthen from U.K. to U.S. and European markets.

Another study conducted by Smales (2016a) to find the relationship between the variation in VIX and U.S, Australia, New Zealand financial market return i.e. stock, bond and foreign exchange market, by choosing a time frame from the period of 2001 to 2015. The result of the study shows that rise in VIX index negatively translate in to stock market, bond market and exchange rate market (AUD and NZD) while this relationship is found to be positive for USD as it appreciates with the rise of VIX index. It has been also observed that VIX index more strongly influences the return of these markets during the financial crisis period because VIX value goes up during such period. Taking all together this study confirms financial market returns quickly responds to the change in the level of VIX, which may help to develop a profitable trading strategy.

To examine the relationship between the change in the level of VIX and foreign exchange rate return of major investing and emerging markets another study also done by Smales and Kininmonth (2016) by using daily data from 2004 to 2014. The result shows changes in VIX negatively affect the return of high interest rate currencies, while it positively effects the return of low interest rate currencies. In addition, result indicates that during financial crisis period the return of the currencies more strongly absorb the variation in the VIX, while low interest (funding) currencies are found to be safest for investment as it showing positive response with the increase in VIX level.

Tsai (2014) employ VAR model proposed by Diebold and Yilmaz (2012) and use monthly index data from 1990 to 2013 of France, Germany, United Kingdom, Japan, United States, to explore the fear spillover between these stock markets. The result of the study concludes that after 1998, spillover between the all the

stock market increases. It is noticed that stock market of Germany and U.S. significantly influencing the other markets, as French market is primarily influenced by the Germany and U.S stock market influences other markets. Further the fear index (VIX) also significantly effect the stock markets of France, Germany, United Kingdom, and Japan.

Adrangi et al. (2019) use daily data from 2013 to 2018 to examine the response of four major stock market i.e. CAC 40, FTSE, S&P 500, and DAX index; to the VIX by employing a Structural Vector Autoregression model (SVAR). The study find three significant breaks during whole sample period in the data, as from 2013 to 2016 which is taken as first and second subperiods, volatility in the Germany UK, US and France equity market responded to shocks to the VIX index. However, it has been also observed that during Brexit, equity indices is not influenced by the shock of VIX.

Badshah et al. (2013) use daily data by choosing time frame from 2008 to 2011 to analyze the contemporaneous relationship between the VIX, gold (GVZ), and exchange rate (EVZ) by employing identification through heteroskedasticity technique. The result of the study provides an evidence of strong unidirectional spillover from VIX to GVZ, and EVZ, indicating rise in VIX lead to rise in GVZ and EVZ. However, this relationship is found to be bi-directional between GVZ and EVZ. Further structural VAR indicates that traditional VAR extremely overrates the impulse responses for GVZ.

To explore the connection between Indian VIX and future stock market volatility a study conducted by the Shaikh and Padhi (2015) choose time period from 2007 to 2013 including monthly observations and utilizing an ordinary least squares (OLS) methodology. The result provides the evidence that VIX act as a fear symbol for the investors. The result further showing that decrease in VIX level leads to increase the expected stock market volatility. In addition, it is also noticed that anxiety of investor leads to possible profit to the options seller.

Kim and Ryu (2015) analyze weekly data from 2003 to 2012 and employ BEKK GARCH model to investigate mean and volatility spillover as well as co-jump behavior among the U.S. and Korean equity markets. The analysis of the

study concludes that there exist mean spillover effect from the U.S. stock market to the Korean stock market. Also, a significant volatility spillover is also observed between these two markets. During financial crisis, looking towards cojump behavior the result also provides a strong alliance in size in contrast with intensity among U.S. and Korean stock market.

Wahab and Masih (2017) use daily values from 2010 to 2017 and employ ARDL approach to investigate (a) the lead and lag behavior between the VIX and realized volatility of S&P 500 index; (b) the intermarket correlation among the VIX, Oil Volatility Index , and Gold Volatility Index. The result of the study indicates that markedly VIX is lagging its historical variance and amazingly also VIX is lead by its price index. Their result also concludes that Gold leads in the market as stock respond more sensitively to the shocks.

Bouri et al. (2018a) choose time frame from 2011 to 2016 including daily observation and employ Bayesian Graphical Structural Vector Autoregressive (BGSVAR) model to explore the predictive power of VIX in the two commodity markets and five developed stock markets for the VIX in individual 11 BRICKS stock markets. The result provides the evidence that certainty of implied volatility in BRICS markets is the function of global as well as inside the group stock market implied volatilities, while the commodity market role is marginal excluding south Africa. Another work done by the Bouri et al. (2018b) to analyze the short, medium and long-term linkage between the VIX and implied volatilities of 5 BRICKS countries (South Africa, Russia, India, China, and Brazil) by employing spectral causality approach and choosing time frame from 2011 to 2018. The result shows leading role of VIX in explaining uncertainty in all BRICKS market. However, it is also observed that there is significant response from Russia, China and Brazil to the VIX.

Chen (2014) employ Markov-switching model and use daily data of implied volatilities of four major countries from 2003 to 2010 to explore the fear spillover between VIX (United States), VDAX (Germany), MVX (Canada) and VXJ (Japan). The result indicate interconnections, contagions, and dependencies between the VIX (United States), VDAX (Germany), MVX (Canada) and VXJ (Japan) that

is strongly supported by data in all copulas. Further, asymmetric investigation provides the evidence that connection between implied volatility indices are very stronger when there is rise in the indices.

Employing T-GARCH model, BEKK and DCC model and choosing a time period from 2007 to 2011 including weekly observations a study conducted by Narwal et al. (2012) to examine the spillover and transmission between the Indian VIX (IVIX) and four major volatility indices including VIX (USA), VCAC (France), VDAX (Germany), VSMI (Switzerland). The result of the study document that there exists asymmetric behavior for the IVIX, VIX and VCAC. Further BEKK-GARCH model results indicate that conditional variance of IVIX, VCAC, VDAX, and VSMI are greatly influence by their own past shocks and volatility. Final approach of the study, DCC model show correlation among the markets at moderate level.

Badshah (2018) use daily data of from 2011 to 2016 and employ mixed Quantile regression- copula approach to analyze the relationship between the VIX (USA) and three implied volatilities including VXEEM (for all emerging stock markets), VXFXI (for Chinese market), VXEWZ (for Brazilian market). The result reveal that changes in VIX positively translate in to the emerging market volatilities, while this relationship is found to be stronger for the higher part of conditional distribution. There exists contemporaneous relationship which is found to be significant in all cases and it is stronger three times as compared to their lagged connection. Further result reveal that there exist highly asymmetric behavior showing positive shocks of VIX create more volatility than negative shocks. All together if positive and negative shocks of VIX is compared on the volatilities of emerging market by employing OLS, QRM and Copulas, the result indicates the volatility of the positive shock by the QRM at the 95% quantile is eight times greater than the one created by OLS.

Alqahtani and Chevallier (2020) use weekly data from 2004 to 2018 and apply DCC-GARCH model to explore the conditional correlation between GCC stock market return and implied volatility indices of S&P500 (VIX), oil (OVX) and gold (GVZ). Their result concludes that (a) there exist negative correlation between

GCC stock market return and all the implied volatility indices as this relationship is more pronounced during the market decline period; (b) There is most correlation found among GCC stock return and oil shocks; (c) Among the all GCC countries, Qatar and Saudi Arabia shows high response towards the shocks, whereas weak correlation is observed for the Bahrain in response to VIX, OVX and GVX.

To examine the time varying effect of VIX on the driving correlation across the international stock markets a study done by Marfatia (2020) by employing time-varying parameter approach and choosing time frame work from 1992 to 2017. The result show that dynamic correlation among U.S and 17 leading stock markets out of 20 is significantly influenced by the VIX. It is also observed that VIX positively influence the correlation of U.S. market with the Latin American and European markets. However, the connection of U.S. market with all the Asian markets negative (positive) as the VIX increase (decrease). The study conclude that in all situations the influence of VIX on the correlation fluctuates significantly from time to time as measured by the time-varying parameter model.

Using daily closing values of VIX and major stock markets of twenty countries from the period of 2000 to 2017 and employing Granger non-causality model a research conducted by Dicle (2017) to explore the impact of VIX on the international stock market return. The result reveal that 18 stock markets are led by the VIX and 17 of the markets is caused by Granger after controlling the return of S&P-500 index and market crisis period. The author argues that investor of US looking to diversify the US uncertainty indicating international stock market cannot provides the benefit of diversification. The study results provide the evidence of ability of VIX in predicting the return of international stock market.

Russon and Vakil (2017) use daily time series data for the period of 1990 to 2017 and employ regression analysis to investigate whether the relationship between the VIX and volatility of the S&P 500 index is linear or nonlinear. The authors argue that realized volatility of S&P 500 index is nonlinear and it increases with the increase in the level of VIX. Frijns et al. (2016) explore the intraday relationship between the VIX and VXF by choosing time span from 2008 to 2012

and employing Vector Autoregression (VAR) model. The result show strong bi-directional linkage between the VIX and VXF by using ultra- high frequency data, while this relationship is found to be stronger from VXF to VIX. The result of Impulse response and variance decomposition also confirms that VXF showing stronger response towards VIX. Further result concludes that causality from VXF to the VIX rising over the sample period, while from VIX to VXF has been decreasing, indicating VIX futures become more vital in pricing of volatility. In addition, the authors further document that VIX future showing strong response than VIX on days showing negative return in contrast with high VIX values, indicating investors use VIX futures for hedging than investing in S&P 500 index options.

Employing quantile regression method and choose time span from 2002 to 2016 a study conducted by Tekin and Hatipoğlu (2017) to examine the effect of VIX, Oil prices and US Dollar rate on the Borsa Istanbul stock exchange (BIST-100). The study found that VIX index significantly influence the BIST-100 index in all quantiles, while US Dollar rate also effect the BIST-100 index but only in high quantiles. Further, the influence of oil prices shows that there exists no asymmetric connection between the variables only showing meaningful response in middle quantile. Qadan and Idilbi-Bayaa (2020) use threshold-GARCH, structural vector auto regression and causality models and choose daily and monthly data from 1990 to 2017 to analyze the effect of VIX on the return and volatility of the oil prices. The result reveal that variation in the oil prices is influenced by the VIX but this relationship is not found from OVX to VIX. The findings of the study reveal that variation in VIX does not play only lead role for stock markets but also for the oil market.

Vodenska and Chambers (2013) use daily data from 1990 to 2009 to explore the relationship between VIX and S&P 500 index. The result shows lag relationship from VIX to one-month volatility of S&P 500 index. Further result provides the evidence that during stable period S&P 500 Index volatility is overestimated by the VIX, while during highly volatile period VIX underestimates the volatility of the S&P 500 Index.

