TIME VARYING CORRELATION BETWEEN ISLAMIC EQUITY AND COMMODITY RETURNS: IMPLICATIONS FOR PORTFOLIO DIVERSIFICATION

Aftab Parvez Khan
Sarkar Humayun Kabir
Omar K M R Bashar
A. Mansur M. Masih

Abstract

This paper aims at investigating the time varying relationship between Islamic equity and commodity returns in order to examine how combination of Islamic equities and commodities contribute to the benefits of portfolio investors and managers. In order to investigate this relationship, we employed multivariate GARCH method on return series of five different commodity groups (energy, precious metals, agricultural, non-ferrous metals and softs group), Dow Jones spot commodity index as a proxy of an aggregate commodity market and Dow Jones Islamic index over the period January 3, 2001 - March 28, 2013. Our findings show that correlations between commodity and Islamic stock markets’ returns change in different time periods and these two markets moved very closely during 2008 financial crisis in particular. Besides, volatility of returns in both markets reached at their peaks during the 2008 crisis period. We also show that despite sharing some common features, commodities cannot be considered as a homogeneous asset class: a speculation phenomenon is for instance, highlighted for energy sector comprising oil, while the safe-haven role of gold is evidenced, which constitutes a part of precious metal sector.

Keywords: Islamic Capital Market, Commodity Market, Financial Crisis, Multivariate GARCH Dynamic Conditional Correlations.

1. Introduction

Rapid growth of Islamic finance industry over the last decade, especially during 2008 global financial crisis in particular, attracted research interest both in academia and industry. Fundamentally, different from the conventional financial model, Islamic finance has its religious identity and is based on a set of principles referred to as Shariah (Islamic law). The most important among them are the profit and loss sharing, risk sharing, prohibition of interest, asset-backing principle, and prohibition of excessive uncertainty (El Khalichi et al., 2014). In addition to the Islamic principles, Islamic financial institutions and products must avoid the businesses involving production of liquor, pornography, pork, etc. By applying these principles, the Islamic financial system was established to take into consideration, besides religious aspects, moral, ethical, and social dimensions. Due to the prohibition of interest, the need for equity markets is higher in Islamic finance (Iqbal, 2002). Islamic equities, founded on profit-loss sharing principles, were accepted by Shariah scholars in the early 1990s, which enabled the Muslim high net worth investors to invest in stock markets. Hence, Islamic financial institutions as well as investors seeking for profit earned from their

1 Taylor’s Business School, Taylor’s University, Lakeside Campus, PJ, Malaysia. Email:aftab113@hotmail.com.
2 Taylor’s Business School, Taylor’s University, Lakeside Campus, PJ, Malaysia. Email: kabir.sarkar@gmail.com.
3 Swinburne Business School, Swinburne University of Technology, Australia. Email: obashar@swin.edu.au.
4 The Global University of Islamic Finance (INCEIF), Malaysia. Email: mansurmasih@gmail.com
portfolio through ownership of assets are involved in the stock markets. Furthermore, the establishment of equity benchmarks such as Dow Jones Islamic Market Index (DJI) and FTSE Global Islamic Index Series has been a turning point for the industry, providing a comparative platform between indices.

Most of the Investors in the major financial markets experienced increasing volatility of return over the last two decades due to financial crises. Return volatility was the highest in the major stock markets around the world followed by sever market meltdown during the 2008 subprime crisis. Consequently, many portfolio investors tend to find alternative investment instruments and they started to invest in different commodities and commodity derivatives. Commodity prices have soared gradually over the last decade but prices jumped when international portfolio investors started to diversify their investment in commodity markets, particularly during 2008 financial crisis. Increasing investment in commodities eventually transmitted stock market volatility into commodity markets. As a result, commodity prices and returns became highly volatile due to increasing correlation between equity and commodity markets leading to another downturn in the commodity markets, which can be seen from the following Figure 1:

