Should investors diversify their portfolios with stocks from major trading countries? A comparative multivariate GARCH-DCC and wavelet correlation analysis

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Abstract

The existing literature have evaluated the performance of stock markets without taking into account the time-varying correlations and different investment horizons of the investors. The present paper attempts to investigate to what extent the Indonesian sharia stock returns can earn portfolio diversification benefits if they are trading with sharia stocks from its major trading partners (China, Japan, United States). The recent Multivariate GARCH Dynamic Conditional Correlation, the Continuous Wavelet Transform and the Maximal Overlap Discrete Wavelet are applied. Our findings tend to indicate that the Indonesian investors may not enjoy portfolio diversification benefits in all investment horizons if investing in China as better investment opportunities are available by investing in Japan and United States. However, in the long run all markets are highly correlated yielding minimal portfolio diversification benefits.

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1. Introduction

The issue of dynamic linkages among stock markets has been extensively researched in the literature of financial economics. Interest in stock market integration arises primarily because financial theory suggests that an integrated regional stock market is more efficient than segmented national capital markets. It is believed that investors from all members of the countries would be able to allocate capital to the locations in the region where it is the most productive in an integrated regional stock market (Click and Plummer, 2005). The degree of linkages or integration among the stock market provides important implications for potential benefits of the international portfolio diversification and financial stability for a country (Ibrahim, 2005). Stock market integrations is also believed to create long run equilibrium relationship, which ties price movements in national stock indices and could considerably reduce benefits from international portfolio diversification.

Existing literatures such as Goldstein and Michael (1993) suggest that international links have been increasing over the past decade, especially for stocks that are mainly traded in major financial centers. An increasing integration among the national stock markets further implies that international financial instabilities are easily transmitted to domestic financial markets, which is known as financial contagion (Ibrahim, 2005). This has been proven during the event of financial crisis, such as the 1997 Asian Financial Crisis and Global Financial Crisis in 2008. The 1997 Financial Crisis is believed to be triggered by the distorted policies and market overreaction which led the exchange rates, asset prices and economic activities in Asian countries to plunge (Roubini et al, 1998). In addition, Global Financial Crisis that occurred in 2008 had indicated that the global financial systems were far more interconnected than was previously recognized (Mishkin, 2011).

Indonesia is a growing and relatively open economy with trade and foreign direct investment play significant roles in driving its economy. The opening of the equity market in Indonesia and other Asian emerging market during 1980 has resulted in rising interest in investing these markets. This was proven by the creation of huge various investments that focus on this region by the creation of huge various investment funds that focus in this region by international find management houses (Hung and Cheung, 1995). In terms of its trade, Indonesia strongly trades with other countries, such as Japan, United States and China. The country started to record trade deficits as exports fell due to slowdown in the global economy and failing commodity prices in 2012. In the end of 2014, it is reported that Indonesia has USD 1.8 billion-trade deficit, but started to recover in the early 2015. In March 2015, Indonesia's trade surplus was USD 1.13 billion, which was increased significantly from USD 0.67

billion surplus reported a year earlier. In terms of its exports, in March 2015, the exports fell by 9.75 percent year on year to 13.71 billion, whereby its imports was also declined by 13.39 percent year on year to 12.58 billion.

As the biggest Muslim country in the world, Indonesia holds an enormous market for the development of Islamic finance industry. Indonesia launched its public first Islamic Index, which is known as Jakarta Islamic Index, which only composed of 30 Sharia compliant securities listed in Indonesia Stock Exchange (IDX). Although its development is still relatively new compared to the Sharia banking and sharia insurance, Sharia investment in capital market of Indonesia is expected to experience rapid growth along with significant growth in Indonesian capital market. Not long after that, there are two Sharia stock indices that is listed in Indonesia stock exchange, which are Jakarta Islamic Index (JII) and Indonesia Sharia Stock Index. Sharia stock indices that are listed in Indonesia Stock Exchange (ISE) is regulated based on legal regulations or laws, and fatwa. It is emphasized in Fatwa No. 40/DSN-MUI/X/2003, that activities of companies that were listed under Sharia stock indices should not contradict with Sharia law, and will be categorized as sharia compliant securities. In order to be sharia compliant, companies should not engage into activities that are prohibited in Sharia law such as: riba (interest), gambling, production and sale of non-halal products, conventional activities, and entertainment activities (Indonesia Stock Exchange, 2014).

Given that Islamic finance industry has been growing rapidly, with estimated to be worth of USD 1 trillion with 14 percent growth rate, it is worthwhile to study the correlations among the sharia indices and observe the sharia stock indices at different time interval to know the level of risk and potential portfolio diversification benefits for Islamic investors. The present paper attempts to study the aspects of diversifications of the Jakarta Islamic Index returns with FTSE Sharia China index return, FTSE Sharia USA index return, and FTSE Sharia Japan returns. The sample period of this study contains daily data spanning from 1st November 2007 to 31st December 2014.

The structure of the paper includes nine chapters that organized as follows: The current section explains the introduction together with the issues motivating the study. Section 2 will discuss the main objective of the paper and section 3 will gives an overview in regards to theoretical framework in regards to the issues related to this paper. Section 4 will review the previous studies in the literature while section 5 will elaborate on the methodology applied in the study. The discussion and the interpretation on the empirical of the findings will be explained in section 6, whereby section 7 and 8 will give summary about the paper and discuss about the policy implications that can be derived from the results. Finally, section 9 will talk about the limitation of the study and suggestion for further research.

2. Main Objective of the Study

The main objective of the study is to study the extent to which Indonesian Sharia investors, particularly in Jakarta Islamic index market would benefit for portfolio diversification with sharia indices from its major trading partners (China, Japan, United States) by examining the correlation of their market returns. In addition, the present paper aims to study the correlation of the market returns with respect to different investment horizons that differ among the nature of behavior of investors that vary across the market.

Overall, the paper intends to contribute by extending previous literature regarding portfolio diversification benefits between Indonesian sharia stock market returns with its major trading partners whereby most of the study used time series techniques that does not reflect the recent econometric methodology. Extension was done by including sharia stock index returns of Indonesia and its major trading partners by applying M-GARCH DCC to see which major trading partner that would help Indonesian investor to diversify their portfolio. In addition, Continuous Wavelet Transforms and Maximal Overlapping Discrete Transform are also applied in order to discover international portfolio diversification benefits with different holding periods (e.g 2-4 days, 4-8 days, 8-16 days, 16-32 days and so on). The present study might also be useful to Indonesian policy makers, whereby it will able to indicate that shocks of major trading countries may result in spill over in Indonesia if it was found to be correlated with sharia stock from major trading countries.

3. Theoretical Framework

The main underlying theory of the present paper is the Markowitz's Modern Portfolio Theory which suggests that expected return on a portfolio for a given amount of portfolio risk is attempted to be maximized or alternately the risk on a given level expected return is attempted to be minimized by choosing the quantities of various securities cautiously, by taking mainly into consideration the way in which the price of each security changes in comparison to that of every other security in the portfolio, rather than selecting securities individually. The theory further elaborates that, each security has its own particular risk, and diversification of portfolio would be able to lower the risk of the portfolio than investing in a single portfolio.