Most of the previous literature that discussed above show global indices effect on local market or it discuss intermarket spillover but there is little work done which discuss effect of VIX on indices, so this study capture VIX spillover on indices. Also, above discussed literature mostly discusses the impact of VIX on the developed and emerging market background or it focuses on regional effect, as Islamic countries as a group is less considered, so this study will focus on Islamic countries. Further there is also less evidence found for the past studies that include **ARMA GARCH model, T-GARCH model, DCC** and **ADCC GARCH model** to capture the spillover effect of VIX on the equity market of Islamic countries, so this study will capture interdependency, asymmetric behavior, and time varying correlation with asymmetric effect between the global fear index (VIX) and equity markets of the selected Islamic countries.

2.2 Hypothesis for This Study

Hypothesis of the study are as follows:

Hypothesis 1

There exists spillover between VIX and the equity market of Islamic countries.

Hypothesis 2

There exists spillover from VIX to equity markets under the consideration of asymmetric behavior.

Hypothesis 3

There exists time-varying correlation among VIX and the equity market of Islamic countries.

Hypothesis 4

There exists asymmetric behavior of conditional correlation among VIX and the equity market of Islamic countries.

Chapter 3

Research Methodology

Research methodology is a process in which various tools, techniques and concepts are used in a study to check the answer of the research question in a methodical manner. Three methodologies are used in this study to examine the spillover from Global Volatility Index to the equity markets of selected Islamic countries. The first methodology is ARMA GARCH presented by Liu and Pan (1997) examine interdependency between the VIX and selected Islamic countries. The second methodology used in the study is T- GARCH model presented by Rabemananjara and Zakoian (1993) and Glosten et al. (1993) to spillover from VIX to Islamic equity markets under the consideration of asymmetric behavior. The last methodology employed in this study is Dynamic Conditional Correlation (DCC) with its extension Asymmetric-DCC (ADCC) proposed by Engle (2002) and Cappiello et al. (2006), to explore the time varying correlation among the markets and also to find whether the correlation among the market is effected by the asymmetric behavior.

3.1 Data Description

3.1.1 Population and Sample of Study

Population of this study is the Islamic stock markets and sample of this study is eleven Islamic stock markets, these stock markets are selected on the basis of

market capitalization and availibility of data. This study utilizes the daily closing data of VIX Index and eleven Islamic stock market i.e. Tawadul stock exchange (Saudi Arabia), Qatar stock exchange (Qatar), Abu Dhabi Securities Exchange (UAE), Muscat securities Market (Oman), Egyptian Exchange (Egypt), Bursa Istanbul Stock Exchange (Turkey), Pakistan stock exchange (Pakistan), Jakarta stock exchange (Indonesia), Bursa Malaysia exchange (Malaysia), Dubai financial market (UAE), Iraq stock exchange (Iraq). Data is taken from the stock markets of Islamic countries and CBOE. The time span of this study is from January 1,2000 to September,30 2019 but time frame of some equity market is different as mentioned in the Table 3.1. The VIX index is matched with the selected Islamic equity markets.

3.2 Description of Variables

The return of VIX and stock market index are calculated by dividing current day closing prices by previous day closing prices and taking their natural log. The formula is as follow:

$$R_t = ln(\frac{P_t}{P_{t-1}}) \tag{3.1}$$

Where Rt = return of VIX index and stock market index

ln = Natural log

P_t = Current day closing prices

P_{t-1} = Previous day closing prices

The detail about Islamic stock market indices is mentioned in table 3.1

Table 3.1: Islamic Equity Markets

Sr. No.	Equity markets	Country	Symbol	Data Availability
1	Tawadul Stock Exchange	Saudi Arabia	TASI	January 12, 2000 to September 30,2019
2	Qatar stock exchange	Qatar	QSE	March 14, 2001 to September 30,2019
3	Abu Dhabi Securities Exchange	UAE	ADX	July 2, 2001 to September 30,2019
4	Muscat securities Market	Oman	MSM30	January 1, 2000 to September 30,2019
5	Egyptian Exchange	Egypt	EGX30	January 2, 2000 to September 30,2019
6	Bursa Istanbul Stock Exchange	Turkey	BIST100	January 4, 2000 to September 30,2019
7	Pakistan stock exchange	Pakistan	KSE100	January 3, 2000 to September 30,2019
8	Jakarta stock exchange	Indonesia	JSX	January 4, 2000 to September 30,2019
9	Bursa Malaysia exchange	Malaysia	KLSE	January 3, 2000 to September 30,2019
10	Dubai financial market	UAE	DFM	January 3, 2004 to September 30,2019
11	Iraq stock exchange	Iraq	ISX60	March 19, 2014 to September 30,2019

This table provides the information about the selected Islamic equity Index with respect to its availibility of data.

3.3 Econometric Model

3.3.1 Return & Volatility Spillover - ARMA GARCH

3.3.1.1 Volatility Index (VIX) to Equity Market of Islamic Countries

Two-stage GARCH-in-mean approach (GARCH-M), proposed by Liu and Pan (1997) is used to examine the return and volatility transmission of Volatility index (VIX) on stock market of Islamic countries. In the 1st stage, the relevant stock market return series are modeled through an ARMA (1, 1)-GARCH (1, 1)-M econometric model.

$$r_{k,t} = \beta_0 + \beta_1 r_{k,t-1} + \beta_2 V_{k,t} + \beta_3 \varepsilon_{k,t-1} + \varepsilon_{k,t}\varepsilon_{k,t} \sim N(0, V_{k,t}) \tag{3.2}$$

$$V_{k,t} = \alpha_0 + \alpha_1 V_{k,t-1} + \alpha_2 \varepsilon^2_{k,t-1} \tag{3.3}$$

Where $r_{k,t}$ is the daily return of volatility index (VIX) at time t, and $\varepsilon_{k,t}$ is the residual (or unexpected return) which is normally distributed with mean zero and time-conditional variance $V_{k,t}$.The inclusion of ARMA (1,1) and/or MA (1) structure in the model is designed to adjust for possible serial correlation in the data.

In the second stage, mean return and volatility spillover effects across markets are estimated by obtaining the standardized residual and its square in the first stage and substituting them into the mean and volatility equations of other markets.

$$r_{j,t} = \beta_0 + \beta_{j,1} r_{j,t-1} + \beta_{j,2} V_{j,t} + \beta_{j,3} \varepsilon_{j,t-1} + \Omega_j \varepsilon_{k,t} + \varepsilon_{j,t}, \varepsilon_{j,t} \sim V(0, V_{j,t}) \tag{3.4}$$

$$V_{j,t} = \alpha_{j,0} + \alpha_{j,1} V_{j,t-1} + \alpha_{j,2} \varepsilon^2_{j,t-1} + \phi_j \varepsilon^2_{k,t} \tag{3.5}$$

where $\varepsilon_{k,t}$ is the standardized residual series for the volatility index (VIX), and is capturing the mean return spillover effect from these sources. In order to examine the volatility spillover, the exogenous variable $\varepsilon^2_{k,t}$ the square of the standardized

residual series is included in the conditional volatility equation and is defined as $\varepsilon_{k,t} = \varepsilon_{k,t}\sqrt{V_{k,t}}$. The subscript j in each of the equations (3) and (4) refers to the one of the stock market of Islamic countries.

3.3.2 GJR-GARCH Model

The GJR-GARCH or threshold GARCH model was proposed by the works of Rabemananjara and Zakoian (1993) and Glosten et al. (1993). The main target of this model is to capture asymmetries in terms of negative (or bad news) and positive shocks (or good news).

$$r_{k,t} = \eta_0 + \eta_1 r_{k,t-1} + \eta_2 V_{k,t} + \eta_3 \varepsilon_{k,t-1} + \varepsilon_{k,t}\varepsilon_{k,t} \sim N(0, V_{k,t}) \tag{3.6}$$

$$V_{k,t} = \rho_0 + \rho_1 V_{k,t-1} + \rho_2 \varepsilon^2_{k,t-1} + \gamma \mu^2_{k,t-1} d_{t-1} \tag{3.7}$$

$$r_{j,t} = \eta_0 + \eta_{j,1} r_{j,t-1} + \eta_{j,2} V_{j,t} + \eta_{j,3} \varepsilon_{j,t-1} + \lambda_j \varepsilon_{k,t} + \varepsilon_{j,t}, \varepsilon_{j,t} \sim V(0, V_{j,t}) \tag{3.8}$$

$$V_{j,t} = \rho_{j,0} + \rho_{j,1} V_{j,t-1} + \rho_{j,2} \varepsilon^2_{j,t-1} + \sigma_j \varepsilon^2_{k,t} + \gamma \mu^2_{j,t-1} d_{t-1} \tag{3.9}$$

3.3.3 Time-Varying Conditional Correlation - DCC and ADCC

The **DCC model** will capture the interdependency between VIX and equity markets of Islamic countries.

$$Q_t = \bar{R} + \sum_{i=1}^{m} \pi i(\varepsilon_{t-i}\varepsilon_{t-1} - \bar{R}) + \sum_{i=1}^{i} \varepsilon i(Q_{t-1} - \bar{R}) \tag{3.10}$$

The **ADCC model** will capture the asymmetric effect on the correlation among the markets.

$$\sigma_t = min(\epsilon_t, 0), \bar{N} = \frac{1}{T}\sum_{t=1}^{T} \sigma_t \acute{\sigma_t} \tag{3.11}$$

Chapter 4

Data Analysis and Discussion

This chapter includes the result of various test, applied to explore the spillover from global volatility index to the selected Islamic equity markets.

4.1 Graphical Representation

4.1.1 Stationarity of Data

The first basic fundamental step in analysis is to check whether the data is stationary or not. Stationarity means statistical properties of the series is constant and do not change over time. To detect the stationarity and heteroscedasticity of data, the most basic method is to plot the data and to see behavior of data through visualization whether it shows some known characteristics of stationary and heteroscedasticity. All graphs are attached in **Appendix-A**.

4.1.2 Descriptive Statistics

The second step is to describe the characteristics of data set through descriptive statistics of VIX and equity market of the selected Islamic countries. The descriptive statistics measure central tendency (mean) and variability (standard deviation, minimum, maximum), skewness and kurtosis of the data, which are show in the table 4.1

TABLE 4.1: Descriptive Statistics

	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis
VIX	-0.0001	0.7682	-0.3506	0.0691	0.9411	9.7188
TASI	0.0003	0.0939	-0.1033	0.0140	-0.8820	13.6238
QSE	0.0005	0.0942	-0.0936	0.0130	-0.3648	11.2760
ADX	0.0003	0.0763	-0.0868	0.0107	-0.0815	11.6330
MSM30	0.0001	0.0804	-0.0870	0.0089	-0.9823	23.5294
EGX30	0.0005	0.1837	-0.1799	0.0167	-0.3631	11.7919
BIST100	0.0004	0.1777	-0.1998	0.0207	-0.0760	10.9419
KSE100	0.0001	0.0851	-0.0774	0.0133	-0.2465	6.7056
JSX	0.0005	0.0762	-0.1095	0.0132	-0.6779	9.9102
KLSE	0.0001	0.0628	-0.0681	0.0082	-0.3511	10.9482
DFM	0.0003	0.1220	-0.1216	0.0167	-0.0197	9.7300
ISX60	-0.0006	0.1103	-0.1258	0.0123	-0.2473	25.2641

This table exhibits the descriptive statistics for the series of VIX and selected Islamic equity markets.