Figure 1 shows that conditional volatility of returns in both commodity and Islamic equity markets has increased in 2009 indicating high correlation between these two markets. During 2008 there were dramatic swings in the prices of some commodities, perhaps none more so than WTI Oil. WTI Oil began 2008 trading at $96 per barrel, reached a high of $145 in July 2008 and then plummeted to a low of $32 in December 2008. Brent prices have displayed a similar behavior, trading at $23.95 per barrel in January 2000 and reaching $108.09 per barrel by December 2011. Similarly, the wheat unit price began trading at $107 in January 2000 and reached a high of $306 in December 2011. These large price swings have quickly focused upon whether the sharp increase of more speculative traders in commodity markets (who view commodities as “financial assets” rather than “real assets”) has contributed to such swings in market prices. This evolution can be compared to that of Islamic financial markets, representing the Dow Jones Islamic Index and Dow Jones Commodity spot price returns’ volatility. While macrorconomic forces, including demand from commodity intensive industrializing economies, played a key role in this boom and bust, other factors, including the financialization of commodity derivatives markets, contributed. Institutional investors and
hedge funds have intensified their interest in commodities as an alternative to traditional asset classes, allocating funds to indices such as the Goldman Sachs Commodities Index (GSCI), and trading in derivatives markets (Silvennoinen and Thorp, 2013).

This paper investigates the time varying relationship between Islamic equity and commodity markets by investigating the dynamic correlation and volatility between their returns. In order to investigate this relationship, we employ DCC-MGARCH (1,1) method on return series of five different commodity groups (energy, precious metals, agricultural, non-ferrous metals and softs group), Dow Jones spot commodity index as a proxy of an aggregate commodity market and Dow Jones Islamic index over the period January 3, 2001 - March 28, 2013.

The objective of the paper is significant attributed to the inculcated theory and implications for portfolio investors. Theoretically, commodity and equity markets are inversely related. Stock valuation models state that stock prices are the discounted value of all future cash flows of the firms. Higher cash inflows and lower discount rate lead the higher stock prices. Higher commodity prices increases cost of production and thus left the firms with lower cash flows. Moreover, higher commodity prices induce higher inflation leading to higher interest rates. These two consequences, in general, contribute to the inverse relation between commodity and equity markets. However, another strand of theories advocate for positive relation between commodity and stock markets. Stock prices and returns tend to move upward in a market when the market has comparative advantage of producing particular commodities. For example, stock returns in Gulf countries surge in line with the increase in crude oil prices in global market. However, stock returns experience declining trend in crude oil importing countries during that time.

As for the implications for portfolio managers, commodities’ investment in general and gold in particular serve as inflation hedging instruments during the crisis periods. Portfolio managers seek to compensate their losses in portfolios of financial instruments by the corresponding gain from their strategic investment in commodities and other commodity allied instruments. Thus, the portfolio managers diversify their investable funds prudently in order to maximize their returns from their portfolios. Not only portfolio managers, policymakers, at a macroeconomic level, pay particular attention to commodity prices and their volatility given their potential to feed inflation pressures. Volatility of commodity prices is thus a central issue for the world economy, as notably illustrated by the G20 which addressed the question of excessive fluctuations and volatility of commodity prices in its September 2009 Pittsburgh summit (Creti et al., 2013). Moreover, analyzing the links between commodity and stock markets is of particular interest for financial players as raw materials enter many investment portfolios, together with stock classes (Dwyer et al., 2011; Silvennoinen and Thorp, 2010; Vivian and Wohar, 2012). Additionally, commodity traders concurrently look at both stock and commodity market fluctuations to infer the trend of each market. Comparing the dynamic volatility of raw materials and equity prices provides useful information about possible substitution strategies between commodity and stock classes (Choi and Hammoudeh, 2010).

The motive of this paper is to contribute to the growing empirical literature dealing with the relationships between Islamic stock and commodity markets. In particular, the focus is on the dynamics of the correlations between both markets, and analyze whether correlations evolve according to the situation—bullish or bearish—in the stock market. Portfolio investors may find portfolios combining Islamic equities and commodities generating better returns when
these two markets are either low or weakly correlated. Moreover, inclusion of Islamic equities rather than conventional equities would be more convincing strategy during financial crises due to low leverage ratio of Islamic equities. We pay particular attention to the recent 2007-2008 global financial crisis by investigating whether it strengthened or disrupted the links between Islamic stock and commodity markets. This research paper allows us to study whether commodities constitute a homogenous asset class with regard to their links with Islamic stock markets, and whether the crisis has caused the financialization of commodity markets.

