

Financial integration between sukuk and bond indices of emerging markets: Insights from wavelet coherence and multivariate-GARCH analysis

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Abstract

Some investors strive for capital appreciation while others may follow capital preservation strategies in terms of investment. In relation to that, Islamic finance receives a lot of attention from institutional investors and asset managers in the search for higher returns, lower correlation and growth potentiality. Therefore, it would be meaningful to investigate whether sukuk can offer any advantage in terms of global diversification. In such context, we have examined the volatilities and correlations of bond indices of emerging countries such as South Korea, Singapore, China, India, Indonesia, and Malaysia with Thomson Reuters BPA Malaysia Sukuk Index by applying wavelet coherence and Multivariate GARCH analyses. The data covers the period January 2010 to December 2015. We conclude that the sukuk market offers effective portfolio diversification opportunities for fixed income investors of the mentioned sample countries. Global and regional investors can avail the benefits of portfolio diversification through investment in sukuk markets but portfolio diversification is not feasible domestically. As a practical implication to the finance industry, the outcome of this research provides a framework for investigating sukuk market integration of several emerging bond markets which serve as an important platform for conducting further research.

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1. Introduction

Some investors strive for capital appreciation while others may follow capital preservation strategies in terms of investment. Capital preservation helps investors to safeguard capital, rather than considering the return on investments. Diversification helps investors to safeguard their capital through the allocation of money to different investments. Diversification can boost a portfolio, not only when markets are prosperous, but also where a sector experiences diminishing returns. It is evident that investors who held 100% equity portfolios over

the last few years had experienced getting very poor returns. On the other hand, the investors who diversified their portfolio through investing in bonds, property, infrastructure and hedge funds, were more likely to gain higher returns ([Goldman Sachs Asset management, 2011](#)). Diversification helps investors to gain positive returns in one market when another market is generating negative returns.

Usually, investors seek diversification opportunities combining bonds and stocks in a portfolio where stocks constitute riskier investments compared to bonds, however in terms of returns, the stock provides a higher return than a bond. [Barsky \(1989\)](#) stated that the bond and stock co-movement is independent. However, a positive stock-bond correlation also observed in the financial markets is regarded as a “spillover” effect which means shocks in the stock market have an impact on volatility and returns in a bond market that causes prices to

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fall for both assets. Another strong reason behind the positive stock-bond correlation relates to the “contagion” effect, which means these two assets may be affected by the macroeconomic variables in an analogous way that may cause positive correlation in bond and stock returns. Based on previous studies, it can be argued that there is negative correlation observed between these two assets. Ideally, correlation needs to shift from a positive to a negative sign to diversify a portfolio, thus enabling investors to gain decoupling benefits. Decoupling is defined as a process whereby the returns to assets shift towards opposite directions which leads to the maximization of diversification benefits for the period of market crisis because of flight-to-safety phenomena (Gulko, 2002). The flight-to-safety phenomenon can be defined as a process involving sharp plummeting of stock markets, with the resulting effects of investors moving their investments from risky to less risky safe havens (Maslov & Roehner, 2004).

Bonds assume a significant role in an investor's portfolio as they assist in preserving capital and offer diversification in many different market environments. Following the removal of government barriers to the international flow of capital in major developed countries during the early 1980s, the integration of global bond markets has increased intensely over the previous two decades. The degree and the nature of association in the global bond markets have significant implications for bond diversification opportunities (e.g., Clare, Maras, & Thomas, 1995). To diversify investment risk or enhance portfolio performance, investors eventually seek opportunities in the emerging global bond markets. However, significant variations can be found in international bond market return co-movements (Clare & Lekkos, 2000). Therefore, the degree of global bond market association constitutes, importantly, an issue of empirical analysis.

In relation to that, Islamic finance receives a lot of attention from institutional investors and asset managers in the search for higher returns, lower correlation and growth potentiality. The global Islamic finance industry was valued at approximately USD1.89 tln as of 2016 (Islamic Financial Services Board, 2017).¹ Significant growth was observed in the Islamic finance industry and the number of investors interested in Shariah-compliant securities is expected to grow along with the industry. Islamic financial industries are found to be insulated from crisis due to the fundamental restriction of the *Shariah* against *Riba* (Interest) and *Gharar* (needless uncertainty), and the impermissibility and inaccessibility of financial derivatives which may have been a vital contributor to protecting the Islamic financial system from encountering the vast effects of the crisis (Smolo & Mirakhor, 2010; Saiti et al., 2016).

1.1. An overview of growth of sukuk industry

The global sukuk market had observed sharp growth in the previous few years as annual issuances were just about USD1172 million in 2001 to USD138 billion in 2013

(International Islamic Financial Market, 2014). The recent growth of the global sukuk market has been very impressively driven by key markets such as Malaysia, the United Arab Emirates (UAE) and Saudi Arabia as well as emerging frontiers such as Indonesia and Turkey. The global outstanding sukuk topped USD349.1 billion as of December 2016, an 8.7% increase from USD321.2 billion at the end- 2015 (MIFC, 2016). An increasing trend is observed in Malaysia's secondary sukuk market which was sizeable at approximately USD183.8 billion at the end of 2016, that representing 54% of the total outstanding sukuk. At the same time, Saudi Arabia and UAE occupied a share of 16.3% and 8.9% respectively of the total outstanding sukuk (MIFC, 2016). Ernst & Young, well renowned as a global consultant, forecasted that there would be a high global demand for sukuk and it may reach US\$900 billion by 2017.² In recent times in 2014, revolutionary issuances have been documented from the UK, Hong Kong, Senegal, South Africa and Luxembourg – strengthening the sukuk market's position as a sustainable and competitive source of funding. Sukuk listings have also moved to cross-border activities as the sukuk is listed on many key stock exchanges specifically in Europe – such as the London Stock Exchange, the Irish Stock Exchange, and the Luxembourg Stock Exchange (Malaysia International Islamic Financial Centre, 2015). Within the corporate sector, national oil and gas producer Petronas issued USD1.25 billion sukuk to raise working capital.³ Mitsubishi UFJ, Bank of Tokyo and Goldman Sachs debuted in the global sukuk market in September 2015.

Typically, sukuk portfolios offer a lower period of duration (less sensitive to interest-rate) than other major fixed income indexes. For example, the average modified duration of Dow Jones Total Return Sukuk Index is 4.4 years, while the average duration of the Barclays Global Aggregate Bond Index is 6.5 years. Hence, according to the Federal's quantitative easing program which first surfaced in 2013, the sukuk held up better than US treasuries and emerging market debts, as is reflected in Fig. 1 (Franklin Templeton Investments, 2014).

