Charles University

Faculty of Social Sciences
Institute of Economic Studies

MASTER'S THESIS

Conventional vs. Shariah stock indices: Volatility, Financial Contagion, Interest Rate Risk and Gold as Safe Haven

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Declaration of Authorship

The author hereby declares that he compiled this thesis independently; using only the listed resources and literature, and the thesis has not been used to obtain a different or the same degree.

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Prague, May 11, 2018

Signature

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Abstract

The thesis aims at the comparison of volatility between conventional stock indices and their Shariah counterparts. We study the time-varying volatility and correlation of both categories using GARCH models, during Global Financial Crisis and afterwards, from January 2008 to March 2017. We analyze the Global stock indices drilling down into their Developed and Emerging market segments, and study the U.S. market; considering U.S. as the origin of the crisis. Extending traditional approach, we study difference of time-varying volatility between conventional and Shariah indices, and thoroughly study its dynamic development during the study period. Employing DCC-GARCH, we investigate the financial contagion within markets and find Shariah indices to be significantly affected by it. We find Shariah stocks to be less risky and a diversification opportunity during crisis, but based on market; unlike other markets, Shariah stocks are more volatile in Emerging markets. We also examine correlations of stock indices with interest rates and analyze the role of gold as a safe-haven for Shariah investors. We observe Shariah indices to be having correlation with interest rates similar to that of conventional indices, hence exposed to interest rate risk. Finally, we find that gold is less correlated to Shariah indices implying risk-mitigation opportunity.

JEL Classification	C10, C16, E4, G0, G14, N2, O10
Keywords	Islamic Finance, Stock markets, Shariah Indices, Global Financial Crisis , Volatility, Financial Contagion

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Contents

List of Tables

List of Figures

Acronyms

AAOIFI	Accounting and Auditing Organization for Islamic Financial Institutions
AIC	Akaike Information Criterion
ARCH	Autoregressive Conditional Heteroskedasticity
DCC-GARCH	Dynamic Conditional Correlation GARCH
DJIM	Dow Jones Islamic Market
EFFR	Effective Federal Funds Rate
FRED	Federal Reserve Economic Data
FTSE	Financial Times Stock Exchange
GARCH	Generalized AutoRegressive Conditional Heteroskedasticity
GED	Generalized Error Distribution
GFC	Global Financial Crisis
IEF	Islamic Equity Funds
JAKISL	Jakarta Islamic Capital Market
KLCI	Kuala Lumpur Composite Index
KLSI	Kuala Lumpur Syariah Index
LIBOR	London Inter-bank Offered Rate
MSCI	Morgan Stanley Capital International
S&P	Standard & Poor's
VECM	Vector Error Correction Model

Master's Thesis Proposal

Author:	Bc. Osaid Hashmi
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Defense Planned:	June 2018

Proposed Topic:

Conventional vs. Shariah stock indices: Volatility, Financial Contagion, Interest Rate Risk and Gold as Safe Haven

Motivation:

A significant growth in Islamic Finance during the last few decades has enticed many potential investors to invest in Shariah-compliant stocks. The stocks are primarily screened on the basis of two criteria: qualitative (extra-financial) screening and quantitative (financial) screening. In Islamic stocks, there is prohibition of interest, gambling, short selling, speculative transactions and dealing in unlawful goods or services. Unlike its conventional counterpart, Islamic finance is primarily based on illiquid assets, which creates real assets and inventories. Therefore, following these limitations investors have demanded more diversified, competitive and transparent investment solutions. The Islamic indices have a critical role in driving the Islamic Financial markets and represent the way how Islamic investors measure the markets. Generally, the Islamic indices show a significant correlation and similar long-term performance with their conventional counterparts.

The question whether Islamic stocks perform better than the conventional stocks is still unanswered. One method is to check correlation and statistical relationship between Islamic and conventional stocks in terms of risk and return. However, the performance of stocks is also dependent on the local and regional market. Reddy & Fu (2014) have compared Islamic and conventional stocks listed in Australian Stock Exchange (ASX) and found a noteworthy difference in terms of risk & return but a similar performance. Islamic stocks were found to be more risky because of less diversification. Habib & Islam (2014) did comparative study of Islamic and conventional stock indices in Indian and Malaysian markets and found Islamic stocks to over-perform in Malaysia and vice versa in India. Tyagi and Rizwan (2012) observed an identical performance between Islamic and conventional stocks by comparing S&P BSE-TASIS Shariah 50 and Sensex. Sukmana & Kholid (2012) found that Islamic stock index was less risky than conventional index during global financial crisis. They applied ARCH and GARCH method to measure the impact of financial crises on both Islamic and conventional stocks, doing the comparison in Indonesian market. Kassab (2013) found Islamic index to be less volatile than conventional index by applying ARCH and GARCH on respective S&P 500 Indices.

None of the works, however, has been done on the global scale by comparing the Global Index of conventional stocks with that of Islamic stocks during and after the crisis considering the financial contagion. Also, U.S. market can be studied for Islamic stocks during the crisis because of its significance. Moreover, since all the Islamic countries lie in the category of emerging markets, it is beneficial to do comparisons of conventional and Islamic stocks in both developed and emerging markets respectively, analyzing the volatility of the these stocks.

Hypotheses:

1. Hypothesis #1: Volatility of Global Islamic stocks was less affected by crisis as compared to conventional stocks.
2. Hypothesis #2: Islamic stocks were less volatile in U.S. market during financial crisis.
3. Hypothesis #3: Islamic stocks in developed markets were less volatile than Islamic stocks in emerging markets.

Methodology:

The first step is the collection of data for Shariah and conventional indices during and after the crisis. I

will use daily prices from Dow Jones Islamic Index since it is the most conservative in screening the stocks on basis of income (debt-to-equity ratio shall be less than 33%). To capture the effect of financial crisis, I will use the data from January 2008 to March 2017. Firstly, I will use S&P Global BMI and S&P Global BMI Shariah indices. I will examine the studies done by Sukmana and Kholid (2012) and Kassab (2013) but will extend the studies to Global BMI Indices instead of restricting to one region. The approximately 11,000 stocks that form the S&P Global BMI are screened for Shariah-compliance resulting in a Shariah-compliant benchmark covering large-, mid- and small-cap stocks across 48 developed and emerging markets. Interestingly, financial institutions constitute only 0.5 to 1% of the total Islamic Indices used in this study. I will measure the effect of financial crisis towards Islamic and conventional indices volatility using ARCH and GARCH models (with GARCH extensions).

Moreover, focusing on the U.S. market, I will compare S&P 500 and S&P 500 Shariah indices to analyze their volatility during and after crisis. Hassan, Antoniou and Paudyal (2005) and Hoepner, Rammal and Rezec (2010) comment that putting the Islamic screens does not substantially affect the performance. I will test it on the data from 2008 – 2017 to verify if Islamic index was less volatile and hence having less risk, during and after crisis. I will use ARCH and GARCH methodologies.

I will also compare the volatility during above mentioned period in Developed and Emerging markets separately by comparing Islamic and conventional stocks in these markets. I will use S&P Developed BMI and S&P Emerging BMI Indices with their Shariah counterparts, from 2008 – 2017 employing ARCH and GARCH models.

Expected Contribution:

I will apply ARCH and GARCH modelling with leverage effect to test the volatility of Islamic indices against their conventional counterparts during and after the crisis period. In contrast to previous works, which were confined to a specified regional market, I will work with the Global BMI Indices which will cover stocks across 48 countries including the developed and emerging markets. Moreover, since U.S. market has a considerable share of Islamic stocks, I will compare the S&P 500 and S&P 500 Shariah indices during crisis periods; a standalone analysis of a developed market. Finally, I will compare the volatility within Islamic developed and emerging markets. This will be interesting since all Islamic countries are in the category of emerging markets. I expect Islamic indices to be less volatile due to low proportion of financial institutions in the indices, prohibition of interest rates and speculation, and other restrictions discussed above. Interest rates can somehow be related to financial crisis according to Adrian and Shin (2008). Islamic stocks being under continuous screening and supervision are supposedly less prone to risk or crisis, as King (2010) mentions that inadequate supervision and regulation is unsuccessful to stop excessive risk.

Outline:

1. Motivation: There are various studies on conventional and Islamic stocks comparisons but mostly are confined to a specified market.
2. Study can be extended to global scale by analyzing the volatility of global indices or by comparing the Islamic stock markets in developed and emerging countries, especially during crisis period.
3. Data: I will measure the impact of global financial crisis in terms of volatility and risk on both Islamic and conventional stocks using indices in Global, Developed and Emerging markets.
4. Methods: In order to measure the volatility and risk involved, I will employ the ARCH and GARCH methodologies.
5. Results: I will discuss the volatility and riskiness of both categories of stocks in above mentioned markets.
6. Conclusion: I will summarize my findings and their implications for future research.

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1 Introduction

In recent decades, financial stock markets have experienced several phases of bearish and bullish trends. Different financial crises have erupted, usually due to various discrepancies and imperfections within the financial systems. Globalization caused trade to become easier as financial markets co-integrated but the likelihood of financial contagion also increased accordingly. Investors have always been seeking to maximize profit and minimize loss. Hence, they sought ethical investments besides seeking opportunities to diversify risk in alternative markets, economic grouping or safe havens. This resulted into increasing attractiveness of Shariah-compliant stocks where investors, particularly Muslims, would be satisfied morally and financially. Shariah stocks filter out various risky activities on quantitative basis; and other activities on quantitative basis—activities prohibited in Islam. On the basis of this filtering, they differ from the conventional stocks. The advocates of Islamic finance have argued that Shariah-compliant stocks are less risky than conventional stocks, after being screened based on above mentioned criteria. Various researches have been conducted to analyze the position, benefits and shortcomings of Shariah investments in the global financial markets. Shariah investments have shown mixed behavior in different times and market structures. However, the market size has still remained limited and so has been the literature; although it has gradually increased over time. The literature to analyze their riskiness during the Global Financial Crisis (GFC) is still constrained to some specific markets with large Muslim population, or the U.S. market—where the global crisis originated. The research of application of Shariah stocks and their riskiness still needs to be investigated in mature and developed markets, due to the presence of Muslims in any part of the world and their inclination towards Shariah-compliant investments.

The objective of this study is to compare the volatility and risk of Conventional and Shariah indices, during and after the Global Financial Crisis (GFC). In this study, we analyze the markets at global and regional or economic-grouping level. We study the global indices, U.S.-market indices (since U.S. was the

place of origin of the crisis), developed markets which primarily include the U.S. and European countries, and the emerging markets which contain BRICS markets and various Islamic countries. We measure the time-varying volatility of the indices based on the idea that volatility is the measure of the riskiness of a security. Regarding volatility, we have three hypothesis of primary interest: at first, Shariah stocks at global level were less volatile than their conventional counterparts; second, that the Shariah stocks in the US market were less volatile during the Global Financial Crisis; third, that Shariah stocks in emerging markets were less volatile during the study period as compared to those in the developed markets.

Besides volatility, we study the correlation between a conventional index and Shariah indices to estimate the financial contagion and volatility spillover within the markets. The correlations can be helpful to investors to study the short-run and long-run co-movements among the markets, enabling them to efficiently manage their portfolio based on cross-border markets or asset classes. Our hypothesis is that Shariah indices did not suffer significantly from financial contagion during the GFC. Additionally, we examine the correlation of the stock indices with U.S. and UK interest rates to investigate the effect of interest rates on Shariah stocks. For interest rates our hypothesis is based on decoupling of Shariah indices from the interest rates, assuming them being impacted by the interest rates differently than conventional indices. Finally, we study the correlation between stock indices and gold prices to analyze the diversification that gold may offer if added to Shariah portfolio. Our hypothesis is that the gold is loosely correlated with Shariah indices implying portfolio diversification.

The thesis is structured as follows: Chapter 2 presents the background of Islamic finance and its principles in order to familiarize the readers with the difference between Islamic and conventional financial markets. The chapter also includes the literature review discussing the areas of interest for researchers and related works that have been conducted so far. Chapter 3 discusses details of the data that we have used, criteria for index construction and the econometric methodology we use for our investigation. Chapter 4 discusses the results of our model comparing the volatilities of indices in various markets and during different times. Chapter 5

deals with analysis of the contagion effects between conventional and Shariah stock indices, during and after crisis. Chapter 6 investigates the comparative correlation of both the index categories with interest rates in the U.S. and UK markets. Chapter 7 investigates diversification opportunities in the gold markets for Shariah investors. The last chapter, Chapter 8, concludes the study providing a general summary, conclusion and results, discussing some implications suggesting possible extensions.

2 Background and Literature Review

2.1 Islamic Finance

2.1.1 Difference between Conventional and Islamic Economy

Shariah, the Islamic way of life, allows investors to earn profit in trade under specific rules and guidelines. The prohibition of interest is one of the core differences between Islamic and Conventional Economic system. It allows trade but prohibits Riba (usury or interest) as mentioned in the 'Quran' and 'Sunnah', the sovereign guidelines for Muslims. Islam allows market forces and economies to function duly but guided through Divine rules mentioned in the religion (Usmani, 1999). On the contrary, Capitalist economy is controlled by man-made set of rules which are subject to change overtime (Scott, 2011). This unpredictable freedom may lead to some economic practices which can negatively affect the whole socio-economic system. Such financial practices include interest, speculation, short-selling, gambling, etc. which are few parts of Capitalist Economy and cause instability resulting into a crisis attributable to Capitalism (Pereira, 2010). Moreover, unethical business activities may be conducted by market leaders to gain high profits and maintain the monopoly in the market. If such activities are ethically unfair to any party, they might disturb the whole economic process of supply and demand.

The regulations in Islamic Financial system are permanent and cannot be changed on humans' will; if modified, it has to be in accordance with the Shariah guidelines. This somehow creates a uniform and supposedly transparent financial and economic framework. The restrictions on activities refraining from hoarding, speculation, interest, gambling, dealing in unlawful goods and short sales are some of the examples which encompass the complete Islamic socio-economic system (Ayub 2007).

2.1.2 Asset-Backed Financing

The main essence of Islamic Finance that differentiates it from Capitalist Financial System is Asset-Backed Financing (Hussain et al., 2015). Islamic Economy

does not regard paper money as an 'asset' having intrinsic utility except a few conditions. Conversely, the Capitalist Economic System is predominantly based on monetary papers or intangible assets, which may or may not have intrinsic value. Islamic financial system considers money merely a medium of exchange. Therefore, two separate units of money with the same denomination are exactly equal to each other; there is no permission to make profit on it since it comes under the category of Riba or interest (Ahmad & Hassan, 2004). Profit can only be made with an asset having intrinsic utility sold for money or two different currencies exchanged during a transaction; transactions are always backed by real assets or inventories (Eng et al., 2013). In Islamic Financial Instruments, the capital of the investors is invested into real assets or production of goods after which profit is made by carrying out transactions on these assets or goods. The profit gained is then distributed among the investors according to the pre-agreed condition.

Since Conventional Finance involves interest, it is possible that real assets may or may not be created. Therefore, when a loan is granted by the financial institution, it does not always produce goods or real inventory. This process often increases the money supply in the system due to artificial money generated by the loans, which is later multiplied (ECB, 2011). This gap increases economic and financial uncertainty including inflation. Hence, by avoiding interest Islamic economy tends to be more immune to such instabilities and crisis.

2.1.3 Islamic Financial Instruments

Similar to conventional markets, Islamic financial markets also contain money and capital markets but with different principles and procedures. The principles are guided by the Shariah and the transactions shall be free of interest. According to Resolution (59/10/6) of Islamic Fiqh Council of the OIC:

> *"Although the original concept of financial markets is sound and its application is very much needed in the present day context, yet their existing structure does not present an example to carry out the objective of investment and growth of capital within the Islamic framework. This situation requires serious academic efforts to be undertaken in collaboration between the 'Fuqaha' (Muslim jurists) and the economists, so that it may*

be possible to review the existing system with its procedure and instruments and to amend what needs amendment in the light of the recognized principles of Shari'a."

Since Islamic financial markets are usually asset-backed, they mainly comprise of equity instruments in the form of shares and stocks. Furthermore, there are short, medium and long term instruments which represent the ownership of real assets and the holders share the profit or loss from asset operations. Examples of such instruments are Mudarabah, Musharakah, Diminishing Musharakah, etc. (Islamic Finance, 2010). Pure debt or bonds are not allowed in Islamic financial markets. Conventional debt securities, based on interest, include time value of money making them invalid in Islamic Financial markets.

2.1.4 Islamic Equity Fund

Equity funds consist of money invested in shares of joint stock companies. The investors buy shares of a company at a certain market or offered price and can make profit when the share prices increase. The profits are also made through dividends on the shares distributed by the issuing companies.

According to Shariah, the company shall not be involved in prohibited business since buying and holding its shares would be considered as a contribution in the prohibited activity. It is also required that the company does not borrow money on interest during its business and that it holds its capital and surplus in Shariah-compliant bank accounts (Usmani, 1999). However, it is very difficult to completely refrain from interest-based transactions or not to hold money in interest-bearing accounts in today's global financial structure. Most of the companies quoted in today's stock markets are by some means related to interest even though their core business is 'Halal' or permissible (Chong & Liu, 2007).

This intricate situation has been a subject of debate among Islamic scholars. Some believe that even if the company owns a Halal business but is involved in interest-based activities, it is not permissible to invest in stocks of such company (Usmani, 1999). They argue that by contributing in such company through shares is considered as a contribution in interest-based transactions, which is not permissible. Moreover, when such a company generates profit, it may include the impure or

impermissible element in income and in the distributed dividends (Eng et al., 2013). The other group of scholars differentiates a joint-stock company from a simple partnership. They argue that in a simple partnership, it is necessary to take the consent of all business partners before making a decision whereas in a joint-stock company, the decision is made by majority. Hence, the decision may or may not be according to the opinion of the shareholder. Therefore, if a company is involved in interest-based transactions and the shareholder opposes it, then the impermissible activity cannot be attributed to a shareholder in his individual capacity.

2.2 Performance of Islamic and Conventional Indices

2.2.1 Volatility of indices

As the Shariah-Compliant, or simply, Shariah (Islamic) stocks are getting matured with time; research work is gradually expanding on these stock indices. Various researchers have conducted standalone analyses of Shariah indices to find the feasibility of introducing them in a specific market, index filter-criteria and mode of operation; while others have compared their performance with their conventional counterparts. However, the existing literature and research on Shariah stocks is still less as compared to the conventional stocks.

One of the most common approaches to evaluate stock performance is in terms of risk and return. Ahmed & Ibrahim (2002) studied Shariah and Conventional indices, and found them similar in performance in terms of raw and risk-adjusted returns. They employ Sharpe Ratio, Treynor Ratio and Jensen's measure on the daily closing prices of Shariah and Conventional Indices of Kuala Lumpur Stock Exchange for the period 1999 – 2002. By dividing the period in two phases of growing and declining trends, they conclude that Kuala Lumpur Syari'ah index (KLSI) outperformed its conventional counterpart Kuala Lumpur Composite Index (KLCI) during the growing phase while underperformed during declining phase and the overall study period as well.

According to Albaity & Ahmad (2008) no statistically-significant difference exists between KLSI and KLCI during 1999 – 2005 when evaluating risk-adjusted return measurements. They observe short and long-term relationship between Shariah

and conventional indices; as Shariah indices are a subset of their conventional counterparts. Using Sharpe Ratio, Treynor Index, Adjusted Jensen's Alpha Index and Beta measure they find that KLSI has comparatively less return and less risk, which is usually an intrinsic tradeoff of Shariah Indices. Using simple correlation they find the indices less-correlated; however, it is noteworthy that simple correlation does not capture the exact dynamics over time. They argue that KLSI is less risky than KLCI which is similar to the findings of Ahmed & Ibrahim (2002) but they find KLCI producing greater returns in the long-term. Nonetheless, the difference in beta values (market risk) is minuscule. Using Impulse Response, they argue that financial shocks have more impact on KLCI as compared to KLSI. It is noteworthy that Ahmed & Ibrahim (2002) and Albaity & Ahmad (2008) conducted the study only in Malaysian market and studied the period after recovery from the Asian financial crisis of 1997-98. Secondly, the volatility comparison was based on Beta Coefficient which probably does not take into account the past volatilities. Moreover, the study period considered was not long enough to capture the actual dynamics of the markets.

Habib & Islam (2014) compare the Shariah indices in Indian and Malaysian markets and find mixed results. In Indian market the Shariah indices exhibit less return and volatility compared to conventional indices whereas the Shariah indices show opposite results in Malaysian markets. Using daily closing prices of MSCI India Islamic Index and MSCI Malaysia Islamic Index during 2003 – 2013 and employing Capital Asset Pricing Model (CAPM), they conclude that Shariah indices are better performers during GFC. Using Risk-Adjusted Returns they find that difference in excess returns of Shariah indices is not statistically significant. However, they do not distinguish between the crisis and post-crisis periods for evaluating the risk; instead, they calculate the risk for the entire study period.

Ashraf & Mohammad (2014) find that Shariah Indices performed better than their conventional counterparts during the period June 2002 – May 2012, which is partially in contrast to the results obtained by Al-Khazali et al. (2014). Similar to Akhtar et al. (2010), they argue that Islamic Equity Indices exhibit lower systematic risk than their benchmarks showing that any excess performance from Islamic

investments originate from the systematic risk of investment with respect to the benchmark during the bearish market.

According to Abdullah et al. (2002) the Shariah and conventional funds perform in similar pattern underperforming the market during 1992 – 2001. They study the Malaysian market with a sample of 65 unit trust funds including both Islamic and conventional funds while KLCI being the proxy for market portfolio returns, and 3-month Treasury Bills for the risk-free rate. They argue that Islamic funds perform better in bearish markets while conventional funds perform better in bullish markets but they do not find any statistically-significant difference in their performances. Moreover, they analyze only Malaysian market, during Asian financial crisis period, based on monthly data, which may decrease the robustness of results.

Elfakhani et al. (2005) analyze 46 Islamic mutual funds from various regions claiming that Shariah screening does not have a negative impact on funds' performance. They employ Sharpe measure, Treynor measure, Jensen measure, and Fama measures on monthly data from 1997 – 2002 obtained from FTSE and Dow Jones (DJ). One limitation of the study may be limited data possibly leading to less robust results. Similar to the results of Abdullah et al. (2002) they argue that Islamic mutual funds outperformed their benchmarks during recession implying improvement in their performance as fund managers gain experience with time. They conclude that American and emerging market funds outperform the Shariah index and S&P 500 respectively whereas European category outperformed its relative Shariah index only. Moreover, Elfakhani et al. (2005) suggest that the outperformance of Islamic Equity Funds (IEFs) depends on measure, benchmark and time period used for performance evaluation, coinciding with findings of Abdullah et al. (2002).

Mumtaz et al. (2014) study Pakistani market using panel data analysis during July 2007 – June 2012. They argue that Islamic funds offer portfolio diversification and investments can be shifted to Islamic funds due to their low volatility. They claim that the low volatility of Islamic funds is due to their nature of filtering the risky or speculative transactions. They conclude that Islamic funds outperformed both benchmarks during the crisis periods and provide an opportunity of less risky investment to investors during high volatility periods. According to them, the Islamic

fund managers need experience due to the immaturity of Islamic financial markets which concurs with the claim of Elfakhani et al. (2005). They argue that Shariah investors are better in fund selectivity skill but lesser in market timing expertise compared to the conventional counterparts. Mumtaz et al. (2014) use various risk-adjustment performance measures, however, due to monthly data; the number of observations is limited to 60 per dataset. They conclude that Islamic funds offer less risk and similar returns to market benchmarks; similar to the findings of Abdullah et al. (2002). The results of Sharpe and Treynor Ratios are same as found by Hakim & Rashidian (2002) who conclude that Shariah screening process does not significantly impact risk return profile of portfolio because the results show minute difference. Ashraf & Mohammad (2014) suggest that performance evaluation of Shariah stocks founded on mutual funds may be biased because of fund managers' caution in stock selection and market timing abilities, along with associated trading costs.

Reddy & Fu (2014) compare Shariah and conventional stocks listed in the Australian Stock Exchange (ASX100) and claim that Shariah stocks are more volatile. Studying the stocks before and after GFC over the period 2001 – 2013, they find significant difference in risk and return between the two categories but a similar trend in financial time series. Like Albaity & Ahmad (2008) and Al-Khazali et al. (2014), they claim that Shariah stocks being the subset of conventional stocks are significantly correlated with their conventional counterparts. They use standard deviation and beta efficiency as proxy for total risk while building a portfolio of top 50 companies, each for conventional and Shariah index. They evaluate the weekly data of the stocks, which may not provide robust results during crisis periods as markets can be extra volatile. Also, there is a probability of the presence of outliers.

Guyot (2011) compared the performance of seven Dow Jones Islamic Market Indices with conventional indices from 1999 – 2008. Using variance ratio analysis he concluded that Shariah Indices can provide diversification benefits and are equally efficient as conventional counterparts. Despite the study of various global regions, the study does not contain any crisis period; hence, it may not test the performance of Shariah indices during financial turmoil. Hakim & Rashidian (2002) claim that putting the Shariah screening on the stocks does not significantly affect the

performance of the stocks and risk is rather decreased. They perform unit-root, co-integration and causality tests on daily closing prices of Dow Jones Islamic Market Index (DJIMI) and its counterpart Wilshire 5000 Total Market Index (W5000) during 1999 – 2002. They claim that DJIM outperformed W5000 in terms of risk during volatile periods, as worldwide equity prices were declining during this period. Using cointegration tests they argue that Shariah index is influenced by completely different factors and hence more stable during crisis; sector-specific stocks are affected by different variables. They claim that the correlation between indices is temporary. Nevertheless, the study period used was after Asian crisis and Shariah index excluded 75% of the companies during Shariah screening. Their results are opposite to those of Reddy & Fu (2014) who claim that Shariah stocks increase portfolio volatility.

Akhtar et al. (2010) claim Shariah stocks to be less volatile than conventional stocks while analyzing the data of 9 Islamic and 37 non-Islamic countries from 2007 – 2010. Using Pearson Correlation and stochastic volatility model, they capture the volatility either across whole period or on monthly data. They argue that less volatility may be due to less information shared across the market and conclude that Islamic markets are less sensitive to financial contagion and hence offer diversification benefits. The volatility linkages are stronger in periods of low market frictions, high liquidity, high volatility and crisis while the differences are greater in Islamic countries which may be due to Islamic principles followed by the investors.

Dewandaru et al. (2015) investigate the systemic risk for Dow Jones indices of 11 countries with focus on the emerging markets and 10 global sectors during 2008 – 2012. Using wavelet analysis, they observe similar market risk for both conventional and Shariah indices. They conclude that Shariah indices may be equally exposed to risk and observe similar volatilities across almost all horizons. They argue that Shariah equities due to nature of less diversification may have high beta in response to more volatile returns. According to them, the nature of less diversification in Shariah indices may offset advantage of lower financial leverage.