The results show that correlations between commodity and Islamic stock markets’ returns change in different time periods and these two markets move very closely during 2008 financial crisis in particular. Besides, volatility of returns in both markets reaches at their peaks during the 2008 crisis period, which could be attributed to the transmission of volatility from equity markets to commodity markets due to greater financialization of commodities. We also show that, while sharing some common features, commodities cannot be considered a homogeneous asset class: a speculation phenomenon is for instance highlighted for energy sector comprising oil, while the safe-haven role of gold is evidenced, which constitutes a part of precious metal sector.

The rest of the paper is organized as follows. Section 2 briefly reviews the literature, section 3 presents the data and methodology, section 4 discusses empirical results and, and finally, section 5 wraps up the paper with conclusion.

2. Literature Review

As documented in the introduction, commodity markets share several characteristics with stock markets and financial assets. So far the literature has analyzed this phenomenon mainly by focusing on conventional stock markets, and looking at the co-movements between conventional stock and oil markets. Most of this literature offers substantial evidence on the impact of oil on stock prices, putting forward a negative relationship between oil price and stock market returns. For instance, Jones and Kaul (1996), using a standard cash-flow dividend valuation model, find a significant negative impact of oil price shocks on US and Canadian quarterly stock prices in the postwar period. Several models, relying on some variants of Vector Autoregressive analysis (VAR), highlight similar findings. Park and Ratti (2008), performing a multivariate VAR analysis, find statistically significant impact of oil prices shocks on real stock returns for US and 13 European countries over the period from January 1986 to December 2005. Sadorsky (1999) investigates relationships among monthly oil prices, S&P 500 conventional stock returns, short-term interest rate, and industrial production for the January 1947-April 1996 period by means of an unrestricted VAR model. The author shows that oil prices and oil price volatility both play important roles in affecting S&P 500 stock returns. Papapetrou (2001) estimates a vector error-correction model on monthly data for Greece from January 1989 to June 1999, and concludes that oil prices drive stock price dynamics. Hussin et al. (2012) using multivariate cointegration analysis, Granger causality test, impulse response function and variance decomposition, reported that Islamic stock prices are cointegrated with oil price and exchange rates. Islamic stock returns were found to be Granger causing oil price in Malaysia.

Shifting from the study of co-movements to volatility analysis, the most recent literature focuses on volatility spillovers between oil/industrial commodity and conventional stock
markets. Hammoudeh et al. (2004) investigate the spillover effects, day effects, and dynamic relationships among five daily S&P oil sector stock indices and five daily oil prices for the US oil markets from July 17, 1995 to October 10, 2001 using co-integration techniques as well as ARCH-type models. They evidence volatility spillovers from the oil futures market on the stocks of some oil sectors. They also find an oil volatility transmission day effect, Friday having a calming effect on the volatility of oil stocks. Chiou and Lee (2009) examine the asymmetric effects of WTI daily oil prices on S&P 500 stock returns from January 1, 1992 to November 7, 2006, by investigating structure changes in this dependency relationship. Using the Autoregressive Conditional Jump Intensity model with expected, unexpected and negative unexpected oil price fluctuations, they find that high fluctuations in oil prices have asymmetric unexpected effects on stock returns. Malik and Ewing (2009) rely on bivariate GARCH models to estimate the volatility transmission between weekly WTI oil prices and equity sector returns from January 1, 1992 to April 30, 2008 and find evidence of spillover mechanisms. Focusing on the Brent market, Filis et al. (2011) analyze time-varying correlations between oil prices and stock markets by differentiating oil-importing (USA, Germany, and the Netherlands) and oil-exporting (Canada, Mexico, and Brazil) countries. Using the multivariate DCC-GARCH approach from January 1988 to September 2009, they find that the conditional variances of oil and stock prices do not differ for oil-importing and oil-exporting economies. However, time-varying correlations depend on the origin of the oil shocks: the response from aggregate demand-side shocks is much greater than supply-side shocks originated by OPEC’s production cuts. Finally, Choi and Hammoudeh (2010) extend the time-varying correlations analysis by considering commodity prices of Brent oil, WTI oil, copper, gold and silver, and the S&P 500 index from January 2, 1990 to May 1, 2006. They show that commodity correlations have increased since 2003, limiting hedging substitutability in portfolios.

