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The diversification benefits from Islamic investment during the financial turmoil: The case for the US-based equity investors☆

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Abstract

A major issue in both Islamic finance and conventional finance is whether the shocks to the volatilities in the asset returns are substitutes or complements in terms of taking risk. An understanding of how volatilities of and correlations between asset returns change over time including their directions (positive or negative) and size (stronger or weaker) is of crucial importance for both the domestic and international investors with a view to diversifying their portfolios for hedging against unforeseen risks.

This study is the first attempt to advance the frontier of knowledge particularly in the fast growing field of Islamic Finance through the application of the recently-developed Dynamic Multivariate GARCH approach. Our study is focused on investigating whether Islamic stock indices provide special avenue for the US-based investors.

Our findings based on the Dynamic Conditional Correlation (DCC) tend to suggest: both the conventional and Islamic MSCI indices of Japan, GCC ex-Saudi, Indonesia, Malaysia and Taiwan provide better diversification benefits compared to Korea, Hong Kong, China and Turkey. It tends to suggest that the Islamic countries provide better diversification benefits compared to the Far East countries with strong policy implications for the domestic and international investors in their portfolio diversification for hedging against unforeseen risks.

JEL classification: G11; G15; C58; F15; F21

Keywords: Dynamic Conditional Correlations; Multivariate GARCH; Conventional and Islamic stock

1. Introduction

Trade and financial liberalization since the late 20th century enhanced the process of globalization, with increased trade ties and economic synchronization, international stock market indices have become integrated. A decision by a country's government to permit foreigners to buy stocks in that country's stock market is called stock market liberalization (Henry, 2000). The rational behind financial liberalization is to restore growth and stability by raising saving and improving economic efficiency. Following the collapse of the Bretton Woods system, the developed countries initiated the international financial liberalization process.

Watson (1986) documented this development in terms of internationalization, securitization, and liberalization. In the

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case of internationalization, in the major industrial countries the speed of activity in financial markets has grown faster than real output, but this has been accompanied by even faster growth in offshore financial market activity. As far as securitization is concerned, there has been a move away from indirect finance, through intermediaries such as banking, to direct finance by means of international bond markets. Liberalization gave birth to the removal of domestic quantity and price controls, better international involvement in domestic financial markets, more cross-border capital flows, and, finally, new financial instruments (Kearney, 1996). As a result, business cycle synchronization and stock correlations are anticipated to rise over time and across countries.

The findings of low correlation among national stock returns in the early studies (Grubel, 1968; Levy & Sarnat, 1970; Solnik, 1974) suggest potential benefits of international diversification. However, recent studies have found evidence of asset market price correlation and contagion. For example, Goldstein and Michael (1993) documented that international linkages have been rising over the past decade, particularly for stocks transacted in the major financial centers of the world.

The highly cointegrated stock markets suggest that there are no diversification benefits since the performance and returns in these markets are highly correlated to each other. Basically, this idea encourages investors to diversify their assets across cross-borders, provided returns to stock in these other markets are less than perfectly correlated with the local market (Masih & Masih, 1997). The finance literature has already discussed the advantages of asset diversification, among them much effort was given to quantifying risk-reduction and its associated benefits available to the internationally diversified portfolio (Solnik, 1991).

From the stock market integration perspective, all assets with similar risk profiles and maturity have the potential to attract the same returns across different financial markets. Additionally, if there are no barriers such as country risk and exchange rate premium, financial assets of similar level of risk and liquidity are anticipated to gain similar yields, irrespective of location (Marashdeh & Shrestha, 2010; Narayan, Smith, & Nandha, 2004; Von Furstenberg & Jeon, 1989).

More recently, Rua and Nunes (2009), by utilizing wavelet coherency approach, found that since the end of the 1990s, the high degree of comovement has been extended to all frequencies. Prior to this date (end of the 1990s) the strong comovement was confined only to long-run fluctuations while after that date the comovement is visible for all sorts of short and long fluctuations. This finding indicates an additional input that there has been an overall rising comovement. Wang, Fang, and Ye (2013) demonstrated that the global financial integration between super-large-cap and small-cap stocks has increased in recent years. Their results also indicate that global market integration is primarily associated with the super-large-cap stocks of large emerging markets.

If the comovement is visible for both short and long-run, then the investors would know how to diversify their portfolios. Investors would be looking for different cross-border or asset classes such as ethical and Islamic investments, commodities, derivatives, real estate, and private equity/hedge funds, etc.

Most researchers have focused on the interdependencies of conventional stock indices and empirical works on Islamic stock indices are either not available or inconclusive. Given the conflicting conclusions of the research in this field, further highlights should be made available through an investigation of an alternative set of financial markets, particularly, a set of Islamic stock indices, at least, from an international diversification perspective. Islamic stock indices can most likely offer a far greater diversification potential for attracting global portfolios. Furthermore, investigations into the dynamic linkages of conventional and Islamic stock indices over time and across markets are of significant importance to investors and financial policy makers;

A related issue in order to help the investors get the diversification benefits is to investigate the comovements of the Islamic stock indices hitherto unexplored. The advocates of Islamic investment argue that the Islamic stock indices are better positioned due to the specific features of Islamic stock Indices such as, ethical and ratio screenings, exclusion of financial sectors, exclusion of highly leveraged firms, the limit of interest-based leverage, and, finally, exclusion of using complex and intensive structured financial products, derivatives, and other toxic assets. An Islamic stock index is argued to be more resilient to a financial crisis compared to a conventional stock index (Charles, Pop, & Darné, 2011; Sukmana & Kolid, 2012). The stocks in Islamic indices have been filtered according to debt-to-equity ratio (a certain upper limit, normally 33%) as well as removing the prohibited sectors. Generally, the application of the filtering criteria for Islamic indices is likely to result in higher concentration of some sectors such as industrials, technology, consumption services. It might be worth noting that trading cash as an asset is not allowed under Islamic rules. Therefore, only the financial sectors related to supportive activities (consultancy for example) are included in Islamic index. That may make the Islamic products less risky. However, we are aware that theoretically one could argue that although lower-leverage might make the Islamic products less risky, the smaller and less diversified universe and also an excessive exposure to sectors like housing might make the Islamic products more risky.

In other words, it is generally argued that the characteristics of the Islamic stocks are different compared to those of the conventional stocks in that the former entails a lower leverage, smaller size of firms and less diversified markets resulting in different risk-return portfolios. This requires an empirical investigation of the conventional and Islamic stock indices. Hence an important objective of this study is to investigate whether Islamic stock indices provide more diversification benefits compared with the conventional indices.

Despite the increasing attention and growth of Islamic investment, empirical studies on Islamic indices are scarce. In filling this gap, we investigate whether Islamic stock indices provide more diversification benefits relative to their conventional counterparts. Therefore, in this study, we investigate

whether Islamic stock indices can help with diversification benefits for the US-based investors.

2. Islamic investment criteria

Shari'ah is a Divine Law which governs the practical aspect of a Muslim's daily life. In commerce, it can determine business style and indicate a desire to comply with 'halal' (lawful) and ethical investing. Islamic investing is growing rapidly as an alternative investment class for all investors, both Muslim and non-Muslim, for its foundation in ethical business practices, social responsibility and fiscal conservatism. The Islamic investors are mandated to invest only in an Islamic manner, for example, Imam and Kpodar (2013) concluded that in the determination of Islamic bank expansion around the world, the interest rates were found to have a negative impact on banking selection, and the quality of institutions was not found to be a significant determinant. However, other investors such as non-Muslim do so for the benefits they derive, including greater stability of returns, transparency and diversification.[2]

In Islamic finance, a market is subject to *Shari'ah* constraint where the market is free from prohibited activities and elements such as *riba* (usury), *maisir* (gambling), *gharar* (ambiguity), and other prohibited activities like tobacco, alcohol, and so on. To describe the Islamic principle in detail, *riba* technically is defined as the "premium" which should be paid by the borrower to the lender together with the principal amount as a condition in the contract of the loan or for an extension in the duration of loan" (Iqbal & Mirakhor, 2007). More specifically, both the premium and the principal are guaranteed regardless of the investment performance. Islamic stock Indices must not include firms that pay or receive interest of any form. However, the percentage of today's listed firms that are fully in compliance with the *Shari'ah* is in small number. Some degree of tolerance therefore is required.

