



*Research article*

**Diversification benefits in energy, metal and agricultural commodities for Islamic investors: evidence from multivariate GARCH approach**

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**Abstract:** The purpose of this paper is to analyze the portfolio diversification opportunities offered by certain commodities to Islamic equity investors by investigating the volatility and correlations of Islamic equity index returns and those commodities. This paper attempts to add value to the existing literature by empirically testing the “time-varying” volatilities and correlations of agricultural, metal and energy commodities using Morgan Stanley Capital International (MSCI) World Islamic Index. The daily data for a time period of nine and a half years, from the inception of MSCI World Islamic Index on 1<sup>st</sup> of July 2007 to January 2017, were collected for this research and analyzed using MGARCH-DCC approach. The findings tend to suggest that: i) the agricultural commodities provide better diversification benefits compared to metal and energy commodities; ii) the Global financial crisis has a significant negative impact on the integration of the indices; and iii) natural gas, gold, wheat, sugar, coffee and corn in general have relatively low correlation, in comparison to the rest of the commodities. As implication of the study, the medium-to-long term investors could gain a better diversification benefit in most of these commodities during all the market periods.

**Keywords:** MGARCH-DCC; Islamic investment; Islamic finance; commodities; diversification

**JEL codes:** G11, Q02, C58

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## 1. Introduction

Over the most recent years there has been an increase in the risk for diversification within the financial markets due to an increase of equity markets correlation and asset price co-movement across the global financial systems. Even though Islamic equity markets are one of the fastest growing markets yet they are not immune from the circumstances of integration. This homogenization and co-movement has been decreasing investors' ability to enhance their investments, and at the same time has increased their concern for the effectiveness of international investment diversification, as these markets correlations decrease their probability of getting diversification benefits and increase the risk for their investments.

In the existing literature, for example, Saiti et al. (2014, 2016) cited that international stock markets are becoming more and more integrated, and at the same time the market equity prices are displaying long-run relationships with each other. There are numbers of studies (Dewandaru et al., 2014, 2016; Saiti et al., 2014; among others) which have examined the correlations of international stock markets, both for the case of conventional as well as Islamic equity markets and have confirmed this issue.

Market integration in this context means the integration of a country's financial market with that of international financial markets or institutions. As stated by Schmukler (2004), market integration happens when opened economies encounter an expansion in cross-country capital movement, including participation from local borrowers and lenders in the global markets and a common use of international financial intermediaries. Even though developed countries are the most active in the case of financial globalization process, nevertheless developing countries have also begun to take interest. In the most recent thirty years financial markets globalization has faced many changes. New technological advancement and the progression of domestic financial sector and the capital account have led to new improvements. According to him the main drivers that are driving financial globalization and making the markets integrated are: i) governments; ii) private investors and borrowers; and iii) financial institutions.

In this period of globalization, financial markets all over the world have witnessed and are still witnessing a growing integration between and within them. Market integration is a threat to investors, because it increases investors' level of risk and reduces their expected level of return. Due to this increase in equity market integration all over the world, both Islamic and conventional investors' concerns have significantly risen regarding the way of achieving an effective investment diversification. As suggested by Saiti et al. (2014), Islamic financial markets are the current hope for investors with either Islamic or conventional investment in order to diversify their portfolios. Financial markets in the Islamic countries provide better diversification benefits in contrast to the Far East countries that have a strong policy for both the domestic and international investors in context of their portfolio diversification against risks of investment. However, even the Islamic markets in terms of integration were not left behind, because the factors that drive integration, such as advancements in information technology, globalization and deregulation are now adopted and are available in most of the developing Muslim countries.

This research paper has its focus on two important questions regarding the increase in risk of diversification within the Islamic Stocks markets, due to general increase of equity market returns correlation and asset price co-movement across the global financial system. First, do commodities provide diversification benefits to the Islamic equity investors? Second, given the correlation of

commodities with Islamic equity indices, how optimal can Islamic investors diversify their investment with commodities? To answer these two questions, MGARCH-DCC is applied to examine the extent to which the selected commodities correlate with the selected Islamic equity market, and to identify the usefulness of commodities in terms of potential benefits of portfolio diversification.

In response to that, this paper will examine the maximum diversification benefits that Islamic index investors can get, by finding and suggesting some appropriate commodities that will necessarily decrease the level of risks of investors when making an investment. As mentioned by Shahzad et al. (2014), Commodities offer substantial diversification benefits when included in the portfolio of stocks. As a commodity's future returns show a stronger correlation with unexpected inflation compared to stocks.

This study hopes to contribute to the existing literature that covers the diversification benefits of commodities due to correlations and dependencies between financial markets of different countries, something which is worth giving attention. Besides that, the equity market's players' understanding about the nature of integration between the stock markets can be significant in determining their success, especially for investors of Islamic stock market. This study will investigate the diversification benefits of commodities for Islamic investors, by applying a substantially more precise methodology for finding correlation, MGARCH-DCC approach, something that will distinguish this research from most of the earlier works. Furthermore, this research will be conducted at the level of commodity categories, while earlier studies focused on commodity indices. Commodity indices are bigger than individual commodity and commodity categories, hence are not representative of the performance of either an individual commodity or categories of a commodity.

The findings tend to suggest that agricultural commodities provide better diversification benefits compared to metal and energy commodities. The results also show that Global financial crisis had a significant negative impact on the integration of the indices, in which correlation of metal commodities with MSCI World Islamic Index is showing a highly fluctuating correlation throughout the tested period, particularly since the 2007–2008 financial crisis. This is same for the correlation of energy commodities with MSCI World Islamic Index. Contrarily, despite the aforementioned results reflecting highly fluctuating correlation of metal and energy sectors, gold from metal commodities and natural gas and palm oil from Energy commodities tend to give somehow better diversification benefits. From this research point of view portfolio diversification benefits can be achieved based on the extent of the dynamic correlations between some commodities and MSCI World Islamic Index. As our results suggest, natural gas, gold, wheat, sugar, coffee and corn have relatively low correlation, compared to rest of the commodities while copper, crude oil, heating oil, gasoline, aluminium and zinc have relatively high correlation. This shows that medium-to-long term investors could gain a better diversification benefit for most of these commodities during all the markets periods.

## **2. Introduction to Islamic financial market**

Islamic finance has rapidly grown over time due to its banking sector that has become systemically important in many countries. Islamic finance is anticipated to keep on expanding in the light of economic development in countries with substantial and generally unbanked Muslim populations. It is furthermore fuelled by the large savings accumulated by various oil-exporting countries that are seeking to invest in *Shariah*-compliant financial products (Kammer et al., 2015).

Since 1990s, there have been intense developments in Islamic funds all over the world. Recently, different capital market products have emerged and have become accessible for Muslims who wish to invest and transact in the Islamic capital market. This occurred as a result of the request from Muslims to participate in capital market investment and in context of the recent growing trend throughout the Muslim world where Muslims are struggling for the implementation of *Shariah* in every walk of their life including investments (Tahir and Brimble, 2011).

Muslim investors are barred from placing their capital into any organizations that are engaged with impermissible (*haram*) businesses. These businesses include, and are not limited to, borrowing and lending on interest (*riba*), gambling (*maysir*), production and selling of alcohol (*khamr*), farming and processing of pork, and entering into excessive risk businesses such as insurance and derivatives (*gharar*). As a result, Islamic funds are created with an intention to address the needs of Muslim investors in order to place their capitals into organizations which are permissible (*halal*) according to the teachings of Islam (Saiti and Abdullah, 2016).