Obviously traditional literature focuses on risk-return relationship between stock market and commodity prices, however, they do not include Islamic stock. For instance, Basher et al. (2007) found significant relationship between conditional volatility and stock returns in Dhaka Stock Exchange. Hunjra et al. (2011) using GARCH model reported asymmetric and seasonal effect in commodity and stock markets in Pakistan. Hussin et al. (2013) using cointegration test and vector error correction model found that Islamic stock prices are cointegrated with strategic commodities and macroeconomic variables. The study concludes that only oil price impacts Islamic stock return—both long-run and short-run in Malaysia.

Keeping in view the lack of literature, especially on Islamic stock indices, this study explores the relationship between different commodities spot indices and Islamic stock indices. We consider 5 different commodity sectors indices, traded in the US: Energy, Precious metals, Agricultural, Non-ferrous metals and Softs. The study allows to compare the behavior of each sector spot index with Islamic stock market fluctuations, and to study whether correlations between commodities and Islamic equities evolve over time and depend on the situation—bearish or bullish—on the stock market.

3. Data and Methodology

3.1 Data

The empirical study portion of this research is a multi-step process, where we attempt to sequentially analyze the data starting from simple descriptive statistical numeric. The crux of
our model attempts to study the volatility of commodity sector spot indices and Islamic equity index. All the commodity and stock indices used for the empirical study have been taken from the Dow Jones Indices family.

The Dow Jones Islamic Market Index family includes thousands of broad-market, blue-chip, fixed-income and strategy and thematic indices that have passed rules-based screens for Shariah compliance. The indices are the most visible and widely-used set of Shariah-compliant benchmarks in the world.

To determine their eligibility for the indices, stocks are screened to ensure that they meet the standards set out in the published methodology. Companies must meet Shariah requirements for acceptable products, business activities, debt levels, and interest income and expenses. The screening methodology is approved by an independent Shariah supervisory board. By screening stocks for consistency with Shariah law, the indices help to reduce research costs and help Muslim high net worth investors to construct their portfolios.

The Dow Jones-UBS Commodity Index is a broadly diversified index that allows investors to track commodity futures through a single simple measure. The index is composed of futures contracts on physical commodities. As the index has grown in popularity since its introduction in 1998, additional versions and a full complement of sub-indexes have been introduced. Together, the family offers investors a comprehensive set of tools for measuring the commodity markets.

The DJ-Commodity index is designed to minimize concentration in one commodity or sector. It currently includes 19 commodity futures in five groups. No one commodity can comprise less than 2% or more than 15% of the index, and no group can represent more than 33% of the index (as of the annual reweightings of the components).

As shown in Figure 2, the index is not highly concentrated in any single commodity type. The weightings for each commodity included in the DJ-Commodity index are calculated in accordance with rules designed to ensure that the relative proportion of each of the underlying individual commodities reflects its global economic significance and market liquidity. Annual rebalancing and reweighting maintain diversity over time.

![Figure 2: DJ UBS Commodity Index](image)
In this study we employ commodity index spot prices. As highlighted by Vivian and Wohar (2012), spot prices are the underlying asset upon which derivatives are based, a fact that is important when analyzing volatility. In addition, relying on spot prices avoids issues related to rollover of futures contracts.

**Dow Jones-UBS Commodity Spot Indexes**

The Dow Jones-UBS Commodity Spot Indexes measure price movements of the commodities included in the DJ-UBSCI and select sub-indexes. The DJ-UBS Commodity Spot Index provides a general estimate of trends in commodity prices. It does not account for the effects of rolling futures contracts or the costs associated with actually holding physical commodities, and is thus not replicable with positions in the underlying commodity futures contracts.

In this study we included the following DJ-UBSCI sub-indices representing the major commodity sectors within the broad index:

1. **Energy** - includes Crude oil, Heating oil, Natural gas and unleaded gasoline.
2. **Industrial metal** - includes Aluminum, Nickel, Copper and Zinc
3. **Precious Metal** - includes Gold and Silver
4. **Agriculture** - includes Coffee, Corn, Cotton, Soybeans, Soybeans oil, Sugar and Wheat
5. **Softs** - include Coffee, Cotton and Sugar

We consider daily spot price series extracted from DataStream for the different commodities covering various sectors over the January 3, 2001 - March 28, 2013 period. We investigate 5 different commodity groups: energy, precious metals, agricultural, non-ferrous metals and softs group. All price series are quoted in US dollars. An aggregate commodity price index, the DJ Spot commodity Index, is also considered. Regarding the equity market, we rely on Dow Jones Islamic index.