The modern *Shari'ah* scholars have provided general rules for Islamic investors to evaluate or screen whether a particular company is *halal* (lawful) or *haram* (unlawful) for investment (Derigs & Marzban, 2008; Wilson, 2004). There are two types of stock screening approaches such as qualitative and quantitative screens (Wahyudi & Sani, 2014). The first one is qualitative screen, the screening process that focuses on the activity of a company that is used as the main principle in Islamic investment criteria. This applies to a company that does not comply with *Shari'ah* principles, for example, a company is involved in the production of alcohol for drinking, gambling, and *riba*-based financial institutions, then, investment in this type of company is prohibited. The second one is quantitative screen, where Islamic scholars have applied a principle of tolerance associated with filtering criteria, namely:

(1) Debt/equity ratio. If a company's debt financing is more than 33 percent of its capital, then it is impermissible for investment.
(2) Interest-related income. If interest-related income of a company is more than 10 percent of its total income, then it is not permissible for investment. This income, however, should not come from its main business activities but from placing its surplus funds in investments that could yield interest income (Rahman, Yahya, & Nasir, 2010).
(3) Monetary assets. This parameter refers to the composition of account receivables and liquid assets (cash at banks and marketable securities) compared to total assets. Various minimums have been set for the ratio of non-liquid assets (assets that are not in the form of money) necessary to make an investment permissible. Some set this minimum at 51 percent while a few cite 33 percent as an acceptable ratio of non-liquid assets to total assets.

On the other hand, the literal meaning of the *gharar* is fraud or *al-khida*. It is interpreted as inadequate market information or uncertainty about exchange objects when there is no practical obstacle to obtain full information about the objects of exchange for the contracting parties. Some *gharar* can be tolerated with the reason that it is sometimes difficult to completely eliminate uncertainty from exchange contracts. Al-Zuhaili (1984) mentions that *gharar* is tolerable if its benefits outweigh its damages. However, if *gharar* is deliberately embodied in the contract, then it becomes unlawful, as stated by the classical jurist cases of selling birds in the sky or fish in the sea (Al-Dharir, 1967; Al-Saati, 2003). This has involved uncertainty about the outcome of the contract. As the financial market is concerned, financial securities are pure information-loaded documents which lead to more *gharar*-prone than real goods. Therefore, the jurists prefer to ensure a *gharar*-free stock exchange rather than one of resolving a gambling evil with, of course, the consideration on a matter of degree of uncertainty itself (el-Din, 1996). In modern finance, the status of derivatives in Islamic finance is subject to this rule where majority Islamic scholars strongly believe that conventional derivatives such as forwards, futures, and options are impermissible. The alternative can be found in Islamic derivatives such as *salam*, *istisna*, etc. Short selling also involves *gharar* which is associated with the prohibition of selling the product before receiving possession.

Maisir or gambling is defined as a game of chance that is a purely competitive zero-sum game which ends up in redistributing total stakes committed by individual parties among only one or a few of them. Gambling is a serious *gharar* where, in capital market, it can be associated with excessive speculation. In financial markets, excessive speculation can be defined as the degree of speculation in excess of the level just needed for an optimal liquidity in the secondary market. Even though the need for liquidity has accommodated speculative activity, a necessary action should be taken to matching between financial and real markets. This may lead Islamic investors to focus on fundamental component in any form of investment.

As our study covers the period of subprime crisis recovery, we refer to Chapra (2008) and Chapra, Ebrahim, Mirakhor, and Siddiqi (2008) who mention that there are four basic

[2] Case for Islamic Asset Management, by CIMB bank, June 30, 2010.

conditions in Islamic finance that may prevent the two main causes of crisis, which are excessive leverage and the formation of speculative bubbles in credit markets. Firstly, all transactions have to be based on real assets rather than merely fictitious or notional assets. This may discourage all speculative transactions which involve excessive ambiguity or gambling. Secondly, the transaction must involve the possession of exchange objects on the seller/lesser where this condition may guarantee that, to obtain certain return, the owner will share the risk with his partner. Thirdly, the transaction must be genuine with full intention to give and take delivery which in turn will prevent the excessive speculation using imaginary assets. Lastly, the credit risk must be borne by the creditor up to the maturity, which is subject to the rule of prohibition of selling the debt except at par value. This is to ensure that the creditor cannot transfer the risk by selling the debt to the market within a speculative and derivative transaction and that prevents the excessive growth of the debt beyond reasonable limits. The last point is also empirically tested by Srairi (2013) that the Islamic banks have a lower exposure to credit risk than the conventional banks. This finding can be justified by the argument that the Islamic banks are more likely to be asset-based and also dependent on the profit and loss sharing (PLS) principles in their transactions. In this context, it is important to note that PLS financing shifts the direct credit risk from the banks to the investment depositors.

Due to the ethical foundations of Islamic stock indices, some argue (Iqbal, Mirakhor, Krichenne, & Askari, 2010) that Islamic stock indices provide better diversification benefits compared with their conventional counterparts. This is because the limit of interest-based leverage would lead to lower systemic risks of Islamic stocks indices, both during expansion and recession. MPT assumes that 'investors are risk averse', meaning that investors will favor the less risky one if two portfolios give the similar expected returns. The finance theory argues that 'higher-beta stocks tend to be more volatile' and therefore more riskier, but are likely to offer the potential for higher returns. Lower-beta stocks are less risky but normally offer lower returns.

During a credit expansion supported by low interest rate, every company may benefit by taking higher leverage which will consequently boost their expected returns. This is unlikely to be found in the case of Islamic stocks. *Shari'ah* screening in the form of the twin screen of ethical and financial ratio filters will lead the Islamic index to take highly leveraged firms out of the index. For instance, Islamic DJIM was able to detect the corporate troubles of Worldcom and Enron, due to increasing high leverage, and removed these companies from the DJIMI indices a year before the stock value of these companies became worthless (Hassan & Zaher, 2001; Hussein, 2004). The leverage limit may lead the performance of individual firms to be less influenced by interest rate movement and would not fluctuate in the same fashion as overall markets. This may conform to the study of Iqbal et al. (2010) who argued about the lower correlation of individual stock price with other assets as well as the whole market.

On the other hand, it is argued that ethical investing will under-perform over the long time horizon due to the ethical investment portfolios are subgroups of the market portfolio, and limited potential diversification benefits (Bauer, Otten, & Rad, 2006). Similarly, conventional stock indices may outperform Islamic investment since the ethical and ratio screenings might cause additional screening and monitoring costs, accessibility of a smaller investment universe, and limited potential for diversification. Especially, the large firms are eliminated from the investment universe by ethical and ratio screenings and consequently the remaining companies tend to be smaller and have more volatile returns. Therefore, it is meaningful to investigate whether Islamic stock indices provide special avenue for the US-based investor.

3. Literature review

Due to the frequent economic crises of late, many international investors have been hurt and are weary of investing in equities. Since then, they have been searching for alternative asset classes as part of a diversified portfolio of investments, for example, Islamic securities, to fulfill the need to maintain some level of returns, while not investing in high risk securities. In this Section, we are going to describe some literature reviews on diversification benefits.

There are two well-known theories in finance literature, such as the Capital Asset Pricing Model (CAPM) and the Modern Portfolio Theory (MPT). These theories advocate that in order to reduce the risk individual and institutional investors should hold a well-diversified portfolios. Put differently, the integration and interdependence of stock markets underlies a major cornerstone of MPT which stresses the issue of diversifying assets. This theory advocates that investors should diversify their assets across national borders, as long as returns to stock in other markets are less than perfectly correlated with the domestic market.

The results of Longin and Solnik (2001) and Meric and Meric (1997) indicate that the co-movements of equity markets increased apparently after the 1987 crash, inferring that the benefits of international diversification decreased considerably. Karolyi and Stulz (1996) found evidence of co-movement of the US and Japanese stock returns, and showed large shocks to broad-based market Indices positively impact both the magnitude and persistence of return correlations. The impacts of the October 1987 stock market crash and the 1997 Asian financial crisis have also increased integration among stock markets (Arshanapalli & Doukas, 1993; Francis, Kim, & Yoon, 2002; Lee & Kim, 1993; Hwahsin & Glascock, 2006; Karim and Majid; 2009; Yang, Kolari, & Min, 2003).

Thus, the opportunities of international diversification have been weakened. Furthermore, Kearney and Lucey (2004) documented that the global economic and financial systems are becoming increasingly integrated because of the fast expansion of international trade in commodities, services and financial assets.

Recently, interest towards empirically examining integration among stock markets in Islamic countries has increased.

Some researchers concentrate on the stock markets of a particular region, for example, GCC, Middle-East and North African (MENA), ASEAN region. Marashdeh (2005) documented that there was no cointegration between the selected MENA stock markets (Egypt, Jordan, Morocco and Turkey) and that of the major developed economies (the US, UK and Germany) based on monthly observations for the period from December 1994 to June 2004 through an application of the autoregressive distributed lag (ARDL) approach. This implies potential diversification benefits for the investors from the major stock markets to the MENA stock markets. Bley and Chen (2006) found that the stock markets of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates provided avenue for portfolio diversification, but there was evidence that the markets tend to be integrated because of the on-going attempts to synchronize the markets in the advent of an economic union and single currency area.

Majid, Yusof, and Razal (2007) investigated the degree of cointegration among eight Islamic countries' stock markets, such as Turkey, Egypt, Oman, Kuwait, Malaysia, Indonesia, Bangladesh and Pakistan by analyzing daily data of 1 January 2002–31 May 2006. At the same time they examined the degree of cointegration between these markets and the world's largest stock markets, namely the US, the UK and Japan by application of time series techniques. The study concluded that the stock markets of Malaysia, Indonesia, Bangladesh and Pakistan (OIC stock markets in the Asian region) are integrated; however, the stock markets in Turkey, Egypt, Oman and Kuwait (OIC stock markets in the Middle-East and North African (MENA) region) are not. This suggests that investors intending to gain from portfolio diversification can benefit by investing in the MENA region, but not in the Asian region. In addition, all the Islamic stock markets are integrated with the major stock markets.