### 2.1. Morgan Stanley Capital International (MSCI) *Shariah*-compliant stocks screening methodology

In the context of current *Shariah*-compliant equity screening practices, the main purpose of *Shariah* screening is to identify for Muslim investors whether investments of the companies are *Shariah*-compliant or not. *Shariah* investment principles do not allow investment in companies deriving substantial earnings from interest or companies that have unnecessary leverage. As mentioned earlier about *Shariah*-compliant screening, this research has made it clear that there are no standard screening methods hence it has been observed from different approaches with different goals, guided by different dealings and standards, as there is no universal predetermined fixed set of *Shariah* screening (MSCI, 2016). Due to that MSCI uses the following three financial ratios for screening its companies as shown in Table 1:

**Table 1.** The MSCI Numerator and Denominator.

Numerator	Denominator	
	Islamic Index Series	Islamic Index M-Series
Total Debt	Total Assets <sup>1</sup>	Average Issuer <sup>2</sup> Market Capitalization
Sum of a company's cash and interest-bearing securities		
Sum of a company's accounts receivables and cash		

Note: source: MSCI Islamic index series methodology.

This yardstick will be applied to the following countries: Gulf Cooperation Council (GCC) Countries ex Saudi Arabia (Bahrain, Oman, Qatar, Kuwait and United Arab Emirates), Malaysia, Pakistan, Bangladesh, Egypt, Indonesia, and Turkey, and none of the current MSCI Islamic Index companies' financial ratios may exceed the thresholds specified in the table below. Securities will be

<sup>1</sup> Total assets represent the total assets of a company based on the latest publically available financial report.

<sup>2</sup> The average market capitalization is calculated as the average of month-end market capitalization of the last 36 months prior to the rebalancing. For example, data from May 2011 to April 2014 will be used to determine average market capitalization for May 2014 rebalancing. In the cases where there are fewer than 36 months of available data, the calculation includes the months for which the data is available.

considered non-*Shariah*-compliant with respect to the financial screening if the financial ratios exceed the respective thresholds during an Index Review (refer to Table 2).

**Table 2.** The MSCI financial screening thresholds.

Ratio	Islamic Index Series	Islamic Index M-Series
Total Debt	33.33%	33.33%
Sum of a company's cash and interest-bearing securities	33.33%	33.33%
Sum of a company's accounts receivables and cash	33.33%	49.00%

Note: source: MSCI Islamic index series methodology.

Additionally, in order to manage index turnover as a result of the financial screening, MSCI considers a lower threshold in determining new inclusions to the *Shariah* Indexes. A security that is currently not an integral part of the MSCI Islamic Indexes will be considered *Shariah*-compliant with respect to the financial screening only if all the three financial ratios do not exceed the thresholds specified in the Table 3.

**Table 3.** The MSCI financial screening threshold for new insertions.

Ratio	Islamic Index Series	Islamic Index M-Series
Total Debt	30.00%	30.00%
Sum of a company's cash and interest-bearing securities	30.00%	30.00%
Sum of a company's accounts receivables and cash	30.00%	46.00%

Note: source: MSCI Islamic index series methodology.

### 3. Theoretical underpinnings and literature review

#### 3.1. Theoretical underpinnings

The Efficient Market Hypothesis (EMH) implies that a market is said to be efficient if the security prices “fully reflect” available information about the security and instantaneously adjust to the availability of new information in the market (Malkiel and Fama, 1970). This theory of efficient market tells that an investor should not rely on readily available information in order to predict the movements of security prices in the future. Malkiel and Fama's (1970) empirical test on the price adjustments towards the types of relevant information can be divided into three categories, namely weak form, semi-strong form and strong form tests. The weak form test asserts that future stock prices can be predicted on the basis of historical prices. Whereas, the semi-strong form of EMH says that all publicly available information is already reflected in stock prices, hence prediction of future prices based on this would have no value. This includes company's announcements, financial statement, accounting ratios and other non-market information. Lastly, in its strong form, the EMH asserts that a market is efficient if all relevant information regarding the value of a stock, whether publicly available or privately held, is fully and quickly reflected in the market price. For instance, the holders of privately held information will continuously buy under-valued stocks to exploit market pricing anomaly until the stock prices go up and stabilize at a new equilibrium due to the excess demand (Saiti and Noordin, 2018).

Another theory that formed the basis for this study is the Modern Portfolio Theory (MPT), which was first developed by the Nobel Prize winner, Harry Markowitz and was published in the *Journal of Finance* under the title “Portfolio Selection” in 1952. This theory implies that the choice of portfolio is made according to the expected return and variance of return on underlying assets, whereby the former is perceived as a “desirable thing” and the latter as an “undesirable thing” by the investors (Markowitz, 1952). In other word, the investors are inclined to maximize the expected returns at a given level of risk or receive similar expected returns with reduced risks. This concept of investment behaviour has led to the formulation of an efficient frontier that serves as a useful tool for the investors to select the most desirable portfolio based on their risk and return preferences (Elton and Gruber, 1997).

Another rule provided by this theory that becomes an important theoretical foundation for portfolio diversification research is that the investors should “diversify their investments among all those securities which give maximum expected return” (Markowitz, 1952). This can be done by combining securities that are not perfectly correlated in a portfolio. By holding a diversified portfolio, the investors would be able to reduce their exposure to risks embedded in individual assets hence receive higher risk-adjusted returns (Bines, 1976). The lower the correlation between underlying assets, the greater the reduction in risk. This rule also implies that an asset should not be assessed based on its own unique characteristics, an investor instead needs to evaluate its co-movements with other assets in the market and how it affects a portfolio’s overall risk and return. In respect of asset evaluation, Rubinstein (2002) asserted that according to the MPT, the investor’s decision to hold an asset should be made by comparing its expected return and variance to that of other relevant investment choices.

In relation to portfolio diversification, the CAPM implies that unsystematic risks associated with individual stocks can be eliminated by increasing the number of constituent stocks in a portfolio (Sharpe, 1970). In addition, the CAPM provides ways to measure the systematic risk, which cannot be eliminated through diversification. It can also be concluded under the CAPM that an investor who holds a diversified portfolio would bare lower risk compared to undiversified investors, hence is willing to receive lower expected returns or pay a higher price. The CAPM however, is not entirely free from any limitations and criticisms. Contrary to the assumptions made by the CAPM, Merton (1973) argued that expected returns on risky assets may vary from that of risk-free assets in the absence of systematic or market risks.