The main outcome of the Portfolio Theory is that the risk weight of a portfolio shall be less than the average risk weights of the securities it contains which will result into optimum portfolio diversifications. The theory uses standard deviation as a substitute to risk and the variance of expected return as illustrates below:

$$\sigma_p^2 = \Sigma W_a^2 \sigma_a^2 + \Sigma\Sigma W_a W_b Cov_{ab}$$

Whereby W_a is the size of the portfolio in security a, σ_a is the standard deviation of the expected return of the security a, and Cov_{ab} is the covariance of the expected returns of the securities a and b. By assuming that the covariance is less than 1, it is derived that the weighted average of the standard deviation of the expected returns of the securities shall be less. Thus, the theory proves that diversification of securities in a portfolio reduces risk. However, it should be noted that this theory had received major criticism on its assumption on the normal distributions of the variances which was believed to be unrealistic.

Another theory that is related to portfolio diversification, which states that it is impossible to "beat the market" b, because when the stock market are efficient, the stock prices will be reflecting all the relevant information needed in the market. Thus, it is argued that stocks are always being traded at their fair value on stock exchanges, which later decreased the chances of investors to buy undervalued stocks or sell stocks for inflated prices. As such, it should be impossible to outperform the overall market through expert stock selection or market timing, and that the only way that an investor can possibly obtain higher returns is by purchasing riskier investments (Fama, 1970).

As the behavior of investor is related to some extent of their physcology factors, thus, the Black Swan theory is found to be relevant in this case. The Black Swan theory argues that human beings are tend to dwell and reflect towards the past event so that they can predict the future, which will limit one's understanding of the world. This, would increases the vulnerability which later on result in extreme and unexpected events (Taleb 2007)

The present paper will use M-GARCH DCC methodology, which has the ability to adopt a t-distribution of variances, which reflects the reality more in capturing the fat nature of the non-normal distributions of the index return. In addition, the use of wavelet techniques in this paper makes no assumptions, which is believed to produced more realistic results (In & Kim, 2013)

4. Empirical Literature Review

4.1 International Portfolio Diversifications

Numerous studies had empirically evaluated the connection between the stock market linkages with the globalization. Jorion (1985) and Grubel (1968) suggest the possibility of portfolio diversification, whereby they argue that international portfolio diversification will reduce the risk for the investors, as they tend to have lower correlation in the stock market returns. These theories were followed by a considerable number of empirical studies that attempted to test the validity of the international portfolio diversification such as Lervy and Sarnat (1970); Solnik (1973);

Eun and Resnick (1994). By examining twenty-eight markets, which include both developed and emerging market, Levy and Sarnat (1970) found there was a significant diversification benefits for US investors. In line with the previous studies, Eun and Resnick (1994) investigated international diversification from the point of view of Japanese investors and US during the period 1979 to 1989. They found diversification benefits for both investors, although US investors enjoy greater benefits. However it should be noted that other research suggests that the portfolio diversification is not necessary to bring benefits for investors. For example, King and Wadhwani (1990) found a significant increase in the correlation markets following a period of turbulence and labeled this as "contagion". Solnik (1995) investigates the behavior of monthly international equity over the period of 1960 and found that the correlations tend to rise, especially in high periods of market volatility. In summary, the study on stock market linkages and its results impact for international portfolio diversification strategies has remained unclear as studies show contradicting result.

While the above studies focus on portfolio diversification in US market, Karim et al (2009) and Ibrahim (2005) focus on the international linkages of Indonesia's stock market. In regards to studies related to Indonesia's stock market, Karim et al (2009) found that Indonesians stock market is cointegrated with its major trading partners, which in this case are United States, Japan, Singapore and China from July 1998 to December 2007. This implies that the opportunities for international investors to gain benefit from international portfolio diversification in those markets are limited. The study had implemented Auto Regressive Distributive Lead Lag (ARDL), regardless of the stationary properties of the variables in the samples and allows for inference on long run estimation. Focusing on the international linkages of Indonesian stock market during the pre- and post crisis periods using cointegration and vector auto regression (VAR), Ibrahim (2005) found evidence for lack of cointegration among Indonesian market, other ASEAN markets and two advanced market (US and Japan). With this, it can be concluded that most of the literatures focus more on the integration between conventional stock market indices, with the usage of time series technique and vector auto coregression, which do not reflect the recent research techniques and does not shed light on the Sharia stock market indices which can potentially raise interest to invest in Sharia compliant stock.

4.*2 Time varying and scale dependent correlation*

Many recent studies have empirically tested and provided evidence that the correlation across national market may not be constant and evolving through time. For example, Longin and Sonik (1995) studied the correlation and covariance if monthly excess returns for seven major countries over the period of 1960 – 1990 and find that the correlations and covariances were not stable over the times. Focusing on the international stock market correlations between Japan and the four Asian tigers (Taiwan, Singapore, Hongkong and South Korea), Yang (2005) found that stock markets correlation tends to fluctuate over the time and volatility is appear to be

contagious across the market. Based on their study on the co-movement dynamics between the developed European markets, Dacjmant et al (2012) find that the co-movements of the stocks are not constant, and returns are time-varying. Thus, it suggested for researchers too use time varying conditional correlation models when modeling volatilities and correlations.

Further studies suggest that there is high possibility that investment holding periods also have impacts to the volatilities and the correlations dynamics of stock market returns for example Gencay et al (2001) and In and Kim (2013). Gencay et al (2001) was one of the earliest studies that used time scaled dependence of returns in financial markets. In addition, In and Kim (2013) published a book that focused on wavelet theory, which were written based on their papers that used wavelet time scaling in finance.

5. Methodology

5.1 Multivariate GARCH Dynamic Conditional Correlations

Autoregressive conditional heteroscedastic (ARCH) was on of the earliest volatility model which was proposed by Engle (1982), which captured the time varying conditional variances of the time series based on past information. This model later was extended by Bollerslev (1986) who proposed a generalized ARCH (GARCH) which took into account both past error terms and conditional variances into its variation equation simultaneously to avoid the problem that the number of parameters to be estimated becomes too large as the number of lagging periods to be considered increases in the ARCH model. Bullerslev (1990) further extended the GARCH model in a multivariate sense to propose a Multivariate GARCH Constant Conditional Correlation or known as M-GARCH CCC. The MGARCH-CCC model only allows the variances of each variable to be time varying while keeping the correlation coefficient among them constant. However, while the CCC assumption makes estimation simple, it may be inconsistent with reality (Longin and Solnik, 1995, 2001). Therefore, Engle (2002) finally proposed an MGARCH-DCC model where the conditional correlations amongst variables were allowed to be dynamic and this paper makes use of this model in answering parts of the research questions. It can be stated as follows:

$$\mathbf{r}_t = \boldsymbol{\beta}_0 + \sum_{i=1}^{k} \boldsymbol{\beta}_i \mathbf{r}_{t-i} + \mathbf{u}_t = \boldsymbol{\mu}_t + \mathbf{u}_t$$

$$\boldsymbol{\mu}_t = E[\mathbf{r}_t | \Omega_{t-1}]$$

$$\mathbf{u}_t | \Omega_{t-1} \sim N(0, \mathbf{H}_t)$$

$$\mathbf{H}_t = \mathbf{G}_t \mathbf{R}_t \mathbf{G}_t$$

$$\mathbf{G}_t = \operatorname{diag}\left\{\sqrt{h_{ii,t}}\right\}$$

$$\mathbf{z}_t = \mathbf{G}_t^{-1} \mathbf{u}_t$$

(Source: Ku, 2008)

