Portfolio Diversification Benefits of Islamic Stocks and Malaysia's Major Trading Partners:MGARCH-DCC and Wavelet Correlation Approaches

Rahim, Adam Mohamed and Masih, Mansur

INCEIF, Malaysia, INCEIF Malaysia

26 September 2014

Portfolio Diversification Benefits of Islamic Stocks and Malaysia's Major Trading Partners: MGARCH-DCC and Wavelet Correlation Approaches

Adam Mohamed Rahim[1*] and Mansur Masih[2]

Abstract

Previous studies have investigated the interdependence of Malaysian stock market with its major trading partners without taking into account the time-varying correlations and different investment horizons of the investors. The main objective of this paper is to study the extent to which the Malaysian Shari'ah (Islamic) investors can benefit from portfolio diversification with the Shari'ah indices of its major trading partners (China, Singapore, Japan, United States and Thailand). The recent Multivariate GARCH Dynamic Conditional Correlation, the Continuous Wavelet Transform and the Maximal Overlap Discrete Wavelet Transform are applied. Findings tend to indicate that the Malaysian Shari'ah investors who have allocated their investments in major trading partners like China and Singapore may not reap great diversification benefits for almost all investment horizons but may reap moderate benefits arising from Thailand and Japan up to the investment horizons of 32-64 days and longer. The evidence suggests that the portfolio diversification benefits are greater if the Malaysian Shari'ah investors invest in the US Shari'ah stock index excepting the long investment horizons. The stock holding periods exceeding 32 to 64 days contain minimal benefits of portfolio diversification. As an implication, the Malaysian Shari'ah investors should carry out the reassessment of their stock exposures and investment horizons more frequently.

Keywords: Shari'ah (Islamic) stock indices, Diversification benefits, Trading partners, M-GARCH, Wavelet analysis, MODWT, CWT

[1] Postgraduate student, INCEIF, Lorong Universiti A, 59100, Kuala Lumpur Malaysia
[2] Professor of Finance and Econometrics, INCEIF, Lorong Universiti A, 59100, Kuala Lumpur Malaysia

[*]Corresponding Author: adamdzar@gmail.com

1.0 Introduction: Motivation of the study

Stock indices highly thrive in information and the information revolution has transformed these markets world over. Investors are now able to keep track on a real time basis and can react to the flow of information around the world. The insulation of national economies towards global events no longer pertain or in other

words, the repercussions of international events can actually influence the movement of shares and other investments (Menon et. al 2009).

Under this purview, the fast information transmission to stock markets of the world is facilitated by economic globalisation making investors to be driven more to invest outside their countries as geographic diversification generates superior risk adjusted returns while capturing the higher rates of returns by these overseas markets (Khan 2011).

From here, there is an aspect that concerns investors around the world and that is the integration happening among various stock markets by holding a diversified portfolio or securities with the goal to reduce one exposure's to risk (Khan 2011).The increasing interdependency among the stock markets suggests that stock markets move together with high correlations and subsequently make it impossible for the investors to reap benefits of the cross borders diversification which can then be only maximised if the stock markets exhibit low correlations of price behaviour (Karim et. al 2009),confirming to international portfolio diversification theories. It is then essential for portfolio managers and investors to examine the dependencies among international stock markets. Another component that is of concern to investors and portfolio managers is the different investment horizons across the investment period whereby market returns are not only time varying but may also be dependent on time scales related to differing investment horizons(Gencay et. al 2001).

A lot of considerable events have taken place over the past two decades that has affected the global financial sector, which also had a substantial effect towards portfolio investment activity.One of the major events happening in the financial world was the 1997 Asian Financial Crisis came which was triggered by the distorted policies plus the market overreaction and herding that led to the plunge of exchange rates, asset prices and economic activity in the countries of the Asian region (Roubini et. al 1998). The most recent crisis which was the global financial crisis in 2008 actually indicated that the global financial system was far more interconnected than was previously recognised and the excessive risk taking that threatened the collapse of the financial system coming from the subprime mortgage crisis along with the existence of Ponzi borrowers(Mishkin 2011).

Looking at a predominant Muslim nation, specifically the South East Asian nation of Malaysia, Malaysia strongly trades with other countries, firstly China, followed by Singapore Japan, the United States of America and then Thailand as from January 2013 to August 2013(Department of Statistics Malaysia 2013) which then translates to Malaysia's top 5 trading partners. In December of 2013, there was a slight decrease in the Malaysian trade surplus from MYR 9.7 billion to MYR 9.47 billion in November. Yet, compared with the same month last year, the surplus widened from MYR 8.46 billion, as exports heaved to 14.4 percent. Exports were also see to amount to MYR 65.7 billion in the last month of 2013 which indicated a 5.6 percent rise over November and a 14.4 percent surge over a year earlier. (Trading Economics 2014). It is also important to see how is the level of correlation Malaysian stock market particularly the shariah stock market with the stock markets of its trading partners which would have an implication towards shariah investors in terms of international portfolio diversification since Malaysia itself is a predominant Muslim country.

With respect to Malaysia again, Malaysia has launched its first public Islamic index known as the KLCI Shariah index in April 17 1999(Hussin et. al 2012) to facilitate participation in equity investments that are compatible with the Islamic principles and a benchmark is provided for investors who seek to make investments based on shari'ah principles and helps them to make better informed decisions.

Shariah Advisory Council under the Securities Commission of Malaysia was also established to enhance the development of Islamic capital markets. It was reported by the Securities Commission in 2008 that there were over 85 percent of total listed Islamic equity companies in Malaysia. Sooner or later after that, there was a cooperation arrangement between Bursa Malaysia and the FTSE which led to the introduction of a new series of tradable equity called the FTSE Bursa Malaysia Shari'ah Index(which will be the focus of our study later on).

A screening process has to take place based on qualitative and quantitative parameters during the selection of shari'ah compliant companies. Under such qualtitative criteria, a standard criterion is applied by the SAC in emphasising on the activities of the companies listed on Bursa Malaysia in which activities that do not contradict the shariah principles will be categorised as shari'ah compliant securities while on the other hand , if the activities of companies are based on core activities such as; financial services based on riba(interest);gambling,manufacture or sale of non-halal products, conventional insurance, entertainment activities that are not permissible according to shari'ah, manufacture or sale of tobacco based products, stockbroking or share trading in shari'ah non-compliant securities and other activities that are deemed non-permissible according to shari'ah.

Quantitative parameters are then implemented to determine the tolerable level of the mixed contributions from permissible and non-permissible activities toward the turnover and profit before tax of the company. If the benchmark is exceed by the contributions from non-permissible activities , then the securities of the company will be classified as *Shari'ah* non-compliant.(Hussin et. al 2012).

Given the Islamic finance industry which is currently estimated to be worth about UD$1trilllion and having grown at an annual rate of about 14% during the last 15 years(Sarif 2011), it is worthwhile to study the correlations of returns among shariah indices together with observing it at different time intervals to provide an idea of riskiness and potential portfolio diversification benefits for Islamic investors .From here, this study intents to attempt to study the aspects of diversification of the Malaysian shariah index returns with the markets of its trading partners by considering correlations of the FTSE Bursa Malasyia EMAS Shari'ah Index returns with the MSCI Islamic China index returns. MSCI Islamic Thailand index returns, MSCI Islamic Singapore Index returns, FTSE Shari'ah USA index returns and FTSE Shari'ah Japan index returns. The sample period of this study contains daily data spanning from 26th November 2007 to 31st December 2013.

The structure of this paper includes nine chapters which are organised as follows. This current chapter explains the introduction together with the issues motivating the study,chapter two discusses about the main objective of this paper followed by chapter 3 that gives an overview of the theoretical framework related to the issues in this paper and then chapter 4 that reviews the related previous empirical literature. Chapter 5 elaborates on the methodology applied while chapter 6 discusses the empirical findings and interprets the results. Chapter 7 and 8 gives a summary about the paper and discusses about the policy implications that can be derived from the results, respectively. Lastly,chapter 9 talks about the limitations of the study and suggestions for further research.