### 3.2. Literature review

Information on market correlations and return co-movements are significant for all stakeholders in the context of investments. Several researches conducted by various researchers in the context of integration are either based on sectors or cross border integration. This research will concentrate more on cross border integration as we can observe that cross border market correlation has been an issue for the market players, both the investors and the managers, despite the benefits it has brought to the managers by increasing their sources of finance. When we look at the literature on the integration of European financial markets as conventional markets before the emergence of Islamic Markets, we can observe that correlation between markets had started decades ago. Starting from Longin and Solnik (1995), who using M-GARCH discovered a co-movement between seven major markets during their time of reference, which include Germany, France, United kingdom,

Switzerland, Japan, Canada, and United States. They witnessed that the co-movement significantly increased between 1960 and 1990. Johnson and Soenen (2002) examined the equity market correlation between Japanese stock market and twelve other equity markets in Asia, in which their results also showed that the equity markets of Australia, Malaysia, China, Singapore, Hong Kong, and New Zealand are highly integrated with the stock market in Japan. Bekaert et al. (2005), examined international stock return co-movements using country-industry and country-style portfolios and found that the correlations between individual stock prices do not automatically increase when the international financial markets become more integrated. This literally confirms the correlation between the markets but confirming the remaining of diversification benefits within the individual stocks, while before that Berben and Jansen (2002) found that numerous investors are willing to invest, but yet in the meantime the level of co-movement among markets appears to have increased over the recent years. It means that the increase in market correlation is making investors afraid of making investments and these correlations between markets have been going on as is confirmed by various researches conducted by Eun and Lee (2010), Lahrech and Sylwester (2011). Recently Uddin et al. (2014) examined the correlation within the centre of Euro and four major international stock markets i.e. between Germany and, US, Canada, Japan, and Australia using daily data from 01 June 1992 to 26 March 2013 in the time and frequency space by resorting to wavelet analysis, and found an increase in correlations which were fuelled by the financial crisis. Beside that there are many recent studies that confirm the increase of market correlation in the context of conventional investments such as (Bentes, 2015; Cao et al., 2017; Deltuvaitė, 2015; Kryzanowski et al., 2016; Oanea, 2015; Siedlecki and Papla, 2016; Vithessonthi and Kumarasinghe, 2016; Zhang et al., 2016).

From the few research papers we have for the case of Islamic financial markets, most of them confirm that Islamic financial markets of the Muslims and Non-Muslims countries were not left behind in terms of correlation. Starting from year 2000, Darrat et al. (2000), in their analyses on the three major stock markets of Middle East and North African countries (MENA), i.e. Egypt, Morocco, and Jordan, found that the three markets were integrated among themselves but offered diversification potentials for international investors as they were not integrated with the world's major stock markets. Furthermore, Hassan (2003) confirmed that there was an increase in integration between stock markets in the Gulf region. The confirmation comes from their study on the relationship of share prices among the Kuwait, Bahrain, and Oman stock markets. They found that there was a considerable correlation within the markets in March 1995 due to their cross listing, in which Bahrain stock market formed a full connection with Omani stock market. The research shows that it's one of their main objectives to work towards economic integration to form a single market. This is to harmonize their economic policies to achieve economic integration. Ceylan and Dogan (2004), conduct a study on the stock market integration among some members with the objective of examining the impact of the 11 September 2001 event on their Islamic stock markets. The study is conducted for Egypt, Jordan, Kuwait, Lebanon, Morocco, Oman, Pakistan, and Turkey by focusing on their daily stock market data over the two sub-periods, from 1999 to 2004, namely the pre- and post- 11 September 2001 periods, and their results suggest that these countries' stock markets have become more integrated following the September 11 incident. On the other hand Marshdeh and Shrestha (2010), include more stock markets, in their study on the long-run relationship and linkages among Gulf Cooperation Council (GCC) stock markets, namely, Oman, Qatar, Bahrain, Kuwait,

Saudi Arabia and United Arab Emirates. Their results suggest that the GCC stock markets are not entirely integrated with each other leaving opportunities between some of the markets in the region.

In the case of Asian Islamic financial markets, Naseri and Masih (2014) found a strong financial integration between Islamic stock markets of China and Malaysia, while a low correlation was found with the US Islamic stock market. This finding comes from their analyses of the extent of financial integration Japan, U.S, China and India have achieved with the Malaysian Islamic stock market. In the case of Japan and Malaysia, they found that Malaysian investors could get a diversification benefit on their portfolios in Japan and US markets in the long run and short run respectively. While Hussin et al. (2013), found that no long-run nor equilibrium relationship exists between FTSE Bursa Malaysia Emas *Shariah* (FBMES), Jakarta Islamic Index (JAKISL), and Dow Jones Islamic Market index (DJIM). The result came from the effort they put in investigating the co-integration between Islamic stock market of Malaysia, Indonesia and the world, using Vector Auto Regression (VAR) method. They concluded that the Islamic stock market of Malaysia does not integrate with Indonesia's, as well as with the world markets in the long run, which creates room both for local and international investors to diversify their Islamic investment portfolios. At the same time, they found that the return of Islamic stock market in Indonesia was considerably affected by the return of Islamic stock market in Malaysia and they placed Malaysia as one of investors' favourite investment destinations.

Due to current increase in equity markets correlation and volatility, investors, other market players and researchers are now questioning the role of commodities as a diversifying asset class and have garnered significant attention to it as it offers refuge in the period of financial turmoil. Many researchers have found a significant benefit associated with commodity investments and the majority of the previous research agrees on the diversification benefits of commodities since the previous researchers confirm the negative correlation of commodities with tradition financial. To begin with, Conover et al. (2010) found strong evidence for the fact that commodity futures offer an equity investor a significant benefit as an instrument of diversification and it significantly reduces risk of portfolio when at least ten percent or more of the portfolio is allocated to commodity investments. At the same time Chong et al. (2010), also found that adding commodity futures in the context of Treasury-bill portfolios could reduce the risk in interest rate volatile environments, which is better for portfolio diversifiers and a better tool for strategic asset allocation.

Nevertheless there also are a number of contradictory results regarding the consistency of those benefits for equity investors due to current financialization of commodity markets. Cao et al. (2010), state that the perceived benefits from commodity future investments are, reduced risk, a hedge against inflation, high returns and portfolio diversification, but the problems of insurance, costs of storage, feeding, veterinarian bills, among others might make it impossible to make long-term investments in most physical commodities, hence its costs may exceed its gains. Hansen-tangen and Overaae (2015), using data for the period of 2000–2014 found that the commodities have been financialized and as a result have contributed to reduce risk-adjusted return and have increased the volatility for most of strategies because the benefits of adding commodities depend on the allocation strategy as well as the period under consideration. Furthermore, their result indicated that the benefits of adding commodities have nearly disappeared, as the period of their analysis does not show the benefits of commodities. They believe most of the studies that show the benefits of commodities are limited to in-sample mean-variance analysis and do not consider the challenge of setting up an allocation strategy. While in contrast Daskalaki et al. (2016), using stochastic dominance efficiency (SDE) approach, found that commodities deliver diversification benefits both in- and out-of-sample.



At the same time their result shows that commodity is an assets class, which is segmented from the equity and bond markets.

A correlation between commodities and traditional financial markets does exist but is not significantly enough to deteriorate the benefits offered by commodity markets. According to Nagayev and Masih (2013) and Ngayev et al. (2016), in the last few years, correlation between commodities and traditional markets is declining, due to which Islamic investors are hopeful to gain diversification benefits by attaching commodities to their portfolios. Bessler and Wolff (2015), found that the out-of-sample benefits of commodities are much lower than previous in-sample analyses suggest. Actually, out-of-sample portfolio benefits differ for types of commodities and the periods. In addition Belousova and Dorfleitner (2012) confirm that commodities are valuable investable instruments from the perspective of diversification. As a result the investors can benefit from the diversification in commodities as the diversification gains hold both in the sample of physical commodities as well as commodity futures.