Mean return measure the performance of the stock market indices of the selected Islamic countries. The descriptive statistics result shows the all the equity market indices has a positive return except Iraq stock market (ISX-60), indicating negative return of (0.06%) per day. The highest mean return is earned by the Egyptian exchange (EGX-30) of about (0.05%) per day. Further maximum and minimum values show the highest and lowest return earned per day by the equity market indices i.e. The highest earning for Tawadul stock exchange (TASI) is (9.3%) and maximum loss earned per day is (10.3%), while for Qatar stock exchange (QSE) highest gain is (9.3%) and loss is (9.4%) and so on.

The standard deviation of Borsa Istanbul stock exchange (BIST-100) showing highest (2%) among all equity market indicating market is highly volatile as compared to other equity markets or we can say this market bear high risk. However, Bursa Malaysia stock exchange (KLSE) shows lowest standard deviation (0.81%) among all equity market indicating market is less volatile and bearing less risk.

Skewness measure the asymmetric behavior of the data around its mean. The skewness coefficient of all the equity market show that distribution of return is negatively skewed. Kurtosis measure the peakedness or flatness of the data. The kurtosis value for all equity markets is greater than 3 indicating the distribution is peaked or all series are leptokurtic.

VIX showing negative mean return of (0.0001%) per day, while showing positive standard deviation (6.9%). Maximum and minimum statistic shows (76.8%) return gain per day and (35%) loss per day. Further coefficient of skewness show that distribution of return is positively skewed indicating appreciating in the global volatility index market. The value of kurtosis is also greater than 3 indicating data is leptokurtic.

4.2 Mean and Volatility Spillover from VIX to the Equity Markets of Selected Islamic Countries

The first stage of the study is to capture mean and volatility spillover from VIX to the equity markets of selected Islamic countries using econometric model.

Table 4.2 shows the measure of spillover between VIX and equity markets of Islamic countries including Saudi Arabia, Qatar, UAE, Oman, Egypt, Turkey by using an ARMA GARCH (p, q) model. Coefficient of ARCH GARCH are stated with their p-value (in parenthesis). The coefficient of GARCH in mean, β_1 is found to be insignificant for all equity markets which indicates through past prices behavior today return can not be forecasted. The coefficient of β_2 is significant and positive for Qatar Stock Exchange, Muscat Securities Market, and Abu Dhabi Securities Exchange which indicate past economic shocks positively effect the today return of equity markets. While for rest of the Equity markets this relationship is found insignificant.

TABLE 4.2: Mean & Volatility Spillovers from VIX to the Equity Markets of Islamic Countries - ARMA GARCH Model

	VIX	**TASI**	**QSE**	**ADX**	**MSM-30**	**EGX-30**	**BIST**
β_0	**0.003240**	0.000555	0.000136	-0.00032	-0.00004	0.000528	-0.00026
	(0.2257)	(0.2189)	(0.7698)	(0.506)	(0.893)	(0.6282)	(0.7944)
β_1	**-0.88686**	0.006085	0.039934	0.089865	0.034701	0.026739	-0.27411
	(0.1879)	(0.8761)	(0.3413)	(0.0836)	(0.4576)	(0.6837)	(0.793)
β_2	**0.507832**	0.228326	0.43748	0.316148	0.38318	0.166159	1.462645
	(0.0046)	(0.2837)	(0.0000)	(0.0047)	(0.0000)	(0.1109)	(0.1692)
β_3	**-0.59889**	-0.13786	-0.25317	-0.14653	-0.12132	0.020655	-1.44735
	(0.001)	(0.5271)	(0.0073)	(0.2008)	(0.0842)	(0.8457)	(0.1742)
Ω	**-**	-0.00159	-0.00127	-0.00104	-0.0005	-0.00172	-0.00324
		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
α_0	**0.000381**	-6.2E-07	1.92E-06	4.18E-06	2.08E-06	1.22E-05	3.87E-07
	(0.0000)	(0.1742)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.5795)
α_1	**0.115333**	0.15191	0.15405	0.180411	0.192553	0.143137	0.064693
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
α_2	**0.807065**	0.838452	0.836733	0.779607	0.773638	0.796361	0.927668
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
ϕ	**-**	3.31E-08	1.51E-08	1.82E-08	8.26E-09	5.94E-08	1.13E-08
		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Where VIX = Volatility index, TASI = Tawadul Stock Exchange, QSE = Qatar Stock Exchange, ADX = Abu Dhabi Securities Exchange, MSM-30 = Muscat securities Market, EGX-30 = Egyptian Exchange, BIST = Bursa Istanbul Stock Exchange, values in the parenthesis denotes the P- Value. Ω denotes the parameter of mean spillover and ϕ denotes the parameter of Volatility spillover.

The coefficient of standardized residual error term, β_3 is significant and negative only for Qatar Stock Exchange, which shows that past abnormal movement negatively translate in to today return, we can say it decreases the today returns of the equity market. While for rest of the Islamic equity markets insignificant lag effect is found. The coefficient of α_1 significant and positive for all the equity markets which indicates past market volatility positively affect in today's equity market and using past prices movement today volatility can be predicted. The coefficient of α_2 is also significant and positive for all equity markets which shows persistence of volatility exist and past volatility positively affect the present volatility.

The coefficient of Ω is showing significant negative means spillover from VIX to the all Islamic equity markets, negative sign indicates change in VIX negatively affect the return of equity markets of Saudi Arabia, Qatar, UAE, Oman, Egypt and Turkey. We can say any change in VIX decreasing the return of equity market of Islamic countries. The coefficient of ϕ is highly significant and positive which showing positive volatility spillover from VIX to the all equity markets of Islamic countries. It indicates that equity markets of Saudi Arabia, Qatar, UAE, Oman, Egypt, Turkey positively exposed to all changes in the VIX. Positive relationship indicates any variation in the VIX increasing the volatility of the all Islamic Equity markets. The sum of coefficient of α_1 and α_2 of all equity market is closer to 1 which indicates persistence of volatility is long in run and shocks to the conditional variance will be highly persistent.

Table 4.3 also showing the measure of mean and volatility spillover from VIX to the equity market of remaining Islamic countries of the study which include Pakistan, Indonesia, Malaysia, UAE, Iraq.

The coefficient of β_1 is found to be significant and positive for the Jakarta Stock Exchange which indicates mean return can be predicted through past prices return. While for Pakistan, Malaysia, UAE, and Iraq it is found insignificant which means there is no relationship exist between forecasted return for the following countries equity market. The coefficient of β_2 is found to be significant and positive for the Pakistan Stock Exchange, Bursa Malaysia Exchange, and Dubai Financial Market, which means past economic shocks positively influence today stock market return.

TABLE 4.3: Mean & Volatility Spillovers from VIX to the Equity Markets of Islamic Countries - ARMA GARCH Model

	VIX	KSE-100	JSX	KLSE	DFM	ISX-60
β_0	**0.003240**	0.000298	0.000698	0.000247	0.00052	-0.00056
	(0.2257)	(0.4535)	(0.0077)	(0.0739)	(0.4851)	(0.6378)
β_1	**-0.88686**	-0.001991	3.623048	-0.22143	-0.013299	-0.00929
	(0.1879)	(0.9993)	(0.0394)	(0.9332)	(0.806)	(0.9302)
β_2	**0.507832**	0.373946	-0.3119	0.371058	0.745217	-0.51793
	(0.0046)	(0.0016)	(0.0609)	(0.0116)	(0.0000)	(0.1248)
β_3	**-0.59889**	-0.273723	0.410433	-0.25971	-0.62902	0.649403
	(0.0010)	(0.0229)	(0.0144)	(0.0796)	(0.0002)	(0.0544)
Ω	**-**	-0.000576	-0.00112	-0.00015	-0.001888	-0.00021
		(0.0001)	(0.0000)	(0.1092)	(0.0000)	(0.5123)
α_0	**0.000381**	0.0000379	1.7E-06	-8E-07	4.38E-06	4.85E-05
	(0.0000)	(0.0000)	(0.0046)	(0.0000)	(0.0006)	(0.0000)
α_1	**0.115333**	0.150000	0.147936	0.098602	0.176743	0.682372
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
α_2	**0.807065**	0.600000	0.829341	0.883832	0.79581	0.196838
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
ϕ	**-**	-5.15E-09	1.51E-08	8.42E-09	4.67E-08	9.14E-08
		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Where VIX = Volatility Index, KSE-100 = Pakistan Stock Exchange, JSX = Jakarta Stock Exchange, KLSE = Bursa Malaysia Exchange, DFM = Dubai Financial Market, ISX-60 = Iraq Stock Exchange. values in the parenthesis denotes the P- Value. Ω denotes the parameter of mean spillover and ϕ denotes the parameter of Volatility spillover.

We can say it is possible to forecast today return of Pakistan stock Exchange and Bursa Malaysia Exchange from past prices variations. While for Indonesia, UAE, and Iraq equity markets result is found to be insignificant which indicates through past volatility today return cannot be predicted for the following countries equity market.

The error term β_3 is showing significant and positive lag effect for the Pakistan stock exchange and Dubai Financial Market, indicating past abnormal movement positively translate in to today return. β_3 coefficient is also significant for Jakarta Stock Exchange but shows negative relationship which indicate past prices behavior decreases today return. While for Bursa Malaysia Exchange, Iraq Stock Exchange, and Dubai Financial Market this relationship is found to be insignificant and past prices movements has no influence on today return of these equity markets. The coefficient of α_1 is found to be significant and positive for all equity markets which means using past prices variation the volatility of current period can be predicted, so we can say past market volatility influence in today equity market. The coefficient of α_2 is also found to be significant and positive for all equity market which provides the evidence for the persistence of volatility which means past volatility effect the today volatility of all equity markets of Islamic countries.

The coefficient of mean spillover Ω is significant and negative for Pakistan stock Exchange, Jakarta Stock Exchange, and Dubai Financial Market, which provides the evidence of mean spillover. It indicates any change in VIX affect the mentioned equity market, while negative sign of coefficient indicates past behavior of VIX decreasing the mean return of Pakistan, Indonesia, and UAE equity market. There is no mean spillover observed for the Bursa Malaysia Exchange, and Iraq Stock Exchange, so we can say any variation in VIX has no influence on these equity markets.