### Table 1: Details of Indices

<table>
<thead>
<tr>
<th>Index Name</th>
<th>Symbol</th>
<th>Sample Period and Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>DJ UBS Commodity Index</td>
<td>CM</td>
<td>3 January 2001 – 28 March 2013 (12 Years)</td>
</tr>
<tr>
<td>DJ UBS Energy Index</td>
<td>EY</td>
<td>3 January 2001 – 28 March 2013 (12 Years)</td>
</tr>
<tr>
<td>DJ UBS Metal Index</td>
<td>ML</td>
<td>3 January 2001 – 28 March 2013 (12 Years)</td>
</tr>
<tr>
<td>DJ UBS Precious Metal Index</td>
<td>PM</td>
<td>3 January 2001 – 28 March 2013 (12 Years)</td>
</tr>
<tr>
<td>DJ UBS Agricultural Index</td>
<td>AR</td>
<td>3 January 2001 – 28 March 2013 (12 Years)</td>
</tr>
<tr>
<td>DJ UBS Soft Index</td>
<td>ST</td>
<td>3 January 2001 – 28 March 2013 (12 Years)</td>
</tr>
<tr>
<td>DJ Islamic Market World Index</td>
<td>DJI</td>
<td>3 January 2001 – 28 March 2013 (12 Years)</td>
</tr>
</tbody>
</table>

To investigate the time evolution of correlations between the stock and commodity markets, we employ dynamic conditional correlation (DCC) GARCH models. To address the research objective, we have used Multivariate Generalized Autoregressive Conditional Heteroscedastic (MGARCH) model. Initially we test the variables on both Normal and t-distribution to determine which distribution is a better fit to the set of variables. To have a cursory glance at the founding basis for our research objective, regarding whether correlations between commodities and Islamic equities evolve over time and depend on the situation, the empirical results of unconditional correlations coefficients will suffice.
3.2 Methodology

This study applies the well-established Dynamic Conditional Correlation (DCC) technique proposed by Engle and Sheppard (2001) and Engle (2002) in order to investigate correlation dynamics between commodity and Islamic equity returns. With the DCC model, a member of the GARCH family, one can pinpoint precisely the timing and nature of plausible changes in the time series co-movement. For each time point, the DCC method gives a value that serves as the forecasted correlation between series for the next period. Estimation of DCC is a two-step process to simplify estimation of time varying correlations. In stage one, using GARCH model for each variable, univariate volatility parameters are estimated. In stage two, for the time varying correlations matrix, residuals from first stage are used as inputs for estimation. For sake of brevity, we omit details of mathematical derivations and the equations which can be found in Pesaran and Pesaran (2009). Following Engle (2002), \( H_t \) is a conditional covariance matrix of the returns on the assets (equities and commodities) and is:

\[
H_t = D_t R_t D_t
\]

Where, \( R_t = k \times k \) time 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:

\[
L = \frac{1}{2} \sum_{t=1}^{T} \left( K \log(2\pi) + 2 \log|H_t| + \hat{\rho}_t^2 H_t^{-1} \right)
\]

\[
= \frac{1}{2} \sum_{t=1}^{T} \left( K \log(2\pi) + 2 \log|D_t R_t D_t| + \hat{\rho}_t^2 D_t^{-1} R_t^{-1} D_t^{-1} \right)
\]

\[
= \frac{1}{2} \sum_{t=1}^{T} \left( K \log(2\pi) + 2 \log|R_t| + \log(|R_t| + \hat{\varepsilon}_t R_t^{-1} \hat{\varepsilon}_t) \right)
\]

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 (p, q) model as follows:

\[
h_t = \omega_0 + \sum_{i=1}^{p} \delta_i h_{t-i} + \sum_{j=1}^{q} \gamma_j \varepsilon_{t-j}^2 \quad \text{for } i = 1, 2, 3, \ldots, k
\]

Then proposed dynamic correlation structure is:

\[
Q_t = \left( 1 - \sum_{m=1}^{M} \alpha_m - \sum_{n=1}^{N} \beta_n \right) \bar{Q} + \sum_{m=1}^{M} \alpha_m \left( \varepsilon_{t-m} \varepsilon_{t-m} \right) + \sum_{n=1}^{N} \beta_n Q_{t-n}
\]

\[
R_t = Q_t^{-1} Q_t Q_t^{-1}
\]