Hassan (2002) employed GARCH modeling to test volatility on daily and monthly data of DJIM aggregate and Regional Indices during 1996 – 2000 and found positive relationship between volatility and index returns. Chiadmi & Ghaiti (2012)

argue that S&P Shariah Index is less volatile than its conventional counterpart S&P 500, by applying ARCH and GARCH models on daily returns during 2006 – 2011. They argue that both indices are volatile but Shariah indices are less risky during crisis periods. However, both studies use simple GARCH with normal distribution, hence do not capture the leptokurticity and leverage effects of financial time series. In contrast, Romli et al.(2012) claim that Shariah indices are more volatile than conventional indices by examining the FTSE Bursa Malaysia EMAS Index (FBMEMAS), FTSE Bursa Malaysia EMAS Shariah Index and FTSE Bursa Malaysia Hijrah Shariah Index during 2007 – 2010 to find the effects of GFC on index volatility. They employed Johansen cointegration tests and Vector Error Correction Model (VECM) to assess the diversity of investments among Shariah stocks, gold index and Treasury Bills and suggested that screening processes do not affect the stocks negatively. They argue that increased volatility is due to less diversification opportunities; which are partially opposite to Hakim & Rashidian (2002) who conclude that the screening process does not affect the returns but volatility is also decreased.

Sukmana & Kholid (2012) claim Shariah stocks are less volatile than conventional stocks especially during times of crisis. They employ ARCH and simple GARCH methodologies to measure the volatility on daily returns of Jakarta Islamic capital market (JAKISL) and its counterpart Jakarta Composite Index (JCI) during the period 2001 – 2009. They find significant correlation between the indices since JAKISL is a subset of JCI index, which agrees with the results of Chiadmi & Ghaiti (2012) and Hassan (2002). Therefore, they suggest that JAKISL can be considered as an alternative to JCI to decrease portfolio volatility during crisis. Similarly, Kassab (2013) concludes that Shariah stocks were less volatile during the crisis as compared to conventional stocks by employing ARCH and GARCH methodology with normal distribution on daily returns of S&P 500 Shariah and its conventional counterpart from 2006 – 2011. He argues that Shariah index was affected by the financial shocks of 2007 crisis to a greater extent as compared to its conventional counterpart but the persistence of volatility was seen slightly higher in conventional index. Both Sukmana & Kholid (2012) and Kassab (2013) use simple GARCH ignoring leptokurticity and leverage effects that are usually present in financial time series.

Furthermore, the time periods considered in both studies include part of the financial crises where the results may not contain the complete volatility of the markets.

Chiadmi & Ghaiti (2014) use GARCH and its extension EGARCH to capture leverage effect and leptokurticity in financial time series. They use Gaussian and non-Gaussian distributions for the analysis to include the fat tail effects. They compare Dow Jones Islamic Market Index (DJIM), S&P Shariah, FTSE Islamic Index and MSCI Islamic World with their respective counterparts i.e. DJIA, S&P 500, FTSE All World and MSCI World, during the period 2006 – 2011. They claim that impact of financial shocks is more on conventional stocks but volatility persistence is high in both indices, which is same as concluded by Ajmi et al. (2014) but opposite to the results of Kassab (2013). They argue that negative news creates more volatility than positive news in all indices, explaining negative asymmetry innate to financial time series. Their study period covers mostly the crisis periods; hence the analysis may not evaluate the performance during tranquil periods of markets.

Ashraf & Deo (2013) claim negative news has more impact than positive news on Shariah indices using the GARCH model with leverage effect which is partially consistent with the findings of Chiadmi & Ghaiti (2014). They study the Shariah indices in GCC countries during 2008 – 2013 and conclude that Shariah indices have same stylized facts and volatility clustering as in conventional time series. However, they use normal distribution which does not take into account the fat tails and leptokurticity of the time series. Secondly, the countries used in the study are mostly different than the ones used in our study. Nasr et al. (2016) claim that Islamic index can barely protect against the financial crisis since it exhibits the same stylized facts of conventional counterparts. Analyzing the DJIMI during 1996 – 2013, they claim simple GARCH model not to be a suitable methodology for forecasting future utility and use FIGARCH, FITVGARCH and MSM in addition.

Miniaoui et al. (2015) compare the DJ GCC Islamic index and its conventional counterparts during 2006 – 2012 and argue that Shariah stocks do not produce benefits of portfolio diversification in terms of volatility during the crisis which is in contrast to the findings of Mumtaz et al. (2014) and Hakim & Rashidian (2002). They study the impact of GFC on Shariah and conventional indices of GCC

and find Shariah indices affected in some countries in terms of returns while others in terms of risk. According to them, there are no benefits of portfolio diversification during crisis. Employing simple GARCH methodology they argue that GCC indices were not affected primarily by the financial crisis. Instead, the volatility during the study period was majorly due to the financial shock in Saudi Arabia and debt crisis in UAE in 2009. After 2011, the countries exhibit calm periods. The study compares the individual conventional indices of GCC countries with Dow Jones Islamic Market Index GCC where the indices have different calculation methodologies. Moreover, the data is on weekly-basis which may not provide robust results.

Khalifa et al. (2014) argue that the key factor for inherent volatility in GCC Index can be the dependency on oil production which coincides with the results of Miniaoui et al. (2015). Marashdeh & Shrestha (2010) and Ajmi et al. (2014) have similar conclusion by mentioning that GCC markets are less affected by crisis due to less cointegration with U.S. and European markets. In contrast, Hammoudeh & Li (2008) argue that GCC markets are significantly affected by the global crisis. Khalifa et al. (2014) argue that Shariah and conventional stocks in UAE suffered during the financial crisis due to large investments before the crisis. These studies exhibit less correlation between U.S. and GCC markets. Employing GARCH and its extensions they conclude that Shariah indices are inherently volatile; hence do not provide cushion during turmoil periods based on being different than conventional indices.

2.2.2 Correlation between Conventional and Shariah indices

Extending the results of volatility, different researchers have evaluated the indices to find the contagion effects between conventional and Shariah indices. As far as the statistical perspective is concerned, two stock markets are said to be integrated if they have a long-run equilibrium relationship and if the trend of their prices moves toward the same direction (Karim & Karim, 2012).

Kenourgios et al. (2016) claim that contagion effects do not exist between Shariah and conventional indices, concluding that Shariah indices provide risk mitigation and diversification benefits during crisis times. Using APARCH-A-DCC framework, they analyze the dynamic conditional correlation to test financial contagion between MSCI World stock index, the MSCI Islamic stock market indices

of the G7, the Islamic stock index of Europe, MSCI Islamic stock indices of the BRICS and MSCI World Islamic stock index. The period under study is 2007 – 2015 which encompasses crisis and stable periods. However, few contagion effects were observed in Shariah stocks of developed markets during the Eurozone crisis. They observe reduced correlation during turmoil periods concluding the presence of diversification benefits in Shariah stocks.

Hammoudeh et al. (2014) used the bivariate copulas to model average and tail dependence between DJIM and conventional stock indices from U.S., Asia and Europe by including various global risk factors during the period 1999 – 2013. In contrast to Kenourgios et al. (2016), they reject decoupling hypothesis of Shariah markets and indices. Similarly, Ajmi et al. (2014) also reject the decoupling hypothesis while studying the relationship between DJIM and S&P stock market indices of U.S., Asia and Europe during 1999 – 2010.

Saiti et al. (2014) use DCC-GARCH on daily return data of MSCI conventional and Shariah stock indices in the Islamic and Far-East countries using MSCI conventional index of U.S. as proxy for U.S.-based investor during the period June 2007 – December 2011. They compare Shariah indices with indices in the Far-East, claiming that Shariah indices provide better diversification for a US-based investor. They use close-to-close daily return data for MSCI conventional and Shariah stock indices in Islamic (Malaysia, Indonesia, Turkey, GCC region ex-Saudi) and Far East (Japan, China, Korea, Hong Kong, Taiwan) countries, besides the MSCI conventional index of U.S. as proxy for U.S.-based investor. Their study period contains the Eurozone crisis which affected European as well as other connected markets. The whole study period can be considered as a crisis period and hence may not be able to capture the effects during tranquil markets.

Majdoub & Mansour (2014) argue that the U.S. and Islamic Emerging markets are weakly correlated overtime. They use multivariate GARCH BEKK, CCC, and DCC to analyze the conditional correlation of MSCI conventional and Islamic indices with Shariah indices of five Muslim majority countries (Turkey, Indonesia, Pakistan, Qatar and Malaysia). Nevertheless, all these 5 countries together, constitute around 9% of indices for the Emerging markets used in our study; hence

our study will be able to capture the effects for different and larger economies. They found low dynamic correlation of MSCI Shariah index with these markets as compared to its conventional counterparts. It is noteworthy that all the five countries lie in the pool of Emerging markets which already is supposed to have less correlation with the U.S. market.

Taşdemir & Yalama (2014) investigate the volatility spillovers between stocks markets of Brazil and Turkey. They employ a two-step causality-in-variance test which is based on cross-correlations of conditional variances obtained by GARCH process, on the data from April 1993 – March 2013. They argue that volatility spillovers are present between Brazilian and Turkish markets, which are further affected during periods of crisis. They argue that such phenomena are present due to international flow of information. Rizvi et al. (2015) study the market co-movements in conventional and Shariah indices during 1996 – 2014, for U.S. and Asia-Pacific markets. They employ wavelength decomposition analysis, claiming that most of the global shocks were transmitted from the U.S. markets to the Asia Pacific markets. According to them, regarding fundamental contagion, the Shariah Asia Pacific market has experienced higher long-term volatility.

Abbes & Trichilli (2015) use monthly closing prices of Shariah indices from 13 developed and 14 emerging countries and employ Johansen-Juselius co-integration, VECM model and Granger causality tests to check the long-run and short-run relationships and causality, between Shariah markets. They argue that Shariah markets of similar economic grouping have long-run equilibrium relationship. They conclude that level of integration and causality relations among Shariah stock markets tends to change over time due to changing market conditions. They claim that by evaluating the correlation coefficients among stock markets over a certain time period, stock market integration and linkage can be analyzed. According to them, highly correlation coefficients provide evidence that stock markets are integrated. They analyze the potential diversification benefits across developed and emerging markets, investigate the impact of GFC on the relationships between Shariah indices and examine influence of the economic development level and the geographical factor on the co-movement of Shariah stock markets. They find only

France, Germany, Singapore and Hong Kong to be related to U.S. markets during the turmoil period. Abbes & Trichilli (2015) claim that Shariah principles such as the interdiction of excessive uncertainty (gharar) and speculation (maysir) risk makes Shariah stocks more stable regarding the global financial crisis. However the data used is on monthly basis which may not be able to capture the true dynamics of the markets, especially during the highly unpredictable crisis periods.

Dewandaru et al. (2015), while analyzing Dow Jones indices of 11 countries during 2008 – 2012, run correlation between different sectors of Shariah stocks and find low correlation at short-horizon. They prefer sector diversification in stock indices rather than country diversification which resonates well with our results. In their study, the differences in betas between Shariah and conventional indices at most of the timescales are not statistically significant.

Alexakis et al. (2015) claim that inclusion of Shariah stocks offers risk mitigation and hence produce portfolio diversification benefits while comparing DJ Islamic Index with its conventional counterpart during 2006 – 2010. They find strong correlation between Shariah and conventional indices where the former is the subset of the latter. Also, they find long-run asymmetric relationship and causality relationship from Shariah to conventional indices during and after crisis which is similar to the results of Ajmi et al. (2014). By employing hidden co-integration and Granger causality analysis on the data they conclude that Islamic finance principles employ lower leverage and speculation. They argue that investors may move to Shariah stocks that are less-correlated instruments in the market, which can be explained on the basis of flight to quality effect.

2.2.3 Correlation between stock indices and interest rates

Ajmi et al. (2014) found causality between the Shariah and conventional indices and also between Shariah indices and interest rates. Using heteroscedasticity-robust linear Granger causality and nonlinear Granger causality tests, they find connection between the Shariah stock market and interest rates and interest-bearing securities, which is inconsistent with the Shariah rules. They use daily data from January 1999 – October 2010. Using causality tests they claim to explore the presence of risk measures which captures the spillover of fear and uncertainty across

markets. According to them, conventional markets use several kinds of hedging strategies against risks which might have helped them to shield themselves from cross market spillovers from the unhedged Shariah market. They find causality between Shariah stock markets and interest rates or interest bearing securities, which is possible since Shariah indices are subset of conventional indices. However, the result is in contrast to the decoupling theory of Islamic financial system with the interest rates. They argue about the reason of two-way causality and spillover mentioning that investors from Islamic countries circulate their money to and from the conventional markets in U.S. and Europe.

Koch & Saporoschenko (2001) analyzed the Japanese market using GARCH methodology and found financial firms to be exposed to market risk and interest-rate risk. They conclude that the company stock prices exhibit negative sensitivity to the long-term bond interest rates. Bohl et al. (2003) find positive relation between stock market movements and interest rates. They find positive but statistically insignificant returns between German stocks and interest rates. Adam et al. (2017) evaluate the effect of U.S. Fund Rate on Indonesian and Malaysian stock market. They employed VAR model and cointegration analysis between interest rates and stock indices during the period August 2000 – January 2016 on monthly data. They did not find any cointegration between the interest rates and the stock indices but while employing the VAR model with exogenous variables, they observed foreign interest rates affecting the Malaysian Shariah indices. Rahim & Masih (2015), using wavelet analysis, find Shariah indices to be exposed to interest rate risk less in short-term horizon but more in long-term horizon. Using the data from March 2007 – December 2014 and applying wavelet analysis, they tested both the conventional and Shariah indices with interest rates.

Bahloul et al. (2017) investigate the impact of short-term interest rates on Shariah indices for ten developed and ten emerging markets using Markov switching model during the period June 2002 – June 2014. Using linear regression, they argue that interest rates do not affect the stock returns in developed or emerging markets. They argue that changes in short-term interest rates are only significant for emerging markets during low-volatility regimes.

2.2.4 Correlation between stock indices and gold price

Ghazali et al. (2013) investigate the role of gold in the Malaysian market and argue that high prices of gold is due to the "fear" trade as the investors are risk-averse during weaker periods of stock markets. In weak financial markets, gold trade increases due to its liquidity (Dee et al., 2013). Raza et al. (2016) also found gold to be hedging instrument for BRICS during Asian and Global financial crisis. They tested the condition in extreme events considering its property of portfolio diversification. Ciner et al. (2013) and Choudhry et al. (2015) claim that gold has the characteristics of hedging and safe haven, for developed stock markets. Moreover, Tiwari et al. (2015) and Dilip Kumar (2014) concluded similar results for emerging markets. On the other hand, Bredin et al. (2014) studied the same relationship in developed markets and argue that the hedge and safe haven property of gold is market dependent.

Beckmann et al. (2015) claim that the recent increase in the price of gold may be attributed to the activity of investors using it as a safe haven or hedging instrument. They claim that gold acts closely to the market expectations and its inclusion in portfolio is an interesting area of consideration both for investors and policy makers. They consider asymmetries of positive and negative extreme shocks using the BFGS numerical optimization method. Analyzing 18 gold markets against five regional indices during the period January 1970 – March 2012 by running regression of gold returns on stock returns, they claim gold as portfolio diversification opportunity.

Bilal et al. (2013) examine the relationship between gold prices and stocks prices in Karachi Stock Exchange (KSE) and Bombay Stock Exchange (BSE). Using cointegration tests on monthly data from July 2005 to June 2011, they find mixed results. They find long-run relationship of average gold prices with BSE index but no relationship with KSE index. Furthermore, they find no causal relationship for average gold prices with either of the indices. Hence, their results imply towards diversification benefits; however, the study period does not cover the complete duration of the crises and the peak of gold prices during the last decade. Their results are slightly in contrast to those of Tiwari et al. (2015) and Dilip Kumar (2014).

Bredin et al. (2014) use wavelet analysis to analyze the safe haven property of gold. They investigate debt and equity markets of the U.S., UK and Germany during the period January 1980 to December 2013. They claim that gold acts as a hedge and safe haven for investors for horizons upto one year. Their results resonate well with the results of Ciner et al. (2013) and Choudhry et al. (2015) for developed markets. In contrast, Choudhry et al. (2015) claim that gold may not be a safe haven during financial crisis but may be a hedge against stock market returns and volatility in stable financial conditions. Choudhry et al. (2015) study the stock indices of FTSE 100 (UK), S&P 500 (US) and Nikkei 225 (Japan) during the period January 2000 to March 2014, by employing bivariate nonlinear test and multilinear test on the data. They find evidence of significant causality between the two variables during the crisis period. Dee et al. (2013) examine the role of gold in Chinese market and argue that gold is not a safe haven during stock and inflation risk.

3 Data and Methodology

3.1 Overview of S&P Indices

Our data includes S&P conventional indices and Shariah indices. Shariah Index is a subset of its conventional counterpart and must be Shariah-compliant; a company has to pass defined screens, after which it is included in the index. The main requirements according to S&P Dow Jones Indices LLC are:

1 The screening is based on two criteria: Sector-based and Accounting-based.
   - Sector-based: The company shall not be involved in activities impermissible in Shariah e.g. interest-based activities, speculation, short-selling, gambling, pornography, alcohol, tobacco, etc.
   - Accounting–based: Company financial ratios are regularly checked in terms of leverage, cash and share of revenues derived from non-compliant activities.
2 Ratings Intelligence Partners, based in UK, provides the Shariah screens and filters the stocks based on these screens.
3 Monthly rebalancing of index is done for the changes due to Shariah compliance.

The description of indices is provided below. The number of companies in each index is as per March 10, 2017.

3.1.1 S&P Global BMI

S&P Global Broad Market Index (S&P Global BMI) which comprises of S&P Developed BMI and S&P Emerging BMI Indices is used to measure the global stock market performance. Launched in 1989, it uses Float-adjusted market capitalization as the weighting method. It has more than 11,500 constituents having Financials, Information Technology and Consumer Discretionary making around 45% of the Index (see Table 3.1). It contains 47 countries making it a suitable index to evaluate an overall global performance.

3.1.2 S&P Global BMI Shariah

S&P Global Broad Market Index Shariah, launched on April 8, 2008, is a global Shariah-compliant benchmark derived from the S&P Global BMI. Approximately 11,500 companies of S&P Global BMI are screened for Shariah-compliance producing this index which consists of large-, mid- and small-cap stocks across developed and emerging markets. The index consists of more than 4200 companies. Information Technology, Health Care and Industrials are among the leading categories in this index as shown in Table 3.1.

3.1.3 S&P 500®

The index is considered as the best measurement index for large-cap U.S. companies. It includes top 500 U.S. companies and captures approximately 80% coverage of available market capitalization. The weighting method used is Float-adjusted market capitalization. Information Technology, Health Care and Financials are among the major constituents making up around 50% of the total as mentioned in Table 3.1.

3.1.4 S&P 500 Shariah

The index is derived from S&P 500 after the screening process of Shariah-compliance. It includes approximately 230 U.S. companies with Information Technology, Health Care and Industrials making up to 65% of the index as seen in Table 3.1. It is noteworthy that Financials make up only 0.5% of the index.

3.1.5 S&P Developed BMI

The index is a subset of S&P Global BMI including stocks from 25 developed markets. It consists of stocks from more than 8,500 companies with Financials, Information Technology and Industrials being the top three sectors and the U.S. market alone making up to 56% of the index. Table 3.1 mentions all sectors in detail.

3.1.6 S&P Developed BMI Shariah

The index is made up of Shariah-compliant constituents of S&P Developed BMI. It contains more than 3,200 companies with Information Technology, Health Care and Industrials being the leading sectors as mentioned in Table 3.1. It is noteworthy that there is no Muslim-majority country present in the 25 developed

countries of this index (see Appendix C: List of countries in Stock Indices for details).

3.1.7 S&P Emerging BMI

The index is a subset of S&P Global BMI including stocks from emerging markets. It consists of stocks from more than 3,000 companies with Financials, Information Technology and Consumer Discretionary being the top three sectors and the Chinese companies making up to 30% of the index as shown in Table 3.1.

3.1.8 S&P Emerging BMI Shariah

The index consists of Shariah-compliant constituents of S&P Emerging BMI. It contains more than 1000 companies with Information Technology, Consumer Discretionary and Telecommunication Services being the leading sectors as shown in Table 3.1. Only six Islamic countries are present in this index out of which Qatar and UAE are leaders in production of petroleum products (see Appendix C: List of countries in Stock Indices for details).

Table 3.1: Sector Breakdown of Conventional and Shariah indices

INDEX	S&P Gl. BMI	S&P Gl. BMI Shariah	S&P 500	S&P 500 Shariah	S&P Dev. BMI	S&P Dev. BMI Shariah	S&P Emer. BMI	S&P Emer. BMI Shariah
Financials	18.2	0.5	14.8	0.5	17.4	0.5	25.4	0.7
Information Technology	15.5	27.5	21.5	34.2	15.2	26.5	18.5	39.4
Consumer Discretionary	12.3	11.4	12.1	10	12.4	11.4	10.8	11.7
Industrials	12	15.6	10.2	13	12.6	16.4	7	6.5
Health Care	10.8	18.4	14.1	17.5	11.7	19.3	3	7.2
Consumer Staples	8.8	10.8	9.4	11	9	11.1	7.1	7.3
Energy	6.2	6.6	6.6	9.7	6.1	6.9	7.5	3.6
Materials	5.8	6.5	2.8	3.6	5.6	6.2	8.3	9.5
Real Estate	4.2	0.9	2.9	0.6	4.2	0.8	3.9	1.8
Utilities	3.1	0.5	3.2	-	3.1	0.4	3.3	2.1
Telecommunication Services	3	1.3	2.4	-	2.8	0.6	5.1	10.3
Total	99.9	100	100	100.1	100.1	100.1	99.9	100.1

Note: The table shows the sector breakdown (in %) of all the indices included in the study. Some values may be less or greater than 100% due to rounding-off after decimal.

3.2 Interest Rates

The proxy for the interest rates are Effective Federal Funds Rate (EFFR), 3-Month Treasury Bill Secondary Market Rate (DTB3), 6-Month Treasury Bill Secondary Market Rate (DTB6), 6-Month London Interbank Offered Rate (LIBOR6M), and 12-Month London Interbank Offered Rate (LIBOR12M); both LIBOR rates are based on U.S. Dollar. The data has been obtained from the website of Federal Reserve Bank of St. Louis. The Federal Reserve Bank of St. Louis is one of 12 regional Reserve Banks that, along with the Board of Governors in Washington, D.C., make up the United States' central bank. We have used the interest rates from U.S. and UK due to the volume of these markets and their impact on global economy.

3.3 Gold Prices

The historical gold prices have been obtained from the World Gold Council, the market development organisation for the global gold industry. The daily prices are mentioned in U.S. Dollars per troy ounce which are updated weekly basis on World Gold Council website.

3.4 Data Description and Model

We use two categories of indices for performance comparisons: the conventional stock indices and their respective Shariah counterparts. The daily returns of the S&P Indices are obtained from S&P Dow Jones Indices website. We compare the performance of Shariah indices with the conventional counterparts in four regions or levels: Global, U.S., Developed and Emerging Markets.

We examine the sample period from January 1, 2008 to March 10, 2017, firstly over the entire period; then we divide the overall period into sub-periods: during, and after the GFC. Since all markets were supposedly affected by GFC, the first sub-period is from January 1, 2008 to August 19, 2009 whereas the second sub-period is from August 20, 2009 to March 10, 2017. A shortcoming of our data is that these Shariah indices were launched in the beginning of 2008 and hence we cannot include any data before January 1, 2008. Moreover, we can also consider the start of

the crisis (Lehman Brothers fail) i.e. September 15, 2008, but it would have less number of observations before crisis, making results unreliable and less robust. We consider August 2009 as our point of division in accordance with the 79th BIS Annual Report 2008/09 (Bank for International Settlements, 2009), according to which, the market started to improve in March 2009. BIS in its report of 2009, has divided the crisis period into five stages in which the first four stages are periods of turmoil and uncertainty while the fifth period, starting from mid-March 2009, shows signs of stabilization and recovery. Accordingly, we consider August 2009 as a suitable month to divide the data into two sub-periods which enables us to obtain our results with sufficient degrees of freedom.

The reason of not considering March 15, 2009 as our point to divide data sample is persistent nature of financial volatility. Hence, we perform structural break test (see Appendix B: Outputs) on the data to do a quantitative verification and detect our first breakpoint. Since our study period consists of two major crises i.e. the Global Financial Crisis and the Eurozone crisis, we truncate our study period ruling out the relatively tranquil periods. Therefore, we perform a structural break test on data of S&P Global BMI index from September 15, 2008 to July 12, 2012. This gives us a structural break on August 19, 2009 resonating well with the BIS report, as the conditions began to improve in March 2009 and volatility gradually subsided by August 2009. The breakpoint obtained for S&P Global BMI is utilized for all the other indices, for the sake of uniformity.

In our dataset for interest rates, we observe some missing observations (mentioned in parentheses) in the downloaded data: EFFR (90), DTB3 (99), DTB6 (99), LIBOR 3M (76), LIBOR 12 (76). However, since the interest rates are not frequently changing and the missing observations are not consecutive but dispersed throughout the dataset, we have copied the value from the preceding day to the missing value; this helps us to keep the data uniform throughout the study. Secondly, S&P 500 indices contain 2314 observations whereas all other indices contain 2398 observations. While using S&P 500 indices data set for correlation with other indices, we have copied the value from the preceding day to the missing value, for keeping the dataset uniform; the missing values are not consecutive and no drastic change is

observed in the values adjacent to the missing values. Gold prices are consistent throughout and no modification was required.

Inspired by the previous works, we study the conditional volatility of the Shariah indices and their respective Conventional counterparts during and after the GFC. This enables us to analyze indices during turmoil and tranquil periods. Since we are considering the daily closing prices of the indices, we need to convert them into daily returns.

We first convert the stock prices into log-returns, as:

$$R_t = [log_e(P_t) - log_e(P_{t-1})] * 100 \quad (3.1)$$

Firstly, we study the time series in terms of characteristics and normality, which is evaluated by computing the descriptive statistics, as shown in Table 3.2. The statistics show that both conventional and Shariah indices move in the same direction.

As shown in Table 3.2 all the conventional indices seem to be more volatile than their corresponding Shariah indices. Also, mean of all Shariah indices is greater than that of conventional indices. All indices are negatively skewed which show asymmetric property of distribution.

Table 3.2: Descriptive Statistics of daily returns of stock indices for whole period

	S&P Global BMI	S&P Global BMI Shariah	S&P 500	S&P 500 Shariah	S&P Emerging BMI	S&P Emerging BMI Shariah	S&P Developed BMI	S&P Developed BMI Shariah
Size	2397	2397	2313	2313	2397	2397	2397	2397
Mean	0.0058	0.0107	0.0214	0.0231	-0.0103	-0.0095	0.0076	0.0127
Median	0.0585	0.0556	0.0575	0.0501	0.0375	0.0489	1.1300	1.0891
Std Dev	1.1179	1.0777	1.3373	1.2488	1.2624	1.2552	0.0539	0.0553
Skewness	-0.5035	-0.5037	-0.3231	-0.1026	-0.4934	-0.5702	-0.5000	-0.4746
Exc. Kurtosis	8.1450	9.1660	10.1836	11.0592	7.5175	9.4261	8.1234	9.2411
Min	-7.1728	-7.7857	-9.4695	-9.5307	-9.6303	-10.3392	-7.1774	-7.8166
Max	8.5673	9.0452	10.9572	11.5827	9.2891	9.8572	8.8188	9.4712
JarqueBera	6727.1	8492.5	10035	11791	5741.5	9004	6690.6	8619.2
Probability	2.20E-16	2.20E-16	2.20E-16	2.20E-16	2.20E-16	2.20E-16	2.20E-16	2.20E-16

Note: The table shows the descriptive statistics of all S&P Indices under study comparing the mean and volatility of the indices.