Generally, some studies highlight the diversification benefits of investing in the various Islamic stock markets. Achsani, Effendi, and Abidin (2007) documented that the interdependence of the Islamic stock markets tends to be asymmetric across a wide geographical area. While there are strong correlations between the Islamic stock indices of Indonesia and Malaysia, the US and Canada, and Japan and Asia Pacific, this is not exactly the case for across the regional stock markets. The index of Islamic stocks listed in the US has strong influence on the other Islamic stock markets and their Indices.

Majid, Meera, Omar, and Aziz (2009) investigated the integration among selected ASEAN markets and their interdependencies with the US and Japan by employing two-step estimation, cointegration and generalized method of moments (GMM). This study revealed that ASEAN stock markets are increasingly cointegrated among themselves as well as with the US and Japan. Thus, the benefits of diversifying investments into ASEAN stock markets tend to disappear.

Based on Vector Error Correction Model (VECM) on the basis of the Generalized Method of Moments (GMM), Majid and Kassim (2010) analyzed the nature of market integration among five major Islamic stock markets, namely Malaysia, Indonesia, Japan, the United Kingdom and the US by covering weekly data of January 1999–August 2006. They found that investors who are interested in diversifying their portfolios can gain benefits by diversifying in the Islamic stock markets across economic groupings such as that in the developed and developing countries. However, limited benefits are available if investors only diversify their investments within the same economic groupings that are within the emerging Islamic stock markets or within the developed Islamic stock markets.

Karim, Kassim, and Arip (2010) investigated the effects of the US Subprime Crisis on the integration of selected Islamic stock markets (Malaysia, Indonesia, US, UK, and Japan). Time series techniques of cointegration were used over the period spanning from February 15, 2006 to December 31, 2008. They failed to prove the existence of co-integration among these Islamic stock markets for both pre-crisis and crisis period. Rahman and Sidek (2011) examined the impact of the US subprime mortgage crisis on the stock market returns of the ASEAN-5. The results indicated that the US and ASEAN-5 stock markets are cointegrated as well. Therefore, there is no diversification benefit in ASEAN-5 market during the financial crisis. More recently, the results of Köksal and Orhan (2013) indicate that value at risk (VaR) performs much more poorly in the context of measuring the risk in the developed countries compared to that in the emerging ones. One possible reason might be the deeper initial impact of the global financial crisis on the developed countries. Therefore, investors would be looking for different cross-border or asset classes such as *Shariah*-compliant investments.

Highly cointegrated stock markets suggest that there are no diversification benefits since performance and returns in these markets are highly correlated with each other. If so, it would be worthwhile to examine whether Islamic stock indices provide an improved avenue for diversification. A general class of such models is the multivariate generalized autoregressive conditional heteroscedastic (MGARCH) model (Engle & Kroner, 1995). This model can be used to estimate the Dynamic Conditional Correlation (DCC), how to compute the VaR of a portfolio and how to calculate forecasts of conditional volatilities and correlations. From a financial point of view, the dynamic MGARCH model opens the door to better decision-making tools in various areas, such as asset pricing, portfolio selection, option pricing, and hedging and risk management. Therefore, we examine whether Islamic stock indices help with diversification, using DCC (Dynamic Conditional Correlation) -MGARCH model.

4. Methodology

The application of multivariate volatility modeling is extensive and expanding. Pesaran and Pesaran (2007) provided a recent application of it on the futures markets such as currency futures, government bonds and equity index futures. DCC is a popular estimation procedure which is reasonably flexible in modeling individual volatilities and can be applied to portfolios with a large number of assets. To capture the fat-tailed nature of the distribution of asset returns, it is more appropriate if the DCC model is used with a multivariate t-distribution, especially for risk analysis where the tail

properties of return distributions are of most concern. Therefore, in order to identify the usefulness of Islamic stock indices on diversification benefits, a recently-developed Multivariate DCC-GARCH approach is employed.

4.1. DCC-MGARCH

In a multivariate GARCH (p,q) model, conditional variance and covariance of each asset depend upon not only on its own past conditional variance and past squared innovations but also on the past squared innovations and past conditional variances of the other assets (Bollerslev, 1990). The multivariate GARCH model is used in this Section to estimate the Dynamic Conditional Correlations (DCC) for a portfolio composed of returns on conventional and Islamic stock indices. The estimation of the Dynamic Conditional Correlations (DCC) has a lot of potentials.

DCC estimation involves 2 steps:

(i) Univariate volatility parameters are estimated by using GARCH models for each of the variables. So if there are two variables, then two GARCH equations are estimated. Just as an example,

$$h_t = c_0 + a_1\varepsilon_{t-1}^2 + b_1 h_{t-1} + b_2 h_{t-2} + m_1\varepsilon_{t-1}^2 I_{\varepsilon>0}$$

(Glosten-Jagannathan-Runkle (GJR), 1992 Asymmetric GARCH equation).where I is an indicator function in which it equals 1 when the standardized residuals of the series (ε_t) are positive and equals 0 otherwise. A negative value of 'm' implies that periods with negative residuals would be immediately followed by periods of higher variance compared to the periods of positive residuals. The equation for GARCH is estimated in step 1 (for each variable) to estimate the residual (ε_t).

(ii) The standardized residuals (ε_t) from the first step are used as inputs for estimating a time-varying correlation matrix (by estimating DCC equation parameters).

$$H_t = D_t R_t D_t$$

Here:

H_t: Conditional covariance matrix
D_t: Diagonal matrix of conditional time varying standardized residuals (ε_t) that are obtained from the univariate GARCH models (on-diagonal elements or variance or volatility component)
R_t: Time varying correlation matrix (off-diagonal elements)

The likelihood of the DCC estimator is written as:

$$L = -0.5\sum_{t=1}^{T}\left(k\log(2\pi) + 2\log\left(|D_t|\right) + \log\left(|R_t| + \varepsilon_t' R_t^{-1}\varepsilon_t\right)\right)$$

(a) In the first step, only the volatility component (D_t) is maximized; i.e. the log likelihood is reduced to the sum of the log likelihood of univariate GARCH equations.

(b) In the second step, correlation component (R_t) is maximized (conditional on the estimated D_t) with elements ε_t from step 1. This step gives the DCC parameters, α and β,

$$R_t = (1-\alpha-\beta)\overline{R} + \alpha\varepsilon_{t-1}\varepsilon_{t-1}' + \beta R_{t-1} \quad \left(\text{DCC equation}\right)$$

If $\alpha = \beta = 0$,[3] then R_t is simply $\overline{R}$ and CCC model is sufficient. The models have GARCH-type dynamics for both the conditional correlations and the conditional variances. The time-varying conditional variances can be interpreted as a measure of uncertainty and thus give us insight into what causes movement in the variance.

Bollerslev (1990) assumed that the conditional variance for each return, h_{it} ($i = 1, \ldots, m$) follows a univariate GARCH process, that is, CCC (constant conditional correlations) specification:

$$h_{it} = \omega_i + \sum_{j=1}^{r} a_{ij}\varepsilon_{i,t-j}^2 + \sum_{j=1}^{s}\beta_{ij}h_{i,t-j} \quad \left(\text{CCC model}\right)$$

where a_{ij} represents the ARCH effects or short-run persistence of shocks to return j and β_{ij} represents the GARCH effects, or contribution of shocks to return i to long-run persistence.

CCC specification above assumes independence of the conditional variances across returns and does not accommodate asymmetric behavior. In order to accommodate the asymmetric impacts of positive and negative shocks, Glosten, Jagannathan, and Runkle (1992) proposed the asymmetric GARCH or GJR specification for the conditional variance, which for $r = s = 1$, is given by:

$$h_{it} = \omega_i + \alpha_i\varepsilon_{i,t-1}^2 + \gamma_i I_{i,t-1}\varepsilon_{i,t-1}^2 + \beta_i h_{i,t-1}$$
(Asymmetric Conditional Variance Model)

(where I_{it} is an indicator function to distinguish between positive and negative shocks on conditional volatility.)

In order to capture the dynamics of time-varying conditional correlation Γ_t, Engle (2002) and Tse and Tsui (2002) proposed the following DCC model:

$$\Gamma_t = (1-\theta_1-\theta_2)\Gamma + \theta_1\eta_{t-1}\eta_{t-1}' + \theta_2\Gamma_{t-1}$$

In which θ_1 and θ_2 are scalar parameters to capture the effects of previous shocks and previous dynamic conditional correlations on current DCC.