The coefficient of ϕ is significant for all equity markets which indicate there exist volatility spillover from VIX to the all equity markets. The coefficient of ϕ is found to positive for Jakarta Stock Exchange, Bursa Malaysia Exchange, Dubai Financial Market, Iraq Stock Exchange, which indicate these equity markets

positively exposed to all changes in the VIX, so we can say volatility of following equity market is increased by the variation in the VIX. However, Pakistan Stock Exchange show a significant but negative relationship with VIX which tells us any happening in VIX negatively affect the volatility of Pakistan Stock Exchange.

The sum of coefficient of α_1 and α_2 of Jakarta Stock Exchange, Bursa Malaysia Exchange, and Dubai Financial Market, is closer to 1 which indicate persistence of volatility is longer in run and shocks to the conditional variance will be highly persistence. While in case of Pakistan Stock Exchange, and Iraq Stock Exchange, it is not closer to 1 which means persistence of volatility is not longer in run.

4.3 T- GARCH -Estimation of Asymmetric Behavior from VIX to the Equity Market of Islamic Countries

As standard ARCH and GARCH model captures bad news and good news symmetrically and their impact on asset volatility is same. It does not capture the asymmetric behavior as news, events, incidents, has great and powerful influence on the decision-making of the financial investor. So, to capture the Asymmetries in term of negative and positive shocks, T- GARCH approach is used in this study.

Table 4.4 captures the spillover from VIX to equity markets of Saudi Arabia, Qatar, UAE Oman, Egypt, Turkey, under the consideration of asymmetric behavior. The GARCH in mean coefficient η_1 shows insignificant result for all equity markets which indicates today return can not be forecasted through past return of the market. The coefficient of η_2 is found to be significant and positive for Qatar Stock Exchange, Muscat Securities Market, and Abu Dhabi Securities Exchange, which indicates current return of these equity markets can be predicted by using past behavior of prices. In simple words, market is efficient and past economic shocks positively effect the today return of the equity market. However, for Tawadul Stock Exchange, Egyptian Exchange, and Bursa Istanbul Stock Exchange, this relationship is found to be insignificant and today return cannot be

TABLE 4.4: Spillover from VIX to the Equity Markets of Islamic Countries under the Consideration of Asymmetric Behavior.

	TASI	**QSE**	**ADX**	**MSM-30**	**EGX-30**	**BIST**
η_0	0.000400	-0.00003	-0.00037	-0.00008	0.00020	-0.00114
	(0.4075)	(0.9527)	(0.4384)	(0.7952)	(0.8632)	(0.4188)
η_1	0.011055	0.043055	0.075568	0.023051	0.027020	9.15E-02
	(0.7934)	(0.3228)	(0.149)	(0.6278)	(0.693)	(0.2044)
η_2	0.242898	0.454359	3.63E-01	3.70E-01	0.185893	0.137625
	(0.2500)	(0.0000)	(0.001)	(0.0000)	(0.0631)	(0.8085)
η_3	-0.15198	-0.26702	-0.19153	-0.109008	0.004808	-0.11197
	(0.4808)	(0.0048)	(0.0899)	(0.1127)	(0.9623)	(0.8437)
λ	-0.00153	-0.00120	-0.00103	-0.000488	-0.00161	-0.00398
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
ρ_0	1.16E-06	3.37E-06	4.31E-06	2.15E-06	1.37E-05	7.07E-05
	(0.0125)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
ρ_1	0.149755	0.139895	0.140656	0.141098	0.092034	0.150354
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
ρ_2	0.833918	0.821089	0.776670	0.780458	0.826818	0.600312
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
σ	2.06E-08	1.05E-08	1.65E-08	6.76E-09	2.64E-08	-4.40E-10
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
γ	0.020652	0.055857	0.082683	0.092114	0.062039	0.050237
	(0.0563)	(0.0000)	(0.0000)	(0.0000)	(0.0184)	(0.0011)

Where TASI = Tawadul Stock Exchange, QSE = Qatar Stock Exchange, ADX = Abu Dhabi Securities Exchange, MSM-30 = Muscat securities Market, EGX-30 = Egyptian Exchange, BIST = Bursa Istanbul Stock Exchange, values in the parenthesis denotes the P- Value. λ denotes the parameter of mean spillover and σ denotes the parameter of Volatility spillover. γ denotes the parameter asymmetric behavior.

predicted using past prices behavior. The coefficient of standardized residual error term, η_3 is significant and negative only for Qatar Stock Exchange, which shows that past abnormal movement negatively translate in to today return, we can say it decreases the today returns of the equity market. While for rest of the Islamic equity markets insignificant lag effect is found.

The coefficient of ρ_1 is found to be significant and positive for all the equity markets which indicates past market behavior positively affect today equity market and using past prices movement today volatility can be predicted. The coefficient of ρ_2 is also significant and positive for all equity markets which shows persistence of volatility influenced and past volatility positively affect the present volatility.

The mean spillover parameter, λ is found to be significant and negative for all Islamic equity market. It indicates there exist negative mean spillover from VIX to the equity markets. The negative relationship indicates any change or variation in the VIX decreasing the return of equity market of Saudi Arabia, Qatar, Oman, UAE, Egypt and Turkey. The coefficient of volatility spillover, σ is found to be significant and positive for Tawadul Stock Exchange, Qatar Stock Exchange, Abu Dhabi Securities Exchange, Muscat securities Market, Egyptian Exchange. It indicates there exist positive volatility spillover from VIX to these equity markets. The positive coefficient indicates any variation in the VIX increases the volatility of equity markets. In simple words equity market positively exposed to all changes in the Volatility Index. Result is also significant for Bursa Istanbul Stock Exchange, but show negative volatility spillover from VIX to the equity market. It indicates any change in VIX negatively affect the volatility of the Bursa Istanbul Stock Exchange. The sum of ARCH and GARCH coefficient ($\rho_1 + \rho_2$) of all equity markets except Bursa Istanbul Stock Exchange is closer to one which indicate persistence of volatility is long in run and shocks to the conditional variance have high persistence.

The asymmetric parameter γ is found to be significant and positive for all equity markets except Tawadul Stock Exchange, which shows no influence of good or bad news. The significant result indicates there exist asymmetric behavior in the market. Asymmetric behavior tells us all equity markets respond differently to

the arrival of bad and good news from VIX. Simply significant result provides the evidence of presence of leverage effect in the equity market. Moreover, the positive sign of coefficient implied that negative return shocks create more volatility than positive return shocks in the equity markets. In simple words, the volatility of the bad news is higher in comparison to the volatility created by good news.

Table 4.5 also shows the estimate of asymmetries in term of bad and good news from VIX to the equity markets of remaining Islamic countries which includes Pakistan, Indonesia, Malaysia, Iraq, and UAE. The coefficient η_1 is only found significant for Iraq Stock Exchange, indicating mean return can be forecasted through past return. The coefficient of η_2 is significant and positive for Pakistan Stock Exchange, Bursa Malaysia Exchange, and Dubai Financial Market, which indicates past economic shocks positively effect today return of these equity markets. In simple words, current mean return of these equity markets can be predicted through past mean return. While for Jakarta Stock Exchange and Iraq Stock Exchange, this relationship is found to be insignificant, so for these equity markets it is not possible to forecast today return through past volatility. The parameter of error term η_3 is significant and positive for Jakarta Stock Exchange, which means these equity markets have positive lag effect and past abnormal movement positively translate in to today return.The result is also significant for Pakistan stock exchange and Bursa Malaysia Exchange but showing negative relationship with respect to its lagged effect. However, for Dubai Financial Market and Iraq Stock Exchange insignificant result is found.

The Coefficient of ρ_1 is found to be significant and positive for all equity markets which indicates volatility of current period can be predicted through past prices variation. The coefficient of ρ_2 is also significant and positive for all equity markets which means there exist persistence of volatility. It indicates past volatility positively effect the today volatility of the equity market. The parameter of mean spillover λ is significant and negative for Pakistan Stock Exchange, Jakarta Stock Exchange, and Dubai Financial Market, which provides the evidence of existence of spillover from VIX to these equity markets. The negative sign of coefficient indicates any variation in the VIX decreases the mean return of

TABLE 4.5: Spillover from VIX to the Equity Markets of Islamic Countries under the Consideration of Asymmetric Behavior.

	KSE-100	**JSX**	**KLSE**	**DFM**	**ISX-60**
η_0	0.000576	-0.000019	0.000202	0.000768	-0.01108
	(0.2790)	(0.9720)	(0.4600)	(0.5763)	(0.0000)
η_1	-0.01763	0.070602	-0.00700	-0.03502	0.726955
	(0.7046)	(0.1737)	(0.8743)	(0.6523)	(0.0003)
η_2	0.450371	-0.18661	0.402889	0.40062	-0.48535
	(0.0002)	(0.1949)	(0.0059)	(0.0141)	(0.2497)
η_3	-0.32124	0.297172	-0.29667	-0.32263	0.421867
	(0.0085)	(0.0401)	(0.0439)	(0.0521)	(0.3094)
λ	-0.00040	-0.00107	-0.00014	-0.00243	0.00015
	(0.0070)	(0.0000)	(0.1191)	(0.0000)	(0.6727)
ρ_0	5.52E-06	3.72E-06	-4.51E-07	8.39E-05	5.30E-05
	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)
ρ_1	0.074405	0.093996	0.082366	0.149999	0.149409
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
ρ_2	0.809038	0.836705	0.883084	0.599995	0.598555
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
σ	8.29E-09	7.09E-09	6.54E-09	-1.56E-08	-2.28E-08
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
γ	0.155978	0.083745	0.036934	0.050000	0.050281
	(0.0000)	(0.0000)	(0.0000)	(0.0354)	(0.2501)

Where KSE-100 = Pakistan Stock Exchange, JSX = Jakarta Stock Exchange, KLSE = Bursa Malaysia Exchange, DFM = Dubai Financial Market, ISX-60 = Iraq Stock Exchange. λ denotes the parameter of mean spillover and σ denotes the parameter of Volatility spillover. γ denotes the parameter asymmetric behavior.

the equity market. In simple words, these equity markets negatively exposed to all changes in the VIX. While for Bursa Malaysia Exchange and Iraq Stock Exchange no mean spillover is observed from VIX.