To confirm if the distributions of the daily logarithmic returns of Shariah and Conventional indices follow a normal distribution, we employ Jarque-Bera Test. Small p-values and large X-squared show that the indices do not possess normal

distribution. The probability is less than 0.05; hence we reject the null hypothesis of the normality of the returns—non-normality is an inherent property of financial time series.

The coefficient of kurtosis is very high (higher than 3—the coefficient for normal distribution) for all four Shariah indices and their conventional counterparts. This high kurtosis depicts high probability of occurrence of extreme points and higher risk. Based on our results, we use Akaike Information Criterion or AIC (1973) to select the best model in our analysis. For determining the presence of stationarity we use Augmented-Dickey Fuller Test (ADF Test) where the null-hypothesis is that series has unit root i.e. non-stationary. Since the p-value is insignificant, the null-hypothesis is rejected and we conclude that the series is stationary. We use Ljung-Box Test to verify the presence of autocorrelations of a time series. Financial time series are highly correlated in general because the returns of the present day are affected by returns of preceding days. We find the p-value to be negligible; hence the null-hypothesis is rejected concluding that the data exhibits serial correlation. In other words, the intrinsic property of volatility clustering in financial time series exists in our series. To test the presence of heteroskedasticity we employ ARCH-LM Test developed by Engle (1982). This is a Lagrange Multiplier Test for testing the autoregressive conditional heteroskedasticity. Null hypothesis is that no ARCH effects are present, and our low and insignificant p-values show that null-hypothesis shall be rejected and ARCH effects are present.

Now we divide the data into sub-periods to analyze if both categories of stock indices exhibit similar behavior during tranquil and turmoil periods. Table 3.3 and Table 3.4 show descriptive statistics for the period during and after crisis respectively. Analyzing the stock indices during crisis, we observe in Table 3.3 that all indices have negative mean depicting financial losses during crisis. All conventional indices show slightly greater volatility than their respective Shariah indices. However, the Emerging Shariah markets show greater volatility during turmoil periods. This may be because of greater sensitivity of emerging markets to the global financial shocks and small market size. This may signify that stocks in

emerging markets do not provide portfolio diversification opportunities during crisis in terms of risk.

Table 3.3: Descriptive Statistics of daily returns of stock indices during crisis

	S&P Global BMI	S&P Global BMI Shariah	S&P 500	S&P 500 Shariah	S&P Emerging BMI	S&P Emerging BMI Shariah	S&P Developed BMI	S&P Developed BMI Shariah
Size	427	427	412	412	427	427	427	427
Mean	-0.0921	-0.0818	-0.0879	-0.0683	-0.0898	-0.1051	-0.0923	-0.0790
Median	0.0179	0.0102	0.0766	0.0767	-0.0194	0.0000	0.0196	0.0170
Std Dev	1.8854	1.8002	2.3844	2.1509	2.1389	2.2148	1.8964	1.8001
Skewness	-0.2443	-0.2610	-0.0676	0.1386	-0.2761	-0.2890	-0.2489	-0.2453
Exc. Kurtosis	3.2276	4.2325	3.4240	4.8972	2.9391	3.2528	3.3008	4.5494
Min	-7.1728	-7.7857	-9.4695	-9.5306	-9.6303	-10.3392	-77.1774	-7.8166
Max	8.5673	9.0452	10.9572	11.5826	9.2891	9.8572	8.8188	9.4712
JarqueBera	191.74	326.92	204.05	416.82	160.98	196.38	200.48	376.29
Probability	2.20E-16	2.20E-16	2.20E-16	2.20E-16	2.20E-16	2.20E-16	2.20E-16	2.20E-16

Note: The table shows the descriptive statistics of all S&P Indices under study comparing the mean and volatility of the indices.

On the other hand, we find Shariah indices performing slightly better than conventional indices during tranquil periods, shown in Table 3.4. Moreover, the Shariah indices in Emerging markets are better than others in terms of both risk and return. Nevertheless, the descriptive statistics do not give a clear idea about the stocks performances. Hence we move to GARCH models to further investigate the volatility.

Table 3.4: Descriptive Statistics of daily returns of stock indices after crisis

	S&P Global BMI	S&P Global BMI Shariah	S&P 500	S&P 500 Shariah	S&P Emerging BMI	S&P Emerging BMI Shariah	S&P Developed BMI	S&P Developed BMI Shariah
Size	1970	1970	1900	1900	1970	1970	1970	1970
Mean	0.0270	0.0308	0.0441	0.0420	0.0070	0.0112	0.0293	0.0326
Median	0.0627	0.0597	0.0560	0.0475	0.0445	0.0510	0.0553	0.0556
Std Dev	0.8656	0.8426	0.9704	0.9452	0.9736	0.9239	0.8793	0.8602
Skewness	-0.4993	-0.4782	-0.4444	-0.3789	-0.4732	-0.5606	-0.4821	-0.4521
Exc. Kurtosis	4.1862	3.8128	4.1340	3.4993	3.0902	3.5423	4.2072	3.7754
Min	-5.4332	-5.2131	-6.8958	-6.0417	-6.5232	-6.5132	-5.4777	-5.2796
Max	4.7667	4.1492	4.6317	4.2958	4.2859	4.0088	4.8338	4.1809
JarqueBera	1531.5	1276.9	1415.7	1014.8	859.91	1136.7	1541	1245.7
Probability	2.20E-16	2.20E-16	2.20E-16	2.20E-16	2.20E-16	2.20E-16	2.20E-16	2.20E-16

Note: The table shows the descriptive statistics of all S&P Indices under study comparing the mean and volatility of the indices.

3.4.1 ARCH, GARCH and EGARCH model

In our study, considering the effects of heteroskedasticity to be present in the time series, we follow the approach of Engle (1982). Engle (1982) while discussing UK inflation mentioned that forecast errors are present in the form of clusters; large errors are followed by large errors and small errors followed by small ones. To evaluate this he proposed the model called Autoregressive Conditional Heteroskedasticity (ARCH) model.

In ARCH (1) model, the conditional variance $\sigma_t{}^2$ depends on the information at time *t-1*. It is a linear function of long-term mean of variance and squared residual return, ε_t observed at *t-1*.

Mean equation:

$$r_t = \mu + \varepsilon_t \tag{3.2}$$

Variance equation:

$$\sigma_t{}^2 = \mathrm{Var}(\varepsilon_t|[\varepsilon_{t-1}, \varepsilon_{t-2}, \dots]) = \omega + \alpha_1 \varepsilon_{t-1}{}^2 + \cdots + \alpha_q \varepsilon_{t-q}{}^2 \tag{3.3}$$

Where the residual return is defined by $\varepsilon_t = \sigma_t z_t$ and z_t is white noise. q is the number of lagged $\varepsilon_t{}^2$ terms.

The conditional variance $\sigma_t{}^2$ is strictly positive at any time *t*. Therefore, all coefficients shall be non-negative:

$$\alpha_i > 0 \forall i = 0,1,2, \dots, q \tag{3.4}$$

Extending the study of Engle (1982), Bollerslev (1986) proposed a general version of ARCH known as Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model. In this model conditional variance $\sigma_t{}^2$ can depend on its own lags.

Mean equation:

$$r_t = \mu + \varepsilon_t \tag{3.5}$$

Variance equation:

$$\sigma_t^2 = \mathrm{Var}(\varepsilon_t|[\varepsilon_{t-1}, \ldots; \sigma_{t-1}, \ldots]) = \omega + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \beta_j \sigma_{t-j}^2 \quad (3.6)$$

where p is the number of lagged σ_t^2 terms and q is the number of lagged ε_t^2 terms. All parameters $\omega, \alpha_i \forall i = 1, 2, \ldots, q$ and $\beta_j \forall j = 1, 2, \ldots, p$ are strictly positive to maintain non-negativity of conditional variance.

The first term ω is a constant, the minimum variance threshold—the conditional variance does not fall below this value. The second term α_i is the sum of squared residuals also known as ARCH effect which signifies the impact of shocks on volatility. The third term β_j, known as GARCH effect, represents the sum of past variances and models the persistence of volatility; it shows the influence of past volatility on future values and hence financial contagion over time.

Due to non-negative conditionality, simple GARCH cannot capture the Leverage Effect—an effect innate in all financial time series. In simple GARCH model it is assumed that effect of different shocks on volatility is only concerned with the magnitude regardless of the sign. The model is comprised of 'square' of shocks, disregarding the nature of volatility. Nevertheless, generally, negative shocks cause more volatility than the positive shocks of the same magnitude (Black, 1976). More precisely, bad news increases volatility more than the good news which shall be taken into consideration during calculation.

To overcome the problem of nature of volatility, Nelson (1991) introduced a modified version of GARCH known as Exponential GARCH. EGARCH is capable of capturing the leverage effect in the time series. In the EGARCH model, the logarithm of the variance is modeled.

$$\ln(\sigma_t^2) = \omega + \sum_{j=1}^{p} \beta_j ln(\sigma_{t-j}^2) + \sum_{j=1}^{q} \{\alpha_j(|z_{t-j}| - E|z_{t-j}|) + \gamma_j z_{t-j}\} \quad (3.7)$$

where γ_j captures the sign effect and α_j the size effect. The effect of asymmetry is depicted by the parameter γ_1 capturing the effect of positive and negative variations. The expected value of the absolute standardized innovation, z_t is

$$E|z_t| = \int_{-\infty}^{\infty} |z| f(z, 0,1, \dots) dz \tag{3.8}$$

It is noteworthy that according to the original model of Nelson (1991) and its corresponding *RStudio* package, *rugarch* (which we used for evaluating the model), γ_1 shows the size effect and α_1 shows the sign effect while β_1 remains the same. To have uniformity in our results, we have reversed the role of γ_1 and α_1. Therefore, in our study, α_1 shows the size effect and γ_1 shows the sign effect whereas β_1 remains the same—showing GARCH effect. According to the AIC criteria, EGARCH with GED distribution gives the most robust results; therefore, we will consider those results in comparisons.

It is important to note that the assumption on GARCH models is the Maximum Likelihood (ML) approach. ML interprets the density as a function of the parameters, conditional on a set of sample outcomes, and the function is called the likelihood function.

3.4.2 Gaussian Distribution

While estimating GARCH models Gaussian distribution is commonly used. The log-likelihood function can be expressed as:

$$L_T = -\frac{1}{2}\sum_{t=1}^{T} [ln(2\pi) + ln({\sigma_t}^2) + {z_t}^2] \tag{3.9}$$

3.4.3 Generalized Error Distribution

Due to non-normality and fat-tails observed in financial time series, we include Generalized Error Distribution in our calculation. The log-likelihood function of GED is given by:

$$L_{GED} = \sum_{t=1}^{T} \left[\ln\left(\frac{v}{\lambda_v} - 0.5 \left|\frac{z_v}{\lambda_v}\right|^v\right) - (1 + v^{-1}) \ln(2) - \ln \Gamma\left(\frac{1}{v}\right) - 0.5 \ln {\sigma_t}^2 \right] \tag{3.10}$$

where $\lambda_v = \sqrt{\frac{\Gamma\left(\frac{1}{v} 2^{\frac{-2}{v}}\right)}{\Gamma\left(\frac{3}{v}\right)}}$

The GED is non-normal density function and involves the phenomenon of fat-tails which is present in the financial time series. In many cases, the normality condition cannot be maintained. However, GED can assume Normal distribution, a leptokurtic distribution (fat tails) or a platykurtic distribution (thin tails).

3.4.4 Time-varying correlation – DCC-GARCH

DCC-GARCH methodology is used to capture the time varying effects of correlation between indices. It helps to capture the effects of past events on correlation enabling to analyze the correlation during turmoil and tranquil periods. The distribution used here for the DCC-GARCH is the multivariate Student distribution.

Bollerslev (1990) produced constant correlation model where volatilities were varying through time but the correlations were constant. His work was further extended by Engle (2002) where the correlations were also allowed to vary through time. This is known as Multivariate Dynamic Conditional Correlation Generalized Autoregressive Conditional Heteroscedasticity (DCC-GARCH) model.

Bollerslev (1990) suggested modeling the time varying covariance matrix as:

$$H_t = D_t R D_t \text{ , where } D_t = diag\{\sqrt{h_{i,t}}\}$$

where R is a correlation matrix containing the conditional correlations. The parameter $h_{i,t}$ is following any univariate GARCH(p,q) process. $i = 1, 2, \ldots, n$ where n is number of assets at time $t = 1, \ldots, T$. Engle (2002) extended the model by allowing R to vary with time. Hence,

$$H_t = D_t R_t D_t$$

Correlation matrix R_t is then defined by

$$R_t = diag\left(\sqrt{q_{11,t}}, \ldots, \sqrt{q_{nn,t}}\right) Q_t \, diag\left(\sqrt{q_{11,t}}, \ldots, \sqrt{q_{nn,t}}\right)$$

where $Q_t = q_{i,j,t}$ is

$$Q_t = S(1 - \alpha - \beta) + \alpha(\varepsilon_{t-1}\varepsilon_{t-1}') + \beta Q_{t-1} \tag{3.11}$$

where *S* is the unconditional correlation matrix of the epsilons, i.e.

$$\varepsilon_t = \frac{\varepsilon_{i,t}}{\sqrt{h_{i,t}}} \text{ and } S = T^{-1} \sum \varepsilon_{t-1}\varepsilon_{t-1}'$$

α and β are non-negative scalars such that $\alpha + \beta < 1$

3.4.5 Student's *t* Distribution

For DCC-GARCH we use *rmgarch* package in *RStudio*, which has the option of using a Normal distribution or Student's *t* Distribution (Multivariate *t* Distribution). Due to the presence of non-normality in the time series, we select Multivariate *t* Distribution (MVT).

The probability density function of the d-dimensional multivariate Student's t distribution is given by:

$$f(x, \Sigma, \nu) = \frac{1}{|\Sigma|^{1/2}} \frac{1}{\sqrt{(\nu\pi)^d}} \frac{\Gamma\left((\nu + \mathrm{d})/2\right)}{\Gamma(\nu/2)} \left(1 + \frac{x'\Sigma^{-1}x}{\nu}\right)^{-(\nu+\mathrm{d})/2} \tag{3.12}$$

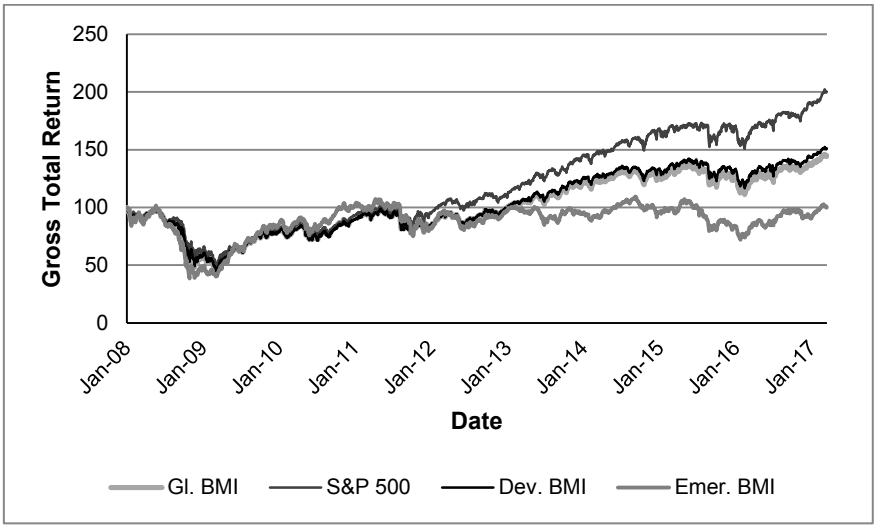
where x is a 1-by-d vector, Σ is a d-by-d symmetric, positive definite matrix, and ν is a positive scalar.

4 Results and Discussion - GARCH

The S&P Global BMI Shariah, S&P 500 Shariah, S&P Developed BMI Shariah and S&P Emerging BMI Shariah have been compared with their respective conventional counterparts during the period from January 2008 to March 2017. The study period consists of crisis and post-crisis sub-periods.

Figure 4.1 shows the daily data of gross total returns for the conventional indices namely S&P Global BMI, S&P 500, S&P Developed BMI and S&P Emerging BMI. All indices exhibit a sharp plunge in returns at Lehman Brothers' fail during September 2008.

Figure 4.1: Gross Total Returns of Conventional Indices



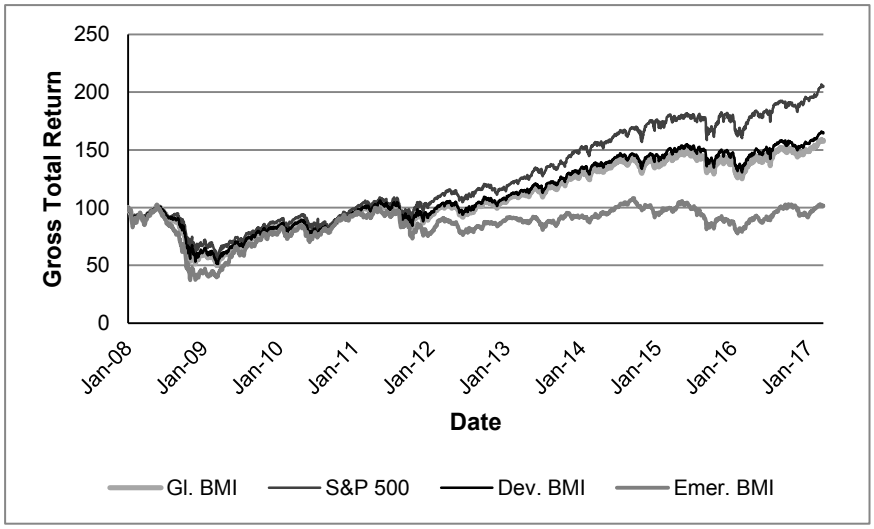
Note: Figure shows total returns of S&P Global BMI, S&P 500, S&P Developed BMI and S&P Emerging BMI. Data has been based at 100. The values of all indices are Gross Total Returns except S&P 500 which is in terms of Total Returns.

From the figure, it is evident that the prices start to recover after the first quarter of 2009 which concurs with the findings of BIS Annual Report (2009). The emerging markets (medium gray) recover quicker and better than the developed markets (black). The developed markets remained under pressure till 2012 due to GFC, and Eurozone crisis afterwards (Ali, 2012). The developed markets seem to recover after 2012 whereas the returns of emerging markets remain lower after 2013.

The U.S. markets (dark gray) show better signs of recovery among all indices, after 2012.

Figure 4.2 shows the daily data of gross total returns for all the four Shariah indices evaluated in our study. Shariah indices, being subsets of respective conventional indices show similar trend; global, developed and the U.S. markets perform better than emerging markets. However, all markets exhibit similar performance till 2011. It is important to note that all Islamic countries included in our study, where Shariah investments may be assumed to be more matured or practiced, are contained in the Shariah indices of emerging markets.

Figure 4.2: Gross Total Returns of Shariah Indices



Note: Figure shows total returns of S&P Global BMI, S&P 500, S&P Developed BMI and S&P Emerging BMI. Data has been based at 100. The values of all indices are Gross Total Returns except S&P 500 which is in terms of Total Returns.

To summarize, we can observe that the Shariah index normally moves in the same direction as the conventional index. During the crisis Global BMI conventional index and Shariah index returns plunge by 32% and 30% respectively. Same trend is observed in S&P 500 conventional and Shariah indices, where they decline by 28% and 25% respectively; S&P Developed BMI conventional and Shariah decline by 31% and 29% respectively whereas S&P Emerging BMI conventional and Shariah decline by 36% and 37% respectively. The GFC created uncertainty propagating systematic risk leading to the Eurozone crisis (Constancio, 2011). It further contributed to the contagion effects within international financial markets, creating

lack of confidence among the investors. The emerging markets were also impacted by the GFC and Eurozone crisis due to collapse of exports, because of tight financial conditions and lack of consumer demand (Ozkan & Unsal, 2012).

The time series of closing prices are non-stationary. We convert it into stationary time series by taking logarithmic differentiation on closing prices which shall give us the daily returns. Figure A.1 to Figure A.4 in Appendix A, show the daily returns of our indices under study. Large residuals may be observed during financial crisis periods as the return values tend to deviate from the average. The series are highly volatile with positive and negative fluctuations. The GFC and Eurozone crisis periods are evident with volatility clustering in both conventional and Shariah indices. S&P 500 indices exhibit highly volatile U.S. markets.

We apply GARCH model to S&P Global BMI indices. Table 4.1 compares the S&P Global BMI Shariah with its conventional counterpart. All the coefficients are significant for both indices. We observe that the financial shocks of global crisis affected both conventional and Shariah indices irrespective of the type of distributions. The negative impact of financial shocks is evident on both indices. Shariah index is impacted more by the financial shocks than its conventional counterpart; although the difference in coefficients is small. Leverage effect is evident for both indices—negative past returns or news increased more volatility than positive past returns.

Table 4.1: GARCH results for S&P Global BMI and S&P Global BMI Shariah

S&P Global BMI	Conventional			Shariah		
	GARCH	EGARCH (Norm.)	EGARCH (GED)	GARCH	EGARCH (Norm.)	EGARCH (GED)
ω	0.0123***	-0.0008	-0.0088***	0.0140***	-0.0029	-0.0115***
	(0.0031)	(0.0024)	(0.0028)	(0.0033)	(0.0029)	(0.0032)
α_1	0.1031***	0.1220***	0.1228***	0.1123***	0.1366***	0.1345***
	(0.0129)	(0.0162)	(0.0180)	(0.0136)	(0.0172)	(0.0195)
β_1	0.8871***	0.9861***	0.9875***	0.8757***	0.9818***	0.9837***
	(0.0132)	(0.0012)	(0.0012)	(0.0134)	(0.0012)	0.001260
γ_1		-0.0987***	-0.1054***		-0.1159***	-0.1233***
		(0.0094)	(0.0118)		(0.0104)	(0.0129)
ν			1.3773***			1.3622***
			(0.0530)			(0.0542)
Log likelihood	-3061.406	-3010.696	-2962.361	-2993.408	-2937.525	-2890.183
AIC	2.5577	2.5162	2.4767	2.5010	2.4552	2.4165

Notes: Significance levels statistically different from zero are denoted by asterisks (* 10%, ** 5%, ***1%)

In terms of persistence of volatility, both conventional and Shariah index seem to show the same behavior where the persistence is higher for both. Shariah index performs slightly better but the difference is statistically small. One reason for Shariah index having greater impact of negative shocks than the conventional index may be the overreaction of Shariah investors to the market news as they are following the conventional markets for news and information. However, referring to the unconditional volatility in Table 3.1, S&P Global BMI Shariah is observed to be less volatile than its respective conventional index.

Table 4.2 and Figure 4.3 the development of volatility over time for S&P Global BMI and it Shariah counterpart. The figure shows the difference in volatilities where volatility of Shariah index has been subtracted from that of its conventional index. Hence, the positive values depict S&P Global BMI to be more volatile than S&P Global BMI Shariah whereas negative values show vice versa. This figure helps us to understand the development of volatility during the crisis and post crisis periods.

Table 4.2: Difference of volatility between S&P Global BMI and S&P Global BMI Shariah

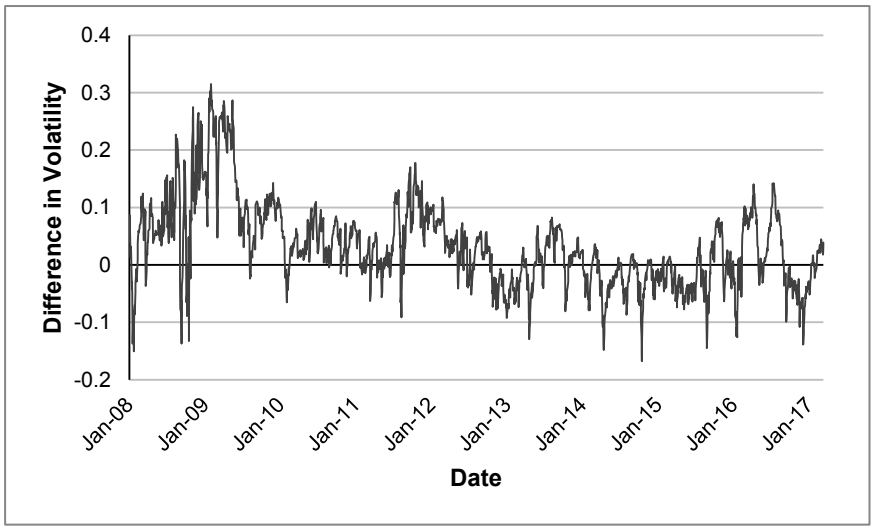
	Conditional SD (vs |returns|)					
Variable	**Min.**	**1st Quantile**	**Median**	**Mean**	**3rd Quantile**	**Max.**
Global BMI	0.2970	0.6153	0.7874	0.9550	1.1040	4.5407
Global BMI Shariah	0.2753	0.5986	0.7754	0.9215	1.0430	4.4630
Difference	-0.1680	-0.0183	0.0244	0.0335	0.0731	0.3153

Notes: The table shows the descriptive statistics of volatility of conventional and Shariah indices. The *Difference* has been calculated by subtracting volatility of the Shariah index from that of conventional index; hence positive values depict a more-volatile conventional index, and negative values show vice versa.

Table 4.2 shows that the mean of difference in volatilities is positive implying that conventional stocks are more volatile. Moreover, the positive median shows that majority of the study period witnessed conventional indices to be more volatile. Our results about volatility are further fortified by the greater persistence of volatility in conventional index. In Figure 4.3 we observe that conventional index is more volatile during GFC, and its aftermath—during the Eurozone crisis. The difference reaches maximum after Lehman Brothers' fail and then starts to subside as GFC started to

mitigate (Bank for International Settlements, 2009). The difference increases again during ESDC but afterwards the difference starts to fluctuate around zero, as Eurozone crisis mitigate by 2012 (Xafa, 2014). Hence the hypothesis that Shariah stocks were less volatile on global level, especially during financial crises, cannot be rejected.

Figure 4.3: Difference of volatility between S&P Global BMI and S&P Global BMI Shariah



Notes: The figure shows the positive difference where conventional index is more volatile, and shows negative difference where Shariah index is more volatile.

Table 4.3 compares the S&P 500 index with S&P 500 Shariah index. All coefficients are significant.

Table 4.3: GARCH results for S&P 500 and S&P 500 Shariah

S&P Global BMI	Conventional			Shariah		
	GARCH	EGARCH (Norm.)	EGARCH (GED)	GARCH	EGARCH (Norm.)	EGARCH (GED)
ω	0.0271***	0.0029	-0.0088**	0.0273***	-0.0011	-0.0113**
	(0.0048)	(0.0049)	(0.0042)	(0.0050)	(0.0040)	(0.0044)
α_1	0.1311***	0.1394***	0.1451***	0.1362***	0.1371***	0.1409***
	(0.0150)	(0.0170)	(0.0207)	(0.0154)	(0.0003)	(0.0158)
β_1	0.8499***	0.9735***	0.9763***	0.8432***	0.9706***	0.9720***
	(0.0148)	(0.0012)	(0.0012)	(0.0151)	(0.0000)	(0.0010)
γ_1		-0.1731***	-0.1876***		-0.1911***	-0.2075***
		(0.0131)	(0.0169)		(0.0135)	(0.0163)
ν			1.3323***			1.3821***
			(0.0546)			(0.0585)
Log likelihood	-3265.601	-3209.384	-3159.633	-3173.766	-3100.738	-3062.824
AIC	2.8272	2.7794	2.7373	2.7477	2.6855	2.6535

Notes: Significance levels statistically different from zero are denoted by asterisks (* 10%, ** 5%, ***1%)

From the table, conventional stocks face greater impact of financial shocks whereas Shariah stocks observed to be impacted more by the negative news. The volatility is slightly more persistent in conventional stocks although the difference is small. Since the constituents of conventional index are greater in number, we can expect more impact of crisis due to common information sharing. Additionally, the unconditional volatility of conventional index is greater as shown in Table 3.2.