In fact, sukuk returns are attractive compared to a traditional fixed income asset and the volatilities of sukuk historically had been more subdued – which could sometimes prove important in a rising interest-rate environment. Furthermore, the sukuk showed the best exposure to the growing and financially sound economics such as Gulf Cooperation Council (GCC) and Southeast Asian countries. In addition, sukuk yields show less correlation with other international fixed income markets because of its distinctive structure and market dynamics (Franklin Templeton Investments, 2014). There is an increasing demand for this asset class due to its strength during the global financial subprime crisis and Eurozone sovereign debt crisis. The reason behind its strength lies in the fact that many sukuk instruments are supported by tangible assets such as infrastructure projects or real estate.

¹ Data for Islamic capital markets is for full-year 2016; data for Islamic banking is for the six months ended June 2016 (1H2016); data for *takāful* is as at end-2015.

² Ernst & Young MENA, “Global Demand for Sukuk to Reach US\$900bn by 2017,” 9 September 2012.

³ “PETRONAS begins USD 17bln bond and sukuk drive” The Star (March 2015).

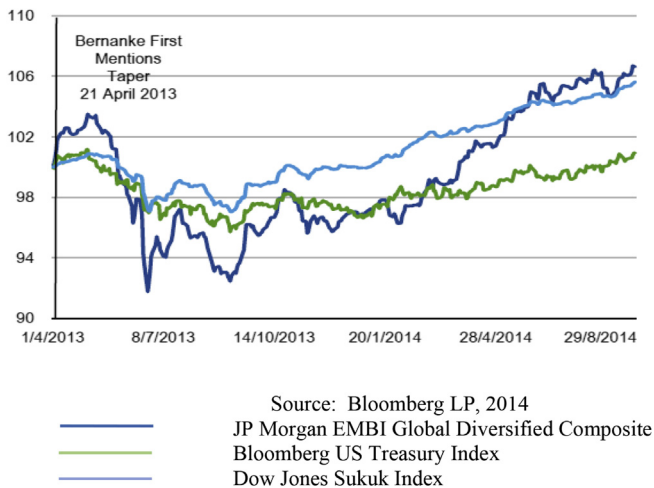


Fig. 1. Sukuk resilient to US fed tapering fears as at 29 August 2014.

Therefore, they are less affected by market events. It can be said that after considering these factors, the sukuk may be serve as a proper complement to investors' existing equity or international bond allocations.

2. Literature review

There is a vast amount of literature on the portfolio diversification benefits of stock and equity, however, few empirical studies have examined the integration among bond markets (Yang, 2005). In many previous studies, researchers observed low correlations among global bond markets which indicated the scope of portfolio diversification opportunities for investors (Clare et al., 1995; DeGennaro, Kunkel, & Lee, 1994; Levy & Lerman, 1988; Yang, 2005). However, other researchers found strong correlations after experimenting with the same markets and these results hindered portfolio diversification opportunities (Barassi, Caporale, & Hall, 2001; Iben & Litterman, 1994; Smith, 2002; Solnik, Boucelle, & Fur, 1996). Considering the mixed findings from both sides, it also observed that correlation among markets is changing through time because of changes in integration across markets (Engle, 2002). Therefore, recent studies have only begun to investigate asset returns in terms of shifting patterns in correlations among markets that have a significant implication on portfolio diversification strategies (Cappiello, Engle, & Sheppard, 2006; Ciner, 2007; Hansson, Liljebloom, & Loflund, 2009; Hunter & Simon, 2005; Kim, Lucey, & Wu, 2006). Thus, investors do not receive specific guidelines from existing empirical studies on bond diversification. Findings from existing empirical studies on bond diversification, were confusing as they were conducted from many different perspectives. Further research is needed in this area to investigate this issue.

To improve economic growth, major central banks have been pumping liquidity into the global economy. For instance, the Bank of England and the US Federal Reserve (Fed) may be getting closer to raising interest rates. Bond prices are inclined to drop when interest rates increase. Nonetheless, the effects are influenced by the bond's duration, or its sensitivity to the

interest rate risk. Changes to interest rates will affect the bond's price if the duration is higher. This is one of the major drawbacks for investors, who hold bond portfolios. Liquidity is continually deepening but there is a perception that if the market is relatively illiquid, demand would increase in such a way that will cause secondary market liquidity to enrich considerably and price discovery becoming somewhat at ease. Today, bid-offer spreads are comparable to those observed in the market for conventional fixed-income instruments (Franklin Templeton Investments, 2014).

Financial markets observed many down trends during the past crisis period, where conventional bond market performance was not in a satisfactory position. Investors, as well as the economy faced economic ruin/experienced recession at that time, but now they are looking for better alternatives. Therefore, there is a strong demand for replacing traditional financial instruments with better alternatives and searching for such investment backed by real asset which is not only a critical issue for investors, but also for policy makers. In this context, the sukuk may play a vital role as an alternative because it is a distinct type of investment which is dissimilar to Shariah compliant equity, as it expands the existing fixed income investment globally and is also considered as an attractive opportunity for conservative investors in a unique class of fixed income assets. Studies carried out by Raei and Cakir (2007), Ariff and Safari (2012), Hassan (2012), Godlewski, Turk-Ariss, and Weill (2013) and Paltrinieri, Dreassi, Miani, & Sclip (2015) agreed that the sukuk offers an alternative investment, but it is still debatable whether the sukuk is an efficient instrument of investment for the purposes of diversification gains.

Raei and Cakir (2007) examined the impact of bonds issued according to Islamic principles (Sukuk), based on the cost and risk structure of investment portfolios by using the Value-at-Risk (VaR) framework. They analyzed whether secondary market behavior of Eurobonds and Sukuk issued by the same issuer are significantly different in providing gains from diversification and concluded that gains are present and in certain cases very significant. By employing similar approach, Hassan (2012) found that Sukuk and conventional bonds prices have different behavior in the secondary market. The results have also confirmed the presence of diversification gains when adding Sukuk to conventional bond portfolio in line with previous literature.

Ariff and Safari (2012) investigated whether the yield to maturities of sukuk securities and conventional bonds of same quality rating generates similar/same returns to investors and identified some differences between yield curves of Islamic Securities and conventional bonds of different types of issuers. Godlewski et al. (2013) investigated whether stock market investors react differently to the announcements of *sukuk* and conventional bond issues by application of an event study methodology on a sample of Malaysian listed companies. They found that the stock market is neutral to announcements of conventional bond issues, but it reacts negatively to announcements of *sukuk* issues.