Where $h_{ii,t}$ is the estimated conditional variance from the individual univariate GARCH models, $\mathbf{G_t}$ is the diagonal matric of conditional standard deviations, $\mathbf{R_t}$ is the time-varying conditional correlation coefficient matrix of returns, and $\mathbf{z_t}$ is the standardized residuals vector with mean zero and variance one. After the above basic construction, the dynamic correlation coefficient matrix of the DCC model can be specified further:

$$\begin{aligned}
\mathbf{R}_t &= (\mathrm{diag}(\mathbf{Q}_t))^{-1/2}\mathbf{Q}_t(\mathrm{diag}(\mathbf{Q}_t))^{-1/2} \\
\mathbf{Q}_t &= (q_{ij,t}) \\
(\mathrm{diag}(\mathbf{Q}_t))^{-1/2} &= \mathrm{diag}\left(\frac{1}{\sqrt{q_{11,t}}}, \ldots, \frac{1}{\sqrt{q_{nn,t}}}\right) \\
q_{ij,t} &= \overline{\rho}_{ij} + \alpha\left(z_{i,t-1}z_{j,t-1} - \overline{\rho}_{ij}\right) \\
&\quad + \beta\left(q_{ij,t-1} - \overline{\rho}_{ij}\right)
\end{aligned}$$

(Source: Ku, 2008)

Where $\overline{\rho}_{ij}$ is the unconditional correlation coefficient and the new time-varying conditional correlation coefficient is $\rho_{i,j,t} = q_{i,j,t}/\sqrt{q_{ii,t}\,q_{jj,t}}$. Meanwhile, the returns on financial assets have often been documented to be fat tailed or leptokurtic where a normal distribution assumption is not appropriate. One possible remedy for such is to use a Student-*t* distribution setting. That is, the conditional distribution $\mathbf{u}_t|\Omega_{t-1} \sim N(0, \mathbf{H}_t)$ is replaced by $\mathbf{u}_t|\Omega_{t-1} \sim f_{\text{Student}-t}(\mathbf{u}_t;\, v)$, where v is the degree of freedom parameter.

4.2 Continuous Wavelet Transforms

Recently, some of the researchers have applied continuous wavelet transform in economics and finance Studies, such as Saiti (2012), Vacha and Barunik (2012) and Madaleno and Pinho (2012). Under CWT, the original time series is mapped and reperesents a function of just one variable time separate into function of two different variables such as time and frequency. The number of wavelets time scales is not required to be defined in CWT since it will be generated automatically based on the data length. The series correlation in two-dimensional figure is mapped by the CWT which enables easy identification and interpretation of patterns. In this CWT technique, we use the Daubechies (1992) least asymmetric wavelet filter of length = 8 denoted by LA (8) based on eight non-zero coefficients. Previous studies on high frequency data have shown that a moderate length filter such as L= 8 is adequate to deal with the characteristics features of the time series data (Gencay et al, 2001 ; In &

Kim, 2013). In literature, it is argues that LA(8) filter generates more smooth wavelet coefficients than other filter such as Haar wavelet filter.

The continuous wavelet transform (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:

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

The position of the wavelet in the time domain is given by u, while its position in the frequency domain is given by s. Therefore, the wavelet transform, by mapping the original series into a function of u and s, gives us information simultaneously on time and frequency. To be able to study the interaction between two time series, how closely X and Y are related by a linear transformation, we need to apply a bivariate framework which is called wavelet coherence. The wavelet coherence of two time series is defined as:

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

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, $W_n^{xy}(s)$ is a cross wavelet transform of the two time series X and Y (Madaleno and Pinho, 2012). For brevity, we omit further detailed mathematical equations and interested readers may refer to Gencay et al (2001; 2002) and In and Kim (2013) for full methodological models.

4.3 Maximum Overlap Discrete Wavelet Transformation (MODWT)

It is known that the co-movements between stock market return may not only be time varying, but also scale dependent (Gencay et al, 2001) which can be analyzed by using wavelet tools. A MODWT based estimator has been shown to be superior to DWT estimator (Percival, 1995). The MODWT is a variant of discrete wavelet transform (DWT) which can handle any sample size and not just those that are multiples of 2^x. The MODWT is highly redundant, non-orthogonal transform, which enables alignment of the decomposed wavelet and scaling coefficients at each level with the original time series, thus allowing a ready comparison between the series and its decompositions. This feature does not exist in the DWT. In addition, The MODWT variance estimator is also asymptotically more efficient than the same estimator based on the DWT. MODWT is generally known as stationary wavelet transform , shift or translation invariant DWT, time variant DWT, and non-decimated

DWT. Hence , this research makes use of the MODWT method which can be described as follows.

Let ***X*** be an *N*-dimensional vector whose elements represent the real-valued time series $\{X_t: t = 0, \ldots, N-1\}$. For any positive integer, J_0, the level J_0 MODWT of ***X*** is a transform consisting of the $J_0 + 1$ vectors $\widetilde{\boldsymbol{W}}_1, \ldots, \widetilde{\boldsymbol{W}}_{J_0}$ and $\widetilde{\boldsymbol{V}}_{J_0}$, all of which have dimension ***N***. The vector $\widetilde{\boldsymbol{W}}_J$ contains the MODWT wavelet coefficients associated with changes on scale $\tau_j = 2^{j-1}$ (for $j = 1, \ldots J_0$) while $\widetilde{\boldsymbol{V}}_{J_0}$ contains MODWT scaling coefficients association with averages on scale $\lambda_{J_0} = 2^{J_0}$. Based on the definition of MODWT coefficients we can write (Percival and Walden, 2000, p. 200):

$$\widetilde{\boldsymbol{W}}_J = \widetilde{W}_J \boldsymbol{X} \text{ and } \widetilde{\boldsymbol{V}}_J^0 = \widetilde{V}_J^0 \boldsymbol{X}$$

Where $\widetilde{W}_J$ and $\widetilde{V}_{J_0}$ are $N \times N$ matrices. Vectors are denoted by bold italics. By definition, elements of $\widetilde{W}_J$ and $\widetilde{V}_{J_0}$ are outputs obtained by filtering ***X***, namely:

$$\widetilde{W}_{j,t} = \sum_{l=0}^{L_{j-1}} \widetilde{h}_{j,l} \, X_{t-l \bmod N}$$

and

$$\widetilde{V}_{j,t} = \sum_{l=0}^{L_{j=1}} \widetilde{g}_{j,l} \, X_{t-l \bmod N}$$

For $t = 0, \ldots\ldots, N-1$, where $\widetilde{h}_{j,l}$ and $\widetilde{g}_{j,l}$ are *j*th MODWT wavelet and scaling filters.