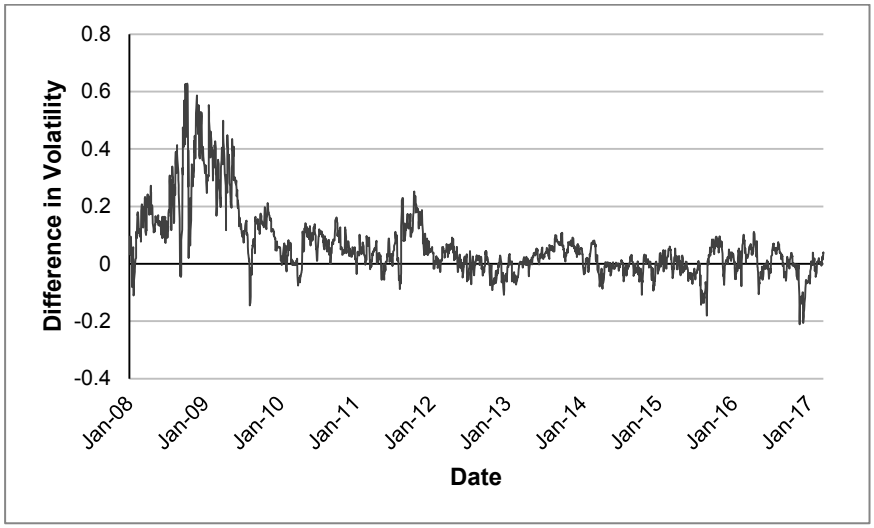
Table 4.4 and Figure 4.4 show the development of volatilities overtime. We observe that the conventional index is highly volatile during the GFC crisis, whereas the volatility does not show much deviation during the Eurozone crisis—since the stocks are primarily based in the U.S. market.

Table 4.4: Difference of volatility between S&P 500 and S&P 500 Shariah

	Conditional SD (vs |returns|)					
Variable	Min.	1st Quantile	Median	Mean	3rd Quantile	Max.
S&P 500	0.3077	0.6668	0.9055	1.1087	1.3237	5.5408
S&P 500 Shariah	0.3032	0.6440	0.8837	1.0460	1.2345	5.5211
Difference	-0.2111	-0.0045	0.0341	0.0627	0.0943	0.6279

Notes: The table shows the descriptive statistics of volatility of conventional and Shariah indices. The *Difference* has been calculated by subtracting volatility of the Shariah index from that of conventional index; hence positive values depict a more-volatile conventional index, and negative values show vice versa.

Figure 4.4: Difference of volatility between S&P 500 and S&P 500 Shariah



Notes: The figure shows the positive difference where conventional index is more volatile, and shows negative difference where Shariah index is more volatile.

The maximum difference is reached during Lehman Brothers' Fail which first impacted the U.S. market. Financial institutions were among some of the most impacted sectors by Lehman Brothers' filing for bankruptcy (Johnson & Mamun, 2011). Since the Shariah index does not include financial institutions more than its 0.5%, it may have shown some resistance against such shocks. The difference decreases during 2009 as GFC starts to mitigate (Bank for International Settlements, 2009). In Table 4.4, we observe that the median value of difference is around 0.03 while the 1st quantile is negative but close to zero. This depicts that nearly three-fourth of the Conventional index observations exhibit more volatility than their Shariah counterparts. Hence, the second hypothesis cannot be rejected and we may conclude that U.S.-based investors in Shariah stocks experienced less volatility during and after the crises.

Table 4.5 shows the results for comparison between S&P Emerging BMI and S&P Emerging BMI Shariah; all coefficients are significant.

Table 4.5: GARCH results for S&P Emerging BMI and S&P Emerging BMI Shariah

S&P Emerging BMI	Conventional			Shariah		
	GARCH	EGARCH (Norm.)	EGARCH (GED)	GARCH	EGARCH (Norm.)	EGARCH (GED)
ω	0.0153***	0.0024	-0.0020	0.0112***	0.0017	-0.0034
	(0.0043)	(0.0021)	(0.0023)	(0.0034)	(0.0020)	(0.0021)
α_1	0.0939***	0.1185***	0.1174***	0.0903***	0.1188***	0.1183***
	(0.0117)	(0.0175)	(0.0250530	(0.0111)	(0.0141)	(0.0050)
β_1	0.8962***	0.9882***	0.9891***	0.9027***	0.9899***	0.9907***
	(0.0124)	(0.0014)	(0.0018)	(0.0114)	(0.0012)	(0.0005)
γ_1		-0.0714***	-0.0714***		-0.0724***	-0.0721***
		(0.0073)	(0.0085)		(0.0072)	(0.0086)
ν			1.5458***			1.4979***
			(0.0631)			(0.0607)
Log likelihood	-3441.391	-3405.974	-3385.782	-3346.441	-3310.581	-3284.678
AIC	2.8748	2.8460	2.8300	2.7955	2.7664	2.7457

Notes: Significance levels statistically different from zero are denoted by asterisks (* 10%, ** 5%, ***1%)

Both conventional and Shariah stocks are equally impacted from the financial shocks and negative market news. However, the persistence of volatility seems to be slightly more persistent in Shariah stocks. This may be due to low number of hedging and portfolio diversification opportunities since several companies are filtered out due to Shariah screening—the number of companies and market capitalization in

S&P Emerging BMI Shariah index is one-third of its conventional counterpart. For the emerging markets, our results are in agreement with those of Dewandaru et al. (2015) who argue that Shariah stocks are less exposed to leverage effect due to upper limit of debt financing imposed by Shariah screening resulting in lower volatility but they may have greater volatility due to smaller size and more concentration in specific sectors. Hence the advantage of lower leverage is offset by less portfolio diversification benefits, due to small investment horizon; hence similar risk may be observed.

Also, the Shariah stocks are based on IT and manufacturing sectors. According to Ozkan & Unsal (2012), a global financial shock reduces global demand causing fall in export resulting into further decline of domestic economic activity. Upon that, filtering of stocks in the emerging markets leaves very little opportunity in Shariah stocks for risk-averse investors. Moreover, the increased volatility may also be due to the fact that investors in emerging markets depend much on the news and information flow from the developed markets (Ozkan & Unsal, 2012).

Table 4.6: Difference of volatility between S&P Emerging BMI and S&P Emerging BMI Shariah

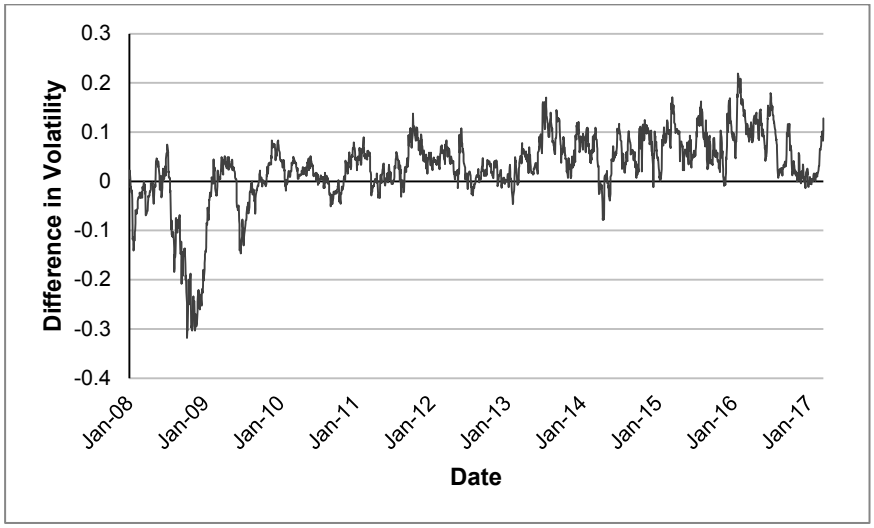
	Conditional SD (vs |returns|)					
Variable	**Min.**	**1st Quantile**	**Median**	**Mean**	**3rd Quantile**	**Max.**
Emerging BMI	0.4093	0.7682	0.9385	1.0994	1.2814	5.1819
Emerging BMI Shariah	0.3704	0.7229	0.8871	1.0719	1.2530	5.4801
Difference	-0.3184	0.0018	0.0325	0.0276	0.0698	0.2191

Notes: The table shows the descriptive statistics of volatility of conventional and Shariah indices. The *Difference* has been calculated by subtracting volatility of the Shariah index from that of conventional index; hence positive values depict a more-volatile conventional index, and negative values show vice versa.

Table 4.6 and Figure 4.5 show the difference in volatilities of S&P Emerging BMI indices. It is observed that the Shariah stocks in emerging markets are under pressure and more volatile during the peak of the crisis. The recovery after GFC improved the condition in the emerging markets whereas Eurozone crisis does not seem to have a significant impact on Shariah index. Throughout the tranquil periods, the Shariah index performs better in terms of volatility than the conventional counterpart. It is noteworthy that the Islamic countries are present in the emerging

markets where the Islamic finance is assumed to be more mature as compared to that in developed countries.

Figure 4.5: Difference of volatility between S&P Emerging BMI and S&P Emerging BMI Shariah



Notes: The figure shows the positive difference where conventional index is more volatile, and shows negative difference where Shariah index is more volatile.

Table 4.7 presents the GARCH results for S&P Developed BMI and S&P Developed BMI Shariah. All the coefficients are significant with Shariah indices being more impacted by the negative markets news and financial shocks.

Table 4.7: GARCH results for S&P Developed BMI and S&P Developed BMI Shariah

S&P Developed BMI	Conventional			Shariah		
	GARCH	EGARCH (Norm.)	EGARCH (GED)	GARCH	EGARCH (Norm.)	EGARCH (GED)
ω	0.0138***	-0.0007	-0.0093***	0.0158***	-0.0029	-0.0119***
	(0.0033)	(0.0025)	(0.0030)	(0.0035)	(0.0030)	(0.0033)
α_1	0.1062***	0.1271***	0.1293***	0.1154***	0.1371***	0.1356***
	(0.0132)	(0.0167)	(0.0194)	(0.0138)	(0.0171)	(0.0196)
β_1	0.8828***	0.9849***	0.9862***	0.8711***	0.9803***	0.9820***
	(0.0134)	(0.0012)	(0.0012)	(0.0137)	(0.0012)	(0.0012)
γ_1		-0.1049***	-0.1127***		-0.1246***	-0.1335***
		(0.0100)	(0.0125)		(0.0110)	(0.0138)
ν			1.3566***			1.3560***
			(0.0527)			0.054366
Log likelihood	-3091.206	-3042.408	-2990.605	-3029.792	-2973.209	-2925.404
AIC	2.5826	2.5427	2.5003	2.5313	2.4849	2.4459

Notes: Significance levels statistically different from zero are denoted by asterisks (* 10%, ** 5%, ***1%)

The results are slightly opposite to our results for S&P 500, although the U.S. market is the major constituent for Developed BMI indices. The developed markets are seen to be hit more than the emerging markets in terms of impacts of financial shocks. This may be due to high correlation of S&P Developed BMI indices with the U.S. market while the emerging markets are loosely correlated with U.S. Moreover, the Developed BMI indices also contain the European markets which are closely linked to the U.S. in terms of trade linkage.

Although emerging markets are linked to the developed markets through trade links but they are less vulnerable to common information sharing. Therefore, the emerging markets seem to be more resilient than the developed markets in terms of volatility. For persistence of volatility, the developed markets show slightly better performance because the emerging Shariah markets have less diversification opportunities due to Shariah screening; many large-cap companies which are not eligible are filtered out thereby increasing the volatility of emerging markets (Saiti et al., 2014).

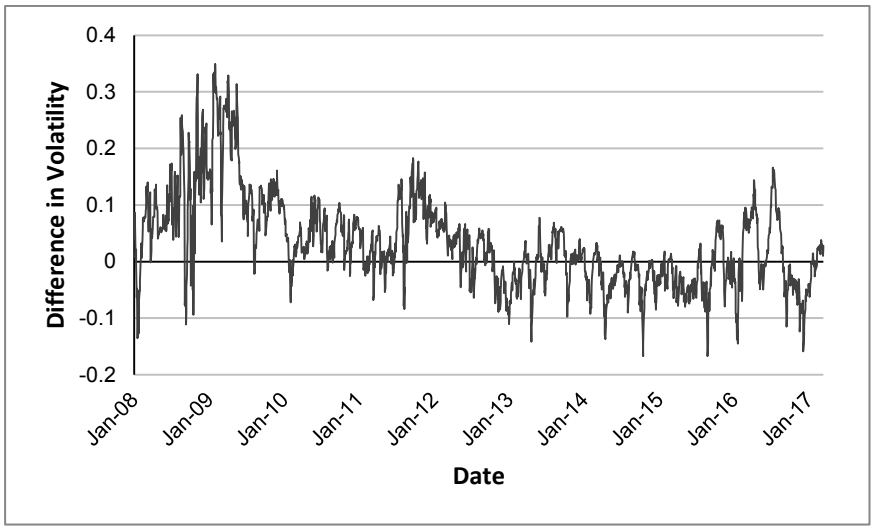
Table 4.8 and Figure 4.6 show results similar to those of S&P Global BMI i.e. conventional index is more volatile during crises and less during tranquil period. Table 4.8 shows positive value of median for difference of volatility, depicting a more volatile conventional index throughout the study period as compared to its Shariah counterpart; a fact which is further fortified by the positive mean value. More than half of the observations show conventional index to be more volatile.

Table 4.8: Difference of volatility between S&P Developed BMI and S&P Developed BMI Shariah

	Conditional SD (vs |returns|)					
Variable	**Min.**	**1st Quantile**	**Median**	**Mean**	**3rd Quantile**	**Max.**
Developed BMI	0.3092	0.6205	0.7970	0.9670	1.1223	4.5201
Developed BMI Shariah	0.2871	0.6080	0.7908	0.9330	1.0580	4.4835
Difference	-0.1673	-0.0228	0.0206	0.0340	0.0756	0.3492

Notes: The table shows the descriptive statistics of volatility of conventional and Shariah indices. The *Difference* has been calculated by subtracting volatility of the Shariah index from that of conventional index; hence positive values depict a more-volatile conventional index, and negative values show vice versa.

Figure 4.6: Difference of volatility between S&P Developed BMI and S&P Developed BMI Shariah



Notes: The figure shows the positive difference where conventional index is more volatile, and shows negative difference where Shariah index is more volatile.

From the above results, we can reject our third hypothesis concluding that Shariah indices in emerging markets were more volatile during GFC as compared to developed markets.

Table 4.9 and Table 4.10 show the performance of Global BMI indices during and after crisis respectively. Impact of shocks on the conventional index is slightly high during the crisis which is also proved from the volatility graph in Figure 4.3.

Table 4.9: GARCH results for S&P Global BMI and S&P Global BMI Shariah during crisis

S&P Global BMI	Conventional			Shariah		
	GARCH	EGARCH (Normal)	EGARCH (GED)	GARCH	EGARCH (Normal)	EGARCH (GED)
ω	0.0212	0.0104	0.0072	0.0212	0.0101	0.0065
	(0.0171)	(0.0080)	(0.0083)	(0.0151)	(0.0077)	(0.0081)
α_1	0.1118***	0.1826***	0.1763***	0.1133***	0.1777***	0.1723***
	(0.0254)	(0.0396)	(0.0425)	(0.0249)	(0.0394)	(0.0425)
β_1	0.8863***	0.9881***	0.9874***	0.8827***	0.9865***	0.9862***
	(0.0221)	(0.0043)	(0.0044)	(0.0220)	(0.0043)	(0.0044)
γ_1		-0.0814***	-0.0829***		-0.0867***	-0.0867***
		(0.0228)	(0.0246)		(0.0224)	(0.0241)
ν			1.6909***			1.6920***
			(0.1686)			(0.1696)
Log likelihood	-785.6186	-778.7978	-777.3973	-751.8737	-744.9377	-743.5471
AIC	3.6984	3.6712	3.6693	3.5404	3.5126	3.5108

Notes: Significance levels statistically different from zero are denoted by asterisks (* 10%, ** 5%, ***1%)

After GFC, the Shariah index is observed to be more impacted by financial shocks and negative news; however, persistence of volatility is almost similar for both indices during all market conditions.

Table 4.10: GARCH results for S&P Global BMI and S&P Global BMI Shariah after crisis

S&P Global BMI	Conventional			Shariah		
	GARCH	EGARCH (Normal)	EGARCH (GED)	GARCH	EGARCH (Normal)	EGARCH (GED)
ω	0.0159***	-0.0085**	-0.0190***	0.0179***	-0.0152***	-0.0268***
	(0.0042)	(0.0040)	(0.0056)	(0.0044)	(0.0053)	(0.0069)
α_1	0.1030***	0.1243***	0.1288***	0.1138***	0.1461***	0.1425***
	(0.0153)	(0.0220)	(0.0264)	(0.0163)	(0.0229)	(0.0257)
β_1	0.8774***	0.9764***	0.9760***	0.8636***	0.9658***	0.9662***
	(0.0174)	(0.0057)	0.007469	(0.0177)	(0.0072)	(0.0087)
γ_1		-0.1159***	-0.1275***		-0.1467***	-0.1623***
		(0.0139)	(0.0180)		(0.0166)	(0.0210)
ν			1.3351***			1.3141***
			(0.0559)			(0.0572)
Log likelihood	-2271.831	-2226.525	-2178.318	-2237.289	-2183.836	-2136.249
AIC	2.3105	2.2655	2.2176	2.2754	2.2222	2.1749

Notes: Significance levels statistically different from zero are denoted by asterisks (* 10%, ** 5%, ***1%)

One reason for Shariah indices to be more impacted by financial shocks can be their dependence on the conventional indices for market news and information. The investors generally follow the market news of the common markets due to low cost of information processing of similar markets (Taşdemir & Yalama, 2014). It concurs with the results of Dewandaru et al. (2015) who argue that systematic risk is slightly increased due to less diversification of Shariah portfolio. Moreover, since these indices also contain emerging markets, we can see their effect reflected in these results. The increased effects of financial shocks on the Shariah indices after crisis imply that Islamic market may be depending on conventional markets during the calm periods but may be slightly resilient to news during the crisis.

Table 4.11 and Table 4.12 show the statistics of GARCH models for S&P 500 and S&P 500 Shariah Indices during and after crisis respectively. All coefficients are significant. We observe that the impact of shocks is more on the conventional index during the crisis but negative-news effect is more on the Shariah index. This may be because Shariah index being the sub-index of the conventional counterpart has fewer constituents and limited investment opportunities (Bauer et al, 2006). The low

persistence of volatility may be due to less information sharing across the market and hence less negative sentiments as compared to the conventional stocks (Saiti et al., 2014).

Table 4.11: GARCH results for S&P 500 and S&P 500 Shariah during crisis

S&P500	Conventional			Shariah		
	GARCH	EGARCH (Normal)	EGARCH (GED)	GARCH	EGARCH (Normal)	EGARCH (GED)
ω	0.0566*	0.0284***	0.0152*	0.0492*	0.0232***	0.0133
	(0.0351)	(0.0091)	(0.0091)	(0.0294)	(0.0054)	(0.0106)
α_1	0.1031***	0.1317***	0.1273**	0.1164***	0.1207***	0.1163**
	(0.0239)	(0.0361)	(0.0497)	(0.0260)	(0.0404)	(0.0515)
β_1	0.8862***	0.9793***	0.9827***	0.8716***	0.9773***	0.9796***
	(0.0235)	(0.0034)	(0.0039)	(0.0248)	(0.0046)	(0.0047)
γ_1		-0.1439***	-0.1406***		-0.1627***	-0.1625***
		(0.0288)	(0.0327)		(0.0156)	(0.0386)
ν			1.5142***			1.6257***
			(0.1684)			(0.1850)
Log likelihood	-860.5934	-853.1473	-850.2953	-802.4503	-793.3554	-791.7948
AIC	4.1971	4.1658	4.1568	3.9148	3.8755	3.8728

Notes: Significance levels statistically different from zero are denoted by asterisks (* 10%, ** 5%, ***1%)

After the crisis, we observe that the conventional index performs slightly better both in terms of persistence of volatility since it recovers from the crisis and has greater number of sector allocations, higher market reachability and hedging opportunities than Shariah index.

Table 4.12: GARCH results for S&P 500 and S&P 500 Shariah after crisis

S&P500	Conventional			Shariah		
	GARCH	EGARCH (Normal)	EGARCH (GED)	GARCH	EGARCH (Normal)	EGARCH (GED)
ω	0.0421***	-0.0146***	-0.0270***	0.0391***	-0.0172***	-0.0284***
	(0.0075)	(0.0056)	(0.0068)	(0.0073)	(0.0056)	(0.0082)
α_1	0.1466***	0.1368***	0.1406***	0.1493***	0.1455***	0.1455***
	(0.0191)	(0.0207)	(0.0258)	(0.0199)	(0.0219)	(0.0264)
β_1	0.8076***	0.9411***	0.9435***	0.8080***	0.9432***	0.9437***
	(0.0214)	(0.00798)	(0.0098)	(0.0216)	(0.0078)	(0.0110)
γ_1		-0.2296***	-0.2497***		-0.2351***	-0.2568***
		(0.0206)	(0.0260)		(0.0203)	(0.0262)
ν			1.3421***			1.3730***
		.	(0.0605)			(0.0640)
Log likelihood	-2390.763	-2328.25	-2288.516	-2359.731	-2285.599	-2253.07
AIC	2.5208	2.4561	2.4153	2.4881	2.4112	2.3780

Notes: Significance levels statistically different from zero are denoted by asterisks (* 10%, ** 5%, ***1%)

Table 4.13 and Table 4.14 depict the S&P Emerging BMI indices during and after the crisis respectively. During the crisis the Shariah index has slightly less impact of shocks however the persistence of volatility is almost the same. The impact of negative news is almost the same which is probably both have loose correlation with the U.S. market, from where the GFC originated.

Table 4.13: GARCH results for S&P Emerging BMI and S&P Emerging BMI Shariah during crisis

S&P Emerging BMI	Conventional			Shariah		
	GARCH	EGARCH (Norm.)	EGARCH (GED)	GARCH	EGARCH (Norm.)	EGARCH (GED)
ω	0.0406	0.0220***	0.0190**	0.0440	0.0257***	0.0209***
	(0.0317)	(0.0069)	(0.0074)	(0.0332)	(0.0070)	(0.0073)
α_1	0.1162***	0.1859***	0.1799***	0.1184***	0.1801***	0.1720***
	(0.0299)	(0.0217)	(0.0146)	(0.0310)	(0.0122)	(0.0104)
β_1	0.8796***	0.9824***	0.9817***	0.8775***	0.9805***	0.9802***
	(0.0262)	(0.0008)	(0.0006)	(0.0270)	(0.0006)	(0.0008)
γ_1		-0.0740***	-0.0760***		-0.0717***	-0.0750***
		(0.0214)	(0.0233)		(0.0211)	(0.0236)
ν			1.6609***			1.5664***
			(0.1596)			(0.1524)
Log likelihood	-859.4205	-854.1671	-852.2844	-871.3211	-866.8781	-863.6902
AIC	4.0441	4.0242	4.0201	4.0999	4.0837	4.0735

Notes: Significance levels statistically different from zero are denoted by asterisks (* 10%, ** 5%, ***1%)

Table 4.14: GARCH results for S&P Emerging BMI and S&P Emerging BMI Shariah after crisis

S&P Emerging BMI	Conventional			Shariah		
	GARCH	EGARCH (Norm.)	EGARCH (GED)	GARCH	EGARCH (Norm.)	EGARCH (GED)
ω	0.0173***	-0.0024	-0.0062**	0.0119***	-0.0038***	-0.0082***
	(0.0056)	(0.0018)	(0.0026)	(0.0041)	(0.0024)	(0.0025)
α_1	0.0830***	0.0975***	0.0983***	0.0773***	0.1005***	0.1030***
	(0.0125)	(0.0101)	(0.0004)	(0.0114)	(0.0152)	(0.0176)
β_1	0.8995***	0.9817***	0.9827***	0.9099***	0.9830***	0.9839***
	(0.0154)	(0.0003)	(0.0002)	(0.0134)	(0.0015)	(0.0015)
γ_1		-0.0757***	-0.0752***		-0.0788***	-0.0774***
		(0.0074)	(0.0091)		(0.0087)	(0.0102)
ν			1.5512***			1.5145
			(0.0714)			(0.0688)
Log likelihood	-2576.486	-2542.869	-2527.459	-2468.916	-2434.317	-2415.431
AIC	2.6198	2.5867	2.5720	2.5106	2.4765	2.4583

Notes: Significance levels statistically different from zero are denoted by asterisks (* 10%, ** 5%, ***1%)

In Table 4.6 and Figure 4.5 we observed that Shariah index underperformed during the crisis; one reason can be the exclusion of large number of companies during Shariah screening leaving few diversification opportunities making Islamic

finance limited in terms of diversity, market size and liquidity (Saiti et al., 2014). After the crisis, both indices show similar behavior in terms of shocks and persistence of volatility. This is also backed by our results in Figure 4.5 where there is no large difference between volatilities of conventional and Shariah indices.

Table 4.15 and Table 4.16 show the results for the S&P Developed BMI indices during and after the crisis respectively. During the crisis, the conventional index is affected by the financial shocks more as compared to the Shariah index whereas the negative news has a slightly greater effect on Shariah index. Both indices show similar behavior in terms of persistence of volatility. The Developed BMI indices show similar behavior to the Global BMI indices and slightly more sensitivity than the Emerging BMI. This may be due to majority of the constituents of this index being from the U.S. market.

Table 4.15: GARCH results for S&P Developed BMI and S&P Developed BMI Shariah during crisis

S&P Developed BMI	Conventional			Shariah		
	GARCH	EGARCH (Norm.)	EGARCH (GED)	GARCH	EGARCH (Norm.)	EGARCH (GED)
ω	0.0225	0.0114	0.0075	0.0215	0.0096	0.0055
	(0.0175)	(0.0080)	(0.0086)	(0.0152)	(0.0076)	(0.0080)
α_1	0.1103***	0.1773***	0.1710***	0.1150***	0.1727***	0.1676***
	(0.0250)	(0.0390)	(0.0423)	(0.0250)	(0.0390)	(0.0424)
β_1	0.8870***	0.9877***	0.9871***	0.8808***	0.9866***	0.9864***
	(0.0221)	(0.0043)	(0.0046)	(0.0221)	(0.0042)	(0.0044)
γ_1		-0.0852***	-0.0866***		-0.0920***	-0.0910***
		(0.0232)	(0.0254)		(0.0235)	(0.0253)
ν			1.6507***			1.6801***
			(0.1667)			(0.1729)
Log likelihood	-788.1621	-781.3737	-779.5919	-749.252	-741.7491	-740.3314
AIC	3.7104	3.6832	3.6796	3.5281	3.4977	3.4957

Notes: Significance levels statistically different from zero are denoted by asterisks (* 10%, ** 5%, ***1%)

After the GFC, the Developed BMI indices are affected from the Eurozone crisis whereas Emerging markets exhibit resilience. In developed markets, the Shariah indices show slightly more sensitivity to financial shocks and negative news. This can be due to the fact that Shariah indices are subset of conventional counterpart and heightened financial stress in conventional markets affects those (Hammoudeh et al., 2014). The increase in volatility may also be due to less liquidity and diversification since many hedging and speculation activities are not allowed, thereby

limiting choices for the investors. This is in line with the results of Saiti et al. (2014) who argue that restricted investment horizon increases the volatility.