The standardized returns used by Engle (2002) are as follows:

$$z_{it} = \frac{r_{it}}{\sigma_{i,t-1}(\lambda_i)}$$

For estimation of cross-asset correlations, Engle proposes a two-step procedure:

(i) Individual GARCH (1,1) models are fitted to the 'm' asset returns separately, and then,

[3] β close to 1 indicates a strong degree of persistence in the series for correlations (R_t), while ($\alpha + \beta$) close to 1 indicates high persistence in the conditional variance.

(ii) The coefficient of the conditional correlations, ∅, is estimated by Maximum Likelihood Estimator (MLE) (assuming that asset returns are conditionally Gaussian).

This procedure has two main drawbacks:

(i) The Gaussianity assumption does not hold for daily returns and its use can under-estimate the portfolio risk
(ii) The two-stage approach is likely to be inefficient (although consistent) even under Gaussianity.

Pesaran and Pesaran (2007), therefore, proposes an alternative formulation of conditional correlations ($\rho_{ij,\ t-1}$)(∅) that makes use of realized volatilities. Pesaran estimates correlations based on devolatized returns[4] that are nearly Gaussian.

$$\tilde{r}_{it} = \frac{r_{it}}{\sigma_{it}^{\text{realized}}} = \frac{r_{it}}{\sigma_{it}(p)}$$

For daily returns a value of $p = 20$ tends to render $\tilde{r}_{it}$ nearly Gaussian.

4.2. Tests of mean-reversion

In our study, the mean reverting as well as the non-mean reverting specifications are considered;

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:

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

Where, $\overline{\sigma}_i^2$ is the unconditional variance of the ith stock return.

λ_1 and λ_2 are stock specific volatility parameters (individual stock 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 then the shock to variance is permanent.

A more general mean reverting specification is given by.

$$q_{ij,t-1} = \overline{\rho}_{ij}(1 - \lambda_1 - \lambda_2) + \lambda_1 q_{ij,t-2} + \lambda_2 \tilde{r}_{i,t-1}\tilde{r}_{j,t-1}$$

where, $\overline{\rho}_{ij}$ is the unconditional correlation between r_{it} and r_{jt} and $\lambda_1 + \lambda_2 < 1$. One would expect $\lambda_1 + \lambda_2$ to be close to 1 in order to be non-mean reverting (does not come back to the mean or equilibrium). The non-mean reverting case can be obtained when $\lambda_1 + \lambda_2 = 1$. Therefore, in order to test the existence of non-mean reversion, we need to put a restriction of $\lambda_1 + \lambda_2 = 1$.

[4] Used by Pesaran for estimating t-DCC model to deal with the fat-tailed nature of the underlying distributions in the case of daily financial asset returns.

5. Data and empirical results

We use close-to-close daily return data in USD for MSCI conventional and Islamic stock indices in Islamic (Malaysia, Indonesia, Turkey, GCC region ex-Saudi) and Far East (Japan, China, Korea, Hong Kong, Taiwan) countries, plus the MSCI conventional index of US as proxy for US-based investor. Refer to Table 1 for the complete list of indices.

We use the sample of mostly the emerging markets. The first group is within East-Asian region while the second group belongs to OIC countries. The rationale for the former group is due to the fact that those countries play the role of one of the backbones of the global economy, with a significant growth driven by the global manufacturing power house. The substantial amount of wealth flowing to this region has motivated this study. Meanwhile, we also focus on the OIC countries in order to serve the Islamic investors' objective since they mix the allocation based on both the U.S. and their domestic markets.

Theoretically, since Islamic equities portray the limit of leverage, their correlation to the other equities across borders should be lower during the financial turmoil, due to less leverage effect. Particularly, emerging markets are very sensitive to the global shocks in relation to the global pricing factor correction, sentiment outflow, etc. Since many emerging markets' firms mostly depend on debt financing, due to the heavy reliance of these countries' economy on banking rather than stock market, thereby many firms have been excluded from the Islamic indices. This results in less leverage effect of the Islamic indices in emerging markets, which provide mitigation tools for the U.S. investors during the global turmoil.

Nonetheless, our findings tend to show that the correlation of the U.S. with the other conventional markets are almost similar to those of the other Islamic markets. It seems that the filtering criteria has substantially reduced the number of

Table 1
List of indices.

Indices	Symbol	Difference form
Conventional Indices		
US MSCI Conventional Index	US	RUS
China MSCI Conventional Index	CHINA	RCHINA
Japan MSCI Conventional Index	JAPAN	RJAPAN
Korea MSCI Conventional Index	KOREA	RKOREA
Taiwan MSCI Conventional Index	TW	RTW
Hong Kong MSCI Conventional Index	HK	RHK
Malaysia MSCI Conventional Index	MY	RMY
Indonesia MSCI Conventional Index	INDO	RINDO
Turkey MSCI Conventional Index	TURKEY	RTURKEY
GCC ex-Saudi MSCI Conventional Index	GCC	RGCC
Islamic Indices		
China MSCI Islamic Index	ICHINA	RICHINA
Japan MSCI Islamic Index	IJAPAN	RIJAPAN
Korea MSCI Islamic Index	IKOREA	RIKOREA
Taiwan MSCI Islamic Index	ITW	RITW
Hong Kong MSCI Islamic Index	IHK	RIHK
Malaysia MSCI Islamic Index	IMY	RIMY
Indonesia MSCI Islamic Index	INDO	RIINDO
Turkey MSCI Islamic Index	ITURKEY	RITURKEY
GCC ex-Saudi MSCI Islamic Index	IGCC	RIGCC

available assets in Islamic universe, which results in higher volatility due to less diversified portfolio associated with the high concentration of the portfolio on particular sectors. The volatility clustering during the crisis period may increase correlation level.

We are aware that there can be an overlapping impact as to whether the diversification is driven by the real risk-return profile of the asset or by the microstructure of the market (cross-border asset listing, spread, ADR, etc.). However, identifying the source of diversification is not the major focus of this study since we are concerned more with the comparative study. A further study in the future can be done to fill in the gaps.

Data are sourced from Datastream and cover the period, June 2007 to December 2011. The sample of observation starts from June 2007 because the MSCI Islamic stock indices just started from the year 2007. The lack of dataset has shifted the focus of the study to the investment universe during both the U.S. subprime crisis as well as the Eurozone crisis in 2010. However, the readers should be warned that our findings cannot be generalized to the case of the other crisis periods such as the Asian crisis, Russian crisis, dotcom crisis, Enron's collapse, and so on. Also, the findings cannot be applied to the strategic allocation for the long term since the length of our observation is only five years, which is more appropriate for those investors with dynamic/tactical strategies. These stock indices are transformed to compounded stock market returns by calculating the natural logarithmic differences of the daily stock prices, that is, $r_t = \ln(p_t/p_{t-1})$, where p_t and p_{t-1} represent the stock price index at time t and $t-1$, respectively. Consistent with other researchers (Kasa, 1992; Masih & Masih, 2001), the raw index values and returns have been transformed to reflect real US dollars in order to adopt the perspective of the US investor.

The mean returns of conventional and Islamic stock indices in Table 2 indicate that the average returns of both conventional and Islamic stock indices of GCC-ex-Saudi, Turkey, Hong Kong, Korea and Japan are negative; while the average returns of both conventional and Islamic stock indices of Malaysia, Indonesia and China are positive. Furthermore, the correlation in Table 3 indicates that, as far as the conventional stock indices are concerned, the stock return of the US maintains high correlations with that of Turkey (0.4469), China (0.2313), Korea (0.2139) and Hong Kong (0.2288) while it maintains the least correlations with GCC-ex-Saudi (0.0483), Malaysia (0.1399), Indonesia (0.1485) and Taiwan (0.1534). It has negative correlation with Japan's conventional stock index (−0.0017). If we look at the correlations between the US stock index and the other Islamic stock indices, it tends to indicate that the correlations are more or less similar to those of the conventional ones.

However, this simple test cannot tell us how volatilities of and correlations between asset returns change over time including their directions (positive or negative) and size (stronger or weaker). Therefore, in order to understand better the usefulness of the Islamic stock indices in terms of diversification benefits during the financial crisis, we have proceeded with the multivariate-GARCH analysis.

5.1. Empirical results

We embark on answering a related question as to whether the Islamic stocks indices provide any diversification benefits as far as the US-based investor is concerned. Three types of empirical tests are conducted, namely, comparison of Gaussian DCC model and t-DCC model, plotting the estimated Conditional Volatilities & Correlations and finally testing for linear restrictions. Initially we tried to cover data of the whole period (1 June 2007–1 December 2011), however, we faced the non-convergence problem for the t-distribution model. After we reduced the data by almost half a year, we did not encounter the case of non-convergence, and furthermore obtained the ML estimates of the Gaussian DCC and t-DCC model on both conventional and Islamic MSCI stock indices daily returns [sample: 1 January 2008–1 December 2011].

5.2. ML Estimates of the Gaussian DCC and t-DCC Model on Conventional MSCI Stock indices

We conducted both ML Estimates of the Gaussian DCC and t-DCC Model on Conventional MSCI Stock indices to serve as a preliminary step to determine which model is relatively more significant (Saiti, 2013). As a result, the maximized Log-Likelihood value under t-DCC model (30487.0) is significantly larger than that obtained under the

Table 2
Descriptive statistics of stock indices.