The MODWT treats the series as if it were periodic, whereby the unobserved samples of the real-valued time series $X_{-1}, X_{-2}, \ldots, X_{-N}$ are assigned the observed values at $X_{N-1}, X_{N-2}, \ldots, X_0$. The MODWT coefficients are thus given by:

$$\widetilde{W}_{j,t} = \sum_{l=0}^{N-1} \widetilde{h}_{j,l}^{\circ} \, X_{t-l \bmod N}$$

and

$$\widetilde{V}_{j,t} = \sum_{l=0}^{N-1} \widetilde{g}_{j,l}^{\circ} X_{t-l \bmod N} (\text{for } t = 0, \ldots, N-1;$$

$\widetilde{h}_{j,l}^{\circ}$ and $\widetilde{g}_{j,l}^{\circ}$ are periodization of $\widetilde{h}_{j,l}^{\circ}$ and $\widetilde{g}_{j,l}^{\circ}$ to circular filters of length N)

Wavelet variance is defined for stationary and non-stationary processes with stationary backward differences. Considering only the non-boundary wavelet coefficient, obtained by filtering stationary series with MODWT, the wavelet variance $v_X^2(\tau_j)$ is defined as the expected value of $\widetilde{W}_{j,t}^2$. In this case $v_X^2(\tau_j)$ represents the contribution to the (possibly infinite) variance of $\{X_t\}$ at the scale $\tau_j = 2^{j-1}$ and can be estimated by the unbiased estimator (Percival and Walden, 2000, p. 306):

$$\hat{v}_X^2(\tau_j) = \frac{1}{M_j} \sum_{t=L_j-1}^{N-1} \widetilde{W}_{j,t}^2$$

where $M_j \equiv N - L_j + 1 > 0$ is the number of non-boundary coefficients at the *j*th level.

The MODWT correlation estimator for scale τ_j is obtained by making use of the wavelet cross-covariance and the square root of wavelet variances:

$$\hat{\rho}_{X,Y}(\tau_j) = \frac{\hat{v}_{X,Y}(\tau_j)}{\hat{v}_X(\tau_j)\hat{v}_Y(\tau_j)}$$

Where $|\hat{\rho}_{X,Y}(\tau_j)| \leq 1$. The wavelet correlation is analogous to its Fourier equivalent, the complex coherency (Gencay et al., 2002, p. 258).

6. Result and Discussion

6.1 Data Analysis

Under this study, Jakarta Islamic Index returns is used as a proxy for the Indonesian Sharia stock index. The present paper uses three methods that are mentioned earlier, which are M-GARCH DCC, CWT and MODWT to analyze the Sharia stock indices of Indonesia's top three trading partners which are United States, Japan and China. The FTSE Islamic indices are used for the entire top trading partners, as listed by table 1 on the next page.

Symbol	Definition

Table 1: Selected Indices for Research

JII	Jakarta Islamic Index
FTCN	FTSE Sharia China Index
FTJP	FTSE Sharia Japan Index
FTUS	FTSE Sharia USA Index

We collected daily time series closing data price from five indices starting from 1st November 2007 to 31st December 2014. The whole data series is obtained from Thomson-Reuters DataStream database, which are available in Knowledge Management Centre of INCEIF. The stock indices return were calculated as differences of logarithmic daily closing prices of indices $\{\ln(p_t) - \ln(p_{t-1})$ where P is the index value. The description of the data is explained by Table 2 below, which shows that the volatility of returns represented by the standard deviation is the highest for FTSE Sharia China Index and lowest for FTSE Sharia United States. This standard deviation shows absolute time independent volatility of return. The fatness of the distribution can be measured by the kurtosis which describe how concentrated the fatness around the mean of the distribution. From the table below, kurtosis values for all stock indices are more than 3, which indicates are not normally distributed, and all variables have high variability risk. For the Jarque-Bera test results, all returns are significant, which means that the non-normality, variability and risk of the returns of Sharia indices is further strengthen

Table 2: Descriptive Statistics of the Data

	JII	**FTCN**	**FTJP**	**FTUS**
Mean	0.000198	-0.000333	-6.88E-05	0.0002
Median	0.0000	0.0000	0.0000	0.000433
Maximum	0.0876	0.3861	0.130801	0.1214
Minimum	-0.1386	-0.3937	-0.105707	-0.101108
Std. Dev.	0.016697	0.024951	0.015827	0.013462
Skewness	-0.593504	-0.269108	-0.326465	-0.244368
Kurtosis	9.988164	70.27996	10.45131	15.28245
Jarque-Bera	3912.706 [.000]	352531 [.000]	4356.982 [.000]	11766.71 [.000]
Sum	0.3692	-0.6229	-0.128516	0.374142
Sum Sq. Dev.	0.520789	1.162886	0.467918	0.338508
Observations	1870	1870	1870	1870

6.2 Estimation using M-GARCH DCC model

Under this section, we did the comparison of Gaussian DCC Model and the t-DCC model is done together with plotting the estimated conditional volatilities and correlations. The comparison between the Gaussian DCC Model and the t-DCC model serves as a preliminary step to determine which model is relatively more significant.

Since we are interested in volatility modeling and the correlation between the selected indices, therefore we set $\square_{\square-1} = 0$, and estimate the DCC models on the Sharia compliant indices daily returns over the period of 1st November 2007 to 31 December 2014. Any case of non-convergence was not occurred, and the Maximum Likelihood estimates of the Gaussian DCC and t-DCC models on stock indices daily return was obtained under this section.

Table 3: Maximum Likelihood estimates of the Gaussian DCC model on the stock indices daily returns:

Parameter	**Estimate**	**Standard Error**	**T-Ratio[Prob]**
lambda1_DJII	0.92312	0.008991	102.6712[.000]
lambda1_DFTCN	0.95263	0.0060054	158.6280[.000]
lambda1_DFTJP	0.89303	0.013421	66.5382[.000]
lambda1_DFTUS	0.86597	0.014758	58.6796[.000]
lambda2_DJII	0.067802	0.0074137	9.1454[.000]
lambda2_DFTCN	0.043418	0.0051946	8.3584[.000]
lambda2_DFTJP	0.091746	0.010801	8.4945[.000]
lambda2_DFTUS	0.12491	0.013315	9.3810[.000]
delta1	0.91318	0.035095	26.0198[.000]
delta2	0.03297	0.0078671	4.1909[.000]
Maximum Log-Likelihood	21580.1		

Table 4. Unconditional Correlation and Volatilities

	DJII	**DFTCN**	**DFTJP**	**DFTUS**
DJII	0.016657	0.48411	0.41519	0.18715
DFTCN	0.48411	0.024625	0.50237	0.25557
DFTJP	0.41519	0.50237	0.015833	0.20666
DFTUS	0.18715	0.25557	0.20666	0.01336

Table 3 shows the result of the Gaussian DCC model, whereby it shows that the maximum likelihood estimates for the returns on the four Sharia index returns, and □1□and □2□. The tables shows that all volatilities decay parameters are significant, which imply that gradual volatility decay for all indices. The volatility parameters observed under this model is highly significant together with the estimates of i= 1,2,3,4,5,6 are very close to unity implying a gradual volatility decay. The estimated unconditional volatilities and correlations are reported within the lower panel of the results in table 4.

Following the estimations, we obtained the maximized log likelihood of the t-DCC model as a preliminary step to determine which model is more significant for this study, which are shown in table 5 on the next page.