Where, \( \bar{Q} \) is the unconditional covariance of the standardized residuals resulting from the univariate GARCH equation and \( \bar{Q}^* \) is a diagonal matrix composed of the square root of the diagonal elements of \( Q_t \), which is as follows:
The typical element of $R_t$ will be $\rho_{ijt} = \frac{q_{ijt}}{\sqrt{q_{ii}q_{jj}}}$ 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

$$V(r_{i,t} | \Omega_{t-1}) = \sigma_{i,t-1}^2(1 - \lambda_1 + \lambda_2) + \lambda_1 \sigma_{i,t-2}^2 + \lambda_2 r_{i,t-1}^2$$

Where, $\sigma_{i,t}^2$ is the unconditional variance of the ith asset return. $\lambda_1$ and $\lambda_2$ are asset specific volatility parameters (individual asset return volatilities). Under the restriction $\lambda_1 + \lambda_2 = 1$, 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 then the shock to variance is permanent.

4. Findings and Discussion

4.1 Descriptive Statistics

The descriptive statistics for the daily returns of the 6 commodity spot price indices and DJ Islamic stock index, in our study provides interesting insights as represented by the standard deviations.

<table>
<thead>
<tr>
<th></th>
<th>DJI</th>
<th>CM</th>
<th>EY</th>
<th>ML</th>
<th>AR</th>
<th>PM</th>
<th>ST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.000069</td>
<td>0.000374</td>
<td>0.000284</td>
<td>0.000279</td>
<td>0.000372</td>
<td>0.000565</td>
<td>0.000315</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>0.011086</td>
<td>0.011149</td>
<td>0.020113</td>
<td>0.015753</td>
<td>0.012688</td>
<td>0.013486</td>
<td>0.013833</td>
</tr>
<tr>
<td>Skewness</td>
<td>-0.29426</td>
<td>-0.238584</td>
<td>-0.166490</td>
<td>-0.281619</td>
<td>-0.215939</td>
<td>-0.399456</td>
<td>-0.193535</td>
</tr>
</tbody>
</table>

The energy commodities (EY) seem to differ from other commodities in terms of volatility: the standard deviation (0.02) is much higher than the other commodity indices and even the DJ Islamic stock index. Together with high volatility, the group of energy and metal sector exhibits low returns on average, leading to the lowest benefit-risk trade off compared to the DJ Islamic and the other commodity indexes. However agriculture (AR), soft (ST) and precious Metal (ML) sector commodities are more profitable on the return-risk basis. However, DJ Islamic stock index is highly volatile as it has a significantly higher kurtosis value (10.36).

4.2 Unconditional Volatility and Unconditional Correlation

As a first step towards estimating dynamic conditional correlations and volatilities we first take a look at the summarized results of maximum likelihood estimates of $\lambda_1$ and $\lambda_2$ in the
Table 3. The table also summarizes the delta 1 and delta 2 estimates while comparing multivariate normal distribution with multivariate student t-distribution. From results it is evident that all estimates are highly significant implying gradual volatility decay for all indices. Also, if we analyze the sum of lambda 1 and lambda 2 values for different indices, we observe that their summation is less than one, pointing that the indices are not following IGARCH; which means that shocks to the volatility is not permanent.

It is observed from the results that the maximized log-likelihood value for t-distribution 74857.3 is larger than the maximized log likelihood under normal distribution 73734.7. This implies that the student t-distribution is a more appropriate representation of the fat tailed nature of indices’ returns. These findings are in agreement with findings of Pesaran & Pesaran (2009). To substantiate this further, we observe the degrees of freedom, which is 7.2941, well below the critical level of 30. Henceforth our analysis of the study works with the t-distribution estimates.