2.0 Main Objective of Study

The main objective of this paper is to study the extent to which the Malaysian shariah investors particularly in FTSE Shari'ah Bursa EMAS index market benefit from portfolio diversification with the shari'ah indices of its major trading partners (China, Singapore,Japan, United States and Thailand) by examining the volatility and correlations of their market returns. Other than that, this study also has an aim to study the correlations with respect to different investment horizons that differ among the nature of behaviour of investors that vary across the markets.

Overall, this paper intends to contribute by filling the gap by extending from the previous literature regarding diversification benefits between conventional Malaysia stock markets with its major trading partners which used time series techniques of cointegration that does not reflect the recent econometric methodology. Extension is done by including shari'ah stock index returns of Malaysia and its major trading partners and applying the recent research methodologies such as the Multivariate-GARCH DCC to see which major trading partner should Malaysian shari'ah investors invest in and together with Continuous wavelet transform and maximal overlapping Discrete Wavelet Transform that aims to fulfil the objective to unravel the international portfolio diversification benefits given different stock holding periods(eg. 2-4 days, 408 days, 8-16 days, 16-32 days, etc.. Through this study of volatilities and correlations between the index returns of Malaysian shari'ah stock index with the shari'ah indices of its major trading partners plus observing correlations at different time intervals, it would be useful for policy makers in Malaysia in a sense that if shari'ah stock index of Malaysia are found to be strongly correlated to its major trading partners then there is a danger that shocks in one market may spill over to other markets and thus, calls for stronger cooperation among the authorities of these countries (Ali et. al 2011). As an additional input, we also tested under the M-GARCH DCC framework to see whether the dynamic parameters for volatility were mean reverting or not.

In short, the study intends to fulfil the needs of Malaysian shari'ah investors who want to diversify their portfolios with respect to major trading partners of Malaysia.

3.0 Theoretical Framework

The main underlying theory of this study is the Markowitz's Modern Portfolio Theory which theory suggests a hypothesis 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 of expected return is attempted to be minimized by choosing the quantities of various securities cautiously 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.

According to the theory, each security has its own particular risk and that a portfolio of diverse securities shall be of lower risk than a single security portfolio, emphasising the importance of portfolio diversification to reduce risk.

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 resulting optimum diversification .The Theory uses standard deviation as a substitute to risk and the variance of expected returns is expressed as follows:

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

$\mathbf{W}_a$ is the size of the portfolio in security a, $\boldsymbol{\sigma}_\mathbf{a}$ is the standard deviation of the expected return of the security a, and $\mathbf{Cov}_{ab}$ is the covariance of the expected returns of the securities a and b. With the assumption that the covariance is less than 1 (which is not a practical assumption), it is derived that the weighted average of the standard deviation of the expected returns of the securities shall be more. As such the theory proves that diversification of securities in a portfolio reduces risk (Portfolio Theory n.d.).

Another theory instilled in this paper is the efficient market hypothesis which states that the ideal market is the one that provides accurate signals for resource allocation whereby firms can investors can make investment decisions under the assumption that security prices at any time fully reflect all available in information. An efficient market is a market whereby the price always reflects the available information (Fama 1970)

The next theory that can be linked to this study is the Black Swan theory. The Black Swan theory argues that the human beings' tendency to dwell and reflect towards the past events in order to come up with a prediction of the future can limit one's understanding of the world and increases the vulnerability to extreme and unexpected events. In short, black swan events are unpredicted events that lie within the outliers of a bell curve which is beyond the realm of regular expectations. (Taleb 2007)

The methodology of the M-GARCH DCC adopted in this paper has the ability to adopt a t-distribution of variances which reflects the reality more in capturing the fat tailed nature of the non-normal distributions of the index returns which overcomes the criticism in Markowitz's portfolio theory of being overly simplistic and assumes that portfolio variances are normally disttributed (JP Morgan n.d.). According to In and Kim (2013), such assumptions were not made in the application of wavelet transform methodologies which can produce more realistic results.

4.0 Literature Review

4.1 International Portfolio Diversification

The connection between stock market linkages with globalisation frequently is studied both theoretically and empirically. A substantial interest also exists among academics and policy-makers on the effects of the integration of stock markets regionally and internationally. Synthesis of a few selected studies is provided below in order to give readers a brief preview of this subject matter be it from the conventional stock markets

Karim at. al (2009) found that the Malaysian stock market is integrated with the stock markets of the United States of America ,Japan and Singapore from January 1999 to May 2008,which was before the 2008 global financial crisis. In order to carry out this study, Karim et. al (2009) the Auto Regressive Distributive Lag(ARDL) approach was implemented regardless of the stationarity properties of the variables in the samples and allows for inference on long-run estimates. On top of that, ARDL model takes the sufficient number of lags to capture the data-generating process in a general-to specific modelling framework. since they included the bounds testing procedure. It can be implied that from the existence of cointegration in previously mentioned stock markets, a long run equilibrium relationship exists between them, therefore changes in the dependent variable are influenced by the deviations from this equilibrium in the short run in order to force movements towards long run equilibrium.

In short, the literatures discussed above focus on the integration between conventional stock market indices with the usage of only time series techniques of cointegration which do not reflect the recent research techniques and does not shed light on the shari'ah stock market indices which can potentially be beneficial towards the shari'ah investors especially to the ones in Malaysia.

4.2 Time varying and scale dependent correlations

There has also been some studies done regarding time varying correlations across markets that are not constant and evolve through time. One of the many studies regarding this issue was carried out by Paramati et. al (2012) which investigated whether foreign trade matters for the stoc markets integration by segmenting Australian trade partners into three groups based on bilateral trade relations. Asymmetric generalized DCC-MGARCH models were employed to examine the time-varying correlations of pairwise stock market returns. Results from the AGDCC-GARCH model revealed that during crisis periods, correlations were to time-varying and significantly increased and revert close to their initial levels after the crisis. Findings then confirm that foreign trade intensity does matter for stock market integration which may have implications for investors in their portfolio selection process to obtain benefits of diversification.

Celik (2012) also applied the M-GARCH DCC model but not the asymmetric version of it to test the existence of financial contagion between foreign exchange markets of several emerging and developed countries during the United States subprime crisis. Findings show that there was contagion effect during the US subprime crisis for most of the developed and emerging countries but most of the effect was directed towards the emerging countries . Again, findings from this study will be of interest to international investors and portfolio managers since the level of correlations between the markets will affect the portfolio diversification benefits.

With regards to the subject of scale dependent correlations particularly the Continuous Wavelet Transform(CWT), Madaleno and Pinho (2010) used Coherence Morlet Wavelet Analysis and found that the relation between the indices (FTSE100, DJIA30, Nikkei 225 and Bovespa) to be strong but not homogenous across scales and a quick transmission was not found across the markets studied. Similarly, Aloui and Hkiri(2014) examined the short term and long term dependencies between stock market returns for the Gulf Cooperation Council(GCC) countries which was based on wavelet squared coherence which allows co-movements in time frequency spaces to be assessed. Results of the study revealed that the linkage among the GCC stock markets during the financial crisis increased and the portfolio benefits for short term investors were enhanced relative to the long term investors which faced reduced diversification benefits.

Now moving on to the Maximal Overlapping Discrete Wavelet Transform(MODWT), Reboredo and Rivera-Castro(2014) examined the connection between oil price and European stock markets returns by decomposing original time series through wavelet to characterize the connection at different time scales which can reveal the contagion and interdependence between oil and stock prices together with analyzing the oil lead and lag effects on stock prices through wavelet cross correlation. Findings of this study reveal that during the crisis period, oil price led exchange rates but this is not the case during post crisis periods and contagion and interdependence was discovered after the crisis happened at the aggregate and sectoral levels. Therefore, oil price lead stock prices and vice versa for higher frequencies after the onset of the financial crisis. Another study was also carried out by Reboredo and Rivera-Castro(2013) with the same methodology but different focus whereby they investigate the relationship between the oil prices and the United States

dollar exchange rates found contagion and interdependence between these two variables after the onset of the crisis and the oil prices led the exchange rates during the crisis period which was similar to the study done on oil price and stock markets

Interestingly, the methodology of CWT and MODWT can be combined together in a study in order to test for robustness of the results as what was done by Tiwari et. al (2014) to investigate the inflation-output gap relationship in France. Through the MODWT analysis, the short and medium term fluctuations of both variables tend to be more correlated while under the CWT analysis states that the output gap leads inflation in short and medium runs.In brief, both methodologies demonstrates that the output gap represents a good predictor of the inflation in the short and medium run.