Table 5. Maximum Likelihood estimates of the t-DCC model on the stock indices daily returns:

Parameter	**Estimate**	**Standard Error**	**T-Ratio[Prob]**
lambda1_DJII	0.87086	0.021357	40.7772[.000]
lambda1_DFTCN	0.88624	0.017132	51.7311[.000]
lambda1_DFTJP	0.88654	0.018348	48.3172[.000]
lambda1_DFTUS	0.88105	0.016447	53.5683[.000]
lambda2_DJII	0.10881	0.01667	6.5270[.000]
lambda2_DFTCN	0.10564	0.015357	6.8789[.000]
lambda2_DFTJP	0.094074	0.014126	6.6597[.000]
lambda2_DFTUS	0.10878	0.014576	7.4631[.000]
delta1	0.96365	0.022909	42.0645[.000]
delta2	0.01543	0.0055751	2.7677[.006]
df	7.0072	0.5159	13.5823[.000]
Maximized Log-Likelihood = 22086.2			

Table 6. Unconditional Correlation and Volatilities

	DJII	**DFTCN**	**DFTJP**	**DFTUS**
DJII	0.016657	0.48411	0.41519	0.18715
DFTCN	0.48411	0.024625	0.50237	0.25557
DFTJP	0.41519	0.50237	0.015833	0.20666
DFTUS	0.18715	0.25557	0.20666	0.01336

The maximized log likelihood value of 22086.2 in t-DCC model is higher than the maximized log likelihood value of 21580.1 in Gaussian model. In addition, the estimated of degree of freedom for the t-normal distribution are below 30 (7.002), which suggest that the t-distribution is more appropriate for capturing the fat-tailed nature of the distribution of stocks returns. By also looking at the summation of lambda 1 and lambda two, which are less than one; this indicates that these indices does not follow I-GARCH; which means shocks to volatility is not permanent. As for implications form the shocks to volatilities that are permanent, it indicates that there is high possibility that investors and portfolio managers to make loses if they are investing in short run. On the contrary, speculators will make benefits as they tend to invest in short duration than long duration. The on diagonals in table 6 explains the unconditional volatilities of the indices. If the unconditional volatility is near to zero, thus, it can be concluded that the particular index has the least volatility, whereby if the volatility is near to one would mean that the index has high volatility levels. Based on the result in table 7, we found out that all indices has very low conditional volatilities ranging from 0.01336 to 0.024625. This indicates that all of Sharia-compliant indices are less volatile. Moreover, it could be seen that FTSE Sharia USA index are relative less volatile compared to other three indices.

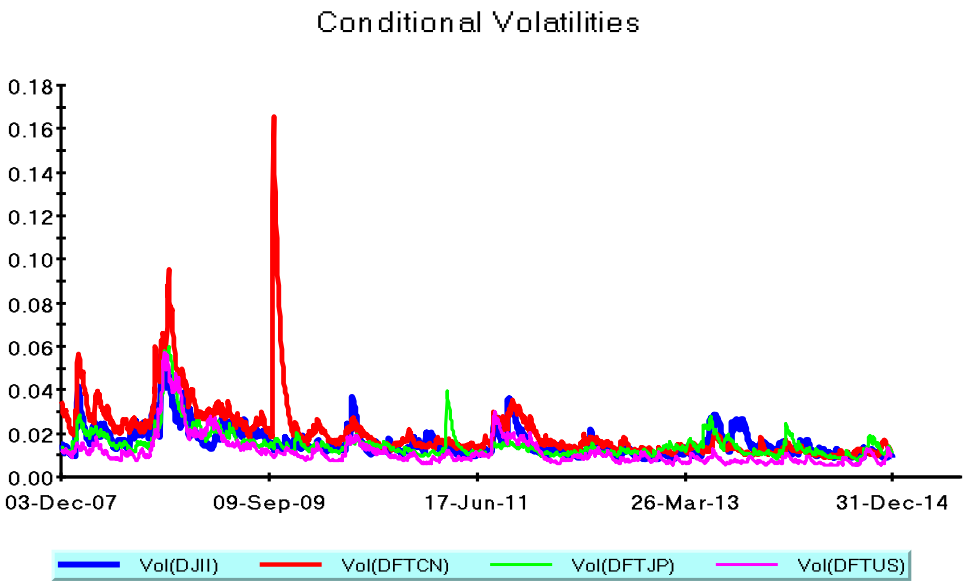
In regards to off diagonal indices, we found that the unconditional correlation between FTSE Sharia China and Jakarta Islamic Index returns to be the highest among the other returns of the four sharia indices, which is +0.48411. This positive correlation of 48 per cent is considered as moderate and not that high. The lower correlation was found to be between Jakarta Islamic Index and FTSE Sharia USA with 18 percent positive correlation. Based on this, it can be concluded that there are less portfolio diversification benefits for Indonesian investors to invest in USA, and therefore, it is suggested for the investor to invest in the other three sharia stock indices.

Table 7. Ranks of the Unconditional Volatilities of Four Sharia Indices Return

No	Indices	Unconditional Volatility
1	FTSE Sharia USA	0.01336
2	FTSE Sharia Japan	0.015833
3	Jakarta Islamic Index	0.016657
4	FTSE Sharia China	0.024625

After examining the unconditional correlations of these four indices, we now proceed to examine the dynamic conditional correlations which capture the time varying properties in the volatilities and the correlations, as illustrate by Figure 1 and Figure 2 be

Figure1: Conditional volatilities- JII, FTCN,FTJP, FTUS

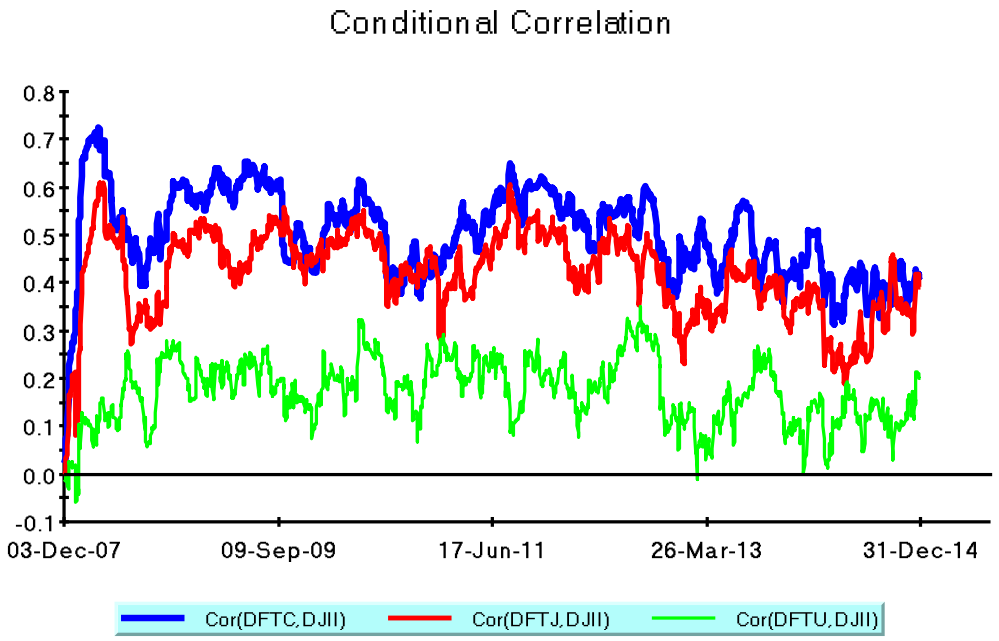


The figure above illustrates the conditional volatilities of all Sharia index returns, which tend to move more or less simultaneously except during the global financial crisis in 2008 and during ethnic violence in Xinjiang, China in 2009. During the global financial crisis, there seems to be a moderate to high convergence of vitality among Sharia stock index of China, United States of America, Japan and Indonesia. This, indicates that there is a higher financial integration between these markets. A higher financial integration in this case means that were less opportunities to obtain from the benefit of the portfolio diversifications. In addition, there was high convergence in 2009 for its Sharia stock indices, in which is believed to be attributed with ethnic violence or riots that occurs in Xinjiang.