Table 3: Estimates of λ1 and λ2 and Delta

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Normal Distribution</th>
<th>T - Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimate</td>
<td>T Ratio</td>
</tr>
<tr>
<td>Lambda 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DJI</td>
<td>.91644</td>
<td>107.6226</td>
</tr>
<tr>
<td>CM</td>
<td>.97123</td>
<td>657.0932</td>
</tr>
<tr>
<td>EY</td>
<td>.96559</td>
<td>494.0573</td>
</tr>
<tr>
<td>ML</td>
<td>.96330</td>
<td>290.8348</td>
</tr>
<tr>
<td>AR</td>
<td>.97273</td>
<td>478.9770</td>
</tr>
<tr>
<td>PM</td>
<td>.97344</td>
<td>432.9338</td>
</tr>
<tr>
<td>ST</td>
<td>.96932</td>
<td>221.5354</td>
</tr>
<tr>
<td>Lambda 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DJI</td>
<td>.07182</td>
<td>10.6211</td>
</tr>
<tr>
<td>CM</td>
<td>.02852</td>
<td>22.3264</td>
</tr>
<tr>
<td>EY</td>
<td>.03348</td>
<td>18.9597</td>
</tr>
<tr>
<td>ML</td>
<td>.03366</td>
<td>12.6290</td>
</tr>
<tr>
<td>AR</td>
<td>.02631</td>
<td>16.0338</td>
</tr>
<tr>
<td>PM</td>
<td>.02610</td>
<td>13.9737</td>
</tr>
<tr>
<td>ST</td>
<td>.02667</td>
<td>8.4546</td>
</tr>
<tr>
<td>Delta 1</td>
<td>.97617</td>
<td>1497.9</td>
</tr>
<tr>
<td>Delta 2</td>
<td>.038114</td>
<td>25.5788</td>
</tr>
<tr>
<td>Max. Log Likelihood</td>
<td>73734.7</td>
<td></td>
</tr>
<tr>
<td>Degrees of Freedom</td>
<td>7.2941</td>
<td></td>
</tr>
</tbody>
</table>

Table 4 presents the unconditional correlation and volatility matrix for the 5 different DJ sector commodity spot indices, DJ main commodity spot index and DJ Islamic stock index, within our study helps us to further delve into the correlations between the indices and their unconditional volatiles. The estimated unconditional volatilities are the diagonal elements highlight and in bold while off diagonal elements represent unconditional correlations.
Table 4: Estimated Unconditional Volatility & Correlation matrix for the indices

<table>
<thead>
<tr>
<th></th>
<th>DJI</th>
<th>CM</th>
<th>EY</th>
<th>ML</th>
<th>AR</th>
<th>PM</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST</td>
<td>DJI</td>
<td>.01108</td>
<td>.42951</td>
<td>.29003</td>
<td>.43183</td>
<td>.31344</td>
</tr>
<tr>
<td>082</td>
<td>CM</td>
<td>.42951</td>
<td>.01116</td>
<td>.83480</td>
<td>.62281</td>
<td>.68718</td>
</tr>
<tr>
<td>551</td>
<td>EY</td>
<td>.29003</td>
<td>.34158</td>
<td>.62281</td>
<td>.68718</td>
<td>.49636</td>
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A perfunctory glance at the unconditional volatility numbers shows the highest volatility for the Energy sector index (EY) (also shown in Figure 3), as expected and is similar to our earlier observation in the descriptive statistics. Now this high volatility in the energy sector is from oil and gas. The crude oil prices during the past decades have shown a tremendous increase, translating into windfall gains for the oil companies, the movement of oil prices has been erratic. The main volatility in oil prices arises from the speculative trading as well as geo political issues. This erratic behavior and high volatility in oil prices, directly impacts the returns and stock values of the oil companies.

Figure 3: Conditional Volatilities
The second most volatile sector is metal (ML). The sharp increase in prices of metals is known to be driven by an upsurge in demand for these commodities from newly industrializing emerging economies, in particular, from the two most rapidly growing economies in the South - China and India - due to intensive use of these raw materials for their industrialization drive, physical infrastructure building and urbanization trends. However, 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 deterioration in global prospects for construction and automobile industries.

To assess the evolution of correlations between Islamic stock and commodity markets over time, Figure 4 reports the dynamic conditional correlations between each commodity sector and the DJ Islamic returns series. The links between markets during periods of financial stress are clearly underlined. The grey bands correspond to periods of bearish stock market, the white stripes corresponding to periods of bullish stock market. It shows that investment in Islamic equities constitutes an alternative to commodities, providing a mechanism for substitution between asset classes. Although there are some specific features for each sector of commodity market some common characteristics emerge.