As for the literatures discussed under this section of the literature review, they have been studies using recent techniques by applying them on shari'ah stock indices.However, no emphasis is given towards the trading partners of a country.Even if there are studies done with regards to trade partners like the one done by Paramati et. al(2012), it did not incorporate shari'ah stock indices and hence cannot provide implications for shari'ah investors

5.0 Methodology

5.1 Multivariate GARCH Dynamic Conditional Correlations

This study employs dynamic conditional correlation (DCC) method in order to estimate time dependent correlation and volatility of returns of Islamic indices which is different frpm typical diversification studies that employ constant correlation(You & Daigler 2010). In addition to DCC, this study also tested mean reversion of volatility by giving linear restrictions. Moreover, forecasting correlation of the returns over a specific period is another focus of this study.

With the DCC model, a member of the GARCH family, one can pinpoint precisely the timing and nature of plausible changes in the time series co-movement(Lee & Crowley 2004). For each time point, the DCC method gives a value that serves as the forecasted correlation between series for the next period(Lebo & Box-Steffensmeier 2008). The estimation of DCC consists two stages, which makes the estimation of a time varying correlation matrix simplified (Engle & Sheppard 2001).

In the first stage, GARCH models are applied to estimate univariate volatility parameters for each of the variables(Engle & Sheppard 2001).So if there are two variables, then 2 GARCH equations are estimated (Glosten et. al 1993). For example:

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

(GJR, 1993 Asymmetric GARCH equation).

I is an indicator function in which it will equal to 1 when the standardized residuals of the series (ε_t) are positive and equals to 0 otherwise. If 'm' has a negative value, it can be implied that periods with negative

residuals would immediately be followed by periods of higher variance compared to periods of positive residuals .

In the second stage, the inputs come from the standardized residuals from the first stage to estimate a time varying correlation matrix (Engle & Sheppard 2001). Following Engle (2002), *Ht* is a conditional covariance matrix and is:

$H_t = D_t R_t D_t$

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

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

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

In the first step, maximisation only happens to the volatility component of D_t in which the log likelihood is reduced to the sum of the log likelihood of the univariate GARCH equations.

In the second step, the correlation component R_t is maximised with elements of (ε_t) from step 1 which gives the DCC parameters α and β(Engle 2002),

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

Over here, if $\alpha = \beta = 0^1$, then R_t is simply $\bar{R}$ and CCC model is sufficient enough. The GARCH type dynamics are contained within these models for both conditional correlation and conditional variances . Time varying conditional variances can be defined as the measure of uncertainty and thus give us insight into what causes the movement in the variance(Engle & Sheppard 2001).

The two-step estimation of the likelihood function is consistent, albeit inefficient (Engle and Sheppard, 2001). Asymmetries are allowed by the DCC, meaning that there are different weights for positive and negative shocks to a series. The asymmetries are in the variances (not in the correlations) (Cappiello, Engle and Shephard, 2003).

Conditional correlation is a forecast of the correlation that would be appropriate next period conditional on this period's data. Therefore the parameter uncertainty only causes the uncertainty in this forecast (assuming correctly specified model).

Lanza et al. (2006) also applied this technique in order to observe the dynamic conditional correlations in the daily returns on West Texas Intermediate oil forward and future prices and discovered that from 1985 to 2004, the DCC can vary dramatically in contrast to the common view that the volatility of futures price returns at different maturities are perfectly correlated. In general, the dynamic volatilities in the returns in the WTI oil forward and future prices could be either independent or interdependent over time.

The DCC estimates of the conditional correlations between the volatilities of forward and futures returns were always statistically significant which indicate that the assumption of constant conditional correlations (CCC) (between returns at different maturities) was not supported empirically since the DCC between the forward and futures returns varied dramatically The range of variation (between the max and min) was relatively narrow in the case of the dynamic volatilities of the 3-months futures returns and 6-months future returns , namely (0.832, 0.996).On a general basis, the dynamic volatilities in the returns in the WTI forward and futures prices could be either independent or interdependent over time.

In the case of DCC between forward 1-month and futures 1-month, the max is 0.998 implying that forward one month and futures one month returns would have the same risk. However, the min is -0.291 implying that shocks to either of them are not perfect substitute in terms of risk

It was assumed by Bollerslev (1990) that the conditional variance for each return, h_{it} (i=1, …, m) follows a univariate GARCH process, that is, CCC specification:

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

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

Independence of the conditional variances across returns is assumed by the CCC specification above and asymmetric behaviour is not accommodated. Asymmetric GARCH or GJR specification for the conditional variance, which for r=s=1 was then proposed by Glosten et al. (1993) to accommodate the asymmetric impacts of positive and negative shocks which is given below:

$$h_{it} = \omega_i + \alpha_i \varepsilon_{i,t-1}^2 + \gamma_i I_{i,t-1} \varepsilon_{i,t-1}^2 + \beta_i h_{i,t-1}$$

(Asymmetric Conditional Variance Model)

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

The following DCC model was proposed by Engle (2002) and Tse and Tsui (2002) in order to capture the dynamics of time-varying conditional correlation Γt:

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

Effects of previous shocks and previous dynamic conditional correlations on current DCC are captured using the scalar parameters θ_1 and θ_2.

The reasonable flexibility in modeling individual volatilities and can be applied to portfolios with a large number of assets has made the DCC model a popular estimation procedure(Pesaran and Pesaran, 2007).

DCC model used with a multivariate t-distribution is more appropriate since it can capture fat-tailed nature of the distribution of index returns especially for risk analysis where the tail properties of return distributions are of most concern. The log-likelihood function of the DCC model can be maximized by using a two step procedures as suggested by Engle (2002). However, such procedures will no longer be applicable to such a t-DCC specification and a simultaneous approach to the estimation of the parameters of the model which includes the degrees of freedom parameter of the multivariate t distribution would be needed (Pesaran and Pesaran, 2007) .

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

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

A two step procedure is also proposed by Engle (2002) in estimating the cross asset correlations which includes; the Individual GARCH (1,1) models are fitted to the 'm' asset returns separately, and then,the coefficient of the conditional correlations,θ , is estimated by Maximum Likelihood Estimator (MLE) (assuming that asset returns are conditionally Gaussian).But such procedure poses drawbacks of the assumption of Gaussianity is not applicable for daily returns and the portfolio risk can be estimated by its use and there would be inefficiency in the two stage approach under the Gaussianity assumption even if it is consistent.

An alternative formulation of conditional correlations $(\rho_{ij,t-1})(\emptyset)$ is therefore proposed by Pesaran which makes use of the realised volatilities. The estimates of the correlations of Pesaran is based on the devolatized returns that are nearly Gaussian (Pesaran & Pesaran 2007).

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

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

Under the study done by Pesaran and Pesaran (2007) by applying the t-DCC estimation procedure towards a portfolio composed of six currency futures, four ten year government bonds and five equity index fuitures over the period of 2 January 1995 to 31 December 2006 and discovered that the normal-DCC model is rejected but the t-DCC specification is favoured.

5.3 Continuous Wavelet Transform and Maximal Overlap Discrete Wavelet Transform

Some of the researchers that have applied continuous wavelet transform in their studies include Alaoui and Hkiri(2014), Reboredo (2012). Under the CWT, the original time series is mapped and represents a function of just one variable time separate into the 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 generates itself based on the

data length. The series correlations in a two dimensional figure is mapped by the CWT which enables easy identification and interpretation of patterns. For this study, the least asymmetric wavelet filter by Daubechies (1992) of length L=8 which is denoted by LA(8) based on eight non-zero coefficients. The length filter of L=8 is shown as a moderate length by previous studies which is adeuqte to deal with the characteristics of time series data (Gencay et. al 2001, In & Kim 2013). It has also been argued that a more smooth wavelet coefficient compared to other filters such as Haar wavelet filter is generated by the LA(8) (In & Kim 2013).