Figure 2 on the next page shows the conditional correlations and again it consistently confirms with the results of the unconditional correlations in table 6, which showed that Indonesian Sharia stock index has the least correlation with the US Sharia stock index. The figure further supports the previous results which indicates that Indonesian Sharia stock index is highly correlated with China Sharia stock return. Moreover, the figure also indicates that the correlation returns of Indonesian Sharia stock with the three major trading partners seems to move quite closely together, especially during the 2008 global financial crisis. Hence, it is suggested that Indonesian investors are better off investing in US Sharia stock markets to gain more

portfolio diversification, compared to other Sharia stocks of the major trading partners.

Figure 2: Conditional Correlations- JII,FTCN,FTJP,FTUS



6.3 Estimation using Continuous Wavelet Transform Analysis

In this section, continuous wavelet analysis is done to analyze the impacts n portfolio diversification benefits given the different investment horizons. To perform continuous wavelet analysis, we will focus on the wavelet coherence methodology. The continuous wavelet transform and phase difference of Indonesia's Jakarta Islamic Index returns with Sharia stocks index returns of China, Japan and United States are presented in figure 3 to 5 respective from scale 1 (day one) up to scale 9 (512 days). The horizontal axis represents the time in terms of number of trading days whereas the vertical axis refers to the investment horizon. The values for 5% significance level represented by the curve line obtained from the Monte Carlo simulation. The color code for power of strength ranges from blue (low coherency, near to zero) to red (near one). The vectors pointing to the right mean that the indexes are in phase but if they point to the left means that the indices are out of phase. In the case that the vectors are pointing to the right and up would indicates that the first series is lagging, whereas when the vectors are pointing to the right down would indicates that the series is

lagging. If the vectors are pointing to the left and up will mean that the first series is leading, whereas first series becomes lagging when the arrows are pointing towards the left and down (Madaleno & Pino, 2010). The present study use Indonesian's Sharia stocks index as the first series in all the wavelet coherency diagrams.

As shows by figure 3 to figure 5 in the next page, it is found that for very short holding period, which are 2-4 and 4-8 days, it is found that the correlation between Indonesian Sharia stock and its major trading partner are quiet low. If we compare it relatively, the returns of China Sharia stock indices tends to have stronger correlation relative to the correlation of the Sharia stock indices of other trading partners. The correlations of Indonesian's stock indices are also relative low during the global financial crisis, which occurs on the observation points of 30 days to 347 days. This would mean that speculators, who tends to invest in this holding period (very short period) would benefit from the investment, which is in line with our expectation.

For the short holding periods of 8-16 days, stock indices of China and Indonesia are highly correlated and moving together during the Global Financial Crisis whereby it was also highly correlated when conflicts were occurred in China, which were occurred in observation 1000, where there is a protest in Wukan Province, China. In the case of the correlation between Indonesian's Sharia stock indices with Japanese Sharia stock indices are relative weak, with exception in the event of Global Financial Crisis. The same case also occurs in the correlation between Indonesian's Sharia stock return with United States' Sharia stock return, whereby it was highly correlated during the Global Financial Crisis, and relatively weak in the rest of the observation. Therefore, it can be concluded that Indonesian investors will enjoy the portfolio diversification benefits if they invest in Japan and United States of America for 8-16 days, with exception of Global Financial Crisis. On the contrary, Indonesian investors will not enjoy the benefit of the portfolio diversification if they invest in China as the co-movement of both stocks tends to be highly correlated. In addition, Indonesian's investor will not enjoy portfolio diversification benefits if they make short-term investments between 16 – 32 days. Similar to the previous case, the correlations between two indices (Indonesia's and China's stocks) tend to be high, with both variables are moving together in the same day observations when political conflicts or events aroused. On the other hand, the correlations of Jakarta Islamic Index with Japanese Sharia stocks tend to be low, with an exception of three major events. The first event is the global financial crisis that occurs in the observations 30-347. The second event occurs in the observations 700 during the resignation of Japan's Prime Minister Yukio Hatayama in June 2010. The third events occur on the 1200 observation, when Prime Minister Yushiko Noda reshuffles his cabinet, but the new appointed justice minister was reported to have illegal donation from yakuza. In the case of United States of America, the correlation between its Sharia stocks and Indonesian's Sharia stocks are relatively low except on the Financial Crisis in observation 30-347, and the downgraded rating of the government credit rating from AAA to AA+ in observation 1200 days (resembling May, 2012).

Moving to medium investment horizons of 64-12 and 128-256 days, higher levels of correlations are observed during and post global financial crisis between

China, Japan and United States with Indonesian's Sharia stock index return. Japanese stock index shows a moderate correlation in observations 883 days to 1200 days, which resembling the period of Japanese's Earthquake and Tsunami that occurs in March 2011. In the case of Indonesian's Sharia stock index returns correlation with China's Sharia stock index returns are relatively high in the same observations (observations 1000), whereby its reasons can be linked to the same reasoning that are state in the short term period. Similarly, United States of America shows the same results, whereby the correlations between US Sharia stocks returns with Indonesian Sharia stocks return are relatively high during the same observation period with the reasoning stated in the short term investment horizon.

In the case of investment horizons of 256-512 days, very strong correlation are observed between all the Sharia stock index returns of Indonesia's major trading partners with the Indonesia's Jakarta Islamic Index returns. This will reduce or eliminate the potential portfolio diversification benefits. In relations to the arrows that indicates the phases of the variables, the directions of most arrows in higher time scales or longer investment periods indicates that the Indonesian's Sharia stock returns with its major trading partners tends to move together most of the time. The present wavelet analysis is aligned with findings in Alaou and Hkri (2014), which found that the occurrence of the financial crisis has considerably increased the co-movements between all stock markets, especially at higher frequency levels.