According to Daskalaki et al. (2014), low correlations of commodities markets with stocks and bonds markets are based on different risk factors, for example, the supply conditions or the weather, and even the geopolitical events that are believed to change the commodity price. Despite the low to negative correlation of equity and commodity only a small percentage of the available funds are invested in Islamic commodities, showing that this particular market is highly unexploited (Hassan and Girard, 2010). Abdullah et al. (2016) found that an investor should be aware that the Philippine Islamic stock index is less correlated with the crude oil in the short run (as evidenced in the continuous wavelet transform analysis) and that an investor holding the crude oil can gain by including the Malaysian Islamic stock index in the portfolio (as evidenced in the Dynamic conditional correlation analysis). Sakti et al. (2018) found that the greater benefits will be obtained by *Shariah* compliant investors if they invest in the USA Islamic indices during long-term investment horizons. If investors want to invest in medium investment horizons, investing in India Islamic equity is a viable option. The findings further suggest that gold leads to diversification benefits and hence is a “safe haven” instrument for investors.

The above literature suggests pressing evidence to exist pertaining to equity markets correlation, which include Islamic and Conventional markets and these correlations as proven to have a negative effect for markets players particularly for investors all over the world despite the fact that little diversification benefits are offered by Islamic markets to investors. The literature provided also indicates the effects of financial markets integration in the case of financial markets crises, as during the time of crises markets are easy to be transformed to other markets whether they are Islamic or Conventional. Furthermore, the literature tries to explain the argument concerning investment in commodities which offer diversification benefits, by serving as an inflation hedge, and by enhancing returns. Most of the literature reinforces these ideas while other studies stress on the difficulty to achieve it, for instance, energy sector covering oil and gas, is quite different in terms of volatility compared to gold that is a safe-haven and which constitutes a part of precious metals. The following research will provide appropriate commodities that will be suitable to achieve the benefits of diversification in commodities.

## 4. Research methodology

### 4.1. Data

This research paper has used some set commodities returns and the returns of MSCI World Islamic index. Daily closing prices of 18 commodities were used, which were derived from the Dow Jones Commodity Index over an approximate period of 9 and half years, from 1<sup>st</sup> of June 2007 to January 2017. From the side of MSCI World Islamic Index equity markets, the data regarding daily closing price of MSCI World Islamic index were extracted since its inception date. The whole data were extracted from the Thomson Reuters DataStream database, with the price series quoted in US dollars, in order to easily assess the correlations between the two markets, i.e. equity and commodities.

The returns of the equity index and the commodities index were then derived by calculating the differences of the logarithmic daily closing price,  $[\ln(p_t) - \ln(p_{t-1})]$ , where  $p_t$  and  $p_{t-1}$  represent the stock price indices at time  $t$  and  $t-1$  respectively.

This research has clustered the commodities into four categories. I) Metals commodities are Gold, Silver, Aluminium, Copper and Zinc. II) Energy commodities are Crude oil, Natural gas, Gasoline, Heating oil and Crude palm oil. III) Agricultural commodities (first category) are Wheat, Grains, Corn and Sugar. IV) Agricultural commodities (second category) are Soybeans, Cocoa, Coffee and Cotton. Due to these clusters we run four different analyses by drawing a comparison between MSCI Islamic equity and the four classes of commodities as follows: (i) MSCI World Islamic Index and metals commodities; (ii) MSCI World Islamic Index and Energy; (iii) MSCI World Islamic Index and Agricultural commodities (first category); (iv) MSCI World Islamic Index and Agricultural commodities (second category).

### 4.2. Estimation methods

Multivariate Generalized Autoregressive Conditional Heteroscedastic (MGARCH) model, MGARCH or Multivariate GARCH model is used to study the relationship between the volatilities and co-volatilities of several markets, which helps us identify the answers for some of the following research questions; Whether the volatility of some markets can lead to the volatility in other markets? Does the volatility of an asset transmit to other assets directly through its conditional variance or indirectly through its conditional covariance? Does shock in some market increase the volatility in another market and if it does, by how much? Furthermore, it helps to analyze whether the correlations between asset returns change over time and whether they are higher during periods of higher volatility? Are they associated with financial crises? Are they increasing in the long run, perhaps because of the globalization of financial markets? All of these above issues can be studied directly by using a Multivariate GARCH model (Bauwens et al., 2006) while DCC model will allow the research to observe and analyze the precise timings of the shifts in conditional correlation as DCC is a popular estimation procedure which is practically flexible in showing individual volatilities and can be applied to portfolios with a large number of assets.

Therefore, in order for us to identify the benefits of diversification in commodities for MSCI Islamic index investors, this Multivariate GARCH-DCC approach is adopted to precisely indicate changes in volatility and correlation of the selected indices over the time, together with its directions (positive or negative) and magnitude (stronger or weaker) as used by Saiti et al. (2014).

This well-established MGARCH-DCC technique was proposed by Engle and Kevin (2001) and Engle (2002) and significantly improves the Constant Conditional Correlation (CCC-GARCH) model of Bollerslev (1990). We adopted it in order to investigate the correlation dynamics between a set of a selected class of commodities and MSCI World Islamic index returns.

The Dynamic Conditional Correlation Multivariate GARCH (DCC) model is the advanced version of the CCC model. The DCC decreases the assumption of CCC that the conditional correlations between series are constant, which looks unrealistic in many empirical applications. This model is called DCC. Another difficulty is that the time dependent conditional correlation matrix must be positive definite. The model involves two steps of estimation: First, estimate the variable from univariate GARCH to generate the standard deviations. Second, using the standard deviations to calculate the standardized residuals, the correlation matrix is estimated. Following Engle (2002),  $H_t$  is a Multivariate conditional covariance matrix and is:

$$H_t = D_t R_t D_t$$

Where,  $R_t = k \times k$  times varying correlation matrix ( $R_t$  varies over time) and  $D_t = k \times k$  diagonal matrix of conditional, i.e. time varying, standardized residuals  $\varepsilon_t$ , that are obtained from the univariate GARCH models.

The log-likelihood of the above estimator can be written as follow:

$$\begin{aligned} L &= -\frac{1}{2} \sum_{t=1}^T (k \log(2\pi) + 2 \log |H_t| + r_t H_t^{-1} r_t) \\ &= -\frac{1}{2} \sum_{t=1}^T (k \log(2\pi) + 2 \log |D_t R_t D_t| + r_t D_t^{-1} R_t^{-1} D_t^{-1} r_t) \\ &= -\frac{1}{2} \sum_{t=1}^T (k \log(2\pi) + 2 \log |D_t| + \log(|R_t| + \varepsilon_t R_t^{-1} \varepsilon_t)) \end{aligned}$$

Where,  $\varepsilon_t \sim N(0, R_t)$  are the residuals standardized on the basis of their conditional standard deviations. First, the conditional variances for any individual asset can be obtained from the univariate GARCH model as follows:

$$h_{it} = \omega_i + \sum_{p=1}^{P_i} \alpha_{ip} r_{it-p}^2 + \sum_{q=1}^{Q_i} \beta_{iq} h_{it-p} \text{ for } i = 1, 2, 3, \dots, k$$

Where  $\omega_i$ ,  $\alpha_{ip}$  and  $\beta_{iq}$  are non-negative and  $\sum_{p=1}^{P_i} \alpha_{ip} + \sum_{q=1}^{Q_i} \beta_{iq} < 1$ .  $h_{it}$  is the estimated conditional variance of an individual asset,  $\alpha_{ip}$  is the short-run persistence of shocks to return P (the ARCH effects) and  $\beta_{iq}$  is the contribution of shocks to return Q to long-run persistence (the GARCH effects).