With referring to Rua and Nunes (2009) and Vacha and Barunik (2012) , the continuous wavelet transform is given by

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

u represents the position of the wavelet in the time domain while *s* is the position in the frequency domain . From here, information on time and frequency can be simultaneously obtained by mapping the original time series into a function of *u* and *s* in the wavelet transform. Next, a bivariate framework called the wavelet coherence is needed to be adopted to investigate the interaction between two time series on how closely X and Y are related by a linear transformation (Madaleno & Pinho 2012) .The wavelet coherence is defined as the scared absolute value of the smoothed cross wavelet spectra normalised by the product of the smoothed individual wavelet power spectra of each selected time series according to Torrence and Webster (1999) The squared wavelet coefficient is given as

$$R^2(u,s) = \frac{\left|S\left(s^{-1}W_{xy}(u,s)\right)\right|^2}{S(s^{-1}|W_x(u,s)|^2)S\left(s^{-1}\left|W_y(u,s)\right|^2\right)}.$$

The smoothing parameter is denoted by *s* and in the case where there is no smoothing, the wavelet coherence will be equal to one . The squared wavelet coherence coefficient is in the range $0 \leq R^2(u,s) \leq 1$ and values that are close to zero signify correlations that are low while values close to one indicates the presence of strong correlations. Based on the discussion above, the wavelet coherence is deemed to be a suitable tool to study stock market co-movements over time (Alaoui & Hkiri 2014).

Besides CWT, MODWT is also applied in this study which decomposes a signal to *J* levels which requires the application of J pairs of filters under theory. The filtering operation at the *j*th level consists of application a rescaled father wavelet to yield a set of fluctuation coefficients and a rescaled mother wavelet to yield a set of scaling coefficients which can overcome some of the difficulties associated with discrete wavelet transforms. Specifically, the variance estimator based on coefficients of the MODWT is asymptotically more efficient compared to the one based on the discrete wavelet transform coefficients. From here it is the wavelet variance and covariance can be efficiently calculated in different time scales. A set of time-dependent wavelet and scaling coefficients with basis vectors associated with a location t and scale $\tau_j = [2^{j-1}, 2^j]$ for each decomposition level j = 1…..J is also produced in MODWT . Hence, the decomposed signals for multi resolution analysis in MODWT is defined as follow:

$$S_j(t) = \sum_k s_{J,k}\phi_{J,k}(t)$$

$$D_j(t) = \sum_k d_{J,k}\psi_{J,k}(t) \quad j = 1, 2 \ldots, J.$$

$S_j(t)$ and $D_j(t)$ correspond to the fluctuation and scaling coefficients at the *j*th level wavelet. Such coefficients measure the contribution of the corresponding wavelet function to the total signal is measured by such coefficients . the *j* level on the other hand is the multi resolution level which reconstrucst the signal in terms of a specific frequency (trending and fluctuation components). Tus a time series *y(t)* can be expressed in terms of those signals as:

$$y(t) = S_j(t) + D_j(t) + D_{j-1}(t) + \ldots + D_1(t).$$

With regards to multi scale analysis correlation the multi-resolution analysis can be applied to represent the variability and dependence structure of a stochastic process on a scale-by-scale basis. $X_t = (y_t, x_t)$ let to be the bivariate stochastic process while $W_{j,t} = (w_{y,j,t}, w_{x,j,t})$ is let to be the scale νj wavelet coefficient computed from Xt. Each wavelet coefficient process is obtained from applying the MODWT to each process in Xt. If it exists and if it is finite, the time-dependent wavelet variance for scale *νj* of signal *Xt* is given by:

$$\sigma_X^2(\nu_j) = Var(\hat{W}_{x,j,t}) \wedge Var(\hat{W}_{y,j,t})$$

Similarly, the wavelet covariance for scale *νj* is given by:

$$\gamma_{x,y}(\nu_j) = Cov\{\hat{W}_{x,j,t}, \hat{W}_{y,j,t}\}.$$

We thus obtain the correlation coefficient as:

$$\rho_{x,y}(\nu_j) = \frac{cov\{\hat{W}_{x,j,t}, \hat{W}_{y,j,t}\}}{\left(var\{\hat{W}_{x,j,t}\} var\{\hat{W}_{y,j,t}\}\right)^{1/2}} = \frac{\gamma_{x,y}(\nu_j)}{\sigma_x(\nu_j)\sigma_y(\nu_j)}$$

Considering a lag τ in one of the time series in equation before this, we obtain the wavelet cross-correlation as (Reboredo & Rivera-Castro 2014)

$$\rho_{x,y,\tau}(\nu_j) = \frac{\gamma_{x,y,\tau}(\nu_j)}{\sigma_x(\nu_j)\sigma_y(\nu_j)}.$$

6.0 Results and Discussions

6.1 Data analysis

Under this study, the FTSE Bursa Malaysia EMAS Shari'ah Index returns is used as a proxy for the Malaysian shari'ah stock index returns which is the principal Islamic benchmark index of the Malaysian stock exchange (Najeeb & Masih forthcoming). Under the three methodologies outlined earlier(M-GARCH DCC,CWT and MODWT), all of them make use of the shariah stock indices of Malaysia's top 5 trading partners which are from China,Singapore,Japan, United States and Thailand. The MSCI Islamic indices are used for trading partners countries of China, Singapore and Thailand. Whereas, the FTSE shari'ah indices are used to represent Japan and the United States. **Table 1** below lists the sample indices being considered in this study.

Table1: Selected indices for research

Symbol	Definition
EMAS	FTSE Bursa Malaysia EMAS Shari'ah index
MSCHN	MSCI Islamic China index
MSSG	MSCI Islamic Singapore Index
FTJPN	FTSE Shari'ah Japan index
FTUSA	FTSE Shar'iah USA Index
MSTHAI	MSCI Islamic Thailand Index

We collected daily time series closing price data for 6 indices starting from 26th November 2007 till 31st December 2013 All the data is obtained from Thomson-Reuters DataStream database available from the Knowledge Management Centre of INCEIF University. The stock indices returns were calculated as differences of the logarithmic daily closing prices of indices $\{ln(p_t) - ln(p_{t-1})\}$ where p is an index value.

As for descriptive Statistics in **Table 2** below show that the volatility of returns represented by the standard deviation is the highest for the MSCI Islamic China index and lowest for the FTSE Bursa EMAS Malaysia returns . This standards deviation shows absolute time independent volatility of the return.

Table 2: Descriptive statistics of the data

	EMAS	MSCHN	MSSG	FTJPN	FTUSA	MSTHAI
Mean	0.000192	-0.00026	-0.00003	-0.00010	0.000193	-0.00001
Median	0.000258	0.000000	0.000114	0.000000	0.000375	0.000000
Maximum	0.036883	0.145362	0.101567	0.130801	0.121400	0.108419
Minimum	-0.11321	-0.12367	-0.08337	-0.10571	-0.10111	-0.14779
Std. Dev.	0.008276	0.020927	0.013745	0.016409	0.014242	0.018514
Skewness	-1.81678	0.072782	-0.33291	-0.30619	-0.23099	-0.34194
Kurtosis	27.85585	9.099757	10.08735	10.29347	14.26155	9.181787
Jarque-Bera	41857.40 (0.0000)	2469.472 (0.0000)	3361.366 (0.0000)	3553.454 (0.0000)	8426.718 (0.0000)	2565.918 (0.0000)

The asymmetric property of any distribution is indicated by the skewness where the findings show that all returns are negatively skewed except for the returns of the MSCI Islamic China index returns, indicating that the returns for this index are not symmetric, leading to higher variability and risk.