Figure 3. Continuous Wavelet Transform- JII and FTCN

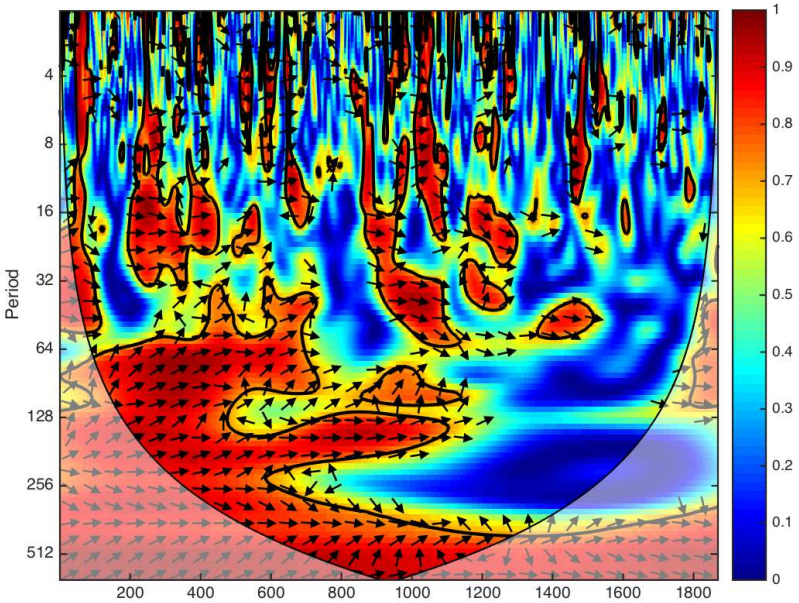


Figure 4. Continuous Wavelet Transform- JII and FTJP

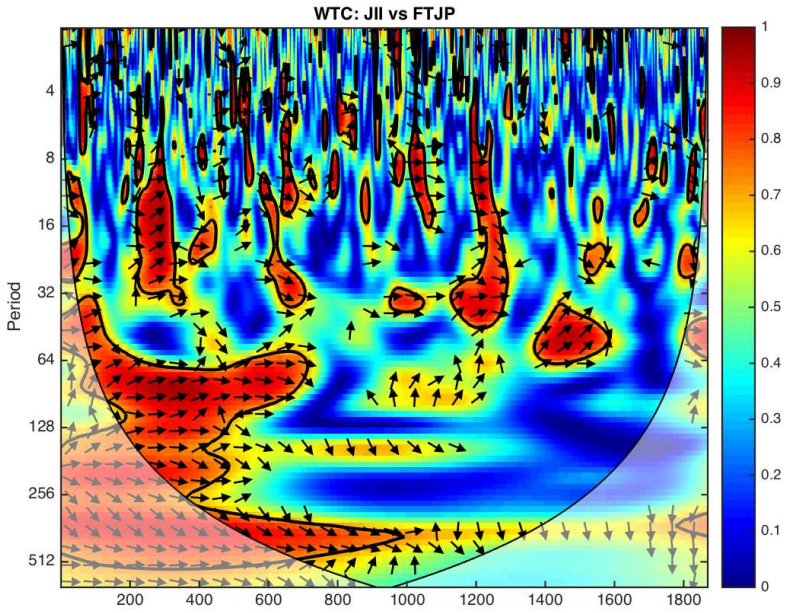
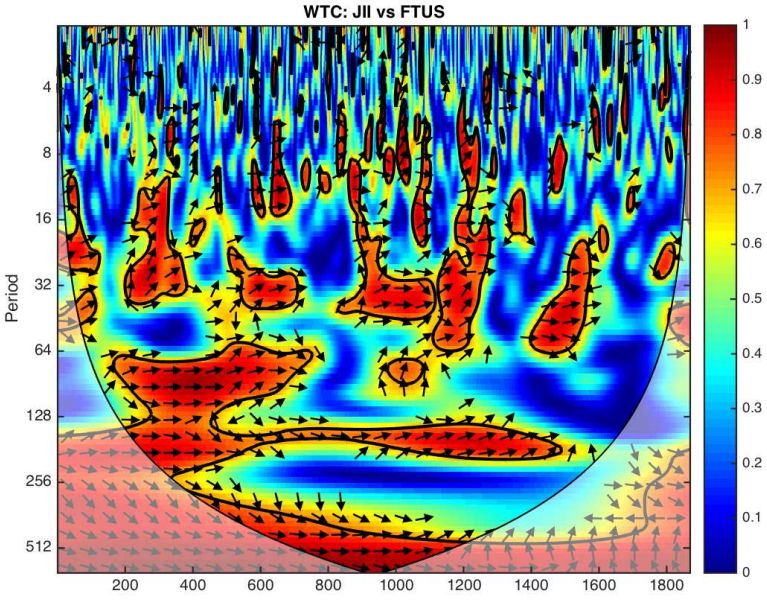


Figure 5. Continuous Wavelet Transform- JII and FTUS



6.4 Robustness test through estimation using the application of MODWT

In order to test the robustness of the results that is obtained in CWT analysis, a Maximal Overlap Discrete Wavelet Transform (MODWT) was applied to our original data set consisting of return of series for all four Sharia indices. In MODWT, researcher is required to specify the time scales for the returns whereby the present paper use eight scales (1-2 days, 2-4 days, 4-8 days, 8-16 days, 16-32 days, 32-64 days, 64-128 days, 128-256 days, and 256-512 days). The correlations between Indonesia's Jakarta Islamic Index returns with the index returns of its major trading partners were examined using the generated MODWT returns series using R studio software and the result is shown by the table below:

Table 8. Wavelet Correlation of Indonesian's Sharia stock returns with the returns of major trading partners of Indonesia – MODWT Transformations.

MODWT SCALING	China	Japan	United States
1-2 days	0.4080823	0.3872032	-0.04129138
2-4 days	0.4948697	0.3831019	0.22511014
4-8 days	**0.6065063**	0.5085759	0.45005611
8-16 days	**0.6490887**	0.5197364	0.46096404
16-32 days	0.5797039	0.4977209	0.55855171
32-64 days	**0.7443759**	**0.6386935**	**0.74064975**
64-128 days	0.5650438	0.35933	0.57251075
128-256 days	**0.6916848**	**0.6803057**	**0.6701574**
256- 512 days	**-0.8373186**	**-0.9357612**	**0.99747065**

Notes: Correlations exceeding the 0.6 level are arbitrarily considered to be strong, hence not effective for portfolio diversification (Najeeb & Masih, 2015)

As shown by the table above, the result happens to be consistent with CWT analysis. The Sharia stock index of China seems to be not providing opportunities of portfolio diversification benefits to Indonesian investors, as the correlations between China's Sharia stock index returns with Indonesian's Sharia stock returns tends to be high, in most of the times. Japan and United States seems to indicate reasonable opportunities of portfolio diversification up to investment horizon of 16-32 days. As a while, the entire Sharia stock index returns of Indonesia's major trading partners show a very strong correlation in investment horizon of 32-64 days, 128-256 days and 256-512 days. However it should be noted that the correlations of all Sharia stock

index returns are quiet low in investment horizon of 64-128 days, although it is almost close to 0.6 for China and United States; which indicates portfolio diversification opportunities. Therefore, the findings from the MODWT analysis are in line with the one obtained under CWT analysis.