Then proposed dynamic correlation structure is:

$$Q = (1 - \sum_{m=1}^M \alpha_m - \sum_{n=1}^N \beta_n) \bar{Q} + \sum_{m=1}^M \alpha_m (\varepsilon_{t-m} \varepsilon_{t-m}) + \sum_{n=1}^N \beta_n Q_{t-n}$$

$$R_t = Q_t^{*-1} Q_t Q_t^{*-1}$$

Where,  $\bar{Q}$  is the unconditional covariance of the standardized residuals resulting from the univariate GARCH equation and  $Q^*$  is a diagonal matrix composed of the square root of the diagonal elements of  $Q_t$ , which is as follows:

$$Q_t^* = \begin{bmatrix} \sqrt{q_{11}} & 0 & \dots & 0 \\ 0 & \sqrt{q_{22}} & \dots & 0 \\ \vdots & \vdots & \vdots & 0 \\ 0 & 0 & \dots & \sqrt{q_{kk}} \end{bmatrix}$$

The typical element of  $R_t$  will be  $P_{ijt} = \frac{q_{ijt}}{\sqrt{q_{ii}q_{jj}}}$  and the matrix  $R_t$  will be positive definite/constant. The K assets covariance  $H_t$  is thus a positive definite/constant and can be written as  $H_t = D_t R_t D_t$ .

The decomposition of  $H_t$  allows separate specification of the conditional volatilities and conditional cross asset returns correlations. For example, one can utilize the GARCH (1, 1) model for the variance  $\sigma_{i,t-1}^2$ , namely:

$$V(r_{it} | \Omega_{t-1}) = \sigma_{i,t-1}^2 = \bar{\sigma}_i^2 (1 - \lambda_{1i} - \lambda_{2i}) + \lambda_{1i} \sigma_{i,t-2}^2 + \lambda_{2i} r_{i,t-1}^2$$

Where,  $\bar{\sigma}_i^2$  is the unconditional variance of the asset return.  $\lambda_1$  and  $\lambda_2$  are asset specific volatility parameters (individual asset return volatilities). Under the restriction  $\lambda_{1i} + \lambda_{2i} = 1$ , the unconditional variance disappears in the above equation and we have the Integrated GARCH (IGARCH) model, which tells us that conditional variance is non-stationary, and the shock to variance is permanent.

## 5. Empirical results

### 5.1. Descriptive analysis

Table 4 presents the descriptive statistics for the daily selected market returns which are MSCI World Islamic Index and some set of commodities in four classes. It reports their mean, median, maximum, minimum, standard deviation of the selected sample, skewness and kurtosis. The table below shows that the mean returns of MSCI World Islamic Index, Grain, Sugar, Soybean, Cocoa, Coffee, Cotton, Gold and Silver are positive while the rest of the variables show negative returns. Average returns are less comparative to standard deviations, in which as represented by the standard deviations, Natural Gas is found to have the highest returns volatility followed by Crude oil and Gasoline while MSCI World Islamic Index recorded the lowest returns volatility followed by Gold and Aluminium. These standard deviations show absolute time independent volatility of the returns. The asymmetric property of any distribution is indicated by the skewness where the findings show that all the series returns are negatively skewed except for coffee and natural gas which are suggesting a high probability of negative returns, not symmetric, and are leading to higher variability

and risk. The wideness of the distribution can be measured by the kurtosis which describes how concentrated the data is around the mean of the distribution.

**Table 4.** Descriptive statistics of MSCI and the selected commodities indices.

	Mean	Median	Max	Min	Std Dev	Skew	Kurt
Equity							
MSCII	0.00005	0.00047	0.09829	-0.08149	0.011204	-0.44227	9.004351
Agric 1st category							
Wheat	-0.00009	0	0.08795	-0.09973	0.020991	-0.03225	1.773507
Grain	0.00005	0	0.07148	-0.0779	0.01539	-0.15399	2.392249
Corn	-0.00004	0	0.08661	-0.08127	0.018955	-0.04542	1.983337
Sugar	0.00029	0	0.08558	-0.12364	0.020825	-0.26573	2.457477
Agric 2nd category							
Soya	0.00009	0	0.06436	-0.0734	0.01586	-0.28541	2.183772
Cocoa	0.00005	0	0.08339	-0.09693	0.017185	-0.2794	2.859227
Coffee	0.00008	0	0.10853	-0.11251	0.019713	0.040819	1.964178
Cotton	0.00013	0	0.06937	-0.07119	0.017265	-0.16442	1.39525
Metal commodities							
Gold	0.00022	0	0.08589	-0.09811	0.012236	-0.25638	5.458828
Silver	0.00007	0.00018	0.1247	-0.19489	0.021827	-0.74895	6.255829
Alum	-0.00020	0	0.05927	-0.07499	0.014099	-0.14269	1.821223
Copper	-0.00012	0	0.11902	-0.1038	0.017873	-0.12019	4.038187
Zinc	-0.00015	0	0.09924	-0.11127	0.020228	-0.07305	2.3755
Energy commodities							
COil	-0.00007	0	0.13342	-0.13066	0.023326	-0.06448	3.445546
NG	-0.00030	0	0.17128	-0.13798	0.027782	0.225425	1.892638
Gol	-0.00011	0	0.12973	-0.11179	0.022305	-0.17829	3.223199
HOil	-0.00003	0	0.10066	-0.09679	0.019795	-0.00865	2.84129
POil	-0.00002	0	0.10567	-0.12921	0.019489	-0.13282	4.950647

## 5.2. Empirical results

Under MGARCH-DCC method, the main research question on whether the commodities provide any diversification benefits to the Islamic Index investors will be answered, in which some analysis were conducted starting from comparison of Gaussian DCC Model and the t-DCC model together with plotting the estimated conditional volatilities and correlations.

### 5.2.1. Model selection

Firstly, the comparison of Gaussian DCC Model and the t-DCC model was made to determine the model with relatively higher significance. No cases of non-convergence were encountered and besides that the Maximum Likelihood estimates of the Gaussian DCC and t-DCC models on stock indices daily returns were obtained.

For the purpose of comparison of the Gaussian DCC with the t-DCC models the Maximized Log-Likelihood (ML) estimates of both the Gaussian DCC and the t-DCC models were made as

shown in the summary in Table 5. It is simple to determine which model is relatively more significant for volatility and estimate the correlations between the returns of the MSCI World Islamic Index and all selected commodities indices.

**Table 5.** Summary for Maximized Log-Likelihood (ML).

No	Analyses	Gaussian model	t-DCC model	The estimated d.f. for the t-normal distribution
1	The variables (asset returns) of MSCII, GOLD, SILVER, ALUM, COPPER and ZINC	46447.1	46959.5	6.1312
2	The variables (asset returns) of MSCII, COIL, NG, GOL, HOIL and POIL	43488.5	43691.9	10.7135
3	The variables (asset returns) of MSCII, WHEAT, GRAIN, CORN and SUGAR	37447	37691.7	8.2495
4	The variables (asset returns) of MSCII, COCOA, COFFEE, SOYBEANS and COTTON	35484.1	35683.1	9.0613

We found that the maximized log-likelihood values under the t-DCC model are larger than the one obtained under the Gaussian model and the estimated degree of freedom for the t-normal distribution is below 30 in all cases. Therefore, this result implies that the t-distribution model is a more appropriate model for capturing the fat-tailed nature of the distribution of the returns of all variables.