The fatness of the distribution can be measured by the kurtosis which describe how concentrated the data are around the mean of the distribution. From the table above,kurtosis values are all more than 3 indicating that the returns in the shari'ah indices are not normally distributed and therefore has higher risks. For the Jarque-Bera test results, all returns are significant meaning that the non-normality,variability and higher risk of the returns of the shari'ah indices is further strengthened(Kabir et. al 2013).

6.2 Estimation using M-GARCH DCC model

Under this section, 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 primarily interested in volatility modelling and correlations between these indices, we set $\mu_{t-1} = 0$, and estimate the DCC models on the shari'ah compliant indices daily returns over the period of 26 November 2007 to 31 December 2013. Any case of non-convergence was not encountered and furthermore the Maximum Likelihood estimates of the Gaussian DCC and t-DCC models on stock indices daily returns was obtained under this section.

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

Parameter	Estimate	Standard Error	T-Ratio	Probability
lambda1_EMAS	0.86282	0.025645	33.6455	[.000]
lambda1_MSCHN	0.92820	0.010328	89.8698	[.000]
lambda1_MSSG	0.90258	0.014902	60.5693	[.000]
lambda1_FTJPN	0.89707	0.014411	62.2484	[.000]
lambda1_FTUSA	0.87365	0.014633	59.7027	[.000]
lambda1_MSTHAI	0.88812	0.016566	53.6097	[.000]
lambda2_EMAS	0.11917	0.020747	5.7441	[.000]
lambda2_MSCHN	0.06454	0.008807	7.3281	[.000]
lambda2_MSSG	0.08791	0.012992	6.7665	[.000]
lambda2_FTJPN	0.08857	0.011493	7.7061	[.000]
lambda2_FTUSA	0.11813	0.013212	8.9413	[.000]
lambda2_MSTHAI	0.09202	0.012512	7.3543	[.000]
delta1	0.98138	0.002885	340.123	[.000]
delta2	0.00839	0.001149	7.3003	[.000]
Maximized Log-Likelihood	29913.6			

Table 4: Unconditional Correlation and volatilities

	EMAS	MSCHN	MSSG	FTJPN	FTUSA	MSTHAI
EMAS	***0.00828***	0.51910	0.47485	0.43600	0.14065	0.42386
MSCHN	0.51910	***0.02092***	0.68878	0.58741	0.25208	0.55254
MSSG	0.47485	0.68878	***0.01374***	0.49669	0.30771	0.52496
FTJPN	0.43600	0.58741	0.49669	***0.01640***	0.14980	0.39364
FTUSA	0.14065	0.25208	0.30771	0.14980	***0.01424***	0.26410
MSTHAI	0.42386	0.55254	0.52496	0.39364	0.26410	***0.01851***

The upper panel(**Table 3**) of the above results of the Gaussian DCC model presents the maximum likelihood estimates for the returns on the six shari'ah stock index returns and λ_{1i} and . λ_{2i} The volatility parameters observed under this model are highly significant together with estimates of λ_{1i}, 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.**

After this, the ML estimates of the t-DCC model were obtained to serve as a preliminary step to determine which model is more significant for this study which can be referred to **Table 5** on the next page.

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

Parameter	Estimate	Standard Error	T-Ratio	Probability
lambda1_EMAS	0.89980	0.018617	48.3314	[.000]
lambda1_MSCHN	0.93241	0.011240	82.9575	[.000]
lambda1_MSSG	0.91950	0.014089	65.2654	[.000]
lambda1_FTJPN	0.90837	0.016111	56.3808	[.000]
lambda1_FTUSA	0.88948	0.015409	57.7253	[.000]
lambda1_MSTHAI	0.86965	0.022215	39.1464	[.000]
lambda2_EMAS	0.08983	0.015792	5.6884	[.000]
lambda2_MSCHN	0.05899	0.009308	6.3374	[.000]
lambda2_MSSG	0.07131	0.011970	5.9573	[.000]
lambda2_FTJPN	0.07660	0.012483	6.1363	[.000]
lambda2_FTUSA	0.10153	0.013687	7.4183	[.000]
lambda2_MSTHAI	0.10200	0.016065	6.3492	[.000]
delta1	0.97577	0.004676	208.657	[.000]
delta2	0.00943	0.001394	6.7638	[.000]
df	7.87290	0.555700	14.1676	[.000]
Maximized Log-Likelihood	30146.5			

Table 6: Unconditional Correlation and volatilities

	EMAS	MSCHN	MSSG	FTJPN	FTUSA	MSTHAI
EMAS	***0.00828***	0.51910	0.47485	0.43600	0.14065	0.42386
MSCHN	0.51910	***0.02092***	0.68878	0.58741	0.25208	0.55254
MSSG	0.47485	0.68878	***0.01374***	0.49669	0.30771	0.52496
FTJPN	0.43600	0.58741	0.49669	***0.01640***	0.14980	0.39364
FTUSA	0.14065	0.25208	0.30771	0.14980	***0.01424***	0.26410
MSTHAI	0.42386	0.55254	0.52496	0.39364	0.26410	***0.01851***

From the ML estimates of the t-DCC model(**Table 5)** on the stock indices daily returns, it could be seen that all return volatility estimates are statistically significant and near to unity implying a gradual decay in volatility under the t-DCC model. The maximized Log-Likelihood value of 30146.5 is larger than the one obtained under the Gaussian model which was 29913.6. on top of that, the estimated degrees of freedom for the t-normal distribution is blow 30 and therefore all of these results suggest that the t-distribution is a more appropriate model for capturing the fat- tailed nature of the distribution of the stock returns.

Since now we have chosen the t-DCC model, we now refer to **table 5** for our following discussion. From the **table 5**, it is observed that the volatility parameters are highly significant that indicates gradual volatility decay in which for example the riskiness involved in the returns gradually cancels out after following a shock in the market. Even after adding Lambda1_EMAS and lambda2_EMAS(0.89980 + 0.08983= 0.98963) and also the other five remaining indices, the result of the summation is still less than 1 or unity which tells us that the volatility of EMAS return together with the other returns are not following the Integrated Generalized Auto Regressive Conditional Heteroskedascticity(IGARCH) or in other words, the shock to the volatilities are not permanent . As an implication from shocks to volatilities that are not permanent, investors and portfolio managers would have a high chance of losing their investment even if they make high profit in the short run . On the other hand, speculators would be welcoming such conditions that are favourable to their interests. From here, it can also be concluded that it is safer to invest in islamic equities regardless whether it is for muslim or non-muslim investors (Kabir et. al 2013).

Table 7: Ranks of the unconditional volatilities of the six shari'ah indices returns

No.	Indices	Unconditional Volatility
1	FTSE Bursa Malaysia EMAS Shari'ah Index	0.00828
2	MSCI Islamic Singapore Index	0.01374
3	FTSE Shari'ah USA Index	0.01424
4	FTSE Shari'ah Japan Index	0.01640
5	MSCI Islamic Thailand Index	0.01851
6	MSCI Islamic China Index	0.02092

The on-diagonals in **table 6** explain the unconditional volatilities of the indices. If the unconditional volatility is near to zero, it can be implied that the particular index has the least volatility whereas if the unconditional volatility is near to 1, it indicates higher volatility levels. In this study, we have ranked the six indices return in **table 7** and we found out that all of them had very low unconditional volatilities ranging from 0.0083 to 0.0209 that in turn signifies on overall that these six returns on the six shari'ah compliant stock indices have

are less volatile. Moreover, it could be observed that the FTSE Bursa Malaysia EMAS Shari'ah index is relatively less volatile compared to the other five shari'ah indices. As far as the researchers know, Malaysia is a developing hub for Islamic capital markets and therefore could imply some sense of stability during the 2008 global financial crisis that may be attributed to the low amount of leveraging which leads to lack of response in the changed happening in the mainstream stock markets which has resulted in considerable impacts on asset allocation in Islamic portfolios (Kabir et. al 2013).