Alam, Hassan, and Haque (2013) examined the impact of conventional bonds and Sukuk announcements on shareholder wealth and their determinants using 79 Sukuks and 87

conventional bonds over the period of 2004–2012 in six developed Islamic financial market. It was revealed that the market reaction is negative for the announcements of Sukuk before and during 2007 global financial crisis. On the other hand, market reaction is positive for announcements of conventional bond before the crisis period and negative during and after crisis periods. Paltrinieri et al. (2015) studied diversification benefits of sukuk, their correlation with other asset classes and the effects of their inclusion in investment portfolios of institutional and retail investors, through a comprehensive comparison of their risk/return profiles during and after the financial crisis and found that a beneficial performance adjusted for the specific volatility together with a lower correlation especially during the financial crisis. Smaoui and Khawaja (2017) found that the larger economic size, higher proportion of Muslims in the population, better investment profile (IP), and lower corruption are associated with larger Sukuk markets, while higher interest rate spread is negatively related to Sukuk market development. Reboredo and Naifar (2017) studied the relationship between Islamic bond (sukuk) prices and financial and policy uncertainty conditions by application of a quantile regression approach. Their empirical results show that US bond prices had a negative impact and causality effects on sukuk prices, whereas European Monetary Union bond prices only co-moved with sukuk prices.

The studies on co-movement and portfolio diversification for Islamic investment certificates are very limited compared to conventional bond markets. Most of the studies highlighted the comparing and contrasting the performance of sukuk and bond based on risk-return profile and examining the sukuk structure (for e.g. Zin et al. (2011), Ariff and Safari (2012), Hassan (2012), Lahsasna and Lin (2012), Godlewski et al. (2013), etc.). Also, Zulkhibri (2015) argued that the literature on *sukuk* is largely qualitative rather than quantitative research, with the bulk of academic research assuming the form of conference and seminar papers.

With regard to research methodology, similar methodologies are applied in the case of Islamic stock indices such as Najeed, Bacha, and Masih (2015), Abdullah, Saiti, and Masih (2016), Buriev, Dewandaru, Zainal, and Masih (2017), Jaffar, Dewandaru, and Masih (2017) and other others. However very limited research can be found in relation to empirical studies on the sukuk which apply wavelet and Multivariate- GARCH analyses. Therefore, to the best of our knowledge, very few studies can be found on market integration between sukuk and conventional bond markets considering global and regional perspectives. This research also attempts to study the portfolio diversification strategy for conventional bond markets investors through combining sukuk with emerging bond markets across heterogeneous investment horizon.

3. Research methodology

3.1. Continuous wavelet transform (CWT)

Many authors have started to apply the continuous wavelet transform (CWT) in finance and economics research (for e.g. Vacha and Barunik (2012), Madaleno and Pinho (2012), Saiti

(2012), among others). This study employed wavelet transformations to examine the time-varying and time-scale dependent returns co-movements between the sample indices. The CWT plots the original time series, which is a function of one variable time-separate into function of two different variables such as time and frequency. The CWT plots the series correlations in a two-dimensional diagram that helps to identify and interpret the patterns or hidden information. The analysis of correlation between two CWT is generally known as the wavelet coherence. These diagrams would specify the degree of correlation between two variables with both varying time and frequency.

For the CWT, this study employed the Daubechies (1992) least asymmetric wavelet filter of length $L = 8$ represented by LA (8) based on eight non-zero coefficients. In terms of selecting the wavelet filter, this study has employed the principals of retaining a ‘balance’ between the sample size and the length of the wavelet filter (In & Kim, 2013). Earlier studies on high-frequency data have revealed that a moderate-length filter such as $L = 8$ is suitable to deal with the characteristic or features of time series data (see Gençay, Selçuk, & Whitcher, 2001; 2002, In & Kim, 2013). In the literature, it is claimed that an LA (8) filter provides smoother wavelet coefficient than others filters such as Haar wavelet filter.

The continuous wavelet transforms (CWT) $W_x(u, s)$ is obtained by projecting a mother wavelet ψ onto the examined time series $x(t) \in L^2(\mathbb{R})$ that is:

$$W_x(u, s) = \int_{-\alpha}^{\alpha} x(t) \frac{1}{\sqrt{s}} \psi\left(\frac{t-u}{s}\right) dt$$

The position of wavelet in the frequency domain is defined by s , while its position in the time domain is defined by u . Thus, the wavelet transform provides information concurrently on time and frequency by mapping the original series into a function of u and s . To study the interaction between two-time series or how closely X and Y are integrated by linear transformation, this study has employed a bivariate framework which is known as wavelet coherence. The wavelet coherence of two-time series is defined as:

$$R_n^2(s) = \frac{|S(s^{-1} W_n^{xy}(s))|^2}{S(s^{-1} |W_n^x(s)|)^2 \cdot S(s^{-1} |W_n^y(s)|)^2}$$

where S is a smoothing operator, s is a wavelet scale, $W_n^x(s)$ is the continuous wavelet transform of the time series X , $W_n^y(s)$ is the continuous wavelet transform of the time series Y , and $W_n^{xy}(s)$ is a cross wavelet transform of the two-time series X and Y (Madaleno & Pinho, 2012).

3.2. Multivariate GARCH - dynamic conditional correlations

The multivariate GARCH model employed in this study, measures the dynamic conditional correlation (DCC) for a portfolio consisting of sukuk and conventional bonds. It is more logical to apply DCC approach to incorporate the

fat-tailed nature of the distribution of asset returns using multivariate t-distribution, specifically for risk assessments involving the tail properties of yield distribution.

DCC method involves 2 steps:

- (i) GARCH models can measure univariate volatility parameters for each of the variables. Therefore, in terms of two variables, two GARCH equations are postulated. For instance,

$$h_t = c_0 + a_1 \varepsilon_{t-1}^2 + b_1 h_{t-1} + b_2 h_{t-2} + m_1 \varepsilon_{t-1}^2 I_{\varepsilon > 0} \quad (\text{Giosten – Jagannathan – Runkle (GJR), 1993 Asymmetric GARCH equation})$$

where I is an indicator function which can be equivalent to 1 if the standardized residuals of the series (ε_t) are positive and equivalent to 0 otherwise. A negative value of ‘m’ indicates that periods of higher variance follow directly periods with negative residuals compared to the periods of positive residuals. To estimate the residual (ε_t), the GARCH equation is measured in step 1 (for each variable).