The coefficient of volatility spillover σ is observed significant and positive for Pakistan Stock Exchange, Jakarta Stock Exchange, and Bursa Malaysia Exchange, which means there exist positive volatility spillover from VIX to these equity markets. The positive relationship indicates any change in VIX positively reflect in these equity market in shape of return. Volatility spillover parameter σ is also found to be significant for Dubai Financial Market and Iraq Stock Exchange but shows negative relationship which indicate any change in VIX negatively affect the volatility of these markets or it decreases the volatility of the equity market. The sum of coefficient of ρ_1 and ρ_2 of Pakistan Stock Exchange, Jakarta Stock Exchange, and Bursa Malaysia Exchange is closer to one which provides the evidence that persistence of volatility is longer in run and shocks to the conditional variance will be highly persistent.

The coefficient of asymmetric term γ is positive and statistically significant for Pakistan Stock Exchange, Jakarta Stock Exchange, Bursa Malaysia Exchange, and Dubai Financial Market which indicates for these equity markets there are asymmetries in the news. These equity markets respond differently to the arrival of bad and good news from the VIX. The positive sign of coefficient indicates bad news from VIX tend to make larger effect on the volatility of stock market than the good news. However, there is no evidence of leverage effect is found for the Iraq Stock Exchange, because asymmetric parameter is found to be insignificant. In simple words,for these equity markets there exist no asymmetric behavior.

4.4 Time-Varying Conditional Correlation DCC & ADCC

Above working include ARMA GARCH which measures the mean and volatility spillover from VIX to the equity market of Islamic countries and T- GARCH

which captures the asymmetric behavior in term of bad and good news. As ARMA GARCH connect day to day effect but correlation can vary over the time, so Dynamic conditional Correlation is used in this study to measure the co-movement among the markets, and to check whether time varying correlation exist between them or not. Also extended version of DCC model, asymmetric dynamic conditional ADCC is also used to check the asymmetric effect.

4.4.1 DCC MV - GARCH Models and Estimates between VIX & Equity Markets of Selected Islamic Countries

Table 4.6 and 4.7 display the suitable univariate DCC model and estimates from VIX to the equity market of selected Islamic countries. The most fitted model is chosen on the basis of lowest Akaike Information Criteria (AIC).

Table 4.7 concludes the result of the DCC GARCH model between VIX and equity market of the selected Islamic countries. This table reports the two parameters θ_1 and θ_2. The θ_1 parameter measures the impact of past residual shocks on conditional correlation while θ_2 measure the effect of lagged dynamic conditional correlation respectively with their P- values. The first basic condition to evaluate the DCC GARCH model is to check the stability condition $(\theta_1 + \theta_2 < 1)$ that must be less than 1. All the equity markets successfully met the stability condition, so DCC GARCH model must be utilize to explore the time varying correlation among VIX and stock market indices.

The coefficient of θ_1 is significant and positive for Tawadul stock exchange and Bursa Istanbul stock exchange, indicating there exist high correlation and past residual shocks positively effect the conditional correlation. However, this relationship is found to be negative for Qatar stock exchange, Abu Dhabi Security Exchange, Pakistan stock exchange, Bursa Malaysia Exchange. There is no significant variation found with respect to θ_1 for Muscat securities exchange, Egyptian exchange (EGX-30), Jakarta stock exchange, Dubai Financial market, Iraq stock exchange.

TABLE 4.6: DCC MV- GARCH Models Estimate between VIX and Equity Markets of Selected Islamic Countries.

Sr. No.	Equity Market	Selected Model
1	Tawadul Stock Exchange	EGARCH
2	Qatar Stock Exchange	EGARCH
3	Abu Dhabi Security Exchange	EGARCH
4	Muscat Securities Market	EGARCH
5	Egyptian Exchange	EGARCH
6	Bursa Istanbul Stock Exchange	EGARCH
7	Pakistan Stock Exchange	GARCH
8	Jakarta Stock Exchange	EGARCH
9	Bursa Malaysia Exchange	EGARCH
10	Dubai Financial Market	EGARCH
11	Iraq Stock Exchange	EGARCH

This table shows the optimal uni-variate DCC GARCH model with respect to each equity markets and then the appropriate model is chosen on the basis of lowest possible Akaike Information Criteria (AIC).

The parameter of θ_2 is found to be highly significant for Tawadul stock exchange, Egyptian exchange, Jakarta stock exchange, Bursa Istanbul stock exchange, Pakistan stock exchange, Dubai Financial market, Iraq stock exchange, which provides the evidence of existence of lagged dynamic conditional correlation in these stock markets, while this relationship is negative for Bursa Malaysia exchange indicating partial effect of lagged dynamic conditional correlation. Further, for Qatar stock exchange, Abu Dhabi Security Exchange, Muscat securities exchange there is no

TABLE 4.7: DCC MV- GARCH Models Estimate between VIX and Equity Markets of Selected Islamic Countries.

Equit Equity Markets	**Volatility Index (VIX)**	
	θ_1	θ_2
Tawadul Stock Exchange	0.006471	0.990421
	(0.0026)	(0.0000)
Qatar Stock Exchange	-0.008458	0.408025
	(0.0000)	(0.4805)
Abu Dhabi Security Exchange	-0.008702	0.385284
	(0.0000)	(0.4664)
Muscat Securities Market	-0.006558	0.617273
	(0.1604)	(0.0553)
Egyptian Exchange	0.005239	0.986197
	(0.1442)	(0.0000)
Bursa Istanbul Stock Exchange	0.00857	0.983282
	(0.0343)	(0.0000)
Pakistan Stock Exchange	-0.005659	0.976485
	(0.0000)	(0.0000)
Jakarta Stock Exchange	0.010372	0.898031
	(0.4047)	(0.0000)
Bursa Malaysia Exchange	-0.006964	-0.93962
	(0.0000)	(0.0000)
Dubai Financial Market	0.004513	0.991119
	(0.0992)	(0.0000)
Iraq Stock Exchange	0.024041	0.806417
	(0.2842)	(0.0000)

This table summarizes the estimated coefficients from the DCC-MV-GARCH model in a bi-variate framework for VIX and selected Islamic Equity Market. Values in parenthesis are the p-values. Theta (1) and Theta (2) are reported above the p-values.The Akaike Information Criteria (AIC) is used for the selection of a suitable uni-variate GARCH model.

effect of lagged dynamic conditional correlation is observed.

4.4.2 ADCC MV - GARCH Models & Estimates between VIX and Selected Islamic Countries

Table 4.8 and 4.9 display the suitable univariate ADCC model and estimates from VIX to the equity market of selected Islamic countries. The most fitted model is choose on the basis of lowest Akaike Information Criteria (AIC).

Table 4.9 also show the parameter θ_1 and θ_2 which is same as previously used in DCC GARCH model i.e. The effect of past residual shocks on conditional correlation (θ_1) and effect of lagged dynamic correlation (θ_2). The third parameter used in this model is (θ_3) to captures the effect of asymmetric behavior (good or bad news) on dynamic conditional correlation. Here also in ADCC the first condition is to check the stability condition whether it met or not (($\theta_1 + \theta_2 < 1$). So, stability condition met for all equity markets and model can be used to examine the linkage among the markets.

The coefficient of θ_1 showing significant and positive result for Tawadul stock exchange and Bursa Istanbul stock exchange, which provides the evidence of positive impact of past residual shocks on conditional correlation, whereas this linkage is found to be negative for Qatar stock exchange, Abu Dhabi Security Exchange, Pakistan stock exchange and Bursa Malaysia exchange, which indicates partial impact of past residual shocks on dynamic correlation. However, for Muscat securities exchange, Egyptian exchange, Jakarta stock exchange, Dubai Financial market, Iraq stock exchange, no impact of past residual shocks on dynamic correlation is observed.

The coefficient of θ_2 showing highly significant result for Tawadul stock exchange, Egyptian exchange, Jakarta stock exchange, Bursa Istanbul stock exchange, Pakistan stock exchange, Dubai Financial market, Iraq stock exchange, which indicates effect of lagged dynamic conditional correlation exist in these equity markets. The partial impact of lagged dynamic conditional correlation is found for the Abu Dhabi Security Exchange, as it is negatively correlated, while

TABLE 4.8: ADCC MV- GARCH Models Estimate between VIX and Equity Markets of Selected Islamic Countries.

Sr. No.	Equity Market	Selected Model
1	Tawadul Stock Exchange	EGARCH
2	Qatar Stock Exchange	EGARCH
3	Abu Dhabi Security Exchange	EGARCH
4	Muscat Securities Market	EGARCH
5	Egyptian Exchange	EGARCH
6	Bursa Istanbul Stock Exchange	EGARCH
7	Pakistan Stock Exchange	EGARCH
8	Jakarta Stock Exchange	EGARCH
9	Bursa Malaysia Exchange	EGARCH
10	Dubai Financial Market	EGARCH
11	Iraq Stock Exchange	EGARCH

This table shows the optimal uni-variate ADCC GARCH model with respect to each equity market and then the appropriate model is chosen on the basis of lowest possible Akaike Information Criteria (AIC).

for Qatar stock exchange and Muscat securities exchange, this relationship is found to be insignificant.

The parameter of asymmetric effect θ_3 is only found to be positive and significant for the Abu Dhabi Security Exchange, which indicates the correlation has been increased with the arrival of bad news. Further, all of the remaining equity markets showing insignificant result which indicates asymmetric effect does not translate into the conditional correlation or simply we can say arrival of good or bad news

TABLE 4.9: ADCC MV- GARCH Models Estimate between VIX & Equity Markets of Selected Islamic Countries.

Equit Equity Markets	**Volatility Index (VIX)**		
	θ_1	θ_2	θ_3
Tawadul Stock Exchange	0.006492	0.990521	-0.00076
	(0.0027)	(0.0000)	(0.5415)
Qatar Stock Exchange	-0.00774	0.42136	-0.00412
	(0.0000)	(0.4788)	(0.9269)
Abu Dhabi Security Exchange	-0.00877	-0.60554	0.09841
	(0.0000)	(0.0000)	(0.0000)
Muscat Securities Market	-0.00637	0.609131	-0.00397
	(0.2173)	(0.0618)	(0.8692)
Egyptian Exchange	0.005561	0.985614	-0.00099
	(0.1449)	(0.0000)	(0.5929)
Bursa Istanbul Stock Exchange	0.008554	0.983356	-0.00026
	(0.0345)	(0.0000)	(0.8708)
Pakistan Stock Exchange	-0.00604	0.805493	0.012095
	(0.0000)	(0.0169)	(0.6112)
Jakarta Stock Exchange	0.010567	0.891864	0.000642
	(0.3344)	(0.0000)	(0.9544)
Bursa Malaysia Exchange	-0.00704	0.782952	0.029614
	(0.0000)	(0.0000)	(0.1127)
Dubai Financial Market	0.004145	0.992442	-0.00082
	(0.1408)	(0.0000)	(0.4445)
Iraq Stock Exchange	0.029181	0.790076	-0.01517
	(0.3243)	(0.0014)	(0.7557)

This table summarizes the estimated coefficients from the ADCC-MV-GARCH model in a bi-variate framework for VIX and selected Islamic equity market. Values in parenthesis are the p-values. Theta (1), Theta (2) and Theta (3) are reported above the p-values. The Akaike Information Criteria (AIC) is used for the selection of a suitable uni-variate GARCH model.

has no impact on the correlation.