Figure 4: Conditional Correlation
First, correlations are highly volatile throughout the period. For many raw materials, this volatility is particularly marked after the 2007-2008 global financial crisis. In all cases, there is an increase in volatility during and following the crisis. Second, in most cases, the largest drop in the correlations appears during the 2008 financial crisis. The stock market collapse has weakened the conditional links between stock and commodity price returns, but only in the very short run. This decrease in correlations during times of high financial markets stress may be linked to a flight-to-quality phenomenon. When risk market rises, the benefits of diversification are most appreciated and investors tend to choose commodities as refuge.
instruments. This short-run characteristic could thus explain the temporary disrupted link between both markets.

Third, for almost all of the series, the highest correlations are observed after the crisis, at the end of the period under study. Both DJ Islamic stock index and commodity markets move upward during episodes of growing world demand for industrial commodities, giving an important role to commercial traders who use commodity futures to hedge their business activities. On the whole, the 2007-2008 global financial crisis has caused significant changes in the relationship between Islamic stock index and commodity markets, as well as increased correlation in the volatility. Regarding the long-run trends, correlations are likely to be governed by industrialization and financialization processes, as well as by commercial and non-commercial traders.

Let us now look more specifically at the different types of commodity sectors, starting by the energy group (EY), which consists of oil, gas and electricity. First, oil is clearly the most related to Islamic stock market. This predominance of oil may be due to the fact that it is one of the most important production factors. From a theoretical viewpoint, the fundamental value of any asset is given by its expected discounted cash flows. Consequently, an oil price increase will generate a rise in production costs, leading to restraining profits and, in turn, to reduction in shareholders’ value. In times of rising stock prices, the correlations between stock and oil markets increase. During periods of declining stock prices, correlations tend to decrease and become negative during the 2007-2008 global financial crisis and 2011 debt-ceiling crisis, as shown in the correlation graph. This is also consistent with the well-documented oil speculation phenomenon, the increase in crude oil prices being prominent in times of rising stock market. From this perspective, oil cannot be seen as a means of portfolio diversification.

Turning to the precious metals group, which mainly includes; gold, platinum and silver, correlations are mostly negative and diminish in times of declining Islamic stock prices, highlighting adverse evolution in the markets. This is consistent with a safe-haven role of gold.

Regarding the other groups, two main findings can be highlighted: (i) volatility changes over time, being quite stable before the 2007-2008 crisis, then getting stable till 2011 debt-ceiling crisis and becoming relatively high during the US debt-ceiling turmoil, and (ii) correlations tend to rise during crisis, showing increased links between Islamic stock and commodity markets.

On the whole, our results show that the 2007-2008 global financial crisis has played a key role in the evolution of the links between Islamic capital and commodity markets. Indeed, higher correlations between both markets are generally observed during the financial turmoil, reflecting the phenomenon of financialization of commodity markets.

This phenomenon is particularly noticeable for energy sector including oil, a result which is consistent with the fact that oil is the most financialized commodity. In addition, our findings show that raw materials cannot be aggregated in an homogeneous asset class: they are not only influenced by common macroeconomic factors but also their own market determinants.
5. Conclusion
This paper investigates the links between commodity and Islamic stock markets. We apply dynamic conditional correlation (DCC) GARCH methodology to establish whether the correlations between both markets change over time and depend on the situation—bearish or bullish—on the stock market.

The main findings can be summarized as follows. In the panel of 6 commodities sectors over the period from January 3, 2001 - March 28, 2013, first, the correlations between various commodity sectors and DJ Islamic stock returns evolve through time, being highly volatile, particularly since the 2007-2008 financial crises. While the stock market collapse has loosened the links between both markets on the very short run, the highest correlations are observed during the financial turmoil, showing increased links between stock and commodity markets. Second, some commodities are characterized by a speculation phenomenon, especially oil in the energy sector, while their correlations with DJ Islamic returns grow in times of increasing stock prices, they diminish in times of bearish financial markets. Third, the safe-haven role of gold is evidenced, which constitutes a part of precious metal commodity. As the precious metal commodities correlations with DJ Islamic returns are mostly negative and diminish in times of declining stock prices. Fourth, while sharing some common features, commodities cannot be considered as an homogeneous asset class.

On the whole, our findings show that the 2007-2008 financial crises has played a key role, emphasizing the links between commodity and Islamic capital markets, and highlighting the financialization of commodity markets. This evolution in Islamic stock and commodity correlations reduces their potential substitutability in portfolios. At the idiosyncratic level, gold found to be an exception, which helped portfolio managers to mitigate their portfolio risks through diversification in times of declining equity prices.

References