Table 4.16: GARCH results for S&P Developed BMI and S&P Developed BMI Shariah after crisis

S&P Developed BMI Shariah	Conventional			Shariah		
	GARCH	**EGARCH (Norm.)**	**EGARCH (GED)**	**GARCH**	**EGARCH (Norm.)**	**EGARCH (GED)**
ω	0.0183***	-0.0100**	-0.0214***	0.0203***	-0.0153***	-0.0274***
	(0.0045)	(0.0046)	(0.0062)	(0.0047)	(0.0054)	(0.0067)
α_1	0.1089***	0.1390***	0.1414***	0.1187***	0.1500***	0.1439***
	(0.0158)	(0.0244)	(0.0274)	(0.0168)	(0.0227)	(0.0254)
β_1	0.8689***	0.9716***	0.9712***	0.8566***	0.9628***	0.9630***
	(0.0178)	(0.0070)	(0.0084)	(0.0182)	(0.0073)	(0.0088)
γ_1		-0.1281***	-0.1416***		-0.1579***	-0.1763***
		(0.0160)	(0.0201)		(0.0174)	(0.0220)
ν			1.3177***			1.3116***
			(0.0557)			(0.0572)
Log likelihood	-2298.574	-2254.765			-2222.328	
AIC	2.3376	2.2942	2.2434	2.3148	2.2612	2.2138

Notes: Significance levels statistically different from zero are denoted by asterisks (* 10%, ** 5%, ***1%)

Our above results of the GARCH models reveal that Shariah indices can provide short-term diversification opportunities during crisis in the developed markets but not in emerging markets. The post crisis results show that Shariah indices can provide diversification opportunities in emerging markets but while showing mixed results in U.S. and other developed markets. Alternatively, it can also be concluded the investors abiding by the Shariah rules in their investments will not face relatively high excess volatility due to the apparent limited diversification opportunities. Our results can also be explained by the fact Shariah indices exhibit less risk due to investment in consumer goods, consumer services, IT and Telecommunication (Rahim & Masih, 2015). The Developed markets are observed to be more sensitive to financial shocks and negative news because of the efficient flow of information. Emerging markets in crisis times may seem extra volatile due to relatively less experienced Shariah investors' overreactions. The emerging markets are less sensitive but still impacted from the developed markets due to trade links and integration of markets (Ozkan & Unsal, 2012).

5 Correlation of Conventional and Shariah indices—financial contagion

In order to find the effects of financial contagion and volatility spillovers we calculate the correlation of every conventional index separately, with all four Shariah indices. We expect Shariah indices to be less correlated as transmission of demand and technology shocks across financial markets is lessened when indices are following Shariah guidelines (Majdoub & Mansour, 2014). They argue that ban on interest-bearing securities and encouragement of asset-backed securities in Islamic finance has considerable impacts on volatility spillovers and shock transmission besides link between real and financial sectors. Moreover, according to Rizvi et al. (2015), subprime and global crisis was caused due to substantial linkages and information transmission between markets, resulting into a contagion. Moreover, Johnson & Soenen (2002) claim that increasing stock market integration may be caused to the presence of more favorable economic and political conditions towards business in developed markets; however, Saiti et al. (2014) claims that the correlations are expected to increase over time due to increased business cycles. Furthermore, due to market globalization, various governments have permitted foreigners to buy stocks in their country's stock markets promoting stock market liberalization (Henry, 2000); this liberization also results into correlation. According to King & Wadhwani (1990), financial contagion may be present if correlation between indices increases after initiation of the crisis.

5.1 Results

As a preliminary analysis, we perform Pearson Correlation of every conventional index with all the Shariah indices whose results are shown in Table 5.1. As expected, the highest correlation is found between a conventional index and its corresponding Shariah index; Shariah index being the sub-index of the conventional

counterpart. A continuous high correlation or its return to a higher value if decreased implies possibility of financial contagion between conventional index and the Shariah index.

In Table 5.1 the U.S. market is the major constituent in three of the four indices under study: Global BMI, S&P 500 and Developed BMI. Therefore, we find them closely correlated pointing towards less diversification opportunities during crisis in terms of volatility. Emerging BMI Shariah is loosely correlated with the developed markets due to difference in the market structure and economic grouping. Nevertheless, emerging markets are also affected by the contagion due to the trade links, global shocks, consumer demand, financial spillover and information transmission that may be explained through correlation between the markets (Saiti et al., 2014). From our Pearson Correlation analysis we may deduce that investor from the developed markets can reduce risk by investing in emerging markets.

Table 5.1: Pearson Correlation between indices

	SBBMGLU	SPX	SBBMWDU	SCRTEM	SPSHGLUP	SHX	SPSHWDDP	SPSHEKUP
SBBMGLU	1							
SPX	0.8586	1						
SBBMWDU	0.9974	0.8784	1					
SCRTEM	0.8258	0.5328	0.7838	1				
SPSHGLUP	0.9867	0.8665	0.9856	0.8027	1			
SHX	0.8054	0.9331	0.8243	0.4973	0.8358	1		
SPSHWDDP	0.9807	0.8862	0.9849	0.7559	0.9969	0.8563	1	
SPSHEKUP	0.8095	0.5170	0.7675	0.9875	0.7935	0.4857	0.7442	1

Notes: The table shows Pearson correlation of every conventional index with all Shariah indices.

Although Pearson Correlation gives an outline about link between the markets, it cannot interpret how volatilities and correlations between asset returns vary over time in terms of magnitude and direction, during crisis and post-crisis periods. It does not consider endogenity and disregards the effects of the past events on the current price. According to Rahim & Masih (2015), the nature of investors is diverse and varies with the type of investments; therefore, investments varying in horizon may produce different results and characteristics. The results are different for speculators and long-term investors, for intraday trading and long-term investments, and so on.

We employ the DCC-GARCH model to investigate the dynamic correlation of every conventional index with all the Shariah indices. The correlations are graphically presented from Figure 5.1 to Figure 5.4. The Global BMI, S&P 500 and Developed BMI exhibit high correlation, especially during the crisis times.

Table 5.2 and Figure 5.1 present the correlation between Global BMI and all four Shariah indices. Table shows that all DCC coefficients are significant. We observe that the Global BMI is closely correlated with the Global BMI Shariah, S&P 500 Shariah and Developed BMI. This is because of the large share of the U.S. market in the indices. According to the figure, the correlation of Global BMI with Global BMI Shariah and Developed BMI Shariah remains close to unity during most of the study period. It drops after the second quarter of 2008, near the announcement by Lehman Brothers' about their quarterly loss showing signs of financial turmoil (Johnson & Mamun, 2011). The correlation increases again after the onset of global crisis displaying signs of financial contagion.

Table 5.2: DCC between S&P Global BMI & Shariah indices

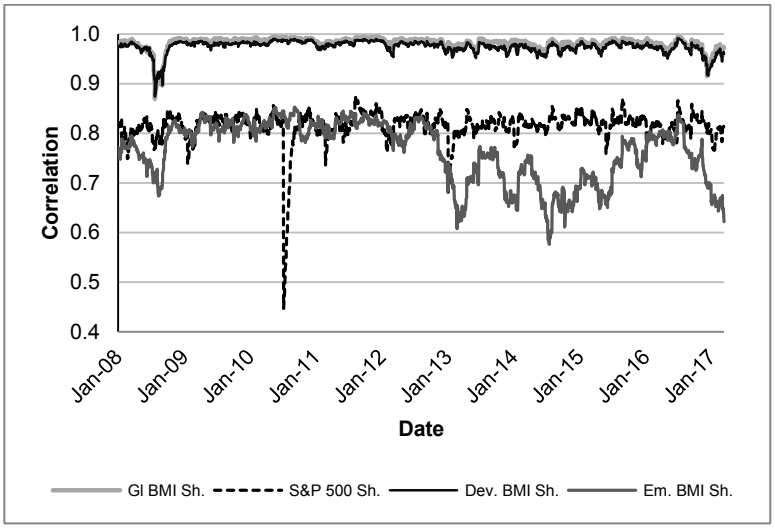
S&P Global BMI	DCC Results	Coeff	Std. Err.	t value	Signif.
S&P Global BMI Shariah	DCC(1)	0.0546	0.0056	9.7531	0.0000
	DCC(2)	0.9272	0.0080	115.4224	0.0000
S&P500 Shariah	DCC(1)	0.0181	0.0073	2.4960	0.0126
	DCC(2)	0.9224	0.0294	31.4096	0.0000
S&P Developed BMI Shariah	DCC(1)	0.0426	0.0050	8.4926	0.0000
	DCC(2)	0.9373	0.0074	126.3174	0.0000
S&P Emerging BMI Shariah	DCC(1)	0.0150	0.0045	3.3171	0.0009
	DCC(2)	0.9801	0.0068	143.6579	0.0000

Notes: The table shows the DCC coefficients of DCC-GARCH. All coefficients are jointly significant exhibiting correlation between indices.

The decreased correlation gives signs of small short-term diversification benefits for investment in Shariah stocks which is also backed by our results in Table 4.2 in Section 4 where conventional indices were more volatile during the crisis. It may be that some volatile industries have been filtered out in Shariah screening as claimed by Majdoub & Mansour (2014). After 2008, the increased correlation shows no diversification benefits and exhibits financial contagion in the markets. The correlation is observed to be high during calm periods depicting close linkages and

dependency of Shariah markets on conventional counterparts. Hence in developed markets the investors can have only short-term diversification benefits in terms of volatility during crisis by investing in Shariah stocks.

Figure 5.1: DCC between S&P Global BMI & Shariah indices



Notes: The figure shows correlation between S&P Global BMI and: S&P Global BMI Shariah (solid light gray), S&P 500 Shariah (dashed black), S&P Developed BMI Shariah (solid dark gray), S&P Emerging BMI Shariah (solid medium gray).

The correlation between Global BMI and S&P 500 Shariah is comparatively less and constant through entire study period. The almost-constant correlation shows no significant signs of diversification. From the statistics in Table 4.2 and Table 4.4 in Section 4 we observe that S&P 500 Shariah was more volatile than S&P Global BMI, hence U.S.-based investors can benefit by investing in conventional or Shariah stocks outside the U.S. markets. The correlation between Global BMI and Emerging BMI Shariah is remarkably less throughout the period. This correlation remains at low levels during the crisis and decreases even further after the Eurozone crisis. Although contagion effects are evident in emerging markets also as the U.S. and European markets tumbled; however, due to an overall less correlation, they offer diversification benefits after the GFC since they were less affected from the Eurozone crisis. Nevertheless, the Shariah investors can benefit by investing in the developed markets during the GFC and can invest in emerging markets during the ESDC and afterwards.

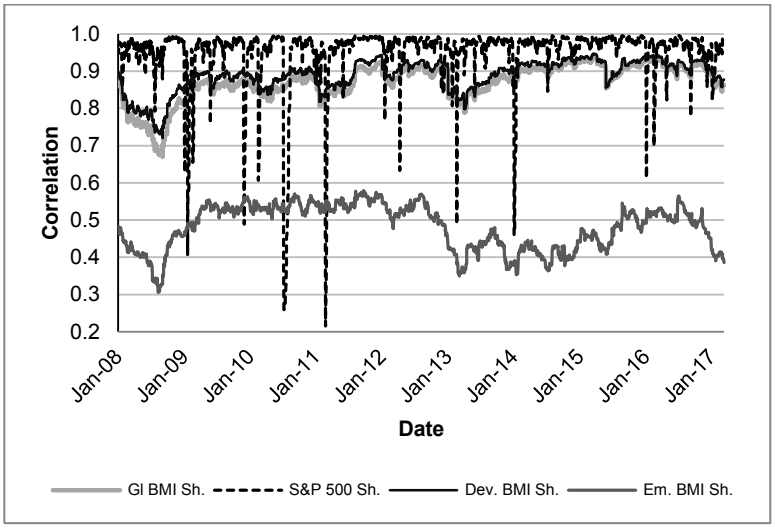
Table 5.3 and Figure 5.2 show the correlations of S&P 500 with the Shariah indices; all coefficients are significant. Since the GFC originated from the U.S. market, we can expect the S&P 500 index to be more volatile.

Table 5.3: DCC between S&P500 & Shariah indices

S&P500	DCC Results	Coeff	Std. Err.	t value	Signif.
S&P Global BMI Shariah	DCC(1)	0.0142	0.0036	3.9040	0.0001
	DCC(2)	0.9855	0.0046	214.2488	0.0000
S&P500 Shariah	DCC(1)	0.1687	0.0221	7.6476	0.0000
	DCC(2)	0.8107	0.0265	30.5772	0.0000
S&P Developed BMI Shariah	DCC(1)	0.0160	0.0043	3.7410	0.0002
	DCC(2)	0.9832	0.0058	170.1834	0.0000
S&P Emerging BMI Shariah	DCC(1)	0.0071	0.0025	2.8427	0.0045
	DCC(2)	0.9883	0.0042	235.9546	0.0000

Notes: The table shows the DCC coefficients of DCC-GARCH. All coefficients are jointly significant exhibiting correlation between indices.

Figure 5.2: DCC between S&P 500 & Shariah indices



Notes: The figure shows correlation between S&P Global BMI and: S&P Global BMI Shariah (solid light gray), S&P 500 Shariah (dashed black), S&P Developed BMI Shariah (solid dark gray), S&P Emerging BMI Shariah (solid medium gray).

It can be noticed from GARCH results in Section 4 that S&P 500 index is the most volatile either during or after the crisis. Its correlation with Shariah indices drops during the GFC for 6 months to 1 year implying diversification benefits for U.S.-based investors during turbulent period. This is evident for the Global BMI Shariah, Developed BMI and Emerging BMI Shariah indices. S&P 500 Shariah indices show high correlation and contagion. The correlation of S&P 500 with S&P

Global BMI Shariah and Developed BMI Shariah decreases slightly during 2008 but increases with the spread of the crisis showing financial contagion between S&P 500 and both Shariah indices. The correlation slightly drops in the beginning of 2011 and increases during 2011 and 2012 exhibiting financial contagion during the Eurozone crisis. The correlation of S&P 500 remains low with Emerging markets especially during the start of the GFC and after the subsiding of Eurozone crisis, whereas from 2009 to 2012 it shows financial contagion. Financial contagion of the emerging markets is due to their dependency and trade links with the U.S. and other developed markets (Ozkan & Unsal, 2012). Also, the increased market cointegration over the past few years has caused higher correlation and contagion (Abbes & Trichilli, 2015). After mitigation of crisis, emerging Shariah stocks provide risk mitigation opportunity due to less correlation. In terms of volatility, Emerging BMI Shariah performs better after June 2012; a U.S.-based investor can have better diversification opportunities by investing in emerging markets such as Islamic countries or those in the Far East (Saiti et al., 2014). Shariah stocks in few Islamic countries, all of which lie in emerging markets in our dataset, provide better diversification opportunities as compared to the some developed markets. According to Saiti et al. (2014), in the case of Islamic countries with higher diversification benefits, it can depend on many factors such as investment inflow, trade ties, or sensitivity to outflow due to sentiment. Also, foreign speculators play an important role if they have high influence in financial markets of Islamic countries; crisis can affect via the channel of credit spread in the emerging countries. Rizvi et al. (2015) argue that Shariah markets in the U.S. are more impacted from outside the region as compared to inside the region.

Table 5.4 and Figure 5.3 show the correlations of Emerging BMI indices with the four Shariah indices. The correlation of Emerging BMI is comparatively less with all the indices of other market categories except its Shariah counterpart. The conventional index of Emerging BMI is highly volatile during the crisis period but is observed less correlated with the S&P 500 Shariah. The correlation of Emerging BMI is increased with the Global BMI Shariah and Developed BMI Shariah during the GFC and Eurozone crisis exhibiting contagion effects. Due to their decreased correlation with Developed BMI Shariah, the investor from the both indices of

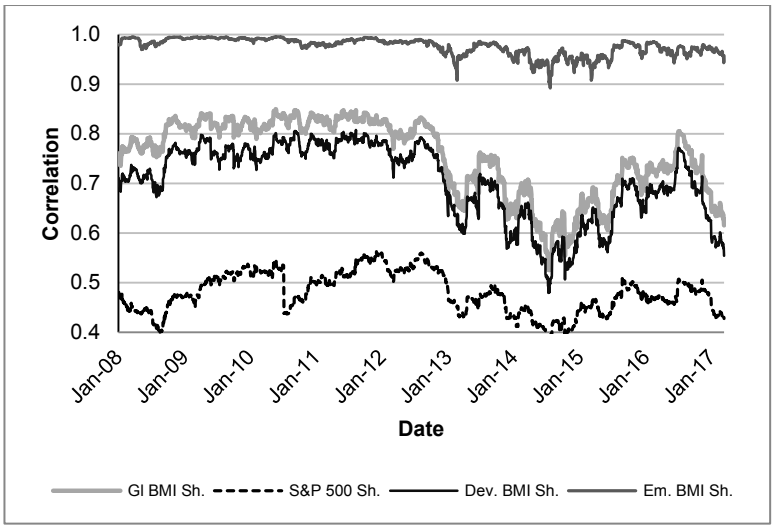
emerging markets may find diversification benefits in developed markets during the crisis. This is in line with the results of Ghazali et al. (2013) who claim that if investors face losses in emerging markets, they can readjust their portfolios by moving their investments to developed markets rather than seeking a safe haven.

Table 5.4: DCC between S&P Emerging BMI & Shariah indices

S&P Emerging BMI	DCC Results	Coeff	Std. Err.	t value	Signif.
S&P Global BMI Shariah	DCC(1)	0.0120	0.0053	2.2618	0.0237
	DCC(2)	0.9848	0.0074	133.1295	0.0000
S&P500 Shariah	DCC(1)	0.0042	0.0023	1.8425	0.0654
	DCC(2)	0.9930	0.0045	221.9223	0.0000
S&P Developed BMI Shariah	DCC(1)	0.0114	0.0055	2.0943	0.0362
	DCC(2)	0.9849	0.0081	121.5374	0.0000
S&P Emerging BMI Shariah	DCC(1)	0.0432	0.0055	7.8100	0.0000
	DCC(2)	0.9525	0.0063	150.8991	0.0000

Notes: The table shows the DCC coefficients of DCC-GARCH. All coefficients are jointly significant exhibiting correlation between indices.

Figure 5.3: DCC between S&P Emerging BMI & Shariah indices



Notes: The figure shows correlation between S&P Global BMI and: S&P Global BMI Shariah (solid light gray), S&P 500 Shariah (dashed black), S&P Developed BMI Shariah (solid dark gray), S&P Emerging BMI Shariah (solid medium gray).

After the Eurozone crisis subsided by the first quarter of 2013 the Emerging BMI Shariah indices can achieve more portfolio diversification in terms of volatility. The Emerging Shariah markets, due to their high correlation with their conventional counterpart do not show much diversification benefit during the crisis period. Taşdemir & Yalama (2014) argue that direct and indirect cross-correlations are

present between emerging markets of different regions. However, it may be assumed that investing in Shariah index is a better alternative during tranquil periods if risk mitigation is desired.

Our results are also backed by the findings of Rizvi et al. (2015) who claim that Emerging Shariah markets, especially in Asia, are more vulnerable to persistent shocks but their lower exposure to financial leverage makes them an ideal hedge to investments that already include such exposures. Rizvi et al. (2015) argue that U.S. crisis affects the Asia Pacific through trade linkage increasing the vulnerability of Shariah indices that have higher allocation in real sector stocks. It is also probable that the Emerging BMI Shariah becomes more volatile after various stocks are filtered out after Shariah screening, which leads to limited investment horizon and increased volatility (Bauer et al., 2006). Shariah screening has excluded many companies, especially large firms, since many large companies in emerging countries are involved in high level of debt financing, mainly because of the fact that the banking system is more developed than the stock market (Dewandaru et al, 2015). In the indices considered in our study, all Islamic countries are listed in emerging markets; hence the Shariah markets in these countries are assumed to be more mature and robust but we have contrary results. The less correlation of emerging markets with the others is beneficial from a perspective that both GFC and its aftershock, the Eurozone crisis, originated from the developed markets (Constancio, 2012), subsequently affecting the emerging markets but to lesser extent due to different economic grouping.

The correlations of S&P Developed BMI and the four Shariah indices are presented in Table 5.5 and Figure 5.4. We notice its high correlation with all indices except the Emerging BMI Shariah. The high correlation is due to the large share of the U.S. market in the indices and the deep financial integration, trade ties and long-run convergence between the developed markets (Rizvi et al., 2015). The correlation drops only for short-term during the second and third quarters of 2008 implying short-term benefits in terms of volatility for the investors.

With the onset of global crisis, we observe signs of contagion in all indices as the correlations rise. The investors from emerging markets may find some short-term

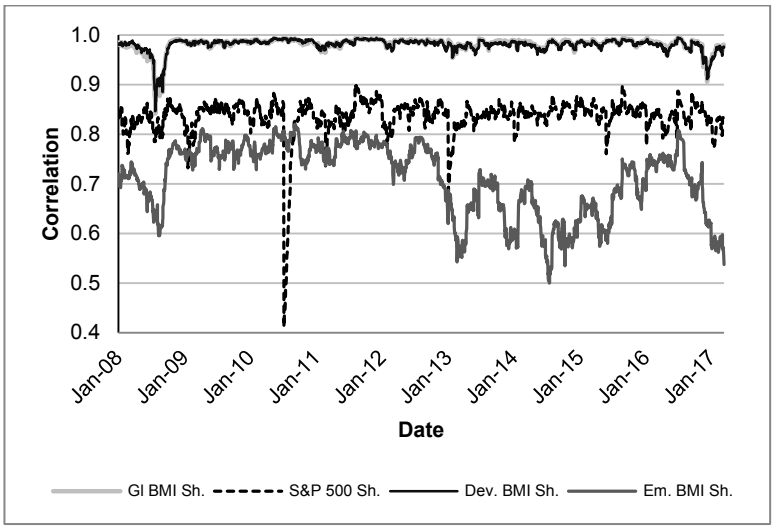
risk mitigation opportunities during crisis due to less correlation based on economic grouping. After the GFC and Eurozone crisis we observe decreased correlation between Emerging BMI Shariah and Developed BMI which may imply diversification for investors in developed markets for of risk aversion. Nevertheless, the Shariah indices provide diversification opportunities in the short-term based on market, region and economic grouping.

Table 5.5: DCC between S&P Developed BMI & Shariah indices

S&P Developed BMI	DCC Results	Coeff	Std. Err.	t value	Signif.
S&P Global BMI Shariah	DCC(1)	0.0600	0.0063	9.5571	0.0000
	DCC(2)	0.9160	0.0094	97.8777	0.0000
S&P500 Shariah	DCC(1)	0.0228	0.0075	3.0364	0.0024
	DCC(2)	0.9225	0.0272	33.9319	0.0000
S&P Developed BMI Shariah	DCC(1)	0.0551	0.0056	9.8484	0.0000
	DCC(2)	0.9233	0.0082	113.1578	0.0000
S&P Emerging BMI Shariah	DCC(1)	0.0155	0.0048	3.2601	0.0011
	DCC(2)	0.9791	0.0074	132.8987	0.0000

Notes: The table shows the DCC coefficients of DCC-GARCH. All coefficients are jointly significant exhibiting correlation between indices.

Figure 5.4: DCC between S&P Developed BMI & Shariah indices



Notes: The figure shows correlation between S&P Global BMI and: S&P Global BMI Shariah (solid light gray), S&P 500 Shariah (dashed black), S&P Developed BMI Shariah (solid dark gray), S&P Emerging BMI Shariah (solid medium gray).

Based on above results, we may reject our hypothesis of Shariah indices not being significantly affected by financial contagion. We notice financial contagion in Shariah indices but it varies with regions and markets. Our results are in line with

those of Saiti et al. (2014) who conclude that diversification opportunities are market dependent. Furthermore, we observe Shariah Asia-Pacific markets showing lesser absorption of internal and external financial shocks (Rizvi et al., 2015).

Above results suggest that Shariah investors can diversify portfolios by investing across different economic groupings i.e. developed and emerging markets. The financial links discovered in our results may be in the form of international investors, common lenders or common markets significantly affecting both countries. While we see that Shariah indices are significantly correlated with the conventional indices, it may be possible that investors tend to follow the trends of similar Conventional markets due to costly processing of information from the international markets as compared to the domestic markets (Taşdemir & Yalama, 2014). Moreover, spillovers during the crisis may also be caused by common bank lender effect (Rijckeghem & Weder, 2003); the banks of specific region offer loans within the same or adjacent regions.

6 Interest Rates and their correlation with Shariah indices

Conventional and Shariah indices exhibiting similar impact of shocks and volatility raise a question whether the Shariah stocks are appropriately following the Shariah guidelines for investment or if they are suffering from spillover effects. After passing through qualitative and quantitative screening by governing bodies they are expected to show significant immunity against interest rate risk, due to prohibition of Riba (interest) in Shariah guidelines; or the Shariah indices shall show different statistical properties than their conventional counterparts.

Mansour et al. (2015) argue that Shariah instruments, like their conventional counterparts, contain various discrepancies in terms of ethical foundation—based in Islamic principles of equity, cooperation, and social justice. According to them, the Islamic banking activity does not fulfill the requirements of exact objectives of Islamic law. They argue that similarity of Islamic financial products to the conventional products is one of the reasons of the failure of Islamic financial practices in following Shariah guidelines. They claim that Islamic financial practices have failed in benefiting a significant number of investors due to less diversity. Islamic banks collect resources from a large spectrum and make them available to a smaller one, which is not Islamic since it impairs the equality and justice values advocated by Shariah (Mansour et al., 2015).

To evaluate the adherence of Shariah indices to the guidelines of Islamic finance, it would be apt to check their correlation with the interest rates; hence measuring their interest rate risk. To compare the relationship of the conventional and Shariah indices with the interest rates, we have chosen the short-term interest rates of different maturities in the U.S. and UK. U.S. has a large open economy which may affect other countries via economic ties (Lee, 2002). Short-term rates if correlated with the stock index can have various effects on stock prices. According to Rigobon & Sack (2004) increase in short-term rates may cause a decline in stock prices, and

vice versa shall be true for decrease in short-term rates. They claim that news about the economy and market condition can have impact on short-term interest rates and asset prices. Rigobon & Sack (2004) claim that news about future economic activity, tend to induce a positive correlation between the two variables. Many types of shocks drive short-term and longer-term interest rates in the same direction, including macroeconomic developments that change investors' expectations for future economic strength or inflation.

6.1 Results

We employ DCC-GARCH to check the correlation since its results are credible taking into account the structural breaks, asymmetry and time-varying properties of time series. We evaluate the correlation of stock indices with short-term rates of different maturities in U.S. and UK. The graphs for correlation of stock indices with Effective Federal Funds Rate (EFFR) are provided in this section; the correlations with other interest rates are provided in Appendix A: Figures, for the sake of consistency and brevity in this section.

Table 6.1 and Figure 6.1 show the correlation of EFFR with S&P Global BMI conventional and Shariah indices. The coefficients are jointly significant for both indices. In the table, we observe similar coefficients for both indices except for the 3-Month Treasury Bill interest rates.