Chapter 5

Conclusion & Recommendations

5.1 Conclusion

The main focus of this study is to explore the spillover from Global Volatility Index to the equity markets of selected Islamic countries. This study includes eleven largest Islamic equity markets from different part of the world i.e. Tawadul Stock Exchange from Saudi Arabia, Qatar stock exchange from Qatar, Abu Dhabi Security Exchange from UAE, Muscat Securities Market from Oman, Egyptian Exchange from Egypt, Bursa Istanbul Stock Exchange from Turkey, Pakistan Stock Exchange from Pakistan, Jakarta Stock Exchange from Indonesia, Bursa Malaysia Exchange from Malaysia, Dubai Financial Market from UAE, Iraq Stock Exchange from Iraq.

This study employs three methodologies (a) ARMA GARCH model to examine the mean and volatility spillover between VIX and Islamic equity markets; (b) T- GARCH model to analyze the spillover from VIX to equity markets under the consideration of asymmetric behavior ; (c) DCC and ADCC GARCH model to explore time varying correlation among the markets and also to examine the asymmetric effect on these correlations. The time span of the study is from 1 January 2000 to 30 September 2019, but time period of some equity market is different, so trading day of equity markets and VIX is matched to find the relationship between the markets.

There is significant and negative mean spillover observed from VIX to the Tawadul Stock Exchange, Qatar stock exchange, Abu Dhabi Security Exchange, Muscat Securities Market, Egyptian Exchange, Bursa Istanbul Stock Exchange, Pakistan stock Exchange, Jakarta Stock Exchange, and Dubai Financial Market. The negative sign indicates change in VIX negatively affect the return of these equity markets or we can say any variation in VIX decreasing the return of equity market of Islamic countries. Further, negative linkage between VIX and equity market indices confirms that VIX act as a fear symbol for the investors as it increases during the market crisis or when market move downward. However, there is no mean spillover relationship is observed for the Bursa Malaysia Exchange and Iraq stock exchange.

The findings of the study also show significant and positive volatility spillover from VIX to the all equity markets of Islamic countries except Pakistan stock exchange, which shows negative volatility spillover relationship from the VIX. The positive relationship indicates any variation in the VIX increasing the volatility of the Islamic Equity markets. However negative linkage confirms that Pakistan stock exchange negatively exposed to all changes in the VIX.

The second approach utilize in this study is GJR GARCH model to capture the spillover from VIX to the equity markets under the consideration of asymmetric behavior. The result of this model shows there exist significant and positive asymmetric behavior in Qatar stock exchange, Abu Dhabi Security Exchange, Muscat Securities Market, Egyptian Exchange, Bursa Istanbul Stock Exchange, Pakistan stock exchange, Jakarta Stock Exchange, Bursa Malaysia Exchange and Dubai Financial market.

Asymmetric behavior tells us that equity markets respond differently to the arrival of bad and good news from VIX. Moreover, the positive sign of coefficient implied that negative return shocks create more volatility than positive return shocks in the equity markets. In simple words, the volatility of the bad news is higher in comparison to the volatility created by good news. However, there is no evidence of leverage effect is found for the Tawadul Stock Exchange and Iraq

Stock Exchange, because asymmetric parameter is found to be insignificant. In simple words for these equity markets there is no influence of good or bad news.

The third methodology employ in this study is DCC GARCH with ADCC extension to explore time varying correlation among the market and to examine the asymmetric effect on these correlations. The stability condition ($\theta_1+\theta_2 <1$) is met for both DCC and ADCC GARCH, so these must be applied to find the relationship among the markets. The result shows the positive impact of past residual shocks on conditional correlation for Tawadul stock exchange and Bursa Istanbul stock exchange, while some impact of past residual shocks on conditional correlation is observed for the Qatar stock exchange, Abu Dhabi Security Exchange, Pakistan stock exchange, Bursa Malaysia exchange, because it is negatively correlated. However, there is no significant variation found with respect to θ_1 for Muscat securities exchange, Egyptian exchange, Jakarta stock exchange, Dubai Financial market, Iraq stock exchange.

The strong positive effect of lagged dynamic conditional correlation is found for the Tawadul stock exchange, Egyptian exchange, Jakarta stock exchange, Bursa Istanbul stock exchange, Pakistan stock exchange, Dubai Financial market, Iraq stock exchange, while this relationship is found be negative for Bursa Malaysia exchange indicating some effect of lagged dynamic conditional correlation. Further, for Qatar stock exchange, Abu Dhabi Security Exchange, Muscat securities exchange, there is no effect of lagged dynamic conditional correlation is observed. These results provide the evidence that markets are interconnected as well as with day to day it is time varying.

The ADCC model shows positive asymmetric effect on the correlation only for the Abu Dhabi Security Exchange which indicates the correlation has been increased with the arrival of bad news. Further, all of the remaining equity market showing insignificant result which indicates asymmetric effect does not translate in to the conditional correlation or simply we can say arrival of good or bad news has no impact on the correlation.

5.2 Recommendations

The prime objective of this study is to explore the spillover effect from Global Volatility Index to the equity markets of Islamic countries. So, linkage between these markets contain an important role for the construction of a portfolio, as the benefit of diversification comes from the addition of shocks that arise in one market and reflect in another market with comparatively low levels of correlation. The overall findings of this study strongly recommend to all markets players including traders, portfolio managers, investors as well as research analyst to keep eyes on the variation of VIX Index as it is negatively linked with the stock market return. The behavior of VIX (rise or fall) tells whether there is too much confidence or fear in the market. The market typically reverses back when the sentiment of the investors reaches one extreme or the other. It is fact that when there is market decline the VIX Index goes up which indicates a fear symbol for the investors and vice versa. The manager can also take decision from VIX about the future direction of the respondent market and initiate steps for risk management.

5.3 Limitations & Future Directions

This study covers the transmission of information from VIX to the equity markets of Islamic countries in an effective manner but there is some space on which there must be research done to fill the remaining gap in future. The sample size of the equity markets utilize in this study is eleven, so in future more Islamic equity markets can be included to explore the impact of VIX throughout the world. Further this study includes daily time series data and employs ARMA GARCH, TGARCH and DCC GARCH with ADCC extension, so experimenting on different set of data and utilizing other GARCH techniques will make it amazing to find the impact of VIX.

The previous literature shows spillover of information from VIX to different financial markets but there is little research found that show spillover from VIX to shariah complaint equity index that is the area which must be explore in future.