### 5.3. *Benefits of diversification with commodities*

#### 5.3.1. Unconditional volatilities and correlations of metals commodities

The left-hand side of Table 6 represents the unconditional volatilities in numbers. In the context of volatility, if the unconditional volatility is close to zero, it means that the particular index has the least volatility and if the unconditional volatility is near to 1, it contrarily means that the particular index has a higher volatility. As the continuation of our analyses, the metal class of commodities is compared with MSCI World Islamic Index and the MSCI Islamic Index is found to be the least volatile one with volatility 0.011, followed by Gold, Aluminium and Copper assets which also have low volatilities (0.012, 0.014 and 0.017) respectively, compared to Zinc and Silver with moderately higher volatilities of 0.020 and 0.021. At the same time, the right-hand side of Table 6 also explains the unconditional correlations which assume the relationship between MSCI World Islamic Index and Metal commodities is constant and does not change over time. The unconditional correlations of the Metal commodities with MSCI Islamic index returns range from 0.15827 to 0.53793. The results indicate that copper is the most correlated commodity with MSCI World Islamic Index with a volatility 0.53793 followed by aluminium with 0.43770 and zinc with 0.41997 volatilities. The least correlated commodity assets in relation to MSCI World Islamic index are gold and silver with correlations of 0.12256 and 0.32674 respectively.

**Table 6.** Ranks of the unconditional volatilities and Correlation of the MSCI World Islamic Index and Metal Commodities Indices returns.

Indices Unconditional Volatilities	Volatility	Indices Unconditional Correlation	Correlation
Equity Index		MSCI Islamic with Metal commodities	
MSCI World Islamic Index	0.01123	Gold	0.15827
Metal commodities		Silver	0.32674
Gold	0.012256	Zinc	0.41997
Aluminium	0.014123	Aluminium	0.4377
Copper	0.01787	Copper	0.53793
Zinc	0.020239		
Silver	0.021863		

### 5.3.2. Unconditional volatilities and correlations of energy commodities

In the case of energy commodities, the left-hand side of Table 7 represents the unconditional volatilities in numbers. As represented the MSCI World Islamic Index, Heating Oil and Palm Oil were found to have the least volatilities compared to rest of the variables with i.e. 0.011250, 0.017818 and 0.019393 respectively, whereas Gasoline, Crude Oil and Natural Gas had moderately high volatilities compared to the earlier ones i.e. 0.022354, 0.023380 and 0.027807 respectively. The right-hand side of Table 7 explains the unconditional correlations which assume the relationship between MSCI World Islamic Index and Energy commodities to be constant and static over time. The unconditional correlations of the indices returns range from 0.11864 to 0.50565. The results indicate that Crude Oil is the most correlated commodity with MSCI World Islamic Index (0.50565) followed by Heating Oil (0.47874) and Gasoline (0.45491). The least correlated commodity assets in relation to MSCI World Islamic in this set are Natural Gas and Palm Oil with correlation 0.11864 and 0.25766 respectively.

**Table 7.** Ranks of the unconditional volatilities and Correlation of the MSCI World Islamic Index and Energy Commodities Indices returns.

Indices Unconditional Volatilities	Volatility	Indices Unconditional Correlation	Correlation
Equity Index		MSCI Islamic with Energy commodities	
MSCI World Islamic Index	0.01123	Natural gas	0.11864
Energy commodities		Palm Oil	0.25766
Heating Oil	0.017818	Gasoline	0.45491
Palm Oil	0.019393	Heating Oil	0.47874
Gasoline	0.022354	Crude Oil	0.50565
Crude Oil	0.02338		
Natural gas	0.027807		

### 5.3.3. Unconditional volatilities and correlations of agricultural commodities

Table 8 shows the estimated unconditional volatilities and unconditional correlations between returns of MSCI World Islamic index and the selected Agricultural commodity indices. Similarly, the left-hand side of Table 8 represents unconditional correlation and unconditional volatilities of the

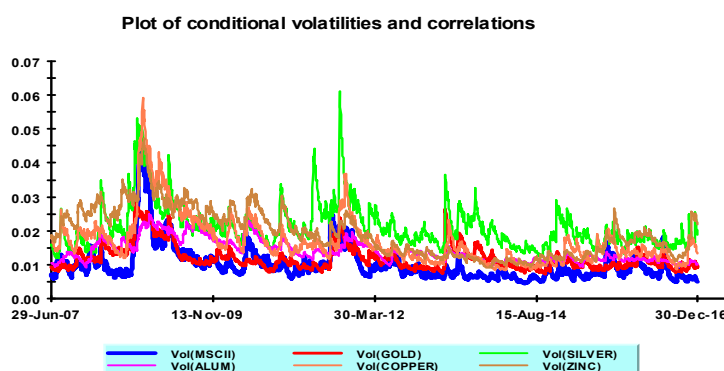
specified indices returns. We can observe that the unconditional volatility of return for Wheat and Sugar to be 0.020957 and 0.020806 respectively i.e. the highest, while the lowest is still the MSCI World Islamic Index with 0.011230, and the moderate ones are Grain and Corn with volatilities 0.015375 and 0.018903 accordingly. Furthermore, the lowest is still the MSCI World Islamic Index and the moderate are Soybean, Cocoa and Cotton with volatilities 0.015866, 0.017204 and 0.017253 respectively, while the highest is Coffee with a volatility of 0.019734. In regard to the returns correlation of the agricultural commodities, we can observe from right-hand side of Table 8 that the highest correlation is between MSCI World Islamic Index and Grains returns i.e. 0.32252 followed by correlation of MSCI World Islamic Index with Wheat, Sugar and Corn i.e. 0.23642, 0.23770 and 0.25656 respectively.

**Table 8.** Ranks of the unconditional volatilities and Correlation of the MSCI World Islamic Index and Energy Commodities Indices returns.

Indices Unconditional Volatilities	Volatility	Indices Unconditional Correlation	Correlation
Equity Index		MSCI Islamic with agricultural commodities	
MSCI World Islamic Index	0.01123	Wheat	0.23642
Agricultural commodities 1st category		Sugar	0.2377
Grain	0.015375	Coffee	0.25279
Corn	0.018903	Corn	0.25656
Sugar	0.020806	Cocoa	0.31067
Wheat	0.020957	Soybean	0.3122
Soya	0.015866	Cotton	0.31555
Cocoa	0.017204	Grain	0.32252
Cotton	0.017253		
Coffee	0.019734		

#### 5.4. The estimated conditional volatilities from all set of analyses for the selected commodities with MSCI World Islamic Index

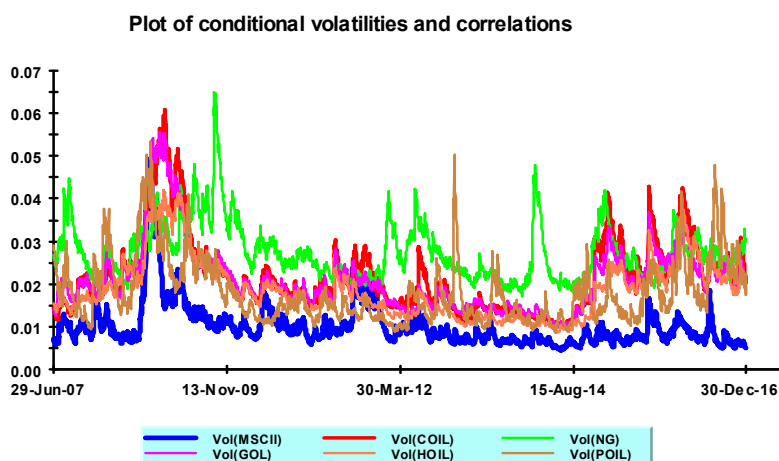
Figures 1 to 4 present the conditional volatilities for the all sets of analyses. In context of conditional volatilities, metals and energy commodities were more volatile than agricultural commodities, particularly during the 2008 global financial crisis as found by (Nagayev et al., 2016).