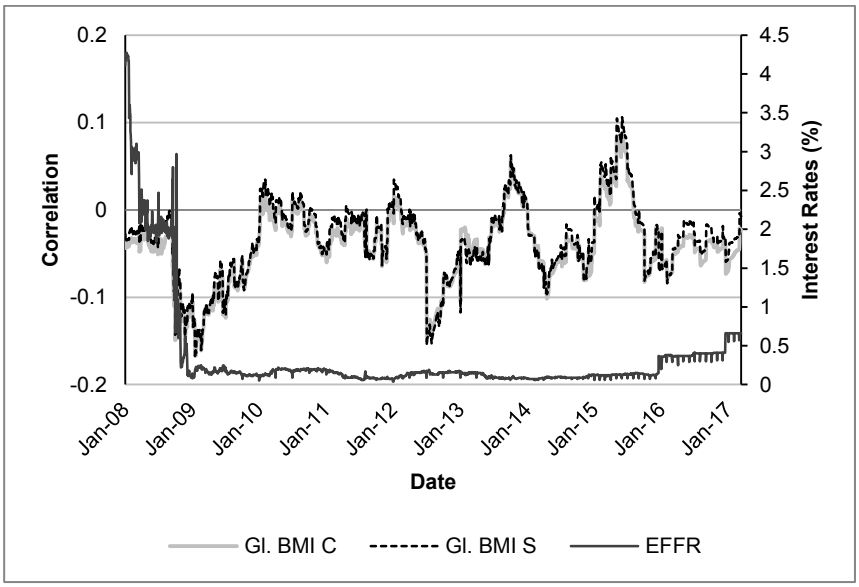
Table 6.1: DCC between S&P Global BMI Indices and Interest Rates

Index	DCC Coeff.	EFFR	DTB3	DTB6	LIB3	LIB12
S&P Global BMI	DCC(1)	0.0060*	0.0120	0.0148*	0.0068	0.0234**
		(0.0032)	(0.0096)	(0.0076)	(0.0049)	(0.0101)
	DCC(2)	0.9809***	0.8785***	0.9580***	0.9585***	0.9039***
		(0.0055)	(0.1045)	(0.0249)	(0.0153)	(0.0501)
S&P Global BMI Shariah	DCC(1)	0.0066*	0.0200	0.0148*	0.0063	0.0213**
		(0.0037)	(0.0148)	(0.0083)	(0.0046)	(0.0104)
	DCC(2)	0.9793*	0.7492***	0.9606***	0.9602***	0.8901***
		(0.0061)	(0.1809)	(0.0285)	(0.0145)	(0.0634)

Notes: Significance levels statistically different from zero are denoted by asterisks (* 10%, ** 5%, ***1%)

It is noteworthy that both indices are affected in a similar manner in terms of magnitude and direction, for all the maturities in both markets. In Figure 6.1 the already-negative correlation between the stock indices and EFFR becomes more negative around Lehman Brothers' Fail. This coincides with the drop in interest rates to near-zero values. The correlation returns back to near-zero as the markets begin to recover during 2009 (Bank for International Settlements, 2009). It remains near zero during the Eurozone crisis showing that both conventional and Shariah indices were affected by the EFFR in global markets. It drops again after the second quarter of 2012 since the Eurozone mitigates with stock markets making recovery. This is in line with the fact that after the financial shocks, the decrease in interest rates help in market recovery as investors find stocks more attractive than debt securities; this further drives the stock prices to increase. Furthermore, the interest rates and stock prices have an inverse correlation because falling interest rates lower the borrowing costs for the companies thereby decreasing the liabilities (Rahim & Masih, 2015). The interest rate is negatively significant to both indices because interest rate is one of the indicators for people decision regarding asset substitution; lower interest rate may encourage people to diversify their stock market investment portfolio.

Figure 6.1: DCC between S&P Global BMI & EFFR



Notes: The figure shows the correlation of Conventional and Shariah indices with vertical axis on the left side whereas Interest rates vertical axis is on the right. The solid dark gray line shows the interest rates.

Table 6.2 shows the summary of dynamic correlation of interest rates with the S&P Global BMI indices. Interest rates belonging to longer maturities are positive correlated; however, the dynamic correlation shows that interest rates are correlated with Shariah indices in a similar way as they are with conventional indices. Similar results for both conventional and Shariah indices concur with the findings of Lee (2002) who argues that over time the stock markets are becoming insensitive to interest rates. There are some periods of slightly positive correlations; however they are negligible as compared to the negative correlations. When stocks produce greater volatility, the correlation between stock prices and interest rates rises due to increasing covariance. Identical correlations between stock prices and interest rates show similar impact of monetary policy on conventional and Shariah stock markets.

Table 6.2: Summary of DCC between S&P Global BMI Indices and Interest Rates

	S&P Global BMI					S&P Global BMI Shariah				
	EFFR	**DTB3**	**DTB6**	**LIB3**	**LIB12**	**EFFR**	**DTB3**	**DTB6**	**LIB3**	**LIB12**
Min.	-0.1676	-0.0730	-0.0863	-0.1434	-0.2948	-0.1672	-0.1235	-0.0949	-0.1378	-0.2755
1st Quantile	-0.0606	0.0361	0.0359	-0.0239	-0.0286	-0.0581	0.0378	0.0311	-0.0248	-0.0256
Median	-0.0396	0.0510	0.0813	-0.0073	0.0066	-0.0336	0.0508	0.0789	-0.0075	0.0008
Mean	-0.0412	0.0511	0.0819	-0.0077	0.0073	-0.0348	0.0519	0.0807	-0.0088	0.0015
3rd Quantile	-0.0181	0.0641	0.1221	0.0044	0.0430	-0.0092	0.0649	0.1270	0.0022	0.0289
Max.	0.0874	0.2280	0.3619	0.0993	0.3192	0.1059	0.2407	0.3305	0.0941	0.2874

Notes: The values represent the summary of dynamic correlation of stock indices with interest rates in U.S. and UK.

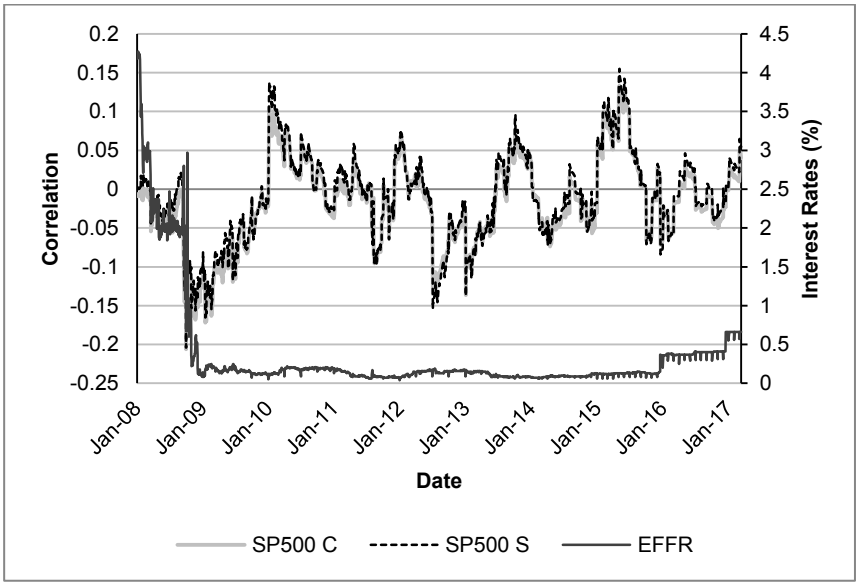
Table 6.3 shows the correlation between S&P 500 indices and interest rates whereas Figure 6.2 shows correlation between indices and EFFR. The results are similar to those of S&P Global BMI but with greater magnitude. The increased magnitude is due to S&P 500, EFFR, DTB3 and DTB6 belonging to the same financial market—the U.S. market. The Shariah indices show higher correlation magnitude than their conventional counterparts at different extreme points. One reason can be investor sentiment since the Shariah stock investors follow the conventional market as Rashid et al. (2014) argue that the investor sentiment plays important role in driving the stock prices. According to Rashid et al. (2014), all Shariah financial assets are being traded beside the conventional financial instruments; hence, we may expect similar reactions from investors.

Table 6.3: DCC between S&P 500 Indices and Interest Rates

Index	DCC Coeff.	EFFR	DTB3	DTB6	LIB3	LIB12
S&P500	DCC(1)	0.0086**	0.0253	0.0126	0.0012	0.0056
		(0.0039)	(0.0154)	(0.0078)	(0.0037)	(0.0080)
	DCC(2)	0.9757***	0.6858***	0.9732***	0.9667***	0.8879***
		(0.0066)	(0.1279)	(0.0202)	(0.0160)	(0.0648)
S&P500 Shariah	DCC(1)	0.0096**	0.0270*	0.0132*	0.0001	0.0048
		(0.0044)	(0.0158)	(0.0077)	(0.0033)	(0.0078)
	DCC(2)	0.9726***	0.6802***	0.9704***	0.9706***	0.8867***
		(0.0077)	(0.1265)	(0.0213)	(0.0154)	(0.0612)

Notes: Significance levels statistically different from zero are denoted by asterisks (* 10%, ** 5%, ***1%)

Figure 6.2: DCC between S&P 500 & EFFR



Notes: The figure shows the correlation of Conventional and Shariah indices with vertical axis on the left side whereas Interest rates vertical axis is on the right. The solid dark gray line shows the interest rates.

The increase in debt of a Shariah-compliant company may also be one reason of increased correlation with the Shariah stocks. It is also possible that the Shariah-compliant companies move towards bond investments and debt-securities. This may increase their debt-to-equity ratio provided it remains less than 33%—keeping them Shariah-compliant and hence included in Shariah index. Another reason can be the use of derivatives by these companies which indirectly links them to the interest rates. Table 6.4 shows the summary of DCC results where the same values of mean

and median show that both conventional and Shariah indices move with interest rates in a similar way.

Table 6.4: Summary of DCC between S&P 500 Indices and Interest Rates

	S&P 500					S&P 500 Shariah				
	EFFR	**DTB3**	**DTB6**	**LIB3**	**LIB12**	**EFFR**	**DTB3**	**DTB6**	**LIB3**	**LIB12**
Min.	-0.2061	-0.1522	-0.1011	-0.0165	-0.0604	-0.2041	-0.1666	-0.1057	0.0024	-0.0565
1st Quantile	-0.0495	0.0585	0.0468	0.0072	0.0023	-0.0444	0.0533	0.0381	0.0053	0.0016
Median	-0.0166	0.0716	0.0887	0.0097	0.0087	-0.0105	0.0675	0.0837	0.0056	0.0069
Mean	-0.0176	0.0728	0.0927	0.0094	0.0085	-0.0105	0.0691	0.0878	0.0056	0.0068
3rd Quantile	0.0179	0.0848	0.1329	0.0119	0.0143	0.0275	0.0824	0.1316	0.0059	0.0119
Max.	0.1334	0.3707	0.3583	0.0293	0.0882	0.1550	0.3591	0.3284	0.0081	0.0758

Notes: The values represent the summary of dynamic correlation of stock indices with interest rates in U.S. and UK.

Table 6.5 shows the correlation coefficient for S&P Emerging BMI indices. All coefficients are jointly significant, especially for the interest rates with longer maturities.

Table 6.5: DCC between S&P Emerging BMI Indices and Interest Rates

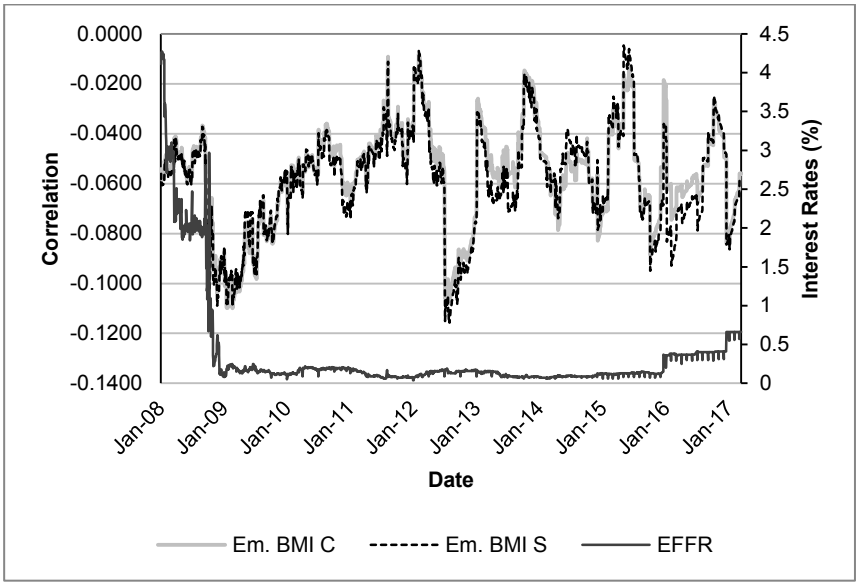
Index	**DCC Coeff.**	**EFFR**	**DTB3**	**DTB6**	**LIB3**	**LIB12**
S&P Emerging BMI	**DCC(1)**	0.0031	0.0102	0.0185**	0.0067	0.0355**
		(0.0028)	(0.0086)	(0.0093)	(0.0050)	(0.0145)
	DCC(2)	0.9855***	0.8851***	0.9227***	0.9720***	0.8886***
		(0.0070)	(0.0660)	(0.0421)	(0.0220)	(0.0599)
S&P Emerging BMI Shariah	**DCC(1)**	0.0034	0.0106	0.0162**	0.0080	0.0368***
		(0.0032)	(0.0094)	(0.0082)	(0.0057)	(0.0133)
	DCC(2)	0.9832***	0.8594***	0.9340***	0.9640***	0.8939***
		(0.0078)	(0.0760)	(0.0360)	(0.0307)	(0.0488)

Notes: Significance levels statistically different from zero are denoted by asterisks (* 10%, ** 5%, ***1%)

Figure 6.3 depicts that the correlation between EFFR and the Emerging market stock indices is different than that for the other markets. Our proxy for the interest rates are from U.S. and UK, and the low values of correlations in Table 6.6 depict that the U.S. and UK interest rates did not significantly affect the emerging economies; opposite to the results of Lee (2002). Nevertheless, the correlation patterns of both conventional and Shariah indices are similar proving identical effect of interest rates on Shariah indices. Moreover, slight spillover effects of interest rates

are present for both indices on cross-region and cross-market level; which may be caused by cross-market intergration. According to Fakhr & Tayebi (2009), changes in the foreign interest rates affect the domestic stock market through the domestic interest rates. According to the theory of interest rate parity, a country's nominal interest rate is the sum of foreign interest rate, exchange rate, and risks premium (Levi, 2009).

Figure 6.3: DCC between S&P Emerging BMI & EFFR



Notes: The figure shows the correlation of Conventional and Shariah indices with vertical axis on the left side whereas Interest rates vertical axis is on the right. The solid dark gray line shows the interest rates.

Table 6.6: Summary of DCC between S&P Emerging BMI Indices and Interest Rates

	S&P Emerging BMI					S&P Emerging BMI Shariah				
	EFFR	**DTB3**	**DTB6**	**LIB3**	**LIB12**	**EFFR**	**DTB3**	**DTB6**	**LIB3**	**LIB12**
Min.	-0.1099	-0.0869	-0.1338	-0.1422	-0.3530	-0.1157	-0.0897	-0.1205	-0.1541	-0.3609
1st Quantile	-0.0682	0.0037	0.0218	-0.0494	-0.0620	-0.0716	0.0041	0.0187	-0.0523	-0.0709
Median	-0.0544	0.0168	0.0506	-0.0284	-0.0104	-0.0567	0.0158	0.0495	-0.0298	-0.0132
Mean	-0.0572	0.0165	0.0546	-0.0273	-0.0046	-0.0594	0.0159	0.0522	-0.0299	-0.0080
3rd Quantile	-0.0452	0.0282	0.0866	-0.0085	0.0478	-0.0462	0.0263	0.0830	-0.0127	0.0512
Max.	-0.0082	0.1744	0.3621	0.1298	0.4374	-0.0046	0.1531	0.3251	0.1475	0.4630

Notes: The values represent the summary of dynamic correlation of stock indices with interest rates in U.S. and UK.

Table 6.7 shows the correlation coefficients for S&P Developed BMI and its Shariah index. All coefficients are jointly significant. Figure 6.4 depicts the

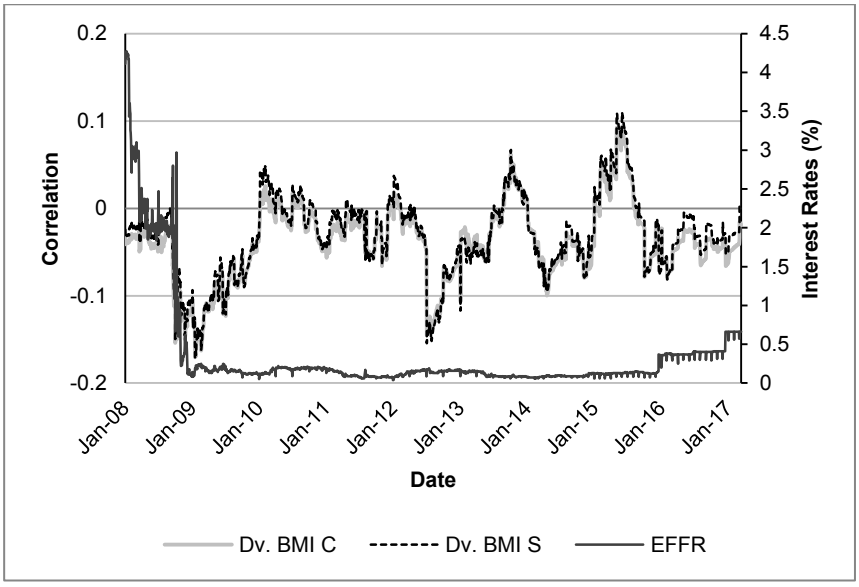
correlation between Developed markets and EFFR. The pattern is similar to that of S&P Global BMI indices since the U.S. and Europe markets are the major constituents in these indices. Both conventional and Shariah indices exhibit similar correlations. We find similar correlation but also it depicts that interest rates in one market affect the stocks of the integrated markets as well. This stock market integration can be influenced by domestic and foreign monetary policy; however, foreign interest rates can affect the domestic stock prices through the channel of domestic interest rates (Adam et al., 2017).

Table 6.7: DCC between S&P Developed BMI Indices and Interest Rates

Index	DCC Coeff.	EFFR	DTB3	DTB6	LIB3	LIB12
S&P Developed BMI	DCC(1)	0.0061*	0.0124	0.0142*	0.0068	0.0211**
		(0.0034)	(0.0106)	(0.0078)	(0.0050)	(0.0095)
	DCC(2)	0.9804***	0.8699***	0.9612***	0.9569***	0.9035***
		(0.0054)	(0.1328)	(0.0259)	(0.0154)	(0.0499)
S&P Developed BMI Shariah	DCC(1)	0.0068*	0.0202	0.0138	0.0060	0.0186*
		(0.0040)	(0.0152)	(0.0088)	(0.0045)	(0.0096)
	DCC(2)	0.9788***	0.7401***	0.9651***	0.9592***	0.8890***
		(0.0061)	(0.1879)	(0.0301)	(0.0140)	(0.0646)

Notes: Significance levels statistically different from zero are denoted by asterisks (* 10%, ** 5%, ***1%)

Figure 6.4: DCC between S&P Developed BMI & EFFR



Notes: The figure shows the correlation of Conventional and Shariah indices with vertical axis on the left side whereas Interest rates vertical axis is on the right. The solid dark gray line shows the interest rates.

From our results, we observe that the Shariah indices do not provide protection against interest rate risk due to the similar performance.

Table 6.8 shows the correlation summary between S&P Developed BMI indices and interest rates. Similar correlation statistics are observed for conventional and Shariah indices.

Table 6.8: Summary of DCC between S&P Developed BMI Indices and Interest Rates

	S&P Developed BMI					S&P Developed BMI Shariah				
	EFFR	**DTB3**	**DTB6**	**LIB3**	**LIB12**	**EFFR**	**DTB3**	**DTB6**	**LIB3**	**LIB12**
Min.	-0.1704	-0.0728	-0.0867	-0.1425	-0.2725	-0.1712	-0.1192	-0.0980	-0.1322	-0.2487
1st Quantile	-0.0597	0.0397	0.0387	-0.0210	-0.0224	-0.0566	0.0405	0.0333	-0.0210	-0.0208
Median	-0.0373	0.0543	0.0845	-0.0042	0.0084	-0.0307	0.0533	0.0809	-0.0053	0.0013
Mean	-0.0384	0.0546	0.0841	-0.0052	0.0093	-0.0318	0.0545	0.0828	-0.0067	0.0020
3rd Quantile	-0.0143	0.0674	0.1260	0.0066	0.0392	-0.0049	0.0674	0.1308	0.0035	0.0245
Max.	0.0936	0.2333	0.3559	0.1042	0.3029	0.1097	0.2454	0.3218	0.0881	0.2591

Notes: The values represent the summary of dynamic correlation of stock indices with interest rates in U.S. and UK.

Overall, the correlation of Shariah indices with the interest rates is possibly due to allowance of 33% debt-to-equity ratio to the Shariah complaint companies. One reason of correlation may be the use of interest-rate derivatives by the companies which are Shariah compliant within these indices. It is also possible that the investors owning a mixed portfolio of Shariah and conventional investments rotate their money between the two categories or different economic groupings. Also, many Islamic governments and private investors shuffle their money between equity markets and government securities in Europe and the United States, but these interest-bearing investments are not Sharia-compliant and are prohibited (Koch & Saporoschenko, 2001). One of the reasons of this attitude of investors can be risk diversity as Jobst (2007) claims that risk diversity through derivatives improves stability in the financial system and enhances general welfare. Another possible reason may be the difference in screening methodologies since every screening provider has its own developed screening methodology (Zandi et al., 2014). Our results resonate well with those of Ajmi et al. (2014) who found correlation between Shariah indices and the interest rates; the magnitude of exposure, however, differs across regions, industries and time horizons. The results may also imply that Islamic ethical screens do not

seem to have much impact on the screening process; similar to the results of Hassan et al. (2005), who argue that application of Shariah screening does not have an adverse impact on investment performance. Another reason may be potential inconsistencies in the Sharia-investment screening criteria and the practice of Shariah investments. The lack of impact of interest rates, as claimed by Lee (2002) is also possible.

In addition to the correlations of stocks indices with EFFR, their correlations with DTB3, DTB6, LIBOR 3M, LIBOR 12M, all provided in Appendix A, also show that both conventional and Shariah indices are correlated with interest rates in a similar pattern. Therefore, we reject the hypothesis of decoupling of Shariah indices with the interest rates.

7 Gold as a Shariah-compliant asset

Islamic finance despite of its dynamic growth during the last two decades, still lags behind conventional finance in terms of portfolio diversification. The high-correlation of Shariah indices with the conventional counterparts, significant correlation with the interest rates, and their high volatility, demand the need of innovation within Islamic mode of financing. Among the ongoing uncertainty after the GFC, Islamic finance demands growth in asset size, service quality, market liquidity and market innovation. It is important to note that commodity traders are considerably related to the stock markets. They observe both stock and commodity markets fluctuations to gather information about the trend of each market (Choi & Hammoudeh, 2010). This helps the investors to make decisions about their portfolio diversification opportunities between stocks, and commodities which involve precious metals like gold and silver.

In Islamic finance, gold is an allowed as mode of investment and has been an attractive asset for the investors due to its own intrinsic value, negative or negligible correlation with the stock indices and high liquidity. It has often been regarded by the investors as ‘safe haven’—safe haven asset can be defined as an asset that is negatively correlated with another asset or portfolio in times of market stress or turmoil (Ghazali et al., 2016). Supposedly, gold can provide portfolio diversification benefits if it is decoupled or less correlated with the movement of the stock prices. According to the report of World Gold Council (2016) the gold market has large volume valued at USD 7.0 trillion, showing signs of market opportunities.

Although gold is not the absolute base of international monetary system in present financial world but it still represents the economic stability. Being a precious metal, gold has emotional, cultural and financial value, and is commonly traded by people across the globe. The demand of gold affects various aspects of financial markets. Firstly, it is used for industrial and productions purpose in health, electronics and chemical industries. The banks also store gold as a store of value and often

engage in buying and selling of gold (Burns, 1997). Gold is also used as investment asset by governments, fund managers and individual investors (Ghosh et al., 2002).

Gold having its significance in global markets and being permissible in Shariah as an asset, offers benefits of portfolio diversification (Raza et al, 2016). In December 2016, Accounting and Auditing Organization for Islamic Financial Institutions (AAOIFI) and the World Gold Council issued 'Shari'ah Standard No. 57 on Gold and its Trading Controls ("The Standard"). "The Standard" defines specific rulings and guidelines about the gold as an asset in various forms and categories, for transactions involving gold and gold-based financial products (World Gold Council, 2016). This has given an opportunity to Shariah investors by introducing new asset class and expanding the investment horizon in an illiquid and limited market.

The principles of Islamic finance do not allow hedging against market and credit risks (Ajmi et al. 2014), and gold with no such risk, offers diversification benefits to the Shariah investors. However, safe haven property of gold is market specific (Beckmann et al., 2015). According to Hoang et al. (2015) the weak correlation of gold is due to the difference between the determinants of gold prices and other financial assets.

7.1 Results

To assess the investment benefits and verify the decoupling of gold with the stock prices, empirical analysis is required. We employ DCC-GARCH to find correlation between gold prices and indices. As a proxy of gold price, we take Gold price troy per ounce in USD from the World Gold Council, throughout the study period.

Table 7.1 reports the volatility-based correlations computed on daily data from the DCC GARCH(1,1) estimates. All the DCC coefficients are jointly significant depicting the significance of our selected model. Figure 7.1 shows the DCC between gold and S&P Global BMI indices. From the figure we can infer several key features. We observe that the correlation between the indices and gold evolves through time but remains at a low correlation level, with an average of

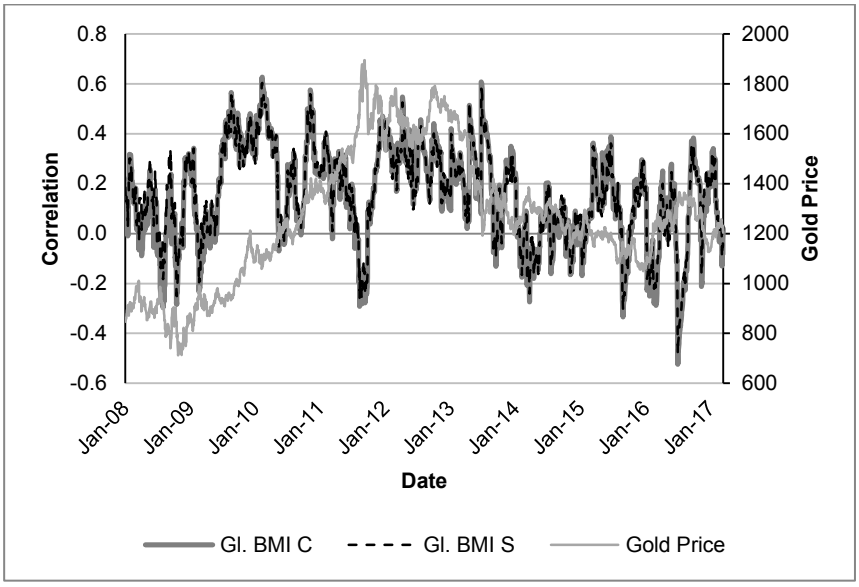
around 0.16, and even negative at few occasions, implying potential portfolio diversification benefits.