With regards to the off-diagonal elements showing the unconditional correlations as presented in **table 6**, it is observed that correlation between FTSE Bursa EMAS Shari'ah index returns with MSCI Islamic China index returns to be the highest among the other returns of the six shari'ah indexes which is +0.51910. This is not much of a surprise since China is Malaysia's top trading partner as reported by the Malaysian Department of statistics in 2013(Malaysian Department of Statistics 2013).This positive correlation of 52% is considered to be moderate and not that high. The lowest correlation was found to be between the returns of the Malaysian shari'ah stock index with the United States shari'ah stock index which is +0.14. From here, we can say that there is more chances of diversification benefits if Malaysian shari'ah investors were to include US shari'ah stock index in their portfolio as compared to the other shari'ah stock indices.

We now then proceed to examine the dynamic conditional correlations which capture the time-varying properties in the volatilities and the correlations. **Figure 1 and 2** illustrate the results on the next page.

Figure 1: Conditional volatilities-EMAS,MSCHN,MSSG,FTJPN,FTUSA,MSTHAI

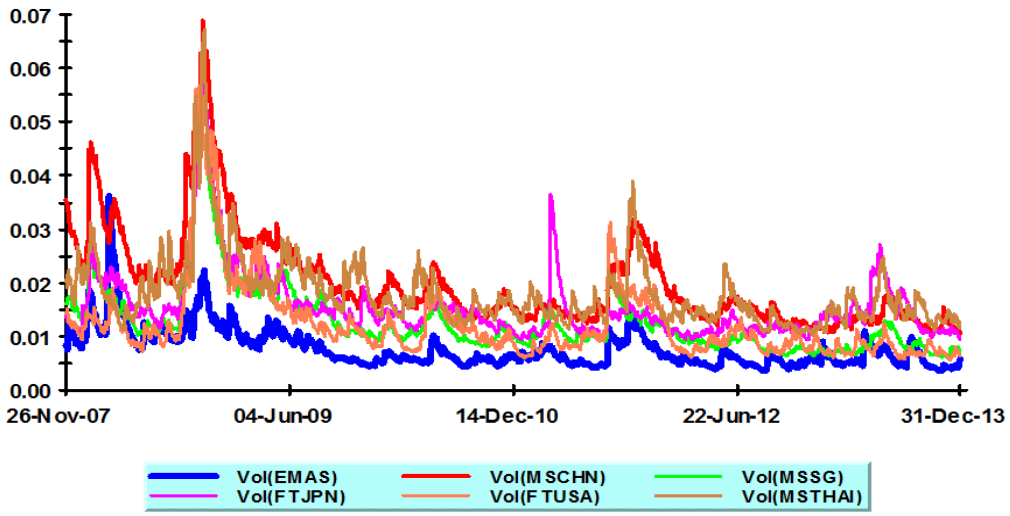
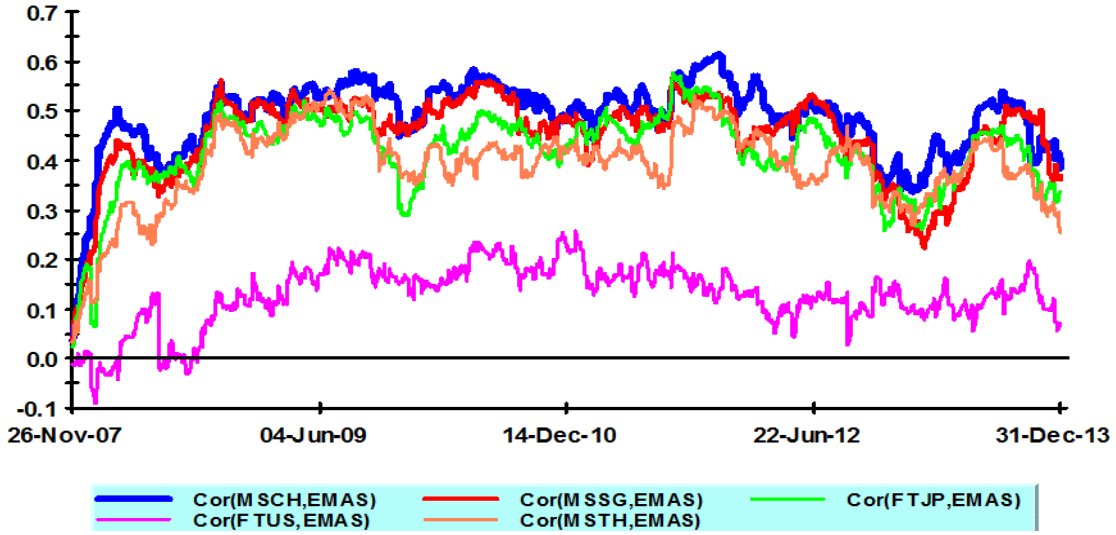


Figure 1 that illustrates the conditional volatilities of all shari'ah index returns tend to move more or less simultaneously except during the 2008 global financial crisis. During the period of the 2008 global financial crisis(Assidenou 2011), there seems to be a high convergence of volatility among shari'ah stock index returns of China, Japan, Singapore, Thailand and the United States which reflects a higher financial integration between these markets but this is not the case with the Malaysian shari'ah stock index returns. Usually higher financial integration between stock returns is unfavourable for investors and portfolio managers since it would lead to less opportunities to obtain benefits from portfolio diversification(Kabir et. al 2013). These results confirm the ones shown in **table 6**. The conditional volatilities of the Malaysian shari'ah stock index returns were also observed to be high just a few months before the global financial crisis

occurred.On the side note, there seems to be an unusual peak for the Japanese shari'ah stock market that is higher than other stock index that can be attributed to the 2011 earthquake and tsunami that occurred in March during that year(Tresor Economics 2012).

Figure 2: Conditional Correlations-EMAS,MSCHN,MSSG,FTJPN,FTUSA,MSTHAI



Next, we plot the conditional correlations in **Figure 2** and again it consistently confirms with the results of the unconditional correlations in **Table 6** showing that the Malaysian shari'ah stock index returns has the least correlation with the US shari'ah stock index returns. Plus, the figure supports the previous results that Malaysian shari'ah stock index returns is highly correlated with the China shari'ah stock index returns. More importantly, the figure actually indicates that the correlations of the returns of the Malaysian shari'ah stock index with returns of shari'ah stock returns of China, Singapore, Thailand and Japan or in other words the Asian trading partners, seem to be moving quite closely together especially during the 2008 global financial crisis period. It can be suggested from here that Malaysian investors are better off investing in US shari'ah stock markets to gain more portfolio diversification compared to other shari'ah stock markets of the major trading partners which happens to be the ones from Asia.

6.3 Estimation using the Continuous Wavelet Transform Analysis

In this section, continuous wavelet transform analysis is done to analyse the impacts on portfolio diversification benefits given the different investment horizons.To perform continuous wavelet transform analysis, we will focus on the wavelet coherency methodology.The continuous wavelet transform and phase difference of Malaysian shari'ah stock index returns with shari'ah stock index returns of China, Singapore, Japan, United states and Thailand are presented in **Figures 2 to 7** respectively from scale 1 (one day) 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 the 5% significance level represented by the curved line was obtained from the Monte Carlo simulations. The colour code for power or strength of correlation ranges from blue (low coherency,near zero) to red(high coherency, near one) The vectors pointing to the right mean that the indexes are in phase but if they point to the left it means that the indices are out of phase.to the right and up means that the first series is lagging. To the right and down means that the first series is lagging. To the left and up indicates that the first series leading whereas first series becomes lagging

when the arrows are pointing towards the left and down (Madaleno & Pinho 2010). In our study, the Malaysian shari'ah stock index is made as the first series in all the wavelet coherency diagrams.

For **very short** stock holding periods consisting of **2-4 days and 4-8 days**, we generally find that correlations seem to be weak for all the shari'ah index returns of Malaysia's trading partners with the Malaysian returns during the whole period studied. But if we were to do a relative comparison, the returns of the China and Singapore shari'ah stock index have a stronger correlation relative to shari'ah stock index returns of Thailand, Japan and the United States. This is also the case when we were to narrow down our scope to the period of the Global Financial Crisis(indicated by observation points 202 to 462 by referring to the period of the global financial crisis used by Assidenou (2011), where China and Singapore shari'ah stock index returns correlate at a higher level with the Malaysian returns when compared to the other shari'ah stock indices. Therefore, if Malaysian shari'ah were to invest in these time periods, investing in shari'ah stock indices other than China and Singapore is a more viable option.