- (ii) The standard residuals that taken from the first stage, are applied as inputs for measuring a time-varying correlation matrix (by measuring DCC equation limits).

$$H_t = D_t \cdot R_t \cdot D_t$$

Here:

H_t = Conditional covariance matrix
 D_t = Diagonal matrix of conditional time varying standardized residuals (ε_t) which can be acquired from the univariate GARCH models (on-diagonal elements or variance)
 R_t = Time-varying correlation matrix (off-diagonal elements)

The likelihood of the DCC estimator is mentioned below:

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

- (a) The volatility component (D_t) is maximized in the primary step; i.e. the log likelihood is lessened to the sum of the log likelihood of univariate GARCH equations.
 (b) Correlation component (R_t) is maximized in the second step (conditional on the estimated D_t) with elements ε_t originated from step 1. DCC parameters α and β obtained from this step 1.

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

If $\alpha = \beta = 0^4$, then R_t is simply \bar{R} and CCC model is sufficient. For both the conditional correlations and the

conditional variances, this model has GARCH-type dynamics. The time-varying conditional variances can be understood as an estimation of uncertainty which shows the insight into the causes of movement in the variance.

Bollerslev (1990) stated that a univariate GARCH process is followed by the conditional variance for each yield, that is, CCC (constant conditional correlations) specification:

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

where a_{ij} represents the ARCH impacts or short-term resolution of shocks to return j and β_{ij} reflects the GARCH effects, or impact of shocks to yield I to long term resolution.

Independence of the conditional variances across returns assumed in above CCC specification does not support asymmetric behavior. Glosten et al. (1993) introduced the asymmetric GARCH or GJR feature for the conditional variance for incorporating the asymmetric effects of positive and negative shocks, where for $r = s = 1$, mentioned below.

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

where positive and negative shocks on conditional volatility can be distinguished through I_{it} which is considered as indicator function.

Engle (2002) and Tse and Tsui (2002) introduced DCC model to incorporate the dynamics of time-varying conditional correlation Γ_t which is mentioned below.

$$\Gamma_t = (1 - \theta_1 - \theta_2) \Gamma + \theta_1 \Gamma_{t-1} + \theta_2 \Gamma_{t-2}$$

Here, θ_1 and θ_2 are scalar parameters to capture the impacts of past shocks and past dynamics conditional correlations on DCC.

As per Engle (2002) the standard returns are mentioned below:

$$Z_{it} = \frac{r_{it}}{\sigma_{i,t-1}(\lambda)_i}$$

Engle introduced two-step procedure in order to estimate cross-asset correlations:

- (i) Individual GARCH (1,1) approach are fitted to the ‘m’ asset yields independently and then,
 (ii) Maximum Likelihood Estimator (MLE) measure the coefficient of the conditional correlations φ (having assumption of asset yields are tentatively Gaussian).

4. Data and empirical results

4.1. Data

Data is collected from Bloomberg and Data stream database which cover the period from January 2010 to December 2015. These bonds and sukuk indices are transformed to bond market returns by computing the natural logarithmic differences of the daily bond or sukuk prices. The list of the indices

⁴ β close to 1 indicates a strong degree of persistence in the series for correlations (R_t), while $(\alpha + \beta)$ close to 1 shows high persistence in the conditional variance.

and the respective tickers are highlighted in [Table 1](#). The selected Bloomberg sovereign bond indices are rule-based market-value weighted index constructed to measure the fixed-rate local currency securities publicly by respected countries. The Thomson Reuters BPA Malaysia Government Sukuk Index includes Malaysia Ringgit dominated long term investment graded Islamic bonds. Bloomberg bond indices data are available from January 2010 which is the reason the data starts from 2010.

The selected emerging market countries have established efficient bond markets in their regions that is effectively representative of those regions. Data availability also constitutes an important reason for selecting the countries. Few of the sampled countries have already issued sovereign sukuk which shows their familiarity and interest in the sukuk market. The selected emerging market countries have sharp growth in their economy - especially China and India which have high savings rate compared to other countries. Malaysian bond and sukuk market indices have been selected to examine the domestic diversification opportunities for Malaysian bond markets investors.

4.2. The results of the wavelet coherence analysis

[Fig. 2](#) illustrates the estimated wavelet coherence and phase difference of the Singapore Bloomberg government bond market (BSIN) returns with the Thomson Reuters Malaysian government sukuk market (TRBPAMGOVI) returns, from scale 1 (one day) up to scale of 8 (256 trading days) applying continuous wavelet transformations (CWT). In this diagram, investment horizon is shown on the vertical axis which represents investors' holding periods (e.g. 2–4 days, 4–8 days, 8–16 days, etc.), while the horizontal axis refers to the time in terms of trading days during the sample years from 2010 to 2015.

As highlighted in the coherence [Fig. 2](#), many blue and light blue areas can be found between Singapore bonds and the sukuk indices. Here, Thomson Reuters Malaysian sukuk offering profitable diversification opportunity for Singapore-based investors through investing in the sukuk market.

The short holding periods such as 2–4 days, 4–8 days, the global and Malaysian sukuk markets are less correlated with Singapore bond markets which have generated/provided effective portfolio diversification over the last six years. The same is true for the medium investment horizons consisting 16–64 days and 64–128 days for this market pair, because less coherency as depicted in the figure. However, the Malaysian sukuk market may not serve as a suitable option for

Singaporean-based fixed income investors during long horizon periods due to higher co-movement between these two indices.

The Malaysian sukuk and Singapore bond were affected by the eurozone crisis during 2011 and 2012, causing higher correlations in terms of daily returns. Both markets are integrated into the long run because they are a close neighbor and trading partner as well which may be a worthy cause of higher correlation. Overall, the Malaysian sukuk market is recommended to the Singaporean investor's because the daily returns are weakly correlated with Singapore bond market for both short and mid-term investments.

[Fig. 3](#) illustrates the estimated wavelet coherence and phase difference of the Indonesia Bloomberg government bond market returns (BINDO) with the Thomson Reuters Malaysian government sukuk market (TRBPAMGOVI) returns. A first glance, it could be seen that the lower level of co-movements between BINDO and TRBPAM on the coherence diagram as witnessed from fewer red areas and plenty of blue and light blue areas.

Specifically, in terms of short holding periods consisting of 2–4 days and 4–8 days, Malaysian sukuk market returns are weakly correlated with Indonesian bond market over the previous six years, thus offering diversification opportunity. However, there is a slight impact of Euro Sovereign Debt 2011–12 crisis on both market pair which is negligible in terms of duration. Moving toward a medium holding period of 16–64 and 64–128 days, the coherence plot shows many blue and light blue areas in this sukuk and bond market pair. Even though there are some red and yellow areas have seen in [Fig. 3](#) from 2013 to 2015 especially in 2015 which hampers the portfolio diversification but still it was favorable for Indonesian fixed income investors for diversifying their portfolio. Finally, for the long-term investment portfolio of 128–256 days holding periods, as per the coherence plot Malaysian market is not a good option due to high correlation with the Indonesian bond market. Overall, the Malaysian sukuk market is recommended for Indonesian investors because daily returns are weakly correlated with those of the Indonesian bond market.