Conventional stock indices										
	RUS	RGCC	RTURKEY	RMY	RINDO	RHK	RTW	RKOREA	RJAPAN	RCHINA
Mean	−0.00017	−0.00050	−0.00024	0.00012	0.00047	−0.00002	−0.00013	−0.00003	−0.00038	0.00013
SD	0.017	0.014	0.027	0.012	0.023	0.018	0.018	0.025	0.017	0.024
SKE	−0.242	−1.583	−0.100	−0.639	−0.242	−0.114	−0.185	−0.186	−0.135	0.052
KUR	6.304	12.657	3.757	7.201	5.824	5.263	2.003	13.595	5.109	4.657
Islamic stock indices										
		RIGCC	RITURKEY	RIMY	RIINDO	RIHK	RITW	RIKOREA	RIJAPAN	RICHINA
Mean		−0.00078	−0.00035	0.00009	0.00017	−0.00006	0.00001	−0.00005	−0.00027	0.00005
SD		0.016	0.027	0.013	0.024	0.016	0.017	0.026	0.017	0.024
SKE		−1.401	0.253	−0.586	−0.245	−0.111	−0.052	−0.027	−0.186	0.073
KUR		12.175	6.715	6.976	6.087	7.178	2.642	13.685	4.759	4.056

Note: SD, SKE and KUR stand for Standard deviation, Skewness and Kurtosis, respectively.

Table 3
Simple correlation Analysis among conventional and Islamic stock indices.

\	RCHINA	RJAPAN	RKOREA	RTW	RHK	RMY	RINDO	RTURKEY	RGCC	RICHINA	RIJAPAN	RIKOREA	RITW	RIHK	RIMY	RIINDO	RITURKEY	RIGCC	
1.0000	0.2313	−0.0017	0.2139	0.1534	0.2288	0.1399	0.1485	0.4469	0.0483	0.2216	0.0160	0.2072	0.1590	0.2131	0.1146	0.1346	0.3964	0.0564	RUS
	1.0000	0.5270	0.6872	0.6418	0.8991	0.6012	0.6300	0.4265	0.2990	0.9827	0.5354	0.6638	0.6243	0.8494	0.5807	0.5759	0.4005	0.2934	RCHINA
		1.0000	0.5743	0.5129	0.5378	0.4132	0.3948	0.1597	0.2353	0.5238	0.9830	0.5599	0.4948	0.5220	0.3939	0.3474	0.1580	0.2267	RJAPAN
			1.0000	0.7226	0.6711	0.5930	0.5372	0.4042	0.2631	0.6796	0.5925	0.9758	0.7034	0.6393	0.5810	0.4609	0.3762	0.2574	RKOREA
				1.0000	0.6171	0.5890	0.5553	0.3723	0.2838	0.6309	0.5163	0.6957	0.9510	0.5816	0.5548	0.4755	0.3562	0.2741	RTW
					1.0000	0.5672	0.6064	0.3906	0.3083	0.8830	0.5469	0.6501	0.5995	0.9538	0.5427	0.5462	0.3682	0.3004	RHK
						1.0000	0.5964	0.4014	0.2589	0.5956	0.4116	0.5645	0.5640	0.5297	0.9342	0.5297	0.3746	0.2499	RMY
							1.0000	0.3815	0.3532	0.6385	0.4034	0.5180	0.5466	0.5585	0.5761	0.9275	0.3680	0.3518	RINDO
								1.0000	0.1775	0.4142	0.1686	0.3932	0.3590	0.3755	0.3684	0.3555	0.8608	0.1836	RTURKEY
									1.0000	0.2983	0.2349	0.2460	0.2684	0.2712	0.2503	0.3438	0.1893	0.9373	RGCC
										1.0000	0.5326	0.6635	0.6262	0.8314	0.5842	0.5863	0.3982	0.2995	RICHINA
											1.0000	0.5803	0.5000	0.5298	0.3935	0.3565	0.1653	0.2241	RIJAPAN
												1.0000	0.7059	0.6188	0.5704	0.4452	0.3701	0.2413	RIKOREA
													1.0000	0.5693	0.5588	0.4652	0.3431	0.2681	RITW
														1.0000	0.5108	0.5000	0.3528	0.2637	RIHK
															1.0000	0.5174	0.3393	0.2419	RIMY
																1.0000	0.3318	0.3428	RIINDO
																	1.0000	0.2082	RITURKEY
																		1.0000	RIGCC

normality assumption (30124.2). The estimated degree of freedom for the t-normal distribution is 7.39 which is below 30. This suggests that the t-distribution is more appropriate in capturing the fat-tailed nature of the distribution of stock returns. We only reported the results based on t-DCC model due to space constrain (the results for the Gaussian DCC model is available upon request).

Table 4 presents ML estimates of the t-DCC model on the MSCI conventional stock indices daily returns. We can see that all return volatility estimates are statistically significant and near to unity, implying a gradual decay in volatility under t-DCC model as well.

The upper panel of Table 4 presents the maximum likelihood estimates ofλ_{1i} and λ_{2i} (Volatility Parameters) for the ten MSCI conventional stock indices returns, and λ_1 and λ_2 (Mean reverting parameters, λ_1 and λ_2). We can observe that all volatility parameters are highly significant, with the estimates of λ_{1i}, $i = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10$ very close to unity implying a gradual volatility decay. The lower panel of the table reports the estimated unconditional volatilities and correlations of the vector of stock indices.

5.3. ML Estimates of the Gaussian DCC and t-DCC Model on MSCI Islamic Stock indices

In the similar way, we conducted also both ML Estimates of the Gaussian DCC and t-DCC Model on Islamic MSCI Stock indices to serve as a preliminary step to determine which model is relatively more significant. .We can see that, similarly, all return volatility estimates are statistically significant and near to unity, implying a gradual decay in volatility under t-DCC model as well. The maximized Log-Likelihood value (29912.9) is significantly larger than that obtained under the normality assumption (29443.4). The estimated degree of freedom for the t-normal distribution is 6.61 which is below 30. This suggests that the t-distribution is also more appropriate in capturing the fat-tailed nature of the distribution of Islamic stock returns.

The upper panel of Table 5 presents the maximum likelihood estimates of λ_{1i} and λ_{2i} (Volatility Parameters) for the ten MSCI Islamic stock indices returns, and λ_1 and λ_2 (Mean reverting parameters, λ_1 and λ_2). We can observe that all volatility parameters are highly significant, with the estimates of λ_{1i}, $i = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10$ very close to unity, implying a gradual volatility decay. The lower panel of the table reports the estimated unconditional volatilities and correlations of the vector of Islamic stock indices.

To have a clear picture of the unconditional volatility between both conventional & Islamic indices and the US market, we ranked the unconditional volatility in Table 6 (from lowest to highest).

The on-diagonals explain the volatility of stock indices. If the unconditional volatility is close to zero, it means that the particular index is less volatile. If the unconditional volatility is close to one, it means that the particular index is more volatile. From Table 6, we could see that unconditional volatilities of the conventional indices returns range from 0.012277 to 0.026904

Table 4
ML estimates of the t-DCC model on MSCI conventional stock Indices daily returns.

Parameter	Estimate	Standard error	T-ratio[Prob]
lambda1_RUS	.90753	.014083	64.4405[.000]
lambda1_RGCC	.92440	.013675	67.6003[.000]
lambda1_RTURKEY	.90941	.019710	46.1383[.000]
lambda1_RMY	.95064	.010848	87.6314[.000]
lambda1_RINDO	.93335	.014733	63.3518[.000]
lambda1_RHK	.93944	.012581	74.6713[.000]
lambda1_RTW	.96146	.0096711	99.4154[.000]
lambda1_RKOREA	.93446	.011743	79.5735[.000]
lambda1_RJAPAN	.87496	.030148	29.0223[.000]
lambda1_RCHINA	.94337	.010937	86.2581[.000]
lambda2_RUS	.083810	.012454	6.7293[.000]
lambda2_RGCC	.068779	.011638	5.9099[.000]
lambda2_RTURKEY	.071077	.014258	4.9849[.000]
lambda2_RMY	.042084	.0084659	4.9710[.000]
lambda2_RINDO	.055488	.011246	4.9340[.000]
lambda2_RHK	.050643	.0097505	5.1939[.000]
lambda2_RTW	.032173	.0074031	4.3459[.000]
lambda2_RKOREA	.055792	.0093625	5.9592[.000]
lambda2_RJAPAN	.092413	.020096	4.5986[.000]
lambda2_RCHINA	.049384	.0090332	5.4670[.000]
delta1	.92665	.021850	42.4098[.000]
delta2	.016531	.0023904	6.9157[.000]
df	7.3907	.47758	15.4754[.000]