Table 7.1: DCC between S&P Indices & Gold Price

Gold Price	DCC Results	Coeff	Std. Err.	t value	Signif.
S&P Global BMI	DCC(1)	0.0415	0.0083	4.9933	0.0000
	DCC(2)	0.9333	0.0146	63.9072	0.0000
S&P Global BMI Shariah	DCC(1)	0.0379	0.0086	4.3957	0.0000
	DCC(2)	0.9372	0.0164	57.1783	0.0000
S&P500	DCC(1)	0.0194	0.0096	2.0185	0.0435
	DCC(2)	0.9643	0.0222	43.4938	0.0000
S&P500 Shariah	DCC(1)	0.0196	0.0114	1.7191	0.0856
	DCC(2)	0.9597	0.0308	31.1800	0.0000
S&P Emerging BMI	DCC(1)	0.0491	0.0089	5.4951	0.0000
	DCC(2)	0.9197	0.0160	57.4580	0.0000
S&P Emerging BMI Shariah	DCC(1)	0.0510	0.0086	5.9278	0.0000
	DCC(2)	0.9188	0.0145	63.2071	0.0000
S&P Developed BMI	DCC(1)	0.0383	0.0081	4.7285	0.0000
	DCC(2)	0.9379	0.0147	63.6793	0.0000
S&P Developed BMI Shariah	DCC(1)	0.0341	0.0085	4.0314	0.0001
	DCC(2)	0.9424	0.0168	56.0178	0.0000

Notes: The table shows the dynamic correlations of stock indices with gold. The high significance of coefficients show the suitability of DCC model for evaluation.

Figure 7.1: DCC between S&P Global BMI Shariah & Gold Price



Notes: The figure shows the correlation of Conventional and Shariah indices with vertical axis on the left side whereas gold price vertical axis is on the right. The solid dark gray line shows the interest rates.

The correlation varies within short horizons fairly frequently exhibiting short-term diversification benefits for the investors. The negative or low correlation may depict that gold having its own intrinsic value and less correlated with the stock movement, seems to be a 'safe haven' for investors (Bilal et al., 2013); when markets decline, the gold price often rises.

Table 7.2 shows the summary of the DCC results for all indices. For S&P Global BMI, with around three-fourth of the observations having correlation less than 0.30, gold can be considered as safe haven for Shariah investors. The increasing gold prices also explain the risk aversion of investors during crisis times as they tend to move towards safer investments. In Figure 7.1, after March 2009, the correlation is observed to be more positive as the global crisis mitigates and the gold price increases. The gold prices from 2009 to 2013 show a noteworthy increase as compared to stock indices, reaching their maximum in 2011 over the last 20 years (World Gold Council, 2016). Moreover, gold prices continue to rise after initial shocks and the net values of portfolios involving gold increase during the crises. Due to increase in financial uncertainty and demand of gold, gold prices increase further. As the stock market becomes stabilized after Eurozone crisis, the gold price starts to drop exhibiting the negative correlation.

Table 7.2: Difference of DCC between S&P Indices & Gold Price

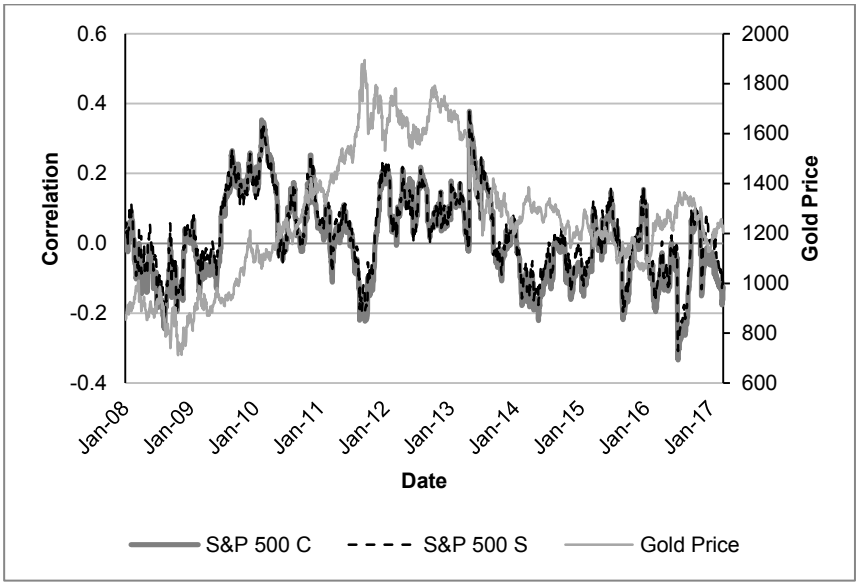
	Correlation with Gold					
Variable	**Min.**	**1st Quantile**	**Median**	**Mean**	**3rd Quantile**	**Max.**
Global BMI	-0.5235	0.0191	0.1513	0.1472	0.2971	0.6265
Global BMI Shariah	-0.4802	0.0372	0.1657	0.1576	0.2917	0.6030
S&P500	-0.3339	-0.0852	-0.0002	0.0095	0.0994	0.3781
S&P500 Shariah	-0.3083	-0.0523	0.0192	0.0276	0.1073	0.3850
Emerging BMI	-0.4640	0.0892	0.2235	0.2113	0.3596	0.6486
Emerging BMI Shariah	-0.5135	0.0934	0.2286	0.2165	0.3706	0.6292
Developed BMI	-0.5081	0.0073	0.1345	0.1329	0.2757	0.5997
Developed BMI Shariah	-0.4491	0.0302	0.1510	0.1442	0.2666	0.5679

Notes: The values represent the summary of dynamic correlation of stock indices with gold prices.

Our finding is in accord with Ghazali et al. (2016) who claim that that gold can be treated as a safe haven but its characteristic is present in the short run. Therefore, the low correlation during the overall period and a frequent negative correlation during the tranquil period show that gold can be added in a portfolio for reducing the downside risk.

Figure 7.2 shows DCC correlation between S&P 500 indices and gold. In Table 7.2, the mean of conditional correlation for S&P 500 Shariah, throughout the period is 0.02, which shows gold as an ideal portfolio diversification opportunity for the U.S. investors during and after the crisis. The correlation of gold with the Shariah stocks in the U.S. market remains negative during the peak of the GFC indicating a safe haven and a risk mitigation tool. The correlation becomes positive when the crisis starts to subside after the first quarter of 2009 since both the stock and gold prices increase. Similar to our results for Global BMI indices, we see negative correlation during Eurozone crisis as gold prices continued to rise as stock markets in the developed countries were affected due to financial contagion.

Figure 7.2: DCC between S&P 500 Shariah & Gold Price



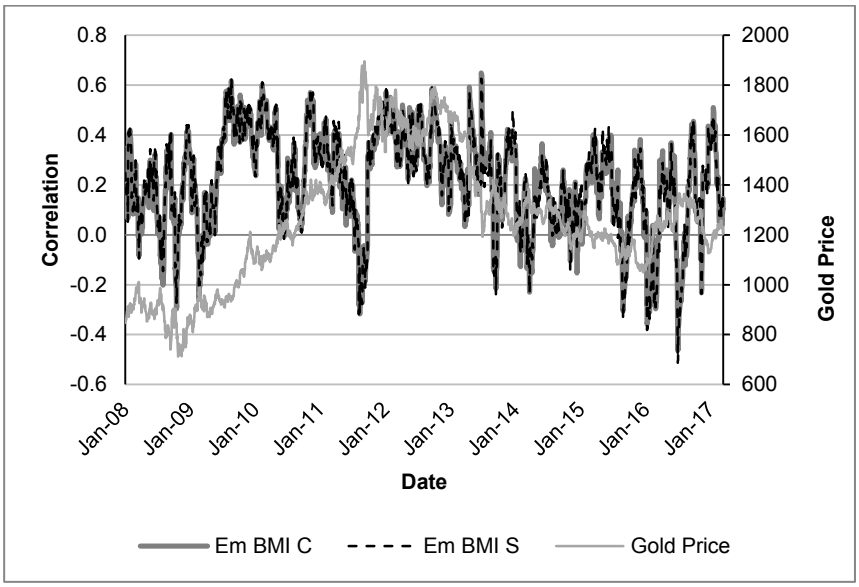
Notes: The figure shows the correlation of Conventional and Shariah indices with vertical axis on the left side whereas gold price vertical axis is on the right. The solid dark gray line shows the interest rates.

During tranquil period we observe that gold prices decline whereas the stock markets recover making stocks a better selection for the investors. These results show that gold can be used to mitigate risk by U.S. Shariah investors during the crisis.

Figure 7.3 and Figure 7.4 show correlation of gold with S&P Emerging BMI and S&P Developed BMI indices respectively. Similar results can be observed that correlation with gold is low for both the markets during most of the period, especially in the developed markets. The correlation increases after first quarter of 2009 since the prices of gold increase and stocks recover. Then it becomes negative or near-zero during the Eurozone crisis before finally becoming negative and almost zero after the subsidence of crisis.

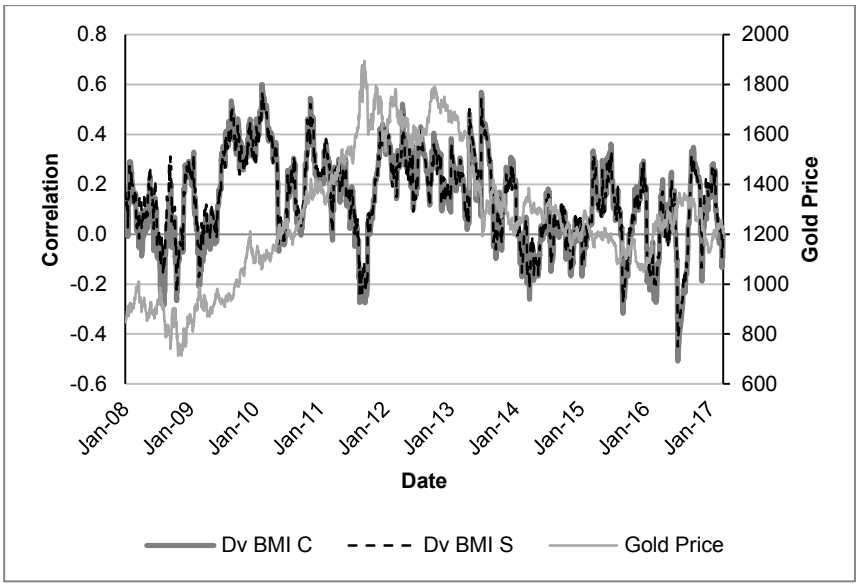
We observe that Shariah investors in developed markets have marginally less correlation than those in emerging markets. This might be explained by the already high demand of gold in two biggest emerging markets of India and China (World Gold Council, 2017). Both in India and China, gold is used for domestic as well as industrial purposes. Also, the Emerging market indices include largest gold producers like China, Russia, South Africa and Brazil.

Figure 7.3: DCC between S&P Emerging BMI Shariah & Gold Price



Notes: The figure shows the correlation of Conventional and Shariah indices with vertical axis on the left side whereas gold price vertical axis is on the right. The solid dark gray line shows the interest rates.

Figure 7.4: DCC between S&P Developed BMI Shariah & Gold Price



Notes: The figure shows the correlation of Conventional and Shariah indices with vertical axis on the left side whereas gold price vertical axis is on the right. The solid dark gray line shows the interest rates.

Overall, the above results indicate that gold maintains its role as safe-haven in short-term during times of crisis. With an average correlation considerably low or near-zero and less volatility, gold can be added to the Shariah portfolio for risk-aversion. Accordingly, we cannot reject our hypothesis and conclude that gold is a portfolio diversification opportunity for Shariah investors. Moreover, with the gold prices achieving high values, gold can also increase the value of the portfolio. The results also depict that the hedge and safe haven ability of gold is market specific.

8 Conclusion

In this study we analyze the S&P Conventional and Shariah indices in various markets during and after the Global Financial Crisis (GFC) by comparing the volatility of Conventional indices with their Shariah counterparts. We analyze the global, U.S., developed and emerging markets using S&P indices from January 1, 2008 to March 10, 2017. The volatility analysis is performed on daily closing prices of the indices firstly for the overall study period, and then for the sub-periods. We also study the correlations of conventional indices with Shariah indices, to examine the presence of contagion and volatility spillover. Furthermore, we study correlations of the indices with interest rates to evaluate interest rate risk, and with gold prices to discover diversification benefits for Shariah investors. GARCH and DCC-GARCH models serve for the comparison of volatility and correlations respectively. To capture the fat-tail distributions and leverage effects, we make use of the non-Normal distributions (GED & MVT) and Exponential GARCH (EGARCH) respectively. This technique enabled us to study the true dynamics of financial time series and see how differently the nature of news affects the conventional and Shariah indices. The DCC-GARCH helps us to study the time-varying correlations based on high-frequency data during highly unpredictable and turbulent markets.

Our findings suggest a better performance of EGARCH over GARCH, and GED distributions over Normal distributions. Also, by evaluating the data separately during crises and afterwards, for different markets, we explore the portfolio diversification opportunities in Shariah indices of different economic groupings and regions. We show that the conventional indices were mostly volatile during the crisis periods and Shariah stocks are attractive investments for risk-averse investors. The results vary according to the market condition; for instance, Shariah stocks in emerging markets did not perform well during the crisis which primarily may be due to limited diversification opportunities and the dependence of emerging markets on the developed markets, both in terms of investor sentiments and trade links. Furthermore, we observe that Shariah investors in the emerging markets over-react to

the news from the developed markets due to their less experience and a relatively immature Islamic financial market. Nevertheless, the emerging market Shariah stocks showed better performance during the Eurozone crisis due to their different economic grouping. Accordingly, we cannot reject the hypotheses that Shariah indices were less volatile at global level and in the U.S. markets as compared to their respective conventional indices. However, we may reject the hypothesis that Shariah indices in emerging markets were less volatile than developed markets; emerging markets show more volatility.

Our overall results suggest that Shariah compliant stocks can be used as risk mitigation tool during crisis or tranquil periods by investing in a portfolio comprised of different developed and emerging markets. Our results also imply that a combination of conventional and Shariah stocks may provide less risk and substantial return, especially during the market downturn.

We show that Shariah stocks are significantly correlated with conventional financial system and find that they faced contagion and spillover effects, being a subset of their corresponding conventional indices and presence of trade links with the other markets. Hence we may reject the hypothesis that Shariah indices do not suffer from financial contagion. However, Shariah stocks were able to provide short-term diversification opportunities if the economic groupings, sector allocation and regional prospects are considered. The emerging markets were the least correlated with other markets included in this study, but volatile during the crisis and tranquil after the GFC. Investigating the relationship of Shariah indices with interest rates, we show that they are similarly affected by interest rates as their conventional counterparts; hence we may reject our hypothesis. To understand the relationship of Shariah indices with the interest rates, we consider U.S. and UK interest rates of differnet maturities; this helps us to broaden our scope in terms of maturities and markets. Also, the correlations of different indices with the U.S. and UK interest rates depict the influence of foreign interest rates. However, we assume that the correlation may be present through direct or indirect channels: involvement of companies in debt but with debt-to-equity ratio less than that of 33%, shuffling of money by the

investors between Shariah compliant and non-Shariah compliant stocks or involvement of Shariah compliant companies in interest-rate derivatives.

We empirically test the Gold standard, called “The Standard”, set by AAOIFI and World Gold Council, by examining the correlation of Shariah indices with gold. This is helpful to the Shariah investors to discover opportunities of portfolio diversification. The negative or remarkably low correlation of gold with the Shariah indices gives the investors an innovation to add to their portfolio. Accordingly, we cannot reject our hypothesis asserting the portfolio diversification benefits of gold. The rise in gold prices during the last decade, especially during crises, also proves the existence of such opportunity. We also observe that gold despite being a short-term safe haven cannot be the safe haven in the long-run or at all times. If investors buy gold in response to a negative shock, this initial shock is followed by a sequence of similar or even larger negative shocks due to overreaction of the investors assuming poor performance of the market. Hence, some investors may be forced to sell gold, thus eventually depressing the price of gold and bringing the safe haven status of gold for that particular event to an end.

In our study, besides the traditional approach of evaluating the impacts of shocks and persistence in volatility, we examine the difference between the time-varying volatilities of conventional and Shariah indices, and study their descriptive statistics as well. This approach is an addition to previous research. This helps us to have close analysis the performances of the indices during and after the crisis. Also, it helps us to analyze which index was most volatile throughout the study period by analyzing its time development. Moreover, we try to narrow down the comparison in terms of economic groupings and sectors by studying different markets. Considering the various interest rates, we study how the foreign interest rates affect the domestic markets of a region over time. We also empirically test gold as a safe haven during crisis times by showing its low correlation with the indices.

Our study will help the investors in understanding the behavior of Shariah indices during crisis and tranquil periods enabling them to be more effective with their portfolio diversification strategies. The study can be further extended by investigating the presence of outliers among the constituents of the indices which

might cause excess volatility in either of the Shariah indices. The study can also be extended by narrowing down the research further within a specific category or economic grouping.

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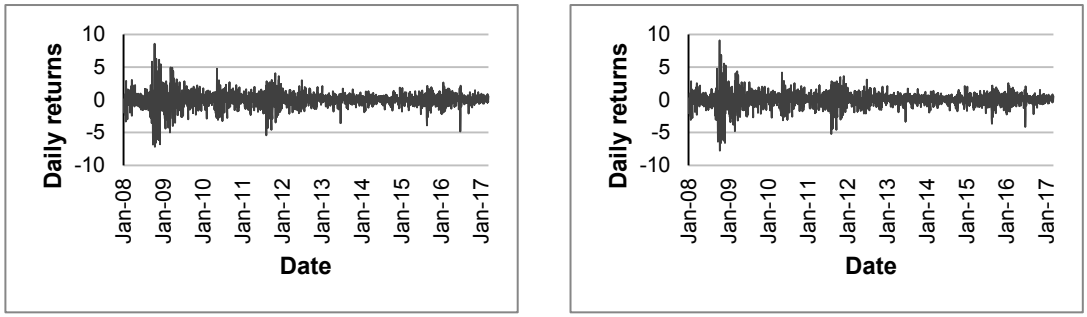
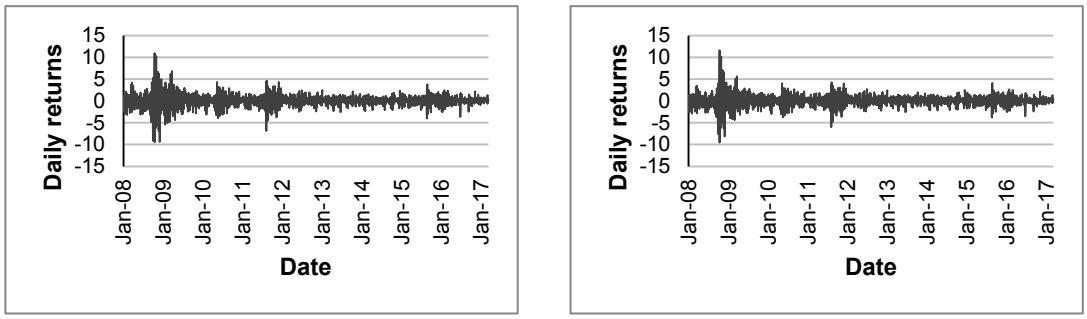
Appendix A: Figures

Figure A.1: Daily returns of S&P Global BMI & S&P Global BMI Shariah



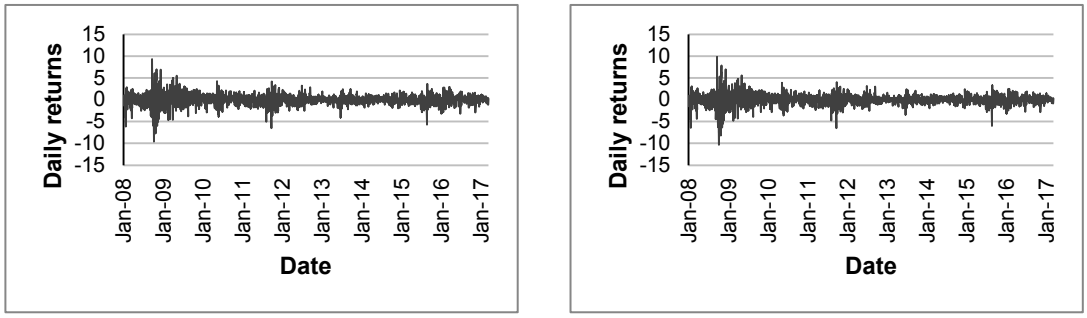
Note: The figure shows the volatility of S&P Global BMI (left) and S&P Global BMI Shariah (right); depicting high volatility during crisis, and low volatility after crisis.

Figure A.2: Daily returns of S&P 500 & S&P 500 Shariah



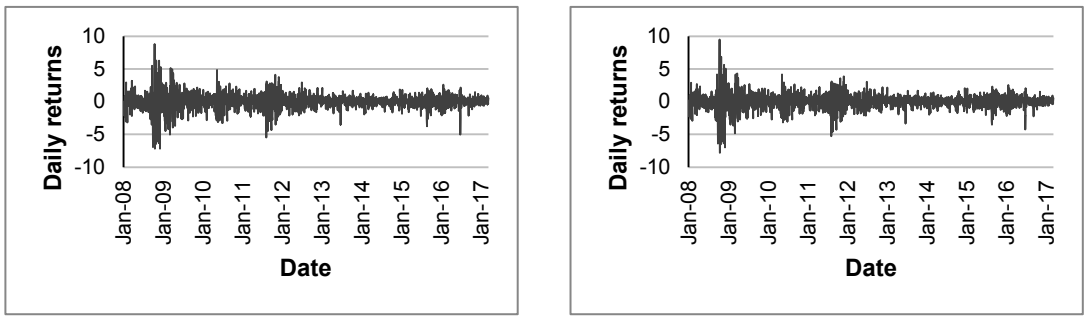
Note: The figure shows the volatility of S&P 500 (left) and S&P 500 Shariah (right); depicting high volatility during crisis, and low volatility after crisis.

Figure A.3: Daily returns of S&P Emerging BMI & S&P Emerging BMI Shariah



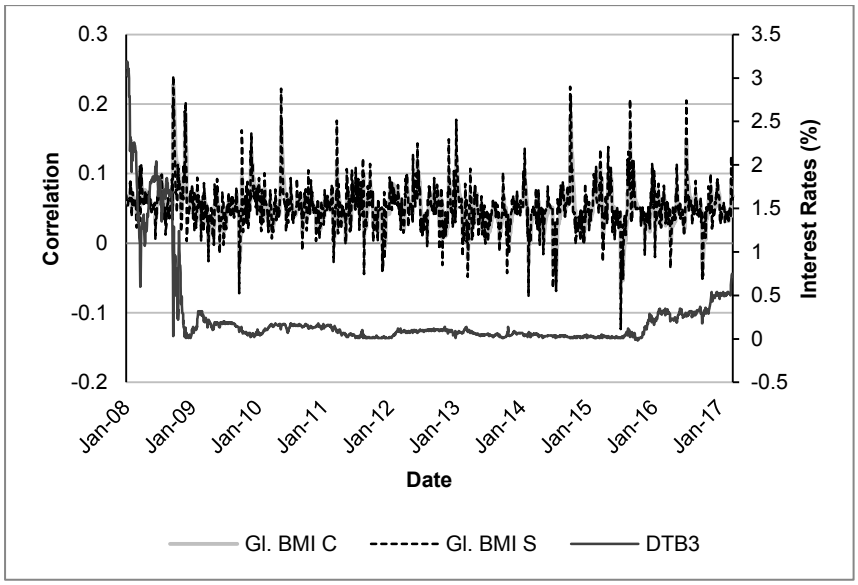
Note: The figure shows the volatility of S&P Emerging BMI (left) and S&P Emerging BMI Shariah (right); depicting high volatility during crisis, and low volatility after crisis.

Figure A.4: Daily returns of S&P Developed BMI & S&P Developed BMI Shariah



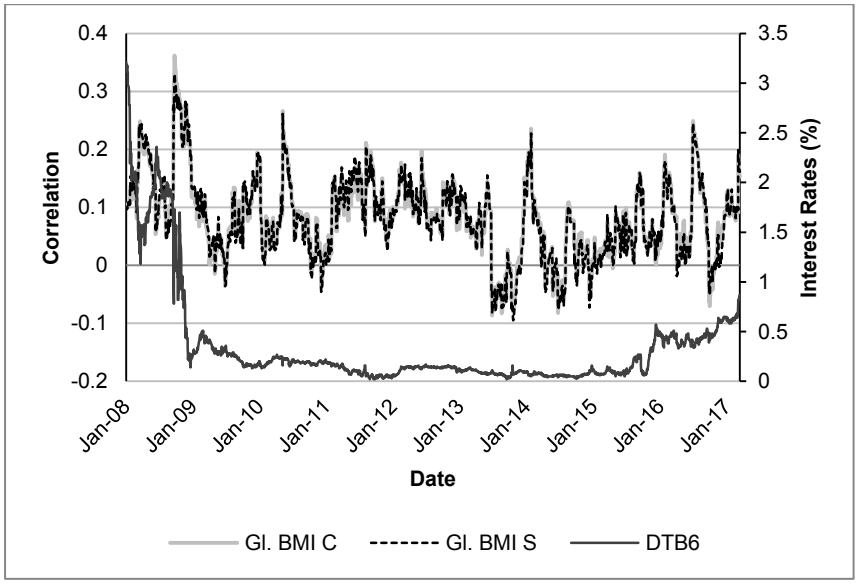
Note: The figure shows the volatility of S&P Developed BMI (left) and S&P Developed BMI Shariah (right); depicting high volatility during crisis, and low volatility after crisis.

Figure A.5: Correlation of S&P Global BMI Indices & DTB3



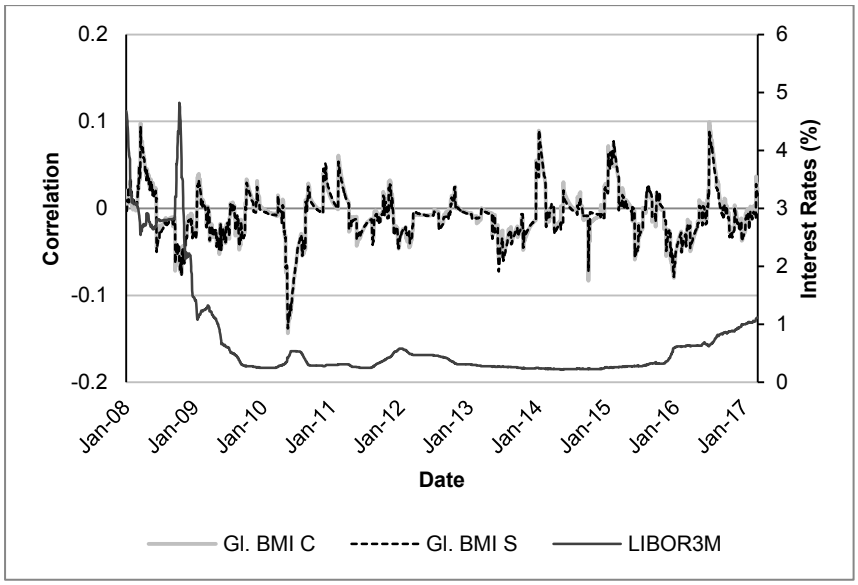
Notes: The figure shows the correlation of Conventional and Shariah indices with vertical axis on the left side whereas Interest rates vertical axis is on the right. The solid dark gray line shows the interest rates.