Now observing the **short** holding periods of **8-16, 16-32, and 32-64 days**, we found strong correlations of the Malaysian shari'ah index returns with the shari'ah stock index returns of China but for other trading partners, correlations were low during the period covered in this study but there are a few exceptions. The first exception is during the 2008 Global Financial Crisis period where all the returns of the shari'ah stock markets of Malaysia's major trading partners showed strong correlations with the Malaysian returns.In other words, there was a change in the co-movement between the Malaysian shari'ah stock index returns with the shariah indices of its major trading partners to relatively higher frequency overlaps during the inception of the global financial crisis. Such increases in the coherence of the shari'ah indices at high frequencies corroborate the contagion hypothesis during crisis periods which could result in structural breaks in the asset price series when external shocks are experienced (Aloui & Hkiri 2014). The second exception is with regards to the returns of the Thailand shari'ah stock index which showed high correlations from observation points from **920 to 1201** resembling the period from June 2011 to July 2012 and observation points from 1**571 to 1587** resembling the time in December 2013 that can be linked to the political uprising that was happening during that period of time. When the pro-Thaksin Pheu Thai party won a landslide victory in elections in July 2011 which made Yingluck Shinawatra the sister of Mr Thaksin Shinawatra to become the prime minister. A few months after that, in October 2011,a rice subsidy scheme was introduced to ensure that the farmers which form the main part of the Pheu Thai's social base in the rural north of Thailand received a guaranteed price for their rice crop. This unfortunately led to the government debt of Thailand to soar causing the increase of the price of Thai rice, losing its tank as the world's number one rice exporter. Later on in June 2012, political tensions occurred when the anti-government yellow shirts blocked the parliament to prevent debate on the proposed reconciliation bill (BBC 2014).Following that year, more than 1,000 anti-government protesters surrounded Thai Prime Minister Yingluck Shinawatra's home in Bangkok in December 2013 when she criticized the main opposition Democrat Party for its plan to boycott an election in February (Yuvejwattana 2013).Therefore, Malaysian shari'ah investors who have short holding periods should firstly avoid shari'ah stock index of China and only invest in periods where there is no crisis occurring and also prevent from investing in periods where political tensions are expected to happen such as the one that occurred in Thailand.Other than that, if we focus solely on time scales of 32-64 days,then we can see that most of the correlations between the Malaysian shari'ah stock index with the shari'ah index of its

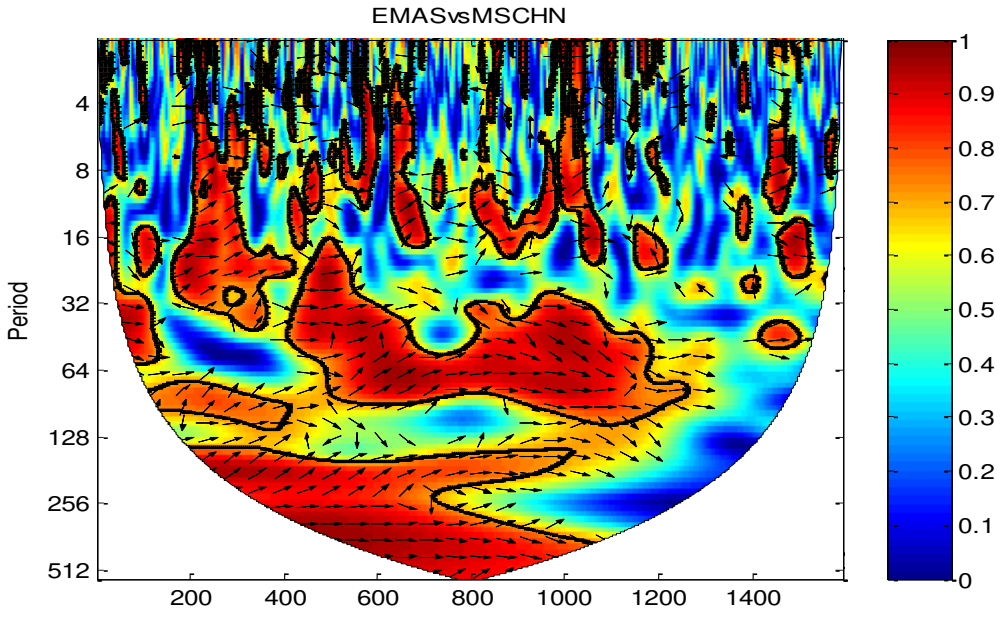
major trading partners are relatively high compared to time scales of 8-16 and 16-32 days which make up the short investment horizon .

Moving on to **medium** investment horizons of **64-128 and 128-256 days** , high level of correlations are observed **during and post** global financial crisis between China, Singapore ,United States and Thailand shari'ah stock index returns with Malaysian shari'ah index returns. Japanese shari'ah stock returns only showed high correlations with Malaysian returns during the global financial crisis but not after that but however there were some considerable level of correlation around observations points around 750 to 900 indicating the earthquake that caused a tsunami that hit the coasts of Japan during 11 March 2011(Tresor Economics 2012). As for the Thailand shari'ah stock index, returns of this stock market had considerable correlations at the medium investment horizons during the crisis period but the correlations became more intensed during the period from July 2011 to June 2012(observation points **920 to 1201**) that was similar for investment horizons for 16-32 days and 32 to 64 days that can be linked to the same reasoning explained earlier for the short investment period. As an addition to this, there were also high correlations from observation points **1201 to 1417**(resembling July 2012 to April 2013) which can be related to the November 2012 protest in Bangkok which called for the overthrow of Prime Minister Yingluck Shinawatra and also the moves of the ruling Pheu Thai party to amend 2007 post-coup constitution that were blocked by the Constitutional Courts in April 2013(BBC 2014). From here medium term investors may want to avoid investing in the shari'ah stock indices of Malaysia's trading partners as it would be difficult to experience benefits from portfolio diversification especially during the rise of political uncertainties and the period after natural disasters hit a nation.

Relating to investment horizons of **256-512 days**, very strong correlations are observed between all the shari'ah stock index returns of Malaysia's major trading partners with the Malaysian shari'ah index returns that in turn reduce or eliminate the benefits for potential portfolio diversification. Speaking of the arrows that indicate the phases of the variables, the direction of most arrows in the higher time scales or longer investment periods indicates that the relationship between the market returns of the Malaysian trading partner with the Malaysian returns are in phase most of the time (Madaleno & Pinho 2010) .

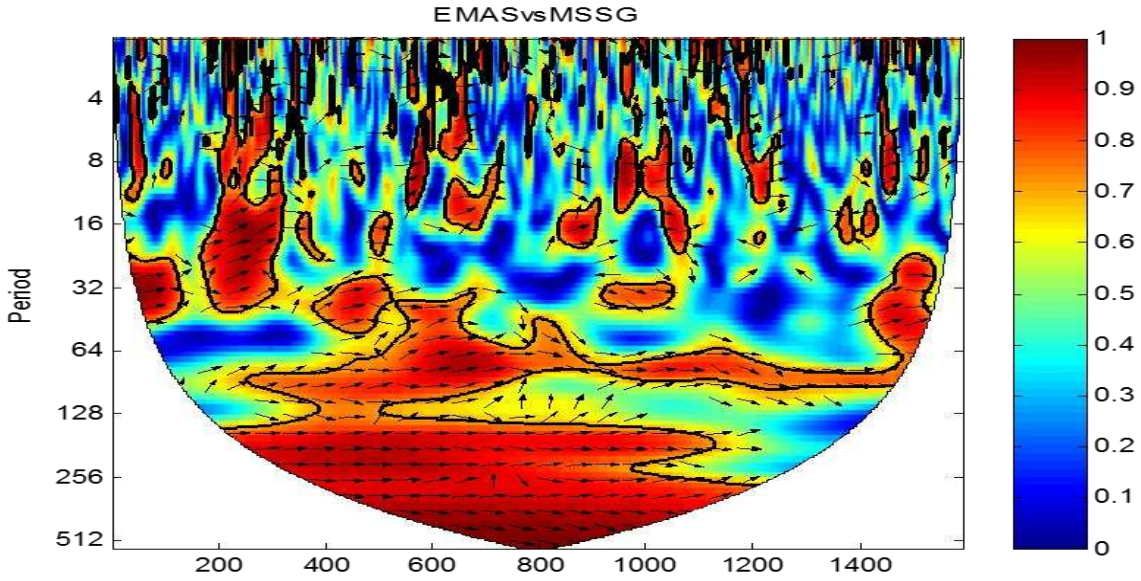
Such results obtained from this wavelet analysis is aligned with the findings in Alaoui and Hkri (2014) which found that the occurrence of the financial crisis has considerably increased the degree of co-movements between all the stock markets especially at high frequency levels or short investment horizons which could be viewed as higher degree of persistence of shock transmission during turbulent periods . By the same token, Aloui and Hkiri (2014) found that the time scale of 128 to 256 days detected a strong co-movement between the stock markets which was also evident in our study between Malaysia shari'ah stock market and its major trading partners.Overall, the wavelet transformations have contributed by helping us understand the potential benefits of international portfolio diversification for investors with different investment horizons.