Maximized Log-Likelihood = 30487.0

Unconditional volatilities (Standard Errors) on the diagonal elements

	RUS	RGCC	RTURKEY	RMY	RINDO	RHK
RUS	.017871	.053530	.45118	.15735	.15476	.24542
RGCC	.053530	.014790	.18619	.26825	.36752	.32646
RTURKEY	.45118	.18619	.026904	.38506	.35222	.37648
RMY	.15735	.26825	.38506	.012277	.57134	.54903
RINDO	.15476	.36752	.35222	.57134	.023373	.59693
RHK	.24542	.32646	.37648	.54903	.59693	.017807
RTW	.17022	.29085	.36075	.57771	.54289	.61039
RKOREA	.22485	.26596	.39578	.58358	.52596	.67007
RJAPAN	.011020	.24171	.17143	.41475	.39849	.54406
RCHINA	.25599	.31062	.41805	.58943	.62434	.90279

Unconditional correlations on the off-diagonal elements

	RTW	RKOREA	RJAPAN	RCHINA
RUS	.17022	.22485	.011020	.25599
RGCC	.29085	.26596	.24171	.31062
RTURKEY	.36075	.39578	.17143	.41805
RMY	.57771	.58358	.41475	.58943
RINDO	.54289	.52596	.39849	.62434
RHK	.61039	.67007	.54406	.90279
RTW	.017718	.71973	.51744	.63256
RKOREA	.71973	.026020	.57696	.68581
RJAPAN	.51744	.57696	.017448	.52922
RCHINA	.63256	.68581	.52922	.023753

Table 5
ML estimates of the t-DCC model on MSCI Islamic stock Indices daily returns.

Parameter	Estimate	Standard error	T-ratio[Prob]
lambda1_RUS	.90297	.014443	62.5193[.000]
lambda1_RIGCC	.91763	.015286	60.0294[.000]
lambda1_RITURKEY	.89941	.033340	26.9772[.000]
lambda1_RIINDO	.93427	.034644	26.9677[.000]
lambda1_RIMY	.94549	.012375	76.4018[.000]
lambda1_RIHK	.91342	.020026	45.6123[.000]
lambda1_RITW	.95888	.012367	77.5361[.000]
lambda1_RIKOREA	.92030	.017981	51.1819[.000]
lambda1_RIJAPAN	.86347	.034216	25.2359[.000]
lambda1_RICHINA	.91421	.022809	40.0804[.000]
lambda2_RUS	.087577	.012642	6.9273[.000]
lambda2_RIGCC	.074176	.013006	5.7034[.000]
lambda2_RITURKEY	.072299	.021441	3.3720[.001]
lambda2_RIINDO	.055623	.027231	2.0426[.041]
lambda2_RIMY	.047203	.0098682	4.7833[.000]
lambda2_RIHK	.071572	.015503	4.6166[.000]
lambda2_RITW	.032293	.0085677	3.7692[.000]
lambda2_RIKOREA	.062309	.012909	4.8266[.000]
lambda2_RIJAPAN	.098001	.022102	4.4341[.000]
lambda2_RICHINA	.070211	.017491	4.0140[.000]
delta1	.98059	.0034932	280.7154[.000]
delta2	.0079459	.0011222	7.0804[.000]
df	6.6132	.40764	16.2232[.000]

Maximized Log-Likelihood = 29912.9

Unconditional volatilities (Standard Errors) on the diagonal elements

	RUS	RIGCC	RITURKEY	RIINDO	RIMY	RIHK
RUS	.017871	.061159	.39617	.14130	.14147	.23533
RIGCC	.061159	.016519	.22144	.36578	.25705	.28775
RITURKEY	.39617	.22144	.027404	.30649	.32509	.34498
RIINDO	.14130	.36578	.30649	.024091	.49629	.48310
RIMY	.14147	.25705	.32509	.49629	.012562	.48281
RIHK	.23533	.28775	.34498	.48310	.48281	.016351
RITW	.17810	.28004	.33488	.45233	.55290	.56326
RIKOREA	.21857	.24700	.36002	.43008	.56301	.61520
RIJAPAN	.028489	.23285	.17675	.36315	.39524	.53538
RICHINA	.24552	.31802	.39387	.58630	.57625	.83266

Unconditional correlations on the off-diagonal elements

	RITW	RIKOREA	RIJAPAN	RICHINA
RUS	.17810	.21857	.028489	.24552
RIGCC	.28004	24700	.23285	.31802
RITURKEY	.33488	.36002	.17675	.39387
RIINDO	.45233	.43008	.36315	.58630
RIMY	.55290	.56301	.39524	.57625
RIHK	.56326	.61520	.53538	.83266
RITW	.016969	.70291	.50409	.62217
RIKOREA	.70291	.026420	.58275	.66520
RIJAPAN	.50409	.58275	.017842	.53875
RICHINA	.62217	.66520	.53875	.024318

while unconditional volatilities of returns of Islamic indices range from 0.012562 to 0.027404, which implies that returns on both the conventional and Islamic stock indices display more or less same degree of volatility. The results are consistent with the findings of Guyot (2011) in the sense that an efficient investment allocation is not compromised by the application of *Shariah* criteria; a vast majority of indices present degrees of liquidity that are similar to conventional indices. Furthermore, in terms of countries, we can see that both the conventional and Islamic MSCI indices of Malaysia, GCC ex-Saudi, Japan, Taiwan and Hong Kong are relatively less volatile compared to both the conventional and Islamic MSCI indices of Indonesia, China, Korea and Turkey.

Our results are consistent with previous research (for example, Alkulaib, Najand, & Mashayekh, 2009); they found that investors in the GCC region continue to benefit from high returns and low volatility with minimal exposure to exchange rate risk. As regards Japan, this finding is similar to the finding

Table 6
Ranks of the unconditional volatilities of the conventional and Islamic Indices (from lowest to highest).

Unconditional volatility				
No.	MSCI conventional indices		MSCI Islamic indices	
1	Malaysia	.012277	Malaysia	.012562
2	GCC ex-Saudi	.014790	GCC ex-Saudi	.016519
3	Japan	.017448	Hong Kong	.016351
4	Taiwan	.017718	Taiwan	.016969
5	Hong Kong	.017807	Japan	.017842
6	United State	.017871	–	–
7	Indonesia	.023373	Indonesia	.024091
8	China	.023753	China	.024318
9	Korea	.026020	Korea	.026420
10	Turkey	.026904	Turkey	.027404

of Chuang, Lu, and Tswei (2007) who analyzed six Asian markets including Japan and found that the Japanese market is the least vulnerable to volatility stimuli from other markets, but, it is the most influential in transmitting volatility to the other East Asian markets.

Walid, Chaker, Masood, and Fry (2011), based on a Markov-state switching approach, found that there is an unconditional probability of 0.65 that a low volatility regime occurs in Hong Kong and an unconditional probability of 0.8 that a low volatility regime occurs in Malaysia. This regime corresponds to a high mean-low variance regime and its persistence ranges from 77 weeks in Hong Kong to 25 weeks in Malaysia. Yu and Kabir (2008), based on the analysis of impulse response functions, found that Turkey's stock market is very sensitive and overreacts to the US shock. These findings are consistent with our findings. The stock indices of Malaysia and Hong Kong are less volatile relative to Turkey's stock index.

To have an easy picture of the relative correlation between both conventional & Islamic indices and the US market, we ranked the unconditional correlations in Table 7 (from lowest to highest).

The off-diagonals explain the unconditional correlations of indices. The rankings in Table 7 indicate some interesting facts. Unconditional correlations of the conventional index returns range from 0.011020 to 0.45118 while unconditional correlations of returns of Islamic indices range from 0.028489 to 0.39617, which implies that returns on both the conventional and Islamic stock indices display more or less the same degree of correlation with the US conventional MSCI index. In other words, the correlation of both the conventional and Islamic MSCI indices of Japan with US is lowest while both the indices of Turkey with US is highest.

Table 7
Unconditional correlations of both conventional and Islamic Indices with US index.

Unconditional correlations with US market			
No.	Country	MSCI conventional indices	MSCI Islamic indices
1	Japan	.011020	.028489
2	GCC ex-Saudi	.053530	.061159
3	Indonesia	.15476	.14130
4	Malaysia	.15735	.14147
5	Taiwan	.17022	.17810
6	Korea	.22485	.21857
7	Hong Kong	.24542	.23533
8	China	.25599	.24552
9	Turkey	.45118	.39617

Apparently, where purely Islamic stock indices are concerned, they do not provide more diversification benefits as far as the US-based investor is concerned. However, there are regional diversification benefits, for example, both the conventional and Islamic MSCI indices of Japan, GCC ex-Saudi, Indonesia, Malaysia and Taiwan provide better diversification benefits compared to Korea, Hong Kong, China and Turkey. In the case of Japan, one can conclude that Japan presents, in general, a low correlation with US index. This feature of the Japan stock index with other major stock markets has also been found elsewhere (Rua & Nunes, 2009).