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Appendix A

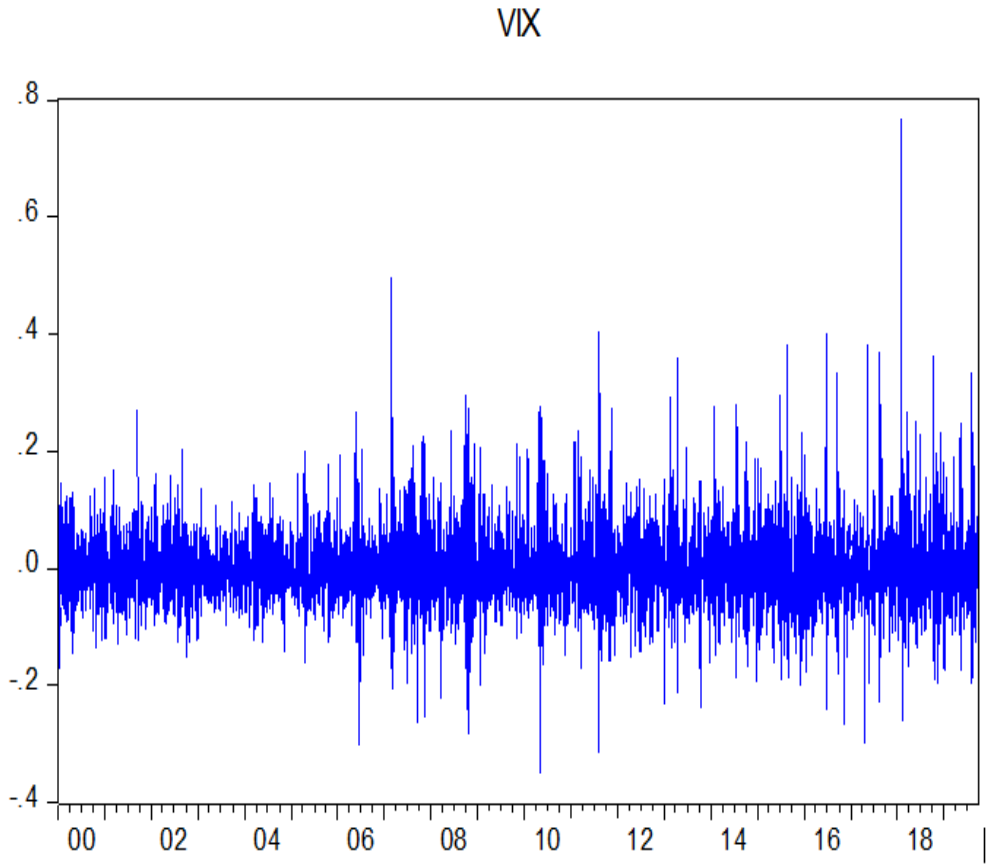

FIGURE 5.1: Return of Global Volatility Index

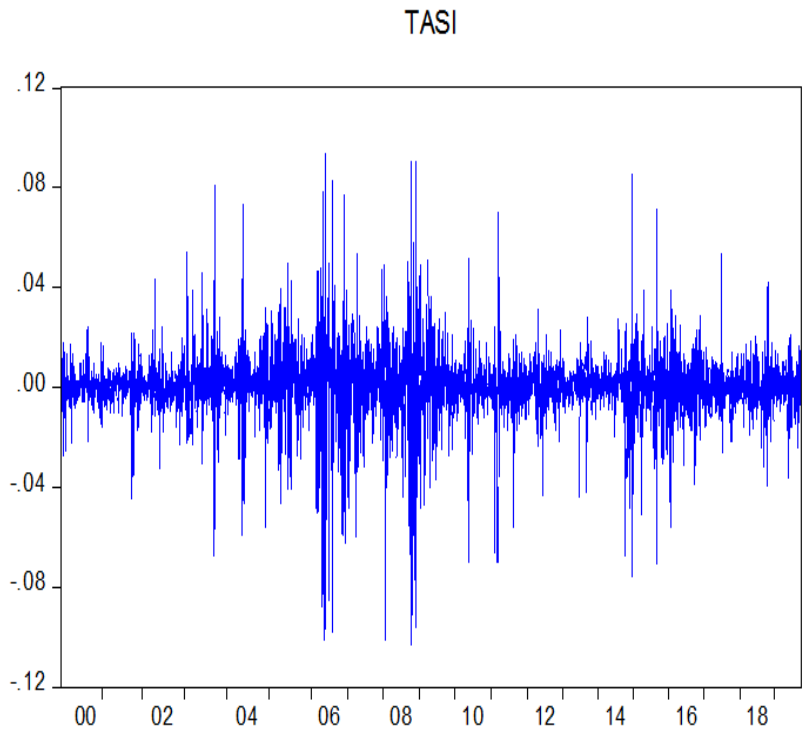

FIGURE 5.2: Return of Tawadul Stock Exchange

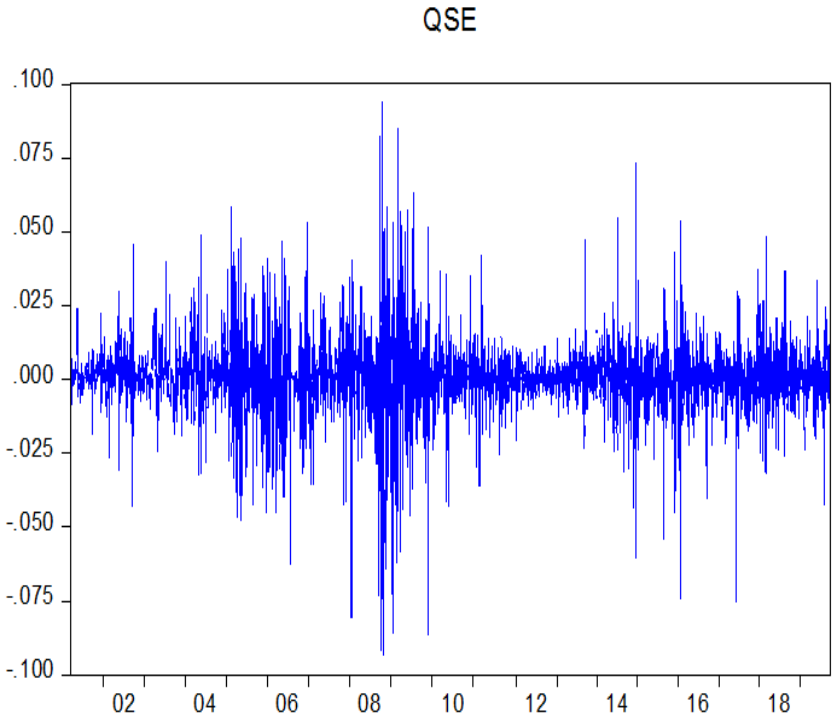

FIGURE 5.3: Return of Qatar Stock Exchange

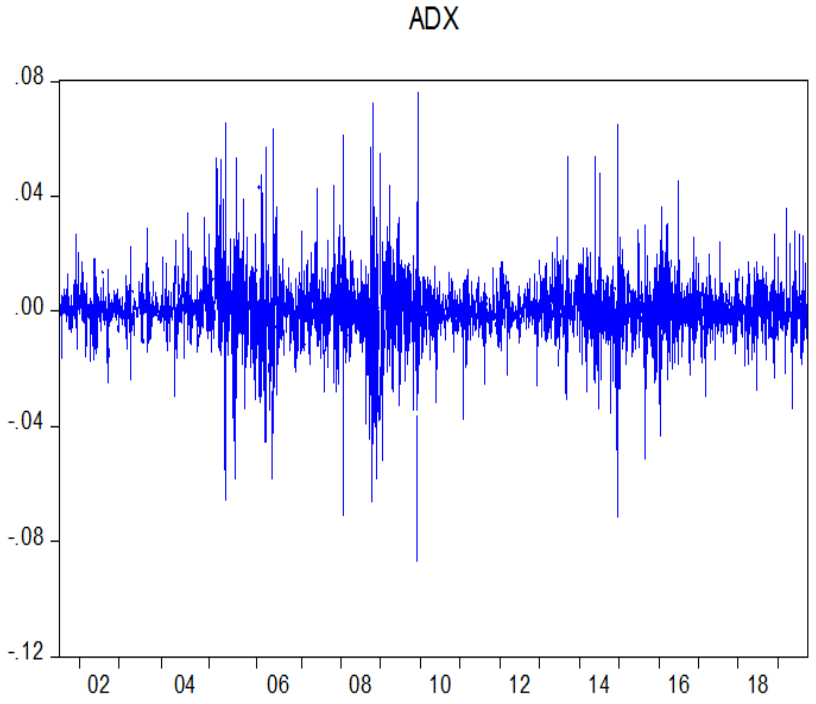

FIGURE 5.4: Return of Abu Dhabi Securities Exchange

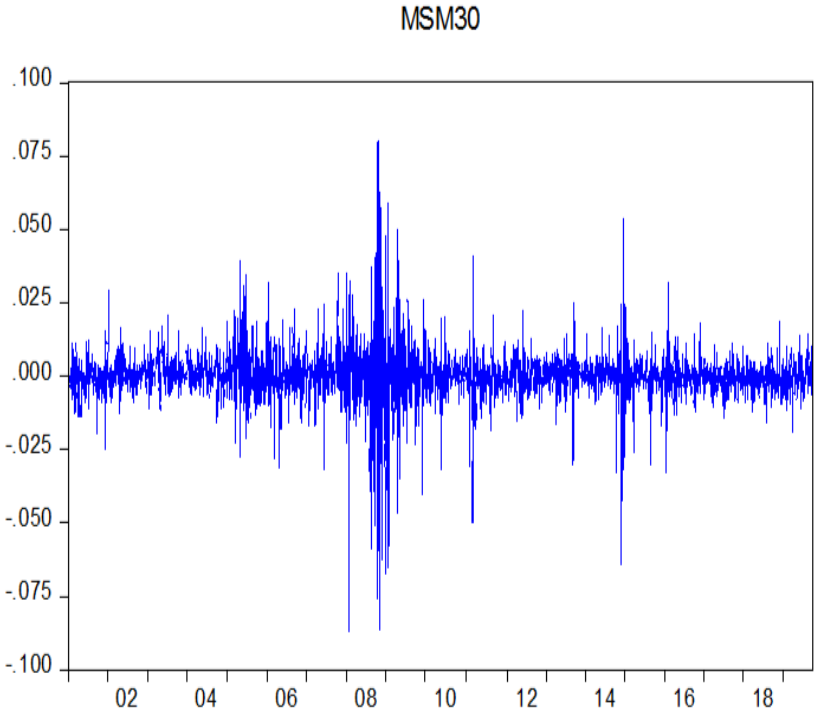

FIGURE 5.5: Return of Muscat Securities Market

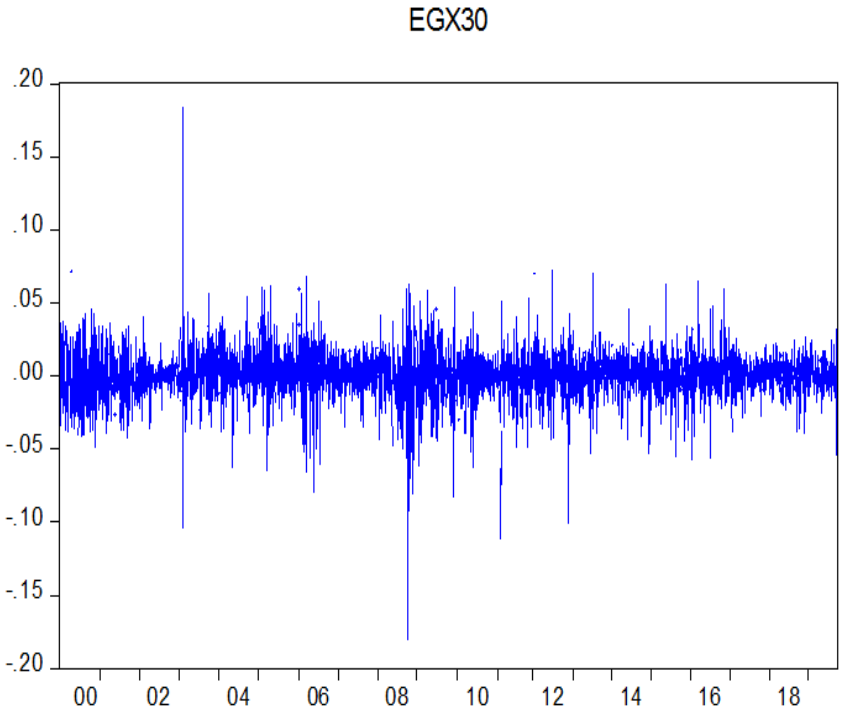