[Fig. 4](#) illustrates the estimated wavelet coherence and phase difference of the Malaysia Bloomberg government bond market returns (BMYR) with the Thomson Reuters Malaysian government sukuk market (TRBPAMGOVI) returns.

Firstly, the coherence diagram illustrates that the Malaysia bond market is highly correlated with the Malaysia sukuk market in terms of returns compared to any other market pairs as evidenced by the largest portion of the area in the diagram and indicated by red areas. For the short holding periods, such as 2–4 days, the Malaysian bond market returns have a low correlation with the sukuk market. However, the co-movement between these two markets has highly positive correlation in terms of medium and long-term investment holding period consist of 64–128 days and 128–256 days period. A notable exception is found during 2011 and 2014 as evidenced by very few blue areas which encourage short and mid-term investment. The outcome of the analysis indicates that the domestic bond and sukuk markets are influenced by the similar macroeconomic factors that have a strong impact on the overall

Table 1
List of indices.

Emerging Market		
1.	Bloomberg Singapore Sovereign Bond Index	BSIN
2.	Bloomberg Indonesia Local Sovereign Index	BINDO
3.	Bloomberg Malaysia Local Sovereign Index	BMYR
4.	Bloomberg S Korea Local Sovereign Index	BKRW
5.	Bloomberg China Local Sovereign Index	BCGB
6.	Bloomberg India Local Sovereign Index	BINDI
7.	Thomson Reuters BPA Malaysia Sukuk Index	TRBPAMGOVI

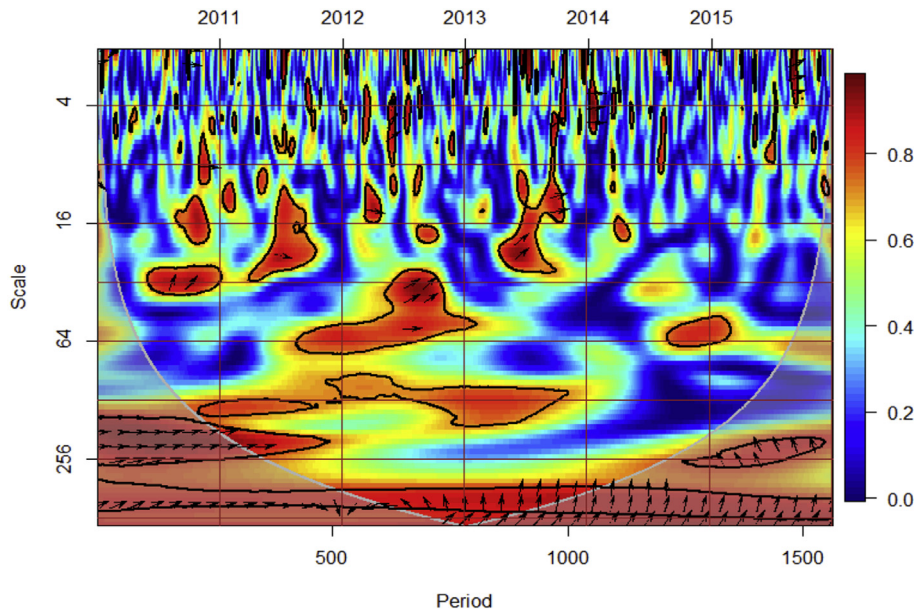


Fig. 2. Continuous wavelet transform: BSIN and TRBAPAMGOVI.

market. The domestic market responds to the macroeconomic fundamentals such as interest rates, inflation, unemployment, economic growth etc. and these fundamentals have a significant role. Impacting the returns of fixed-income instruments on the long run which also leads to strong correlations. Moreover, the domestic bond and sukuk markets are also influenced by monetary and fiscal policies.

Fig. 5 illustrates the estimated wavelet coherence and phase difference of the China Bloomberg government bond market returns (BCGB) with the Thomson Reuters Malaysian government sukuk market (TRBPAMGOVI) returns. In general, the color code represents the low co-movements on the long term as well as short term between these two market pairs

which are more persistent during the period 2010 to 2015. During the crisis period, the correlation was not strong which is beneficial for the China investors through investing in Malaysian sukuk market. The nature of the co-movement between the bond and sukuk indices are similar in both long and short run except few disparities in mid-term investment. Overall, the Malaysia sukuk market would be a better choice for Chinese fixed income investors in terms of portfolio diversification.

Fig. 6 illustrates the estimated wavelet coherence and phase difference of the India Bloomberg government bond market returns (BINDI) with the Thomson Reuters Malaysian government sukuk market (TRBPAMGOVI) returns. The short holding periods such as 2–4 days, 4–8 days, the global and

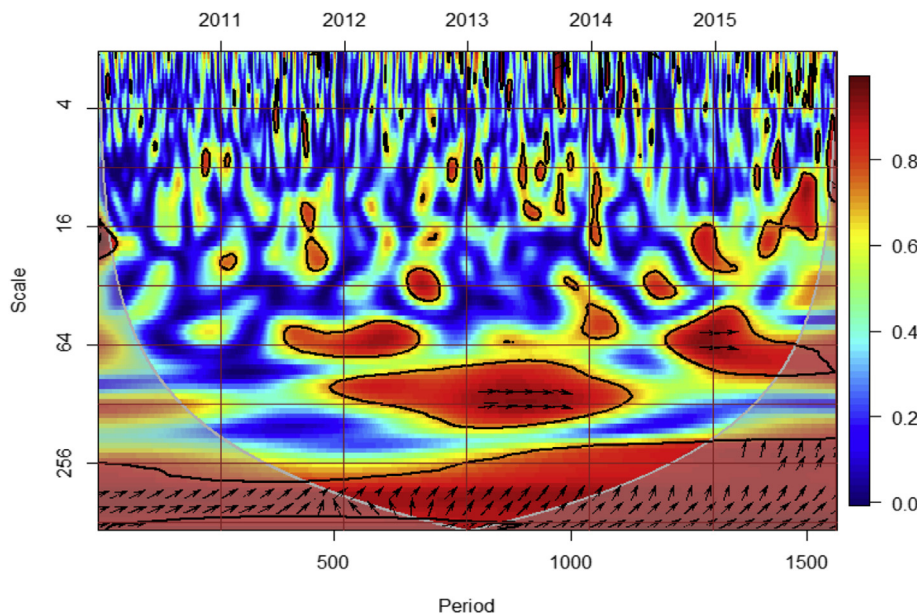


Fig. 3. Continuous wavelet transform: BINDO and TRBAPAMGOVI.