Due to the GCC regions' massive oil earnings, the GCC economy grew rapidly, with positive fiscal and external current account positions. The GCC corporate sector had explosive profitability and earnings growth relative to its global peers, supported by expansionary fiscal, spending and massive investment programs throughout the region. These conditions, coupled with rosy economic prospects, accelerated the unprecedented boom in most GCC equity markets beginning in 2003. The GCC markets surpassed the gains in stock price indices during the NASDAQ dot.com bubble and the Japanese asset price bubble of the late 1980s (Mansur, 2008).

The findings by Mansourfar, Mohamad, and Hassan (2010) indicate that the stock markets of oil producing countries can be considered as a potential avenue for international portfolio diversification for investors not only from the same countries but also from the other MENA markets. A study by Cheng, Jahan-Parvar, and Rothman (2010) suggests that investing in most of the Arabic MENA markets other than Turkey provides returns of stock indices uncorrelated with global markets, and thus would serve as financial instruments with which portfolio diversification can be improved. In another study, Alkulaib et al. (2009) found that, as far as global investors are concerned, the stock markets in the GCC region present an opportunity for further diversification as these markets exhibit low correlations with developed financial markets.

Click and Plummer (2005) investigated the Asian financial crisis of 1997–1998 for its implications on the degree of stock market integration in the ASEAN-5 region. It is found that the ASEAN-5 stock markets (which include Indonesia and Malaysia) are cointegrated, but it is far from being complete. Therefore, there is still some room for portfolio diversification possibilities for international investors.

5.4. Plotting the estimated conditional volatilities for both conventional and Islamic stock indices

Figs. 1–4 presents conditional volatilities[5] of both conventional and Islamic MSCI stock indices returns of the under review countries plus the US conventional MSCI index.

[5] Conditional volatility of a time series implies explicit dependence on a past sequence of observations.

As presented in Figs. 1 and 2, the conditional volatilities of those conventional MSCI indices returns of Islamic and the Far East countries plus the US conventional MSCI index, respectively. The conditional volatilities of those conventional MSCI index returns move more closely together over time. In consistent with previous findings, the Turkey conventional MSCI index and Korea conventional MSCI index appear to have the highest volatility and Malaysia appears to have the lowest volatility. The high volatility of Turkey's index could be the reason that the Turkish economy is highly exposed not only to the US global financial crisis but also to the Eurozone's sovereign debt crisis at the level of its export industries.

Figs. 3 and 4, present conditional volatilities of Islamic MSCI stock indices returns of Islamic and the Far East countries plus the US conventional MSCI index. Similarly, the conditional volatilities of those Islamic MSCI indices returns move more closely together over time. Similarly, consistent with previous findings, the Turkey Islamic MSCI index and the Korea Islamic MSCI index appear to have the highest volatility and Malaysia Islamic MSCI index and Hong Kong Islamic MSCI index appear to have the lowest volatility.

In conclusion, there is relatively high volatility in stock indices returns in year 2008 due to the collapse of Lehman Brothers. In terms of the conventional MSCI indices, Turkey and Korea appear to have the highest volatility and Malaysia and US appear to have the lowest volatility. In the case of the Islamic MSCI indices, the Turkey and Korea Islamic MSCI indices appear to have the highest volatility and the Malaysia and Hong Kong Islamic MSCI indices appear to have the lowest volatility.

5.5. Plotting the estimated conditional correlations for both conventional and Islamic stock indices

Figs. 5–8 presents conditional correlations of both conventional and Islamic MSCI stock indices returns of the under review countries plus the US conventional MSCI index.

Figs. 5 and 6 display conditional correlations of the conventional MSCI stock indices returns of Islamic and the Far East countries with the US conventional MSCI index. We notice that the US conventional MSCI index has relatively less correlation with the GCC ex-Saudi and Japan conventional indices. However, it has relatively high correlation with the Turkey, China and Hong Kong conventional MSCI indices. This also confirms our results which were presented earlier.

Figs. 7 and 8 show conditional correlations of the Islamic MSCI stock indices returns of Islamic and the Far East countries with the US conventional MSCI index. We conclude that the US conventional MSCI index has relatively less correlation with the GCC ex-Saudi and Japan Islamic indices but relatively high correlation with the Turkey, China and Hong Kong Islamic MSCI indices.

As a conclusion, as far as the US based-investor is concerned, both the conventional and Islamic MSCI indices of Japan and GCC ex-Saudi provide better diversification benefits compared to Hong Kong, China and Turkey.

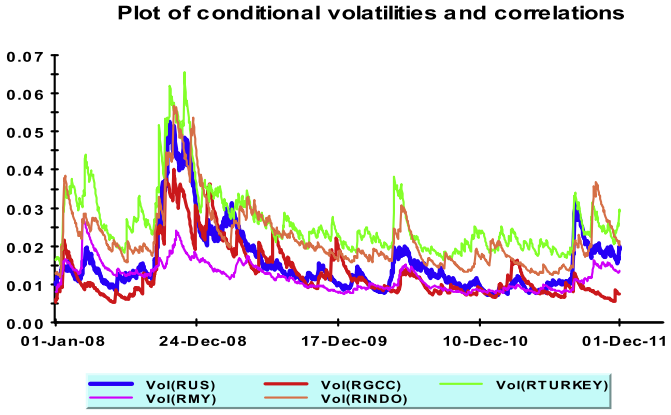

Fig. 1. Conditional volatilities of conventional stock Indices returns of Islamic countries and US market.

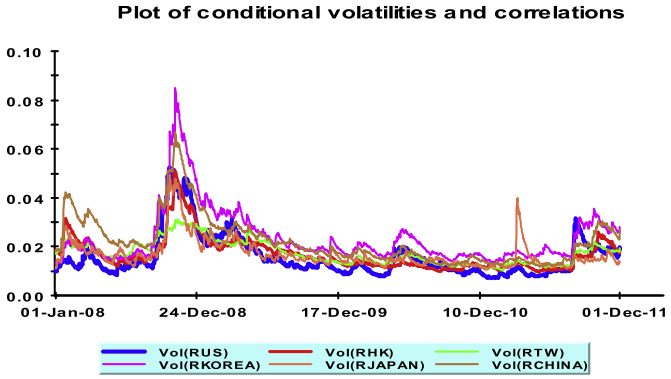

Fig. 2. Conditional volatilities of conventional stock Indices returns of non-Islamic countries and US market.

5.6. Testing for mean reversion of volatility

In this section, we focus on the problem of testing the null hypothesis that the volatility is non-mean reverting.

We wish to test : $H_0 : \lambda_{1i} + \lambda_{2i} = 1$

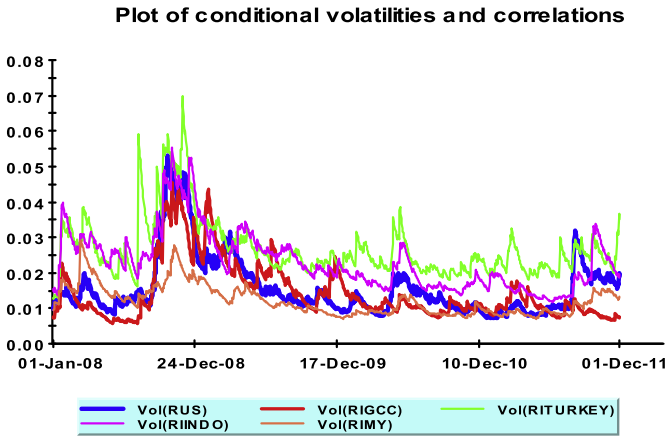

Fig. 3. Conditional volatilities of Islamic stock Indices returns of Islamic countries and US market.

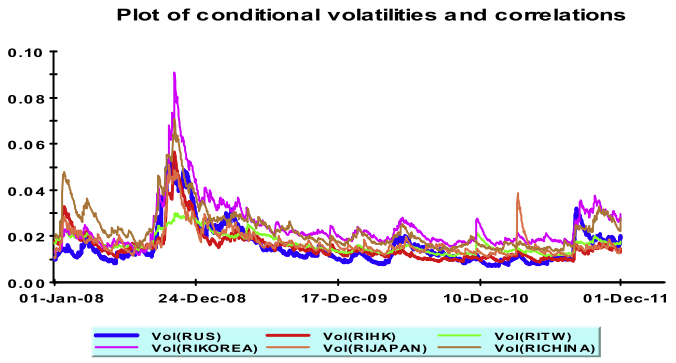

Fig. 4. Conditional volatilities of Islamic stock Indices returns of non-Islamic countries and US market.

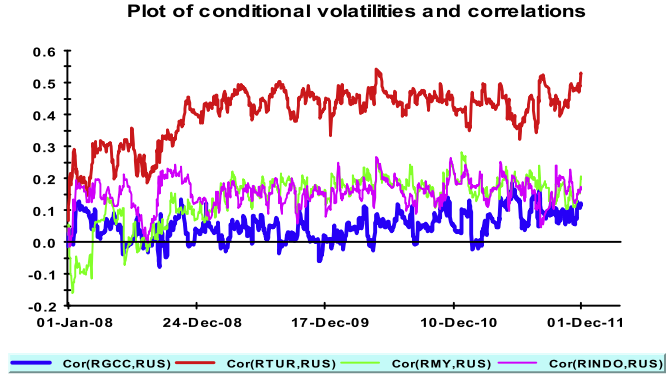

Fig. 5. Conditional correlations of MSCI US Index returns with other conventional Indices of Islamic countries.