6.5 Interpretation of the result

From the results obtained from three different methodology, it can be seen that sharia stock index of China are not really suitable for Indonesian's investor to include that stock in their portfolio diversifications. This can be explained by some underlying factors. The first underlying factor is the high intensity of trading activity between these two countries. Since the early 2000, there has been a significant investment made by China in ASEAN countries, particularly Indonesia. Scissors (2011) show that the cumulative non-bond investment outflows from China to Indonesia in the years from 2005 to 2010 was amounted to USD 9.8 billion, which made Indonesia the eight largest recipient of Chinese non-bond investment, after Australia, USA, Nigeria, Iran, Brazil, Kazakhstan and Canada. Furthermore, ASEAN countries, including Indonesia had made a bilateral agreement, which was called ASEAN-China Free Trade Area (AFTA) in 1990. Since the trade agreement was made, China has been become the most important sources of imports and the second largest export destination after Japan, reaching the value more than USD 14 billion (Booth, 2011). Aside from bilateral agreement through AFTA in 1990, China and Indonesia had build up strategic partnership of their trade bilateral partnership in 2005.

Furthermore, majority of Indonesians consider China's growing economy as a threat to their economy opportunities. The economic threat posed by China is twofold: first, inflows of foreign direct investment into China occur at the expense of Indonesia; and second, a combination of high-technology and low labor costs enable Chinese companies to mass produce high-quality but inexpensive goods. Chinese competition has already taken a heavy toll on Indonesia's massive footwear industry, and its textile industry seems destined to suffer a similar fate. Labor unions in Indonesia fear that the proposed China-ASEAN Free Trade Area will be the death-knell of the country's manufacturing industry as Indonesian goods will be unable to compete with Chinese manufactured goods (Storey, n.d). Higher intensity indicates that the international financial instabilities are easily transmitted to domestic financial market, which lead into an increase to the correlation of the stock market between two countries (Ibrahim, 2005).

Another issues is related to China's politic condition whereby any conflict aroused in China tends to make the correlation of these two Sharia stock market indices to be high during the period. Political stability is believed to have direct impact to stock market reactions or fluctuations. Pastor and Venronesi (2011) describe that uncertainty that was caused by politic instability effect stock markets in two ways. First, if uncertainty forced the government to undertake corrective action to protect the market and these protection that is done by the government will increase the risk premia even though political shocks are orthogonal to fundamental shock.

Second, political uncertainty also makes the stocks more volatile and more correlated, especially when the economy is weak. Larger heterogeneity among the potential new government policies will increase risk premia as well as volatilities and correlations of stock returns. By now, it is already clear that Indonesian Sharia investors should avoid investing in Sharia stock indices of China, which happens to have high intensity of economic activities and high political risks, since it would give them minimal benefits based on the factors outlined above.

In the case of Japanese Sharia stock index, the Japan-Indonesia free trade agreement (IJEPA) was signed in 2005 that aimed to boost trade and investment between the two countries, which would make researchers assume or expect that the correlation between the countries would be higher, as suggested by the existing literatures mentioned in this study. The trade agreement states that both countries should remove their tariffs on approximately 92 percent of trade between the two nations. Abolishing tariffs policy seems to be effective as Japan was the top trading partners as reported by Statistics of Indonesia (2014). However, it is reported that Indonesia has been facing trade deficit since IJEPA was implemented; Indonesia suffered USD 2.4 billion trade deficit in terms of non oil and gas sectors in 2014, compared to the USD 627 million deficit in 2008. Other factors that should be considered is the frequency of the natural disasters occurred in Japan. Japan's geographical positions is believe to be prone to several natural disasters such as earthquakes, typhoons and tsunamis. The correlations of Sharia stock returns between Japan and Indonesia was moderately correlated in that period, especially medium investment horizon. This cannot really be comprehended by the normal humanmidn who will think that such natural disasters would cause inter-linkages between Indonesia and Japan, to be adversely affected by the disruption in the highly integrated supply chain through cross border production network between Japan and Asian economies (Danninger & Kang, 2011). In the event of occurance of Natural Disaster, Kabir et al (2013) suggest that the high correlation in natural disasters can be linked to the bearish trend in the Japanese stock markets, whereby natural disasters tend to cause information and volatility spillover in the market due to the psychological effects of the market players.

Lastly, we look at the weak correlation between United States Sharia index return with Indonesia as shown by M-GARCH DCC analysis, Wavelet Coherence Analysis and MODWT analysis. The correlation between both stocks are found to be low in short investment horizon, where it was high during pre and post crisis. In addition, the correlation between US Sharia stock return with Indonesian Sharia stock returns tends to be high in the event of natural disasters which occurred in observation 1300 that resembles the period of Hurricane Sandy disaster in October 2012. Petel and Sarkar (n.d) found strong evidence of contagion between US' stock market returns and Emerging markets, and the stock returns of emerging countries recovery tend to take longer time than US' states.

7. Conclusions

The study examines the correlations between Indonesian sharia stock index returns and the returns of sharia stock indices of major trading partners, namely China, Japan and United States to discover the extent of possible portfolio diversification benefits among these sharia indices for Indonesian investors. The present paper use daily data which spanning from November 2007 to December 2014 to apply MGARCH DCC and wavelet transforms techniques that consist of CWT and MODWT analysis. The study found that Indonesian's investors might not enjoy portfolio diversification benefits by investing in China's sharia stocks in majority of investment horizons. Japan and United State's stock return index are found to have moderate correlations in most of investment before investment horizons of 64-128 days or longer. In general, the results if this study supports the previous empirical literatures whereby stock market tends to have strong cointegration after the crisis period, which later on will decrease the portfolio diversification benefit (Karim and Majid, 2010). The findings of this paper are expected to have significant implications for Indonesian sharia investors and portfolio manager as it is necessary to understand return correlation among the sharia stock indices in order to enjoy portfolio diversification benefits. This result may be also important for even government authorities in regards with the allocations and stock index polices at different investment horizons.

8. Policy Implications

It is suggested for policy makers to keep alert on any event of shocks, natural disasters and also political conflicts on their major trading partner, as Indonesian's sharia stocks are found to be correlated with China and Japan. Indonesia's policy makers should implement macroeconomics policies that are able to stabilize Indonesia's Sharia stock market during such events, as ignoring those events will result in contagion effect on Indonesian's stock market. Furthermore, the findings address the need of policy coordination between Indonesia with China and Japan to mitigate the impacts of financial fluctuation. In order to take advantages of financial integration and interdependence, greater liberation including reduction or removal or trade and investment barrier will be necessary. In addition, in order to move towards greater financial integration among the market trade, liberalization and agreements have important and far-reaching implication in the region. Economic cooperation among the neighbors might not only will strengthens the economic and financial integration, but also enhances greater political stability and social cooperation between the member nations (Chowdhury, 2005)

Similarly, the extent of integration among the markets would give important bearings on the formulation of the financial policies of multinational corporations. Therefore, knowing co-movement among the stock markets would give an idea of exchange risk between countries. Such knowledge is believed to be able to help

managers to mitigate international risks and managing economic, transaction and translation of the risks (Karim et al, 2009).

9. Limitations of the Study

The study can be further enriched in the future by looking at groups of trading partners, such as Middle East, Asian, European and South American Trading partners instead taking countries from the top of the list of the trading partners. Moreover, since the present study is focusing only at sharia indices, therefore, future studies may attempt to investigate more by doing a comparison of portfolio diversification benefits between conventional stock indices and sharia stock indices. Future study on portfolio diversification based on sectors is suggested, as it is likely that it will allow investors to diversify their portfolio more efficiently.

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