FIGURE 5.6: Return of Egyptian Exchange

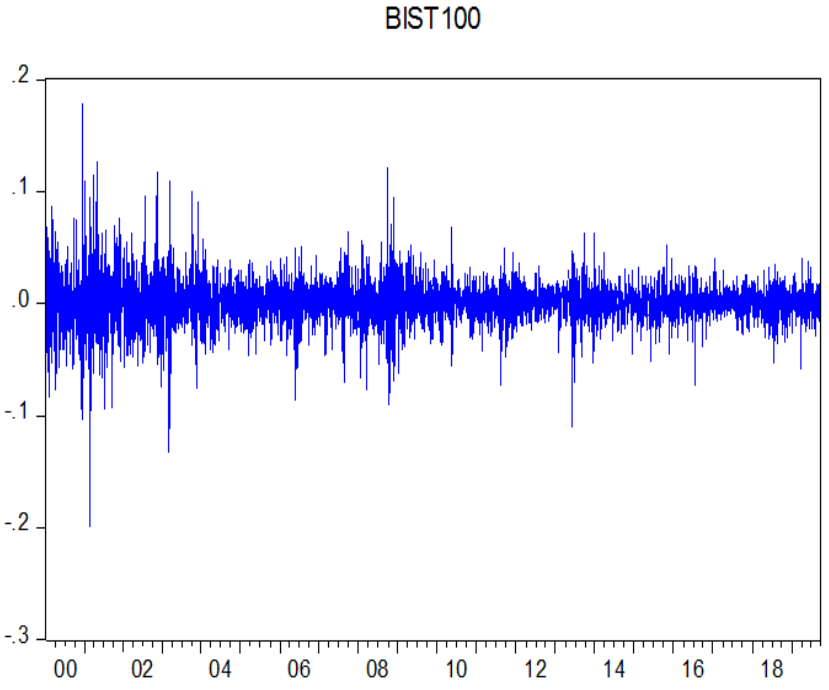

FIGURE 5.7: Return of Bursa Istanbul Stock Exchange

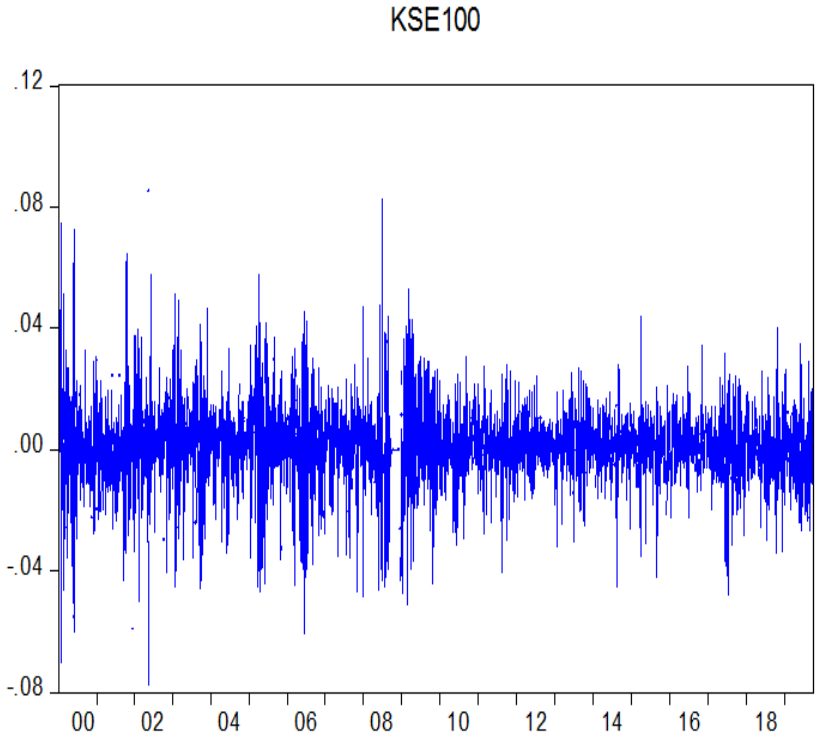

FIGURE 5.8: Return of Pakistan Stock Exchange

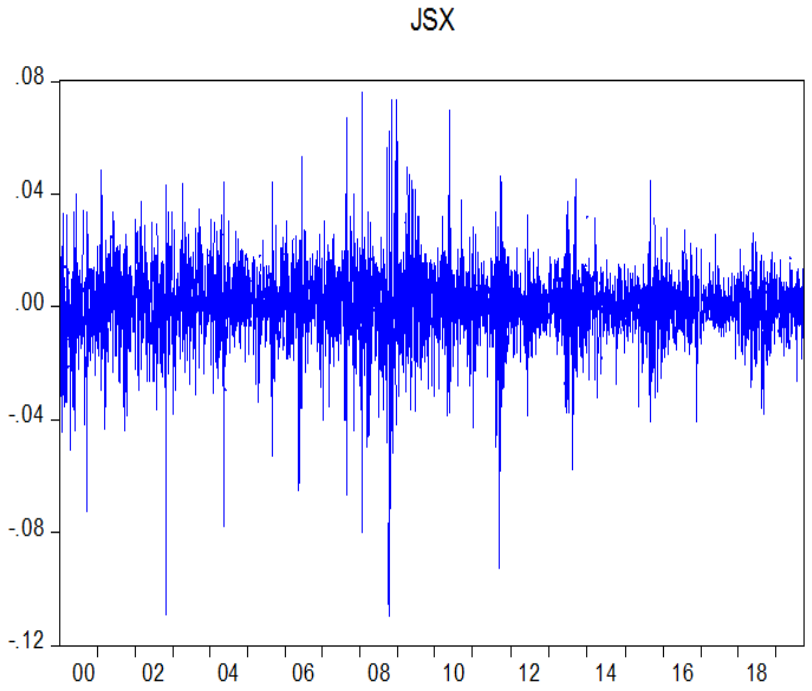

FIGURE 5.9: Return of Jakarta Stock Exchange

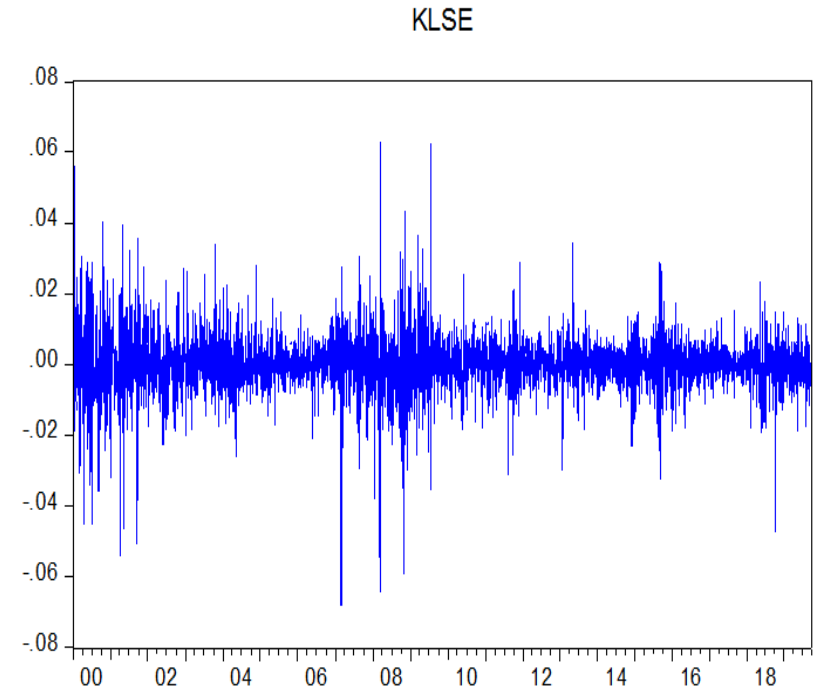

FIGURE 5.10: Return of Bursa Malaysia Exchange

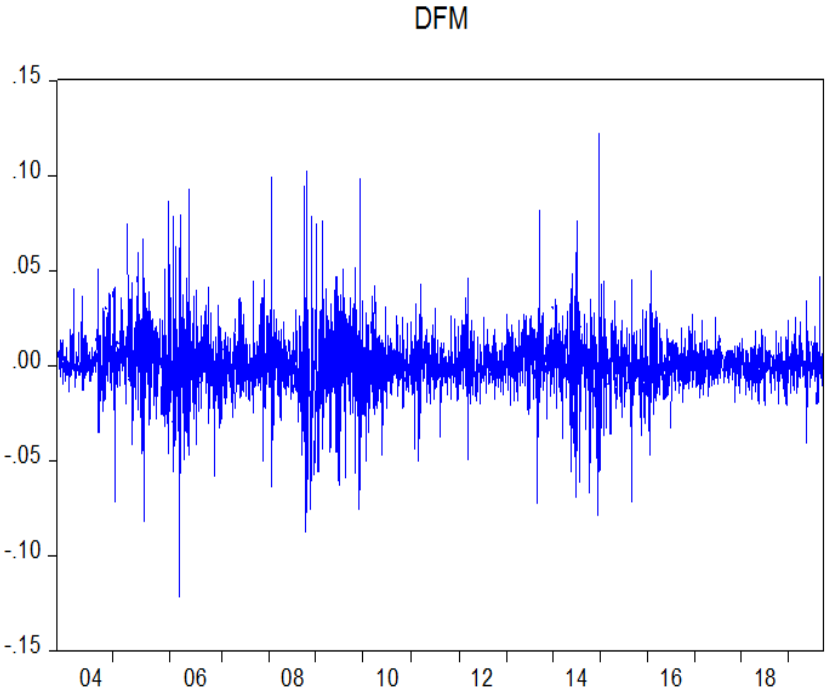

FIGURE 5.11: Return of Dubai Financial Market

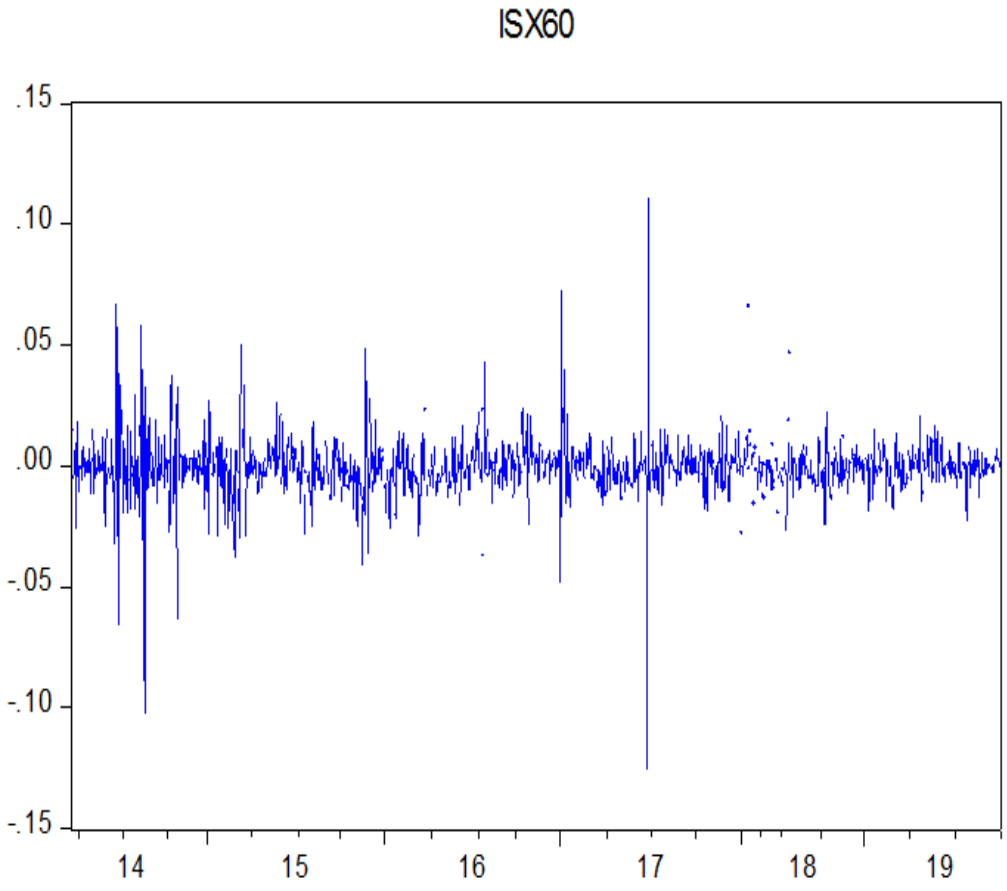

FIGURE 5.12: Return of Iraq Stock Exchange