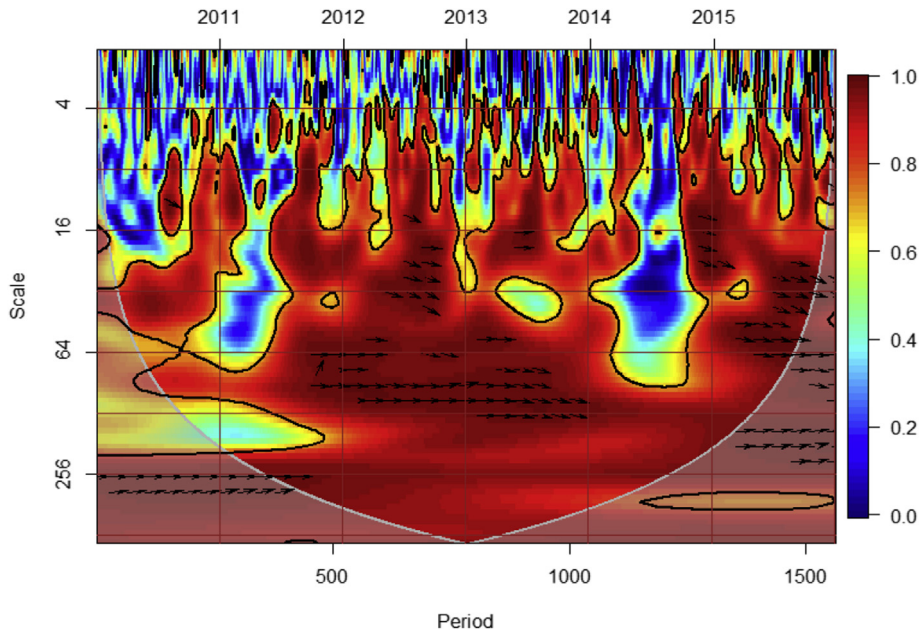


Fig. 4. Continuous wavelet transform: BMYR and TRBAPAMGOVI.

Malaysian sukuk markets are less correlated with India bond market which offer effective portfolio diversification over the last six years. For medium investment range between 16 and 128 days, the coherence diagram represented many blue and light blue areas compared to red and yellow areas that indicate opportunities for portfolio diversification. However, the outcome of the analysis shows that the market pair is slightly affected by the euro zone crisis and emerging market instabilities in mid-2011. Finally, for long time investment ranging from 128 to 256 days holding periods, there are low co-movements in returns between these two market pairs except few variations during 2011 and 2013 which also shows opportunities for global diversification.

Fig. 7 illustrates the estimated wavelet coherence and phase difference of the South Korea Bloomberg government bond market returns (BKRW) with the Thomson Reuters Malaysian government sukuk market (TRBAPAMGOVI) returns.

In the short holding periods, such as 2–4 days, 4–8 days, the Malaysian sukuk markets are less correlated with South Korea bond market which offer effective portfolio diversification over the last six years. The same is not true for the medium investment horizon consisting 16–64 days and 64–128 days for South Korea - Malaysia pair due to many dark areas found in the coherence diagram during the period 2011 to 2013. In terms of long term investment, the Malaysian sukuk market is not that much suitable for South Korean fixed income investors

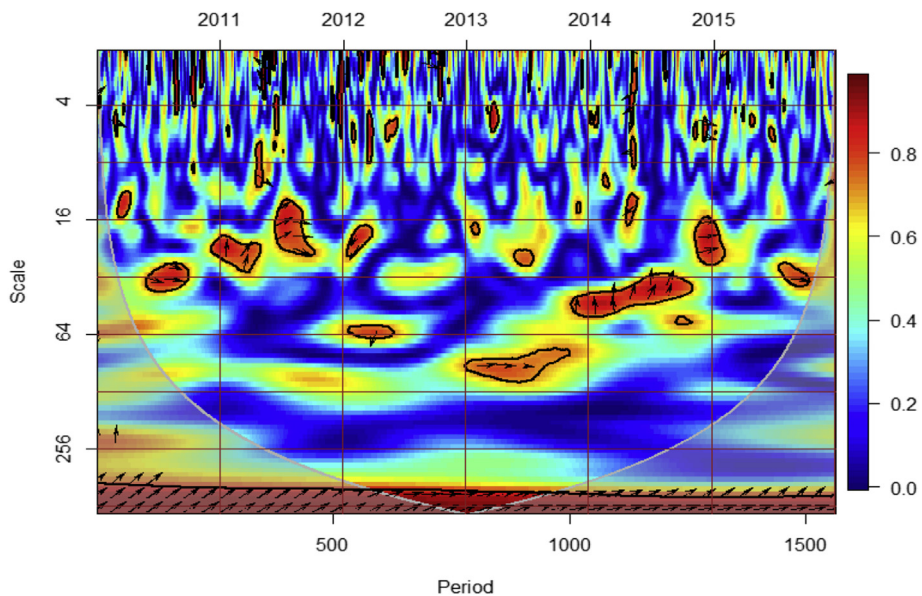


Fig. 5. Continuous wavelet transform: BCGB and TRBAPAMGOVI.

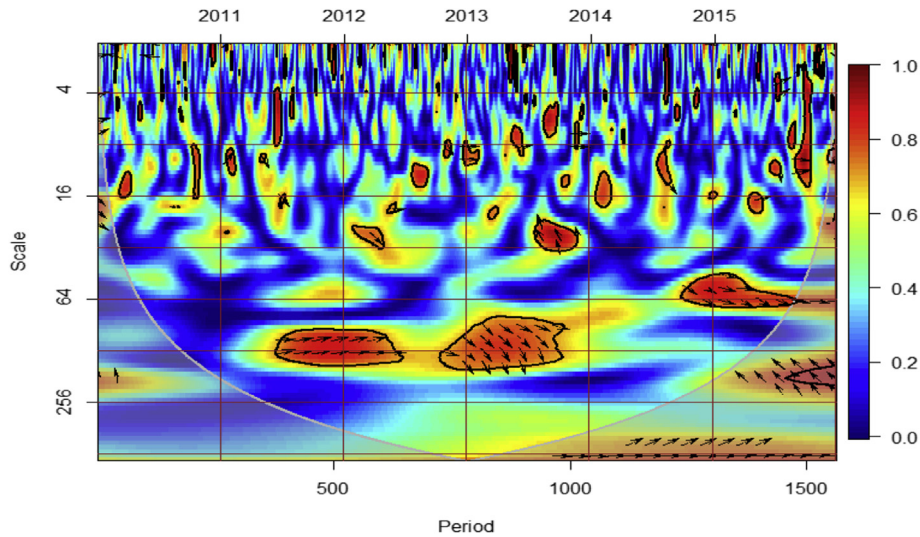


Fig. 6. Continuous wavelet transform: BINDI and TRBAPAMGOVI.

from 2010 to 2012 due to co-movement is slightly higher between these two indices, however, there is a scope of portfolio diversification after 2012. The Malaysian sukuk and South Korea bond markets were affected by the eurozone crisis during 2011 and 2012, causing higher correlations in terms of daily returns especially for the mid-investment period.