**Figure 1.** Conditional volatilities of metal commodities with MSCI World Islamic Index.



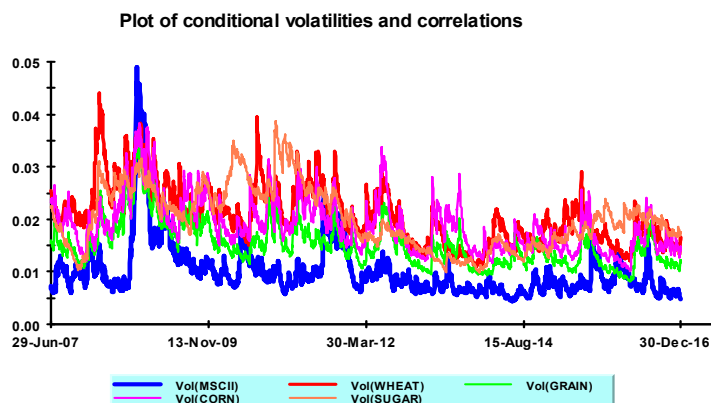
Figure 1 presents the conditional volatilities of metal commodities with MSCI World Islamic Index returns, in which Silver appears to have the highest volatility while the conditional volatilities of MSCI World Islamic index returns tend to move more or less consecutively except during the 2008 to 2011 financial crisis when it fluctuate more than some commodities, though still having the lowest volatility. The figure illustrates that conditional volatilities of the rest are moving more closely together over time. According to Khan and Masih (2014), the sharp rise in prices of metals is known to be steered by an increase in demand of these commodities from India and South China. These newly emerging industrializing economies are the most rapidly growing economies in the world due to intensive use of these raw materials for their industrialization drive, physical infrastructure building and urbanization trends. On the other hand, a dramatic fall was reported for a number of metal prices such as nickel, zinc and copper due to immediate and impending reduction in world demand, notably, a drastic decline in global prospects for construction and automobile industries.



**Figure 2.** The conditional volatilities of Energy commodities with MSCI World Islamic Index.

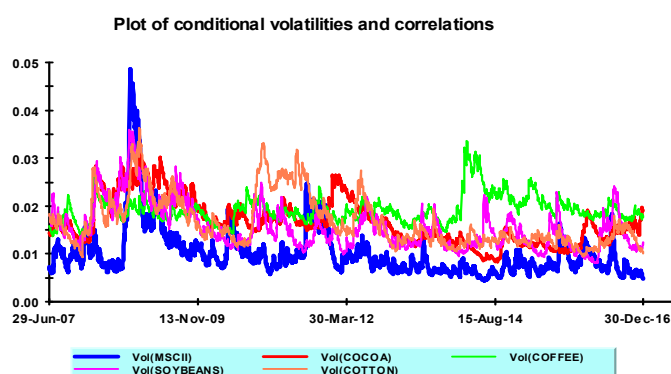
Figure 2 presents the conditional volatilities of MSCI World Islamic Index with Energy commodities indices returns. Similar to the Metal conditional volatilities the MSCI World Islamic Index appears to have the lowest volatility returns while in this case Natural Gas appears to have the highest volatility. In general, all the examined Energy commodities in this research have a higher volatility during the 2008 global financial crisis and after 2014 commodity markets crash during which most of this high volatility in the energy sector is attributed to oil and gas.

From the Figure 3, we can observe that the conditional volatilities of all the examined agricultural commodity returns are moving more closely together except during the financial crisis, when MSCI World Islamic Index returns are highly volatile as compared to others. Generally, this set of analysis shows a lower volatility compared to Metal and Energy sectors.



**Figure 3.** The conditional volatilities of agricultural commodities returns (first category).

Figure 4 confirms that the volatility of agricultural commodities indices returns are substantially lower than for any other commodity. From the figure, the conditional volatility numbers show that Coffee has the highest volatility for the second category of agricultural commodities. An interesting observation from the volatilities graph is that MSCI World Islamic Index appears to have the highest volatility during the 2008 financial crisis but in terms of the numbers it is the lowest in volatility, while the second highest volatility just ahead of Cocoa is that of Cotton.

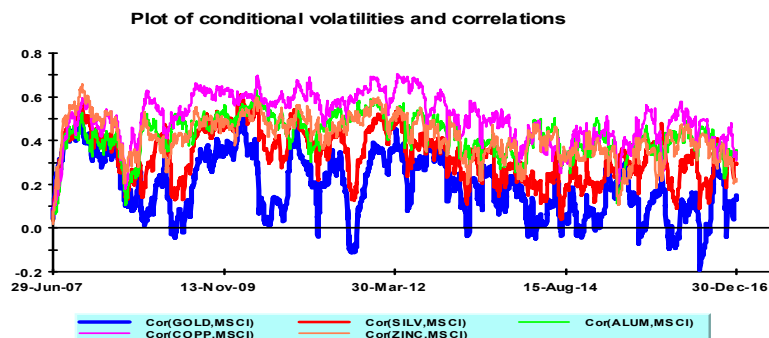


**Figure 4.** The conditional volatilities of agricultural commodities returns (second category).

#### 5.5. *The estimated conditional correlations for all sets of analyses conducted on a selected class of commodities with MSCI World Islamic Index return*

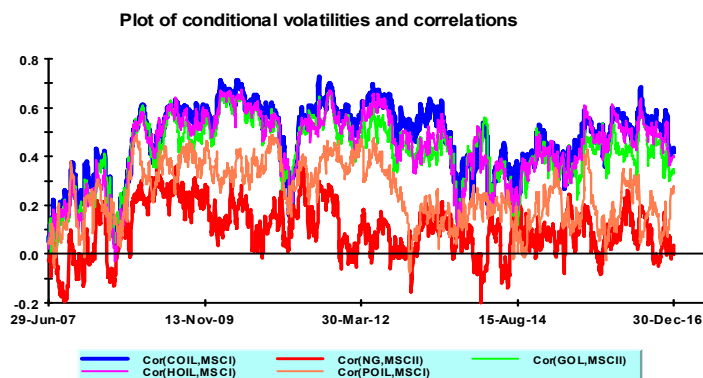
Due to the sharp increase in commodities, many investors have concerns regarding prospective movement of commodities nowadays with respect to changes in the traditional financial assets. This section will provide more evidence and confirm earlier discussion through further enumeration. Using dynamic correlation, we find that the correlation between the returns of MSCI World Islamic Index with the selected classes of commodities has been fluctuating over the time. Figures 6–9 present the conditional correlations of all sets of analyses conducted for the selected classes of commodities with MSCI World Islamic Index return.