Under H_0 the process is non-mean reverting and the unconditional variance for this asset does not exist.

Table 8 displays the test for mean reversion of volatility of the conventional MSCI indices returns. The result shows statistically significant mean reverting volatility for all conventional MSCI indices. In terms of the speed of mean reversion, the Turkey and Japan conventional MSCI indices have better ability to get back to equilibrium while the GCC ex-Saudi and Taiwan conventional indices have the least ability to get back to equilibrium.

Table 9 displays the test for mean reversion of volatility of the Islamic MSCI indices returns. The result shows

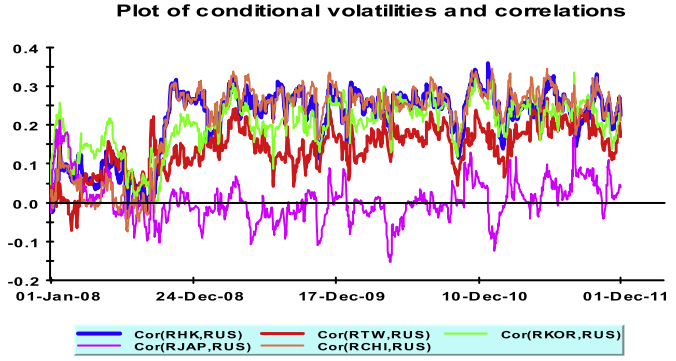

Fig. 6. Conditional correlations of MSCI US Index returns with other conventional Indices of non-Islamic countries.

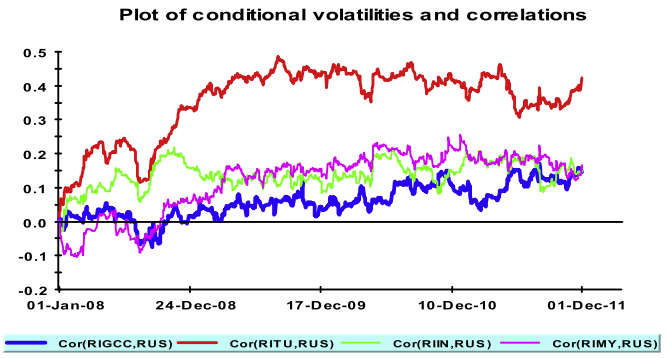

Fig. 7. Conditional correlations of MSCI US Index returns with other Islamic Indices of Islamic countries.

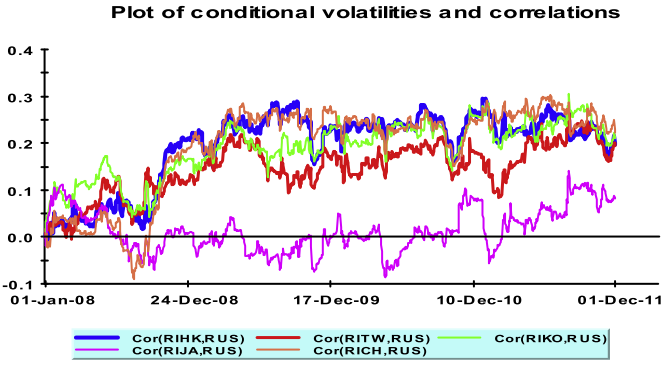

Fig. 8. Conditional correlations of MSCI US Index returns with other Islamic Indices of non-Islamic countries.

statistically significant mean reverting volatility for all Islamic MSCI indices except those of Indonesia and Taiwan. In terms of the speed of mean reversion, the Turkey and Japan Islamic MSCI indices have better ability to get back to equilibrium while the GCC ex-Saudi and Malaysia Islamic MSCI indices have the least ability to get back to equilibrium.

6. Conclusions and implications

We employed the multivariate GARCH-DCC model to examine the usefulness of the Islamic stock indices in terms of potential benefit of portfolio diversification as far as the US-based investor is concerned. As a humble contribution, this study is the first attempt at estimating the dynamic conditional correlations among both the conventional and Islamic MSCI stock indices through the application of a recently-developed dynamic multivariate GARCH approach with a view to helping the US-based investors to diversify their portfolios by hedging against unforeseen risks.

Firstly, the time-varying conditional volatility parameters of both the conventional and Islamic MSCI stock indices are found to be highly significant with most of their estimates very close to unity, implying a gradual decay in volatility (assuming both the Gaussian and '*t*' distributions). Of the two distributions, however, the *t*-distribution appears to be more appropriate in capturing the fat-tailed nature of the distributions of stock returns.

Table 8
Testing for mean reversion of volatility of conventional Indices returns.

Conventional indices	$1-\widehat{\lambda}_1-\widehat{\lambda}_2$	Std. errors	T-ratio
MSCI US	.0086560	.0026221	3.3011
GCC ex-Saudi	.0068173	.0026628	2.5602
Turkey	.019517	.0070097	2.7843
Malaysia	.0072750	.0032002	2.2733
Indonesia	.011158	.0043306	2.5766
Hong Kong	.0099130	.0032942	3.0092
Taiwan	.0063669	.0028795	2.2111
Korea	.0097521	.0030831	3.1631
Japan	.032624	.011604	2.8115
China	.0072477	.0022731	3.1885

Table 9
Testing for mean reversion of volatility of Islamic Indices returns.

Islamic indices	$1-\widehat{\lambda}_1-\widehat{\lambda}_2$	Std. errors	T-ratio
GCC ex-Saudi	.0081916	.0029742	2.7542
Turkey	.028286	.013286	2.1289
Malaysia	.0073106	.0032167	2.2727
Indonesia	.010106	.0078045	1.2949
Hong Kong	.015007	.0051631	2.9066
Taiwan	.0088230	.0044925	1.9639
Korea	.017395	.0059792	2.9093
Japan	.038531	.013838	2.7845
China	.015576	.0058970	2.6414

Secondly, there is relatively high volatility in stock indices returns in year 2008 due to the collapse of Lehman Brothers. In terms of countries, we could see that both the conventional and Islamic MSCI indices of Malaysia, GCC ex-Saudi, Japan, Taiwan and Hong Kong are relatively less volatile compared to both the conventional and Islamic MSCI indices of Indonesia, China, Korea and Turkey.

Thirdly, where purely Islamic stock indices are concerned, they do not provide more diversification benefits compared to their conventional counterparts as far as the US-based investor is concerned. However, there are regional diversification benefits, for example, both the conventional and Islamic MSCI indices of Japan, GCC ex-Saudi, Indonesia, Malaysia and Taiwan provide better diversification benefits compared to Korea, Hong Kong, China and Turkey. It tends to suggest that the Islamic countries provide better diversification benefits compared to the Far East countries.

Regarding the same profile of Islamic and conventional stock indices, we argue that Islamic stocks would be less exposed to the leverage effect since there is an upper limit of debt financing imposed by *Shariah* screening. This should result in lower volatility and higher diversification level among the mix of all Islamic equities, especially during the market downturn. This is consistent with the findings of Cakir and Raei (2007), and Alam, Hassan, and Haque (2013) who claim that the Islamic financial assets are different from the conventional financial assets since they have diversification advantages especially in terms of risk reduction when added to a basket of fixed income securities.

However, *Shariah* screening has excluded many companies, especially large firms, since many large companies in emerging countries are involved in high level of debt financing, mainly because of the fact that the banking system is more developed than the stock market. Therefore, Islamic index will have a smaller number of firms and higher exposure to smaller size as well as more concentration to a few sectors such as, housing. This may result in higher volatility due to the nature of less diversified portfolio as well as size and concentration effects. It seems that the advantage of lower leverage has been reduced by the nature of less diversification, resulting in the same risk profile of Islamic and conventional indices. In the case of Islamic countries with higher diversification benefits, it can depend on many factors such as investment inflow, trade ties, or sensitivity to outflow due to sentiment. Also, it depends on whether the Islamic countries have higher proportion of foreign speculators since sentiment can play a role here when there is a subprime crisis, via the channel of credit spread in the emerging countries.

Finally, a test of 'no mean-reversion of volatility parameters' of both the conventional and Islamic MSCI stock Indices rejects the null hypothesis in all cases with the results showing a slow but significant mean reverting volatility of all indices excepting the cases of Indonesia and Taiwan Islamic stock indices.

Our findings are very important and valuable to financial analysts who need to understand that the conventional and Islamic stock markets are not mutually exclusive of each other. Furthermore, the knowledge of financial co-movement among stock markets is important for portfolio diversification by international investors. Evidence of interdependence among these markets will also have important implications for macro stabilization policies in each of these countries and also for the financial policies of multinational corporations. As we know the financial markets of the world are moving, in order to know the international financial integration, it is very important to have a knowledge of how integrated the stock markets are and to have insights into the propagation mechanism or dynamics driving these relationships.

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