As a conclusion to wavelet coherence analysis and the purpose of made it easy for readers, we have summarized the main findings from Figs. 2–7 and presented in Table 2.

4.3. The estimated conditional volatilities of emerging market bond and sukuk indices

Fig. 8 illustrates the time varying properties of conditional volatilities of the Singapore, China, South Korea and Malaysia

sukuk indices. From the above graph, it could be observed that the conditional volatilities of all indices move closely with one another except China. High volatility observed in Chinese bond index returns during mid-2010 to until 2012 due to eurozone crisis, however, since then the volatility of Chinese bond markets has considerably declined. In contrast, the Malaysian sukuk index are less volatile among all indices.

Fig. 9 illustrates the time varying properties of conditional volatilities of the India, Indonesia Malaysia bond and Malaysia sukuk indices. From the above graph, it could be observed that the conditional volatilities of all indices move closely with one another except Indonesia. Malaysian sukuk and bond indices appear to have the lowest volatility whereas Indonesian bond index is observed to be highly volatile. This volatility period began from 2015 and persisted through over

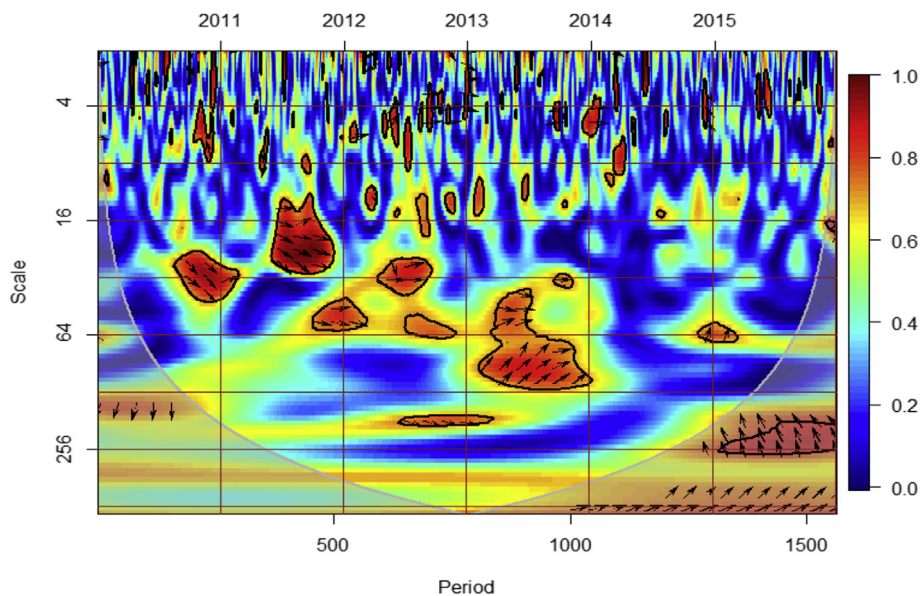


Fig. 7. Continuous wavelet transform: BKRW and TRBAPAMGOVI.

Table 2
Summary of wavelet coherence analysis on emerging bond and sukuk markets.

Bond indices	Dow Jones sukuk index			Malaysia sukuk index		
	Short term	Mid term	Long term	Short term	Mid term	Long term
BMYR	✓	✓ ^d	✓	X	X	X
BINDI	✓	✓	X	✓	✓ ^e	✓
BCGB	✓	✓	✓	✓	✓	✓
BINDO	✓	✓ ^c	✓	✓	✓	X
BKRW	✓	✓	✓	✓	✓ ^f	X
BSIN	✓	✓ ^b	✓	✓	✓ ^a	X

✓ Diversification possible, X Diversification not possible.

^a High positive correlation observed between BSIN and TRBPAMGOVI in 2011 and 2012 for the mid-term period.

^b High positive correlation observed between BSIN and DJSUKUK in 2013, 2014 and 2015 for the mid-term period.

^c High positive correlation observed between BINDO and DJSUKUK in 2014 and 2015 for the mid-term period.

^d High positive correlation observed between BMYR and DJSUKUK 2015 for the mid-term period.

^e High positive correlation observed between BINDI and TRBPAMGOVI 2011, 2012 and 2013 for the mid-term period.

^f High positive correlation observed between BKRW and TRBPAMGOVI 2011, 2012 and 2013 for the mid-term period.

all phase which indicates high instability in terms of return. However, the above emerging market indices are not affected by euro zone crisis without China and this is a good sign for investors in terms of diversification.

4.4. The estimated conditional correlations of emerging market bond and sukuk indices

Fig. 10 illustrates conditional correlations of Singapore, China and South Korea Bond index returns with the Malaysian sukuk index returns. The outcome of the result highlights that the Malaysian sukuk has very low correlation with the Chinese bond index but relatively high correlation with Singapore bond index, suggesting that fixed income investors from emerging market can be better off through investing in the Malaysian sukuk market.

Fig. 11 illustrates conditional correlations of India, Indonesia and Malaysia bond index returns with the Malaysia sukuk index returns. The result of the analysis shows that the Malaysia sukuk market is less correlated with bond markets in India and Indonesia but highly correlated with the Malaysia bond market. This is because of the domestic markets is influenced by the similar macroeconomic factors that might causing strong correlation between the markets.

5. Recommendations and conclusion

The Malaysia sukuk market could be a better option in terms of short term as well as midterm for fixed income investors from China and India. However, for long term investment, the Malaysia sukuk market is not suitable for Indian investors while in case of China, the sukuk market offers better diversification opportunities for investors.