Figure 5 presents conditional correlations of MSCI World Islamic Index with Metal Commodities indices. We can notice from the figure above that MSCI World Islamic Index has relatively less and sometimes negative correlation with the Gold commodity followed by Silver commodity. It however has relatively high correlation with Aluminium, Copper and Zinc.



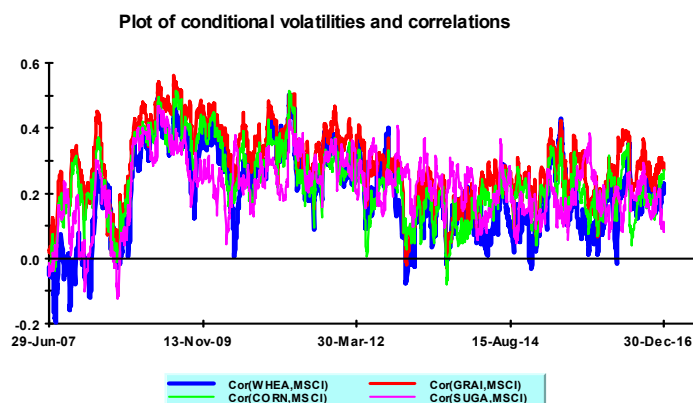
**Figure 5.** The conditional correlations of MSCI World Islamic Index with Metal Commodities.

Figure 6 shows conditional correlations of the MSCI World Islamic stock index returns along with the Energy commodity index returns. Also, from the figure above we can see that the MSCI World Islamic index has relatively less correlation with the Natural Gas followed by Palm oil, while Gasoline, Crude oil and Heating oil have relatively high correlation with the MSCI World Islamic index.

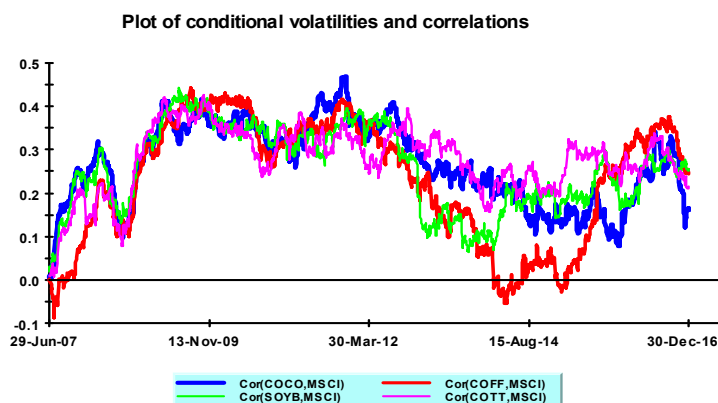


**Figure 6.** The conditional correlations of the MSCI World Islamic stock index returns with the Energy commodities.

From the Figure 7, we can see that conditional correlations of MSCI World Islamic Index with the agricultural commodities indices are almost constant in case of the selected commodities but the correlations are relatively low and changing over the time. From the figure above we have noticed that MSCI World Islamic Index has a relatively lower correlation with Wheat and Sugar followed by Corn commodities index while it has a relatively higher correlation with Grain commodity index.



**Figure 7.** The conditional correlations of MSCI World Islamic Index with the agricultural commodities (first category).



**Figure 8.** The conditional correlations of MSCI World Islamic Index with the agricultural commodities (second category).

Figure 8 gives some preliminary insights into the correlation between the second category of agricultural commodities with MSCI World Islamic index. The figure above allows the readers to picture almost all the movement of the MSCI World Islamic index with the selected agricultural commodities. In particular the figure above shows the correlation between the two assets classes to be moving together, somehow positive but weak. Correlation between MSCI World Islamic index and Coffee commodity index from the graph starts from a negative figure and fall in the negative region in 2014 and again faced a continuous decline followed by rest of the commodities.

## 6. Concluding remarks

In summary of our research paper, we firstly realize the current issues in markets which include the increase in risk of diversification within the same sector. We firstly tried to explain what market correlation is and what makes markets to integrate with each other. We then proceed to explaining the importance of commodities in context of diversification for the Islamic investors as commodity

markets have no *Shariah* issue and since spot trading is permissible according to the principles of *Shariah* as discussed in the research paper. This research paper has discussed the financial integration together with analyzing the extent to which some set of commodities have correlations with MSCI World Islamic Index for the time period between 1<sup>st</sup> June 2007 and January 2017.

In light of the research findings, the correlations of MSCI World Islamic Index with Metal, Energy and Agricultural commodities were found using conditional correlation (DCC) MGARCH methodology, in which we firstly compared Gaussian model and “t” distributions model, however, the t-distribution appears to be more appropriate in capturing the fat-tailed nature of the distributions of the related indices returns. When plotted the estimated conditional volatilities and correlations, Metal and 2<sup>nd</sup> category of Agricultural commodities was found to have less volatility compared to Energy and the 1<sup>st</sup> category of Agricultural commodities. At the same time our results through the same conditional correlation and volatilities plots showed that correlation of Metal commodities with MSCI World Islamic Index was high and volatile throughout the tested period, particularly since the 2007–2008 financial crisis. The same result was found for correlation of Energy commodities with MSCI World Islamic Index. Despite the earlier finding of highly fluctuating correlation of Metal and Energy sectors, Gold from Metal commodities and Natural gas and Palm oil from Energy commodities tend to give somehow better diversification benefits. In the case of 1<sup>st</sup> category of Agricultural commodities, conditional correlations with MSCI World Islamic Index tend to fall over the time specially after 2008 financial crisis, while the 2<sup>nd</sup> category of the conditional correlation of Agricultural commodities stayed high from 2008 financial crisis until post 2012 and started to decline and fluctuate in 2016.

To summarize our findings, let us recall the research question of the paper i.e. which commodities provides diversification benefits to the Islamic equity investors? Firstly, the research shows strong evidence that conditional correlations between MSCI World Islamic Index and the selected commodities indices have been rising since 2007 and 2008 financial crisis and have been highly volatile except for 1<sup>st</sup> category of Agricultural commodities which shows a reverse trend.

To answer the question from point of view of this research, portfolio diversification benefits can be achieved based on the extent of the dynamic correlations between some commodities and MSCI World Islamic Index. In general as our results suggested, Natural gas, Gold Wheat, Sugar, Coffee and Corn have relatively low correlation, compared to rest of the commodities while Copper, Crude oil, Heating oil, Gasoline, Aluminium and Zinc have relatively high correlations. This shows that medium-to-long term investors could gain a better diversification benefit from most of these commodities during all the markets periods.

To answer the second question i.e. given the correlation of commodities with Islamic equity indices, how best can Islamic investors diversify their investment with commodities? This research found that it is important for investors to verify whether the alternative commodity markets could reduce their (investors) market risk exposure and provide diversification benefits to them (investors), as not all the commodities offer the benefits of diversification as reflected in the results of this research.

In context of policy implications of this research, as far as MSCI Islamic stock investors are concerned, the agricultural commodities provide better diversification benefits compared to metal and energy commodities; more specifically, the natural gas, gold, wheat, sugar, coffee and corn have relatively low correlation with MSCI Islamic stock index compared to rest of the commodities.

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