Figure A.6: Correlation of S&P Global BMI Indices & DTB6



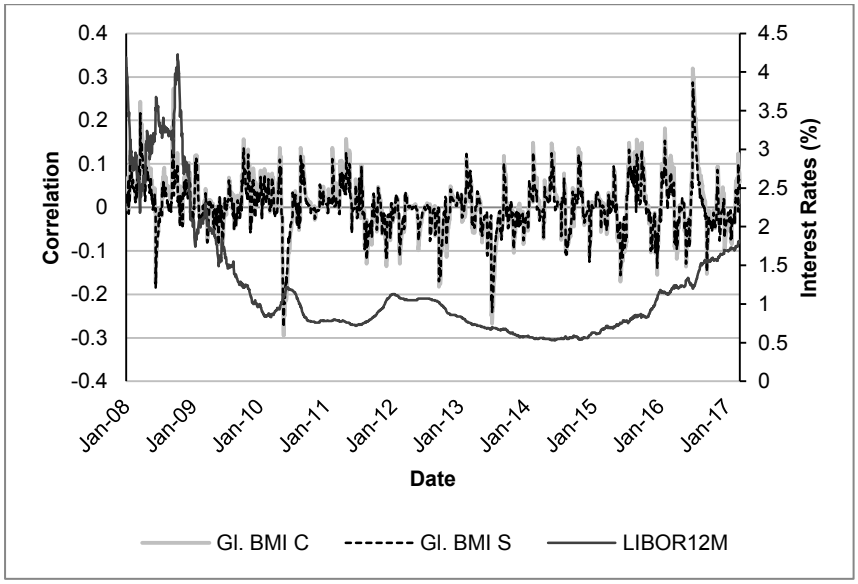
Notes: The figure shows the correlation of Conventional and Shariah indices with vertical axis on the left side whereas Interest rates vertical axis is on the right. The solid dark gray line shows the interest rates.

Figure A.7: Correlation of S&P Global BMI Indices & LIBOR3M



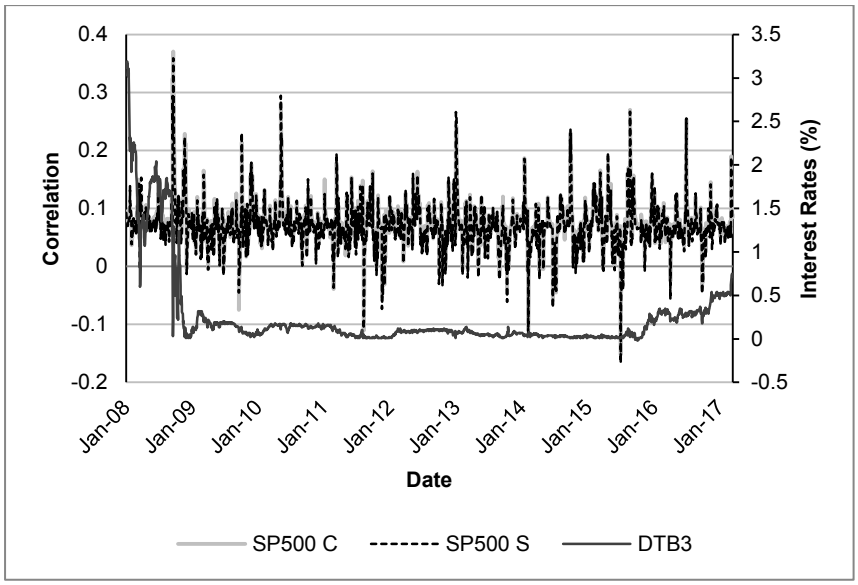
Notes: The figure shows the correlation of Conventional and Shariah indices with vertical axis on the left side whereas Interest rates vertical axis is on the right. The solid dark gray line shows the interest rates.

Figure A.8: Correlation of S&P Global BMI Indices & LIBOR12M



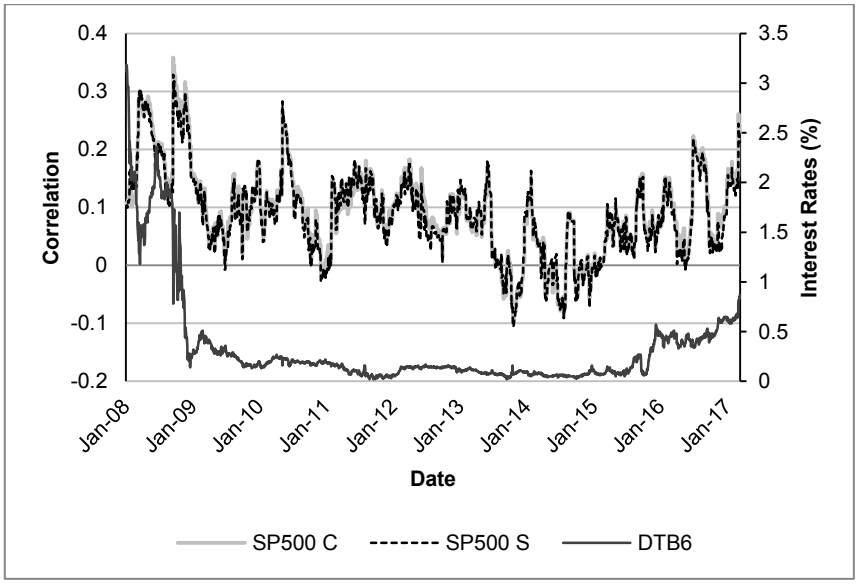
Notes: The figure shows the correlation of Conventional and Shariah indices with vertical axis on the left side whereas Interest rates vertical axis is on the right. The solid dark gray line shows the interest rates.

Figure A.9: Correlation of S&P 500 Indices & DTB3



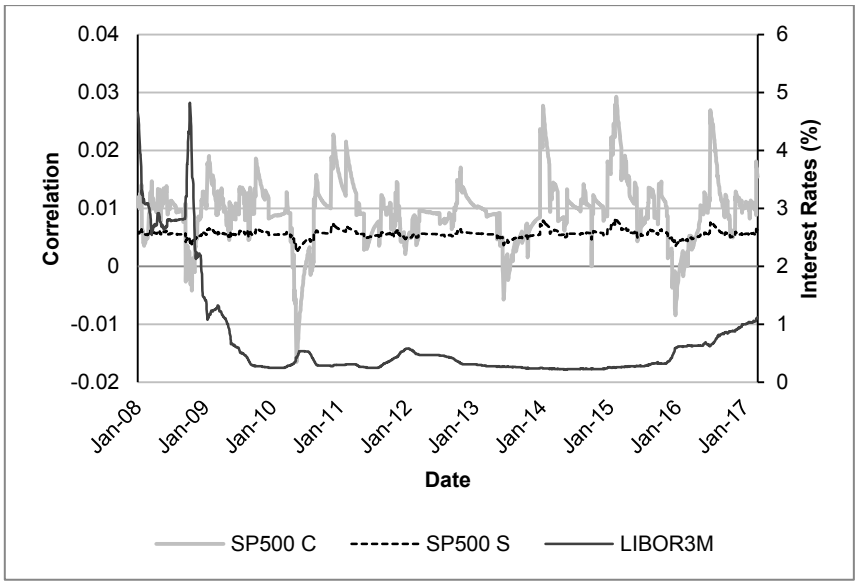
Notes: The figure shows the correlation of Conventional and Shariah indices with vertical axis on the left side whereas Interest rates vertical axis is on the right. The solid dark gray line shows the interest rates.

Figure A.10: Correlation of S&P 500 Indices & DTB6



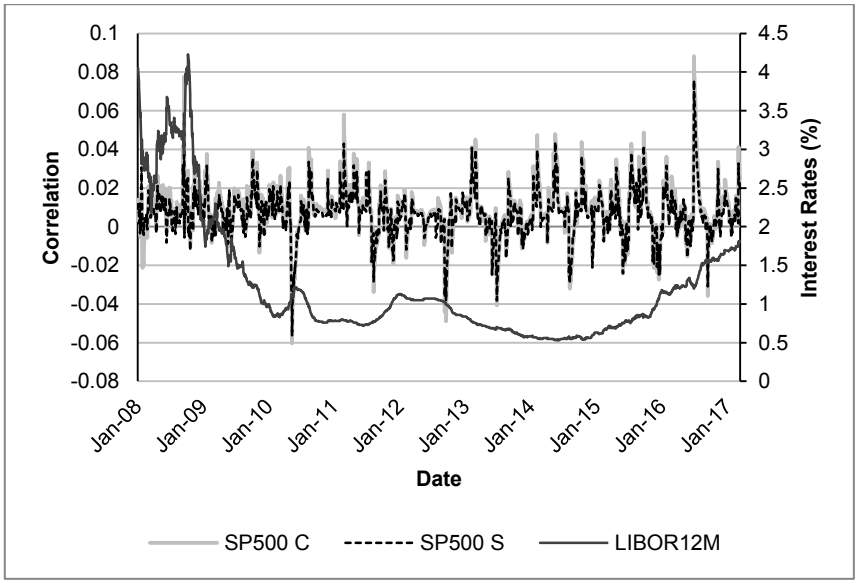
Notes: The figure shows the correlation of Conventional and Shariah indices with vertical axis on the left side whereas Interest rates vertical axis is on the right. The solid dark gray line shows the interest rates.

Figure A.11: Correlation of S&P 500 Indices & LIBOR3M



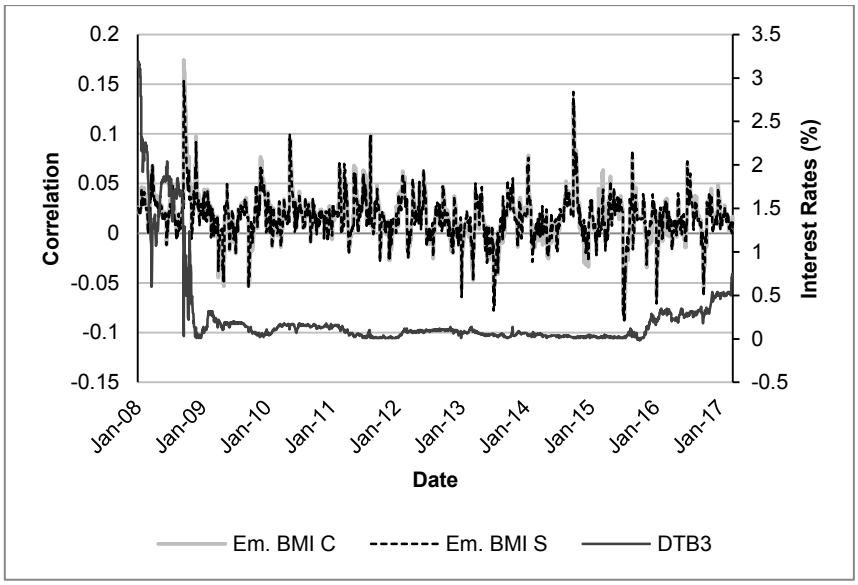
Notes: The figure shows the correlation of Conventional and Shariah indices with vertical axis on the left side whereas Interest rates vertical axis is on the right. The solid dark gray line shows the interest rates.

Figure A.12: Correlation of S&P 500 Indices & LIBOR12M



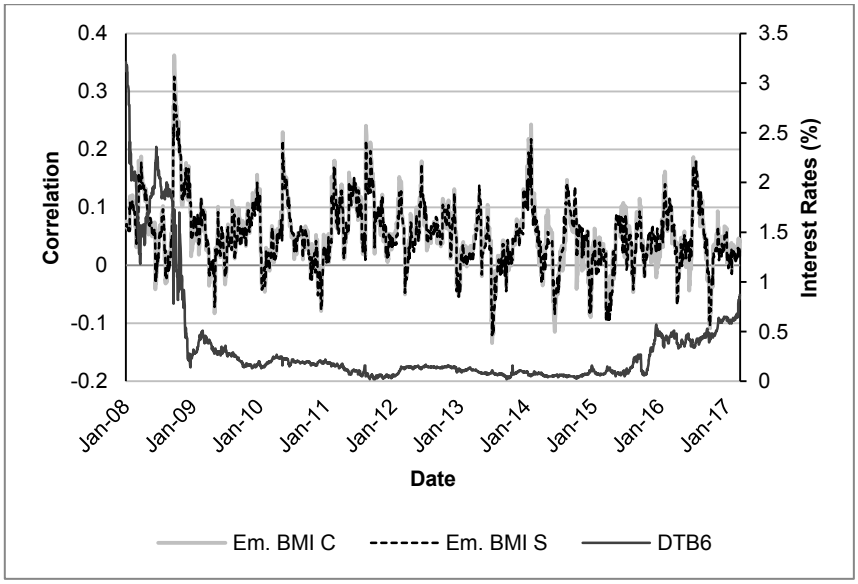
Notes: The figure shows the correlation of Conventional and Shariah indices with vertical axis on the left side whereas Interest rates vertical axis is on the right. The solid dark gray line shows the interest rates.

Figure A.13: Correlation of S&P Emerging BMI Indices & DTB3



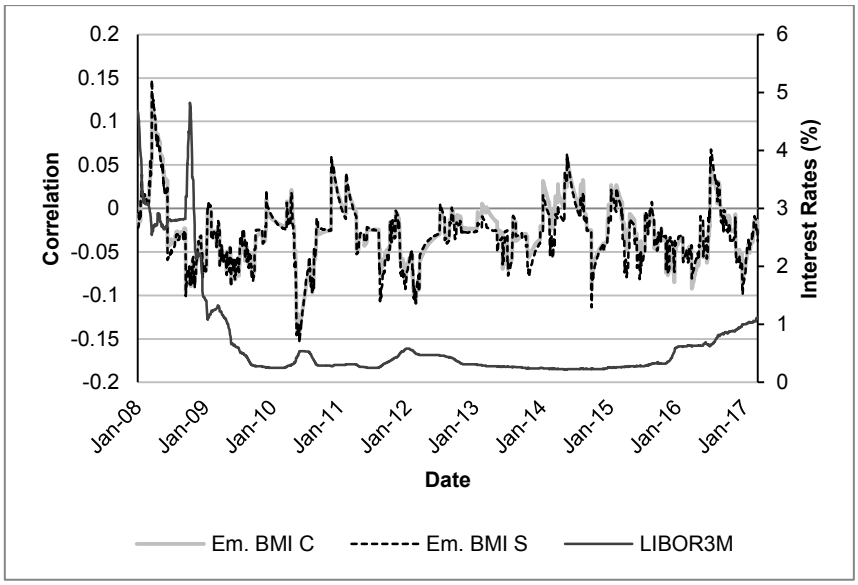
Notes: The figure shows the correlation of Conventional and Shariah indices with vertical axis on the left side whereas Interest rates vertical axis is on the right. The solid dark gray line shows the interest rates.

Figure A.14: Correlation of S&P Emerging BMI Indices & DTB6



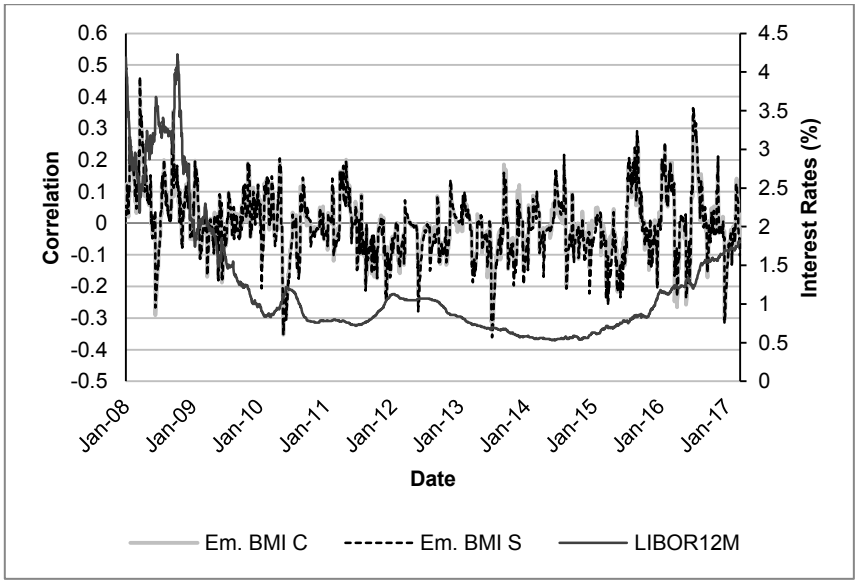
Notes: The figure shows the correlation of Conventional and Shariah indices with vertical axis on the left side whereas Interest rates vertical axis is on the right. The solid dark gray line shows the interest rates.

Figure A.15: Correlation of S&P Emerging BMI Indices & LIBOR3M



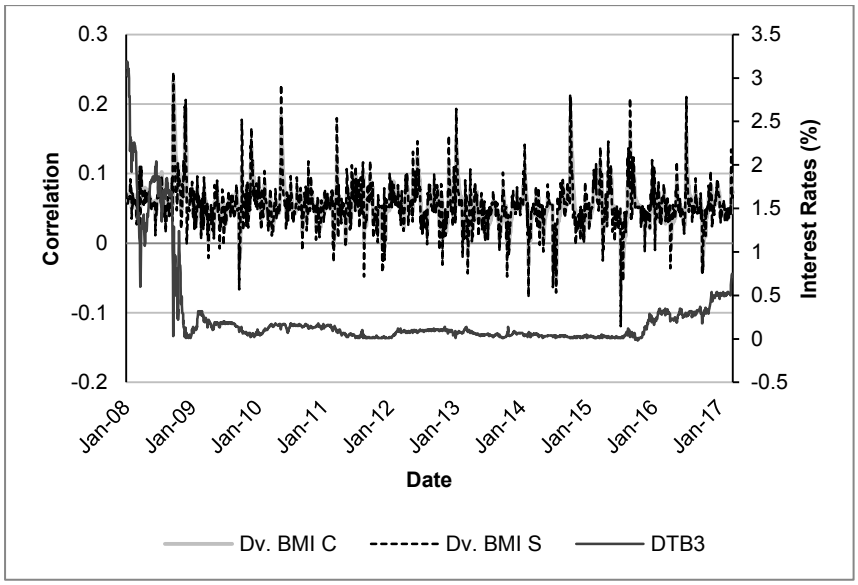
Notes: The figure shows the correlation of Conventional and Shariah indices with vertical axis on the left side whereas Interest rates vertical axis is on the right. The solid dark gray line shows the interest rates.

Figure A.16: Correlation of S&P Emerging BMI Indices & LIBOR12M



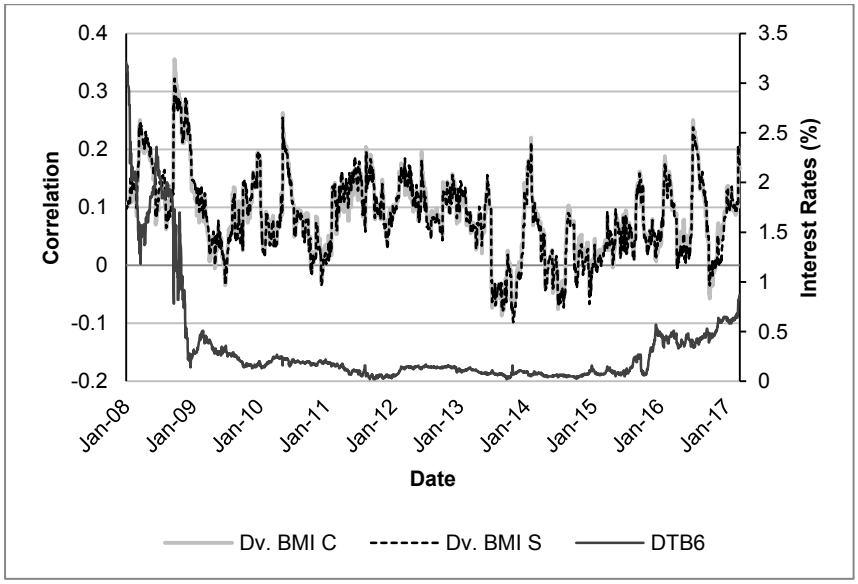
Notes: The figure shows the correlation of Conventional and Shariah indices with vertical axis on the left side whereas Interest rates vertical axis is on the right. The solid dark gray line shows the interest rates.

Figure A.17: Correlation of S&P Developed BMI Indices & DTB3



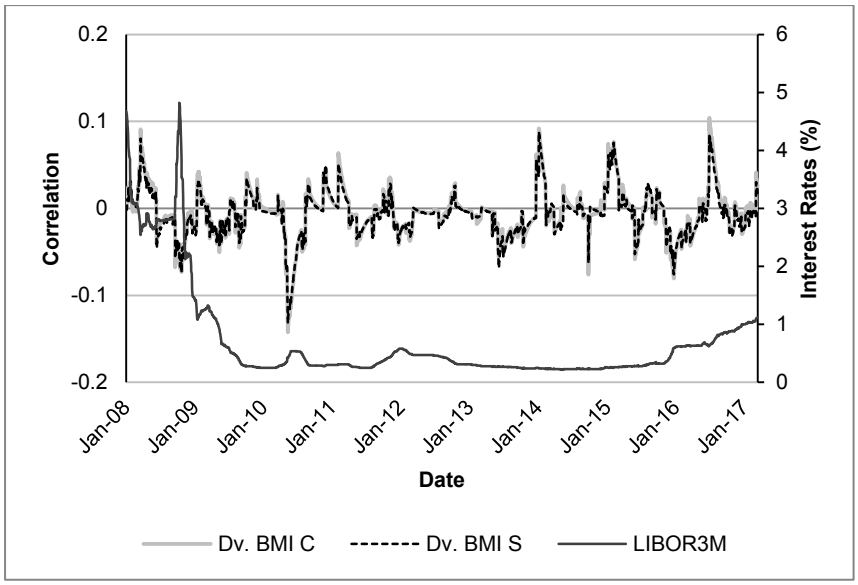
Notes: The figure shows the correlation of Conventional and Shariah indices with vertical axis on the left side whereas Interest rates vertical axis is on the right. The solid dark gray line shows the interest rates.

Figure A.18: Correlation of S&P Developed BMI Indices & DTB6



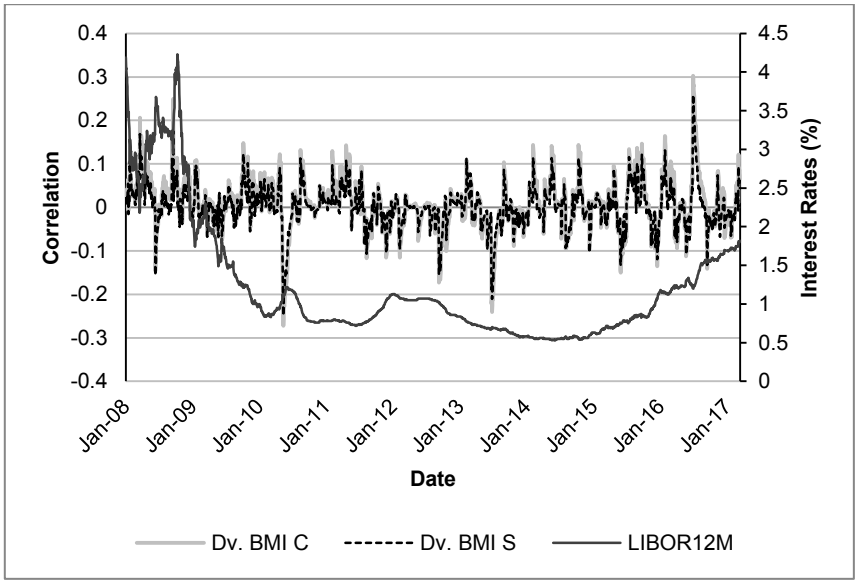
Notes: The figure shows the correlation of Conventional and Shariah indices with vertical axis on the left side whereas Interest rates vertical axis is on the right. The solid dark gray line shows the interest rates.

Figure A.19: Correlation of S&P Developed BMI Indices & LIBOR3M



Notes: The figure shows the correlation of Conventional and Shariah indices with vertical axis on the left side whereas Interest rates vertical axis is on the right. The solid dark gray line shows the interest rates.

Figure A.20: Correlation of S&P Developed BMI Indices & LIBOR12M



Notes: The figure shows the correlation of Conventional and Shariah indices with vertical axis on the left side whereas Interest rates vertical axis is on the right. The solid dark gray line shows the interest rates.

Appendix B: Outputs

B.1. Breakpoint test for S&P Global BMI

```
       Optimal 2-segment partition:

Call:
breakpoints.formula(formula = gl_bmi_1 ~ 1, breaks = 1)

Breakpoints at observation number:
243
```

B.2. Breakpoint test for S&P 500

```
       Optimal 2-segment partition:

Call:
breakpoints.formula(formula = sp_500_1 ~ 1, breaks = 1)

Breakpoints at observation number:
290
```

B.3. Breakpoint test for S&P Emerging BMI

```
       Optimal 2-segment partition:

Call:
breakpoints.formula(formula = em_bmi_1 ~ 1, breaks = 1)

Breakpoints at observation number:
222
```

B.4. Breakpoint test for S&P Emerging BMI

```
       Optimal 2-segment partition:

Call:
breakpoints.formula(formula = dv_bmi_1 ~ 1, breaks = 1)

Breakpoints at observation number:
243
```

Appendix C: List of countries in Stock Indices

Table C.1: List of countries included in "non-U.S. market" S&P Stock Indices

S&P Global BMI	S&P Developed BMI	S&P Emerging BMI
1. United States	1. United States	1. China
2. Japan	2. Japan	2. Taiwan
3. United Kingdom	3. United Kingdom	3. India
4. France	4. France	4. Brazil
5. Canada	5. Canada	5. South Africa
6. China	6. Germany	6. Russia
7. Germany	7. Switzerland	7. Mexico
8. Switzerland	8. Australia	8. Malaysia
9. Australia	9. South Korea	9. Thailan
10. South Korea (Republic of Korea)	10. Hong Kong	10. Indonesia
	11. Netherlands	11. Philippines
11. Taiwan	12. Sweden	12. Chile
12. India	13. Spain	13. Poland
13. Hong Kong	14. Italy	14. Turkey
14. Netherlands	15. Denmark	15. United Arab Emirates
15. Sweden	16. Singapore	16. Qatar
16. Spain	17. Belgium	17. Colombia
17. Italy	18. Finland	18. Peru
18. Brazil	19. Israel	19. Greece
19. South Africa	20. Norway	20. Hungary
20. Denmark	21. Ireland	21. Egypt
21. Singapore	22. Austria	22. Czech Republic
22. Belgium	23. New Zealand	
23. Russia	24. Luxembourg	
24. Finland	25. Portugal	
25. Mexico		
26. Malaysia		
27. Thailand		
28. Israel		
29. Indonesia		
30. Norway		
31. Ireland		
32. Philippines		
33. Chile		
34. Poland		
35. Turkey		
36. Austria		
37. New Zealand		
38. United Arab Emirates		
39. Qatar		
40. Colombia		
41. Luxembourg		
42. Portugal		
43. Peru		
44. Greece		
45. Hungary		
46. Egypt		
47. Czech Republic		

Source: S&P Dow Jones Indices. The list is the same for Conventional and Shariah indices.