In the short holding period between 2 and 16 days, Malaysia sukuk markets are less correlated with Singapore and Indonesia bond markets. However, a similar outcome is not true for mid and long-term investment periods. For long term investment period, the Malaysia sukuk market is not suitable while in terms of midterm investment period, the Malaysia sukuk market is preferable for Indonesian and Singaporean investors. Malaysia sukuk and Singapore bond market pair was highly affected by the euro zone crisis and emerging market instabilities, and that caused higher correlations in terms of daily returns. A probable reason could be due to the countries being neighbors and trading partners so that any shock in economy is transmitted to one another and may be reflected in their financial markets in the long run. On the other hand, the findings are different to the Indonesia bond market, as it is not significantly affected by the crisis. Hence,

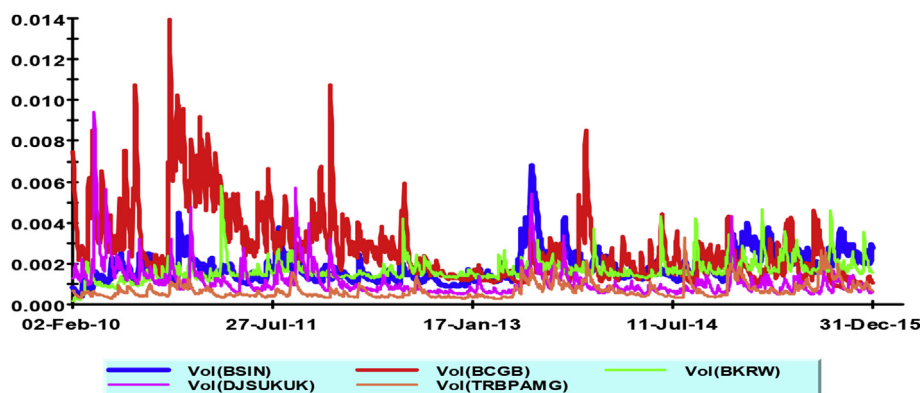


Fig. 8. Conditional volatilities of sukuk and emerging market bond indices returns.

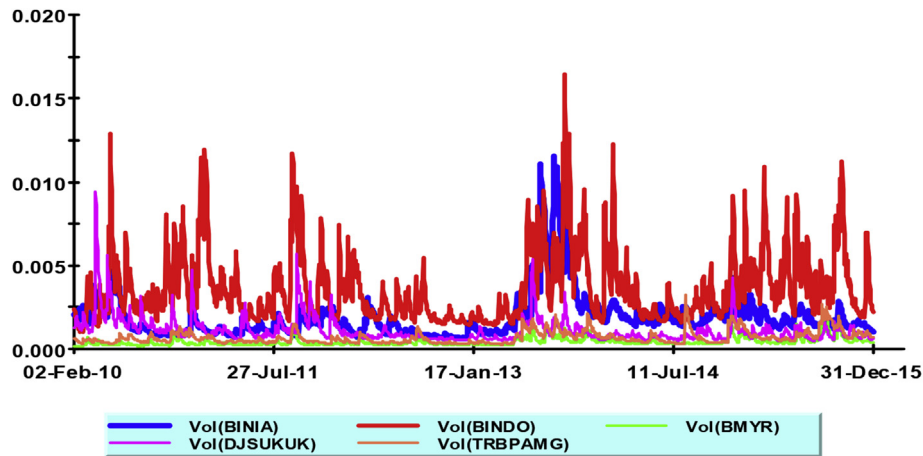


Fig. 9. Conditional volatilities of sukuk and emerging market bond indices returns.

the overall Malaysia sukuk market are suitable for Indonesian investors.

The coherence diagram illustrates that the Malaysia bond market was highly correlated with the Malaysia sukuk market in terms of returns compared to any other market pairs as witnessed by the largest portion of the area in the diagram covered by red areas. For the short holding period, such as 2–4 days, the Malaysian bond market returns had a low correlation with the sukuk market. However, the co-movement between these two markets has a highly positive correlation in terms of medium and long-term investment holding periods. The outcome of the analysis indicates that the domestic bond and sukuk markets are influenced by similar macroeconomic factors that have a strong impact on the overall market which leads to strong correlations among the indices. Finally, the Malaysia sukuk market offer diversification opportunities for South Korea fixed income investors in terms of short term and midterm holding periods while for the long-term investment, Malaysian market is less preferable. Johansson (2008) estimated the dynamic conditional correlations between four Asian bond markets show that the correlations are time-varying and highly correlated except for the short-run where the correlations are reduced drastically. These findings were revealed after the analysis of conventional bonds while, in the

case of Islamic assets, Aloui, Hammoudeh, and Hamida (2015) discovered that investors may reduce portfolio risk during a crisis by holding long-term Islamic assets. Hence, the findings of this study are similar to the study by Aloui et al. (2015) since the sukuk market also offers the opportunity of portfolio diversification.

Finally, it can be concluded that the sukuk market offers effective portfolio diversification opportunity for fixed income investors of the mentioned sample countries. Global and regional investors can avail the benefits of portfolio diversification through investing in sukuk markets but portfolio diversification is not feasible domestically. This analysis provides evidence on the timely and appropriate measure of correlation changes and the behavior of sukuk and bond indices globally, which is beneficial in the management of sukuk and bond portfolios. This study has uncovered the attractive opportunities in terms of diversification benefits with credit quality and *Shariah*-compliant financial sector exposure for investors who want to invest in fixed income securities. This research contributes to the discussion whether portfolio diversification benefits can be gained through combining sukuk with emerging markets bond across heterogeneous investment horizon and to what extent. As a practical implication to the finance industry, the outcome of this research

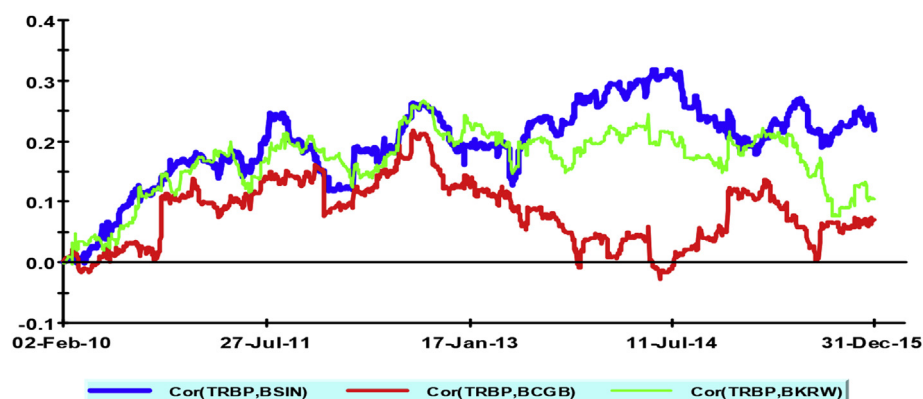


Fig. 10. Conditional correlations of Malaysia sukuk index returns with emerging market bond indices.



Fig. 11. Conditional correlations of Malaysia sukuk index returns with emerging market bond indices.

provides a framework for investigating sukuk market integration of several emerging bond markets which serve as an important platform of conducting further research for the students and academicians.

Conflict of interest

None declared.

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