Figure 3:Continuous Wavelet Transform- EMAS and MSCHN



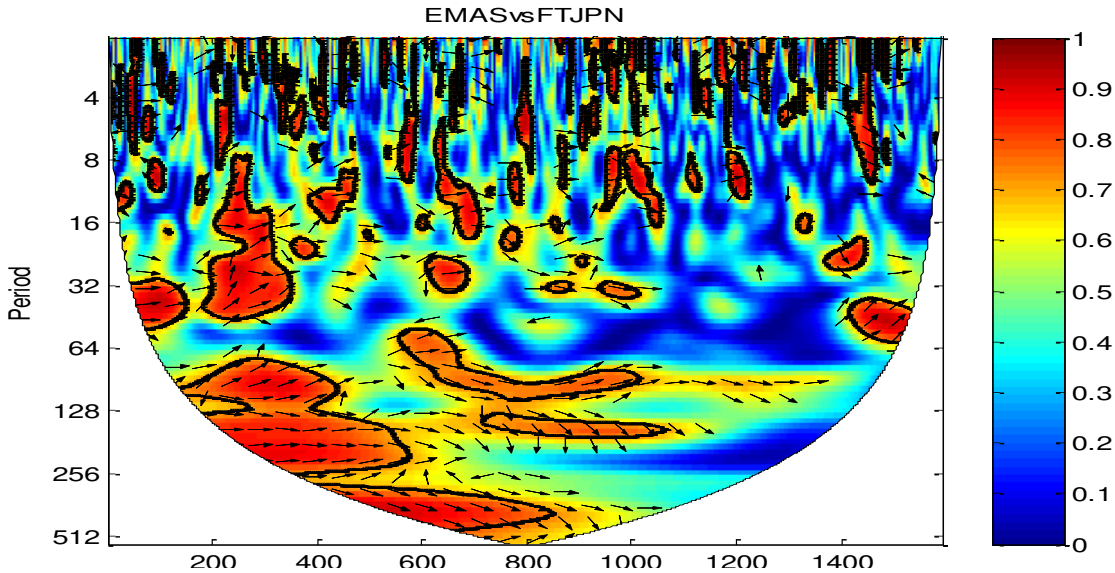
*Global Financial Crisis occurring from observation point 201-461

Figure 4: Continuous Wavelet Transform- EMAS and MSSG



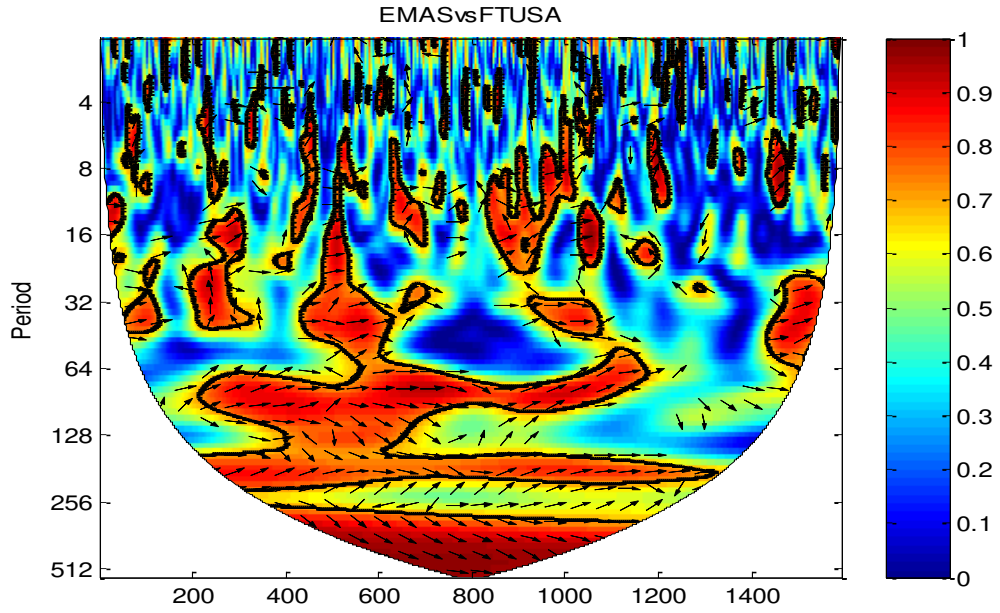
*Global Financial Crisis occurring from observation point 201-461

Figure 5: Continuous Wavelet Transform- EMAS and FTJPN



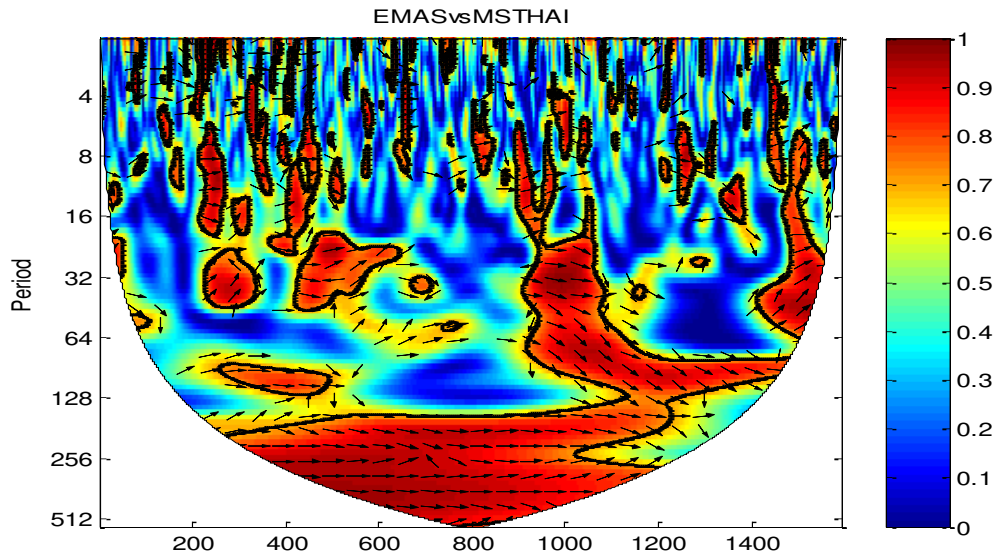
*Global Financial Crisis occurring from observation point 201-461 and the Japanese earthquake around observation points of 750-900

Figure 6: Continuous Wavelet Transform- EMAS and FTUSA



*Global Financial Crisis occurring from observation point 201-461

Figure 7: Continuous Wavelet Transform- EMAS and MSTHAI



*Global Financial Crisis occurring from observation point 201-461 and political turmoil from points 920 to 1201, 1201 to 1417 and 1571-1587.

6.4 Robustness test through estimation using the application of MODWT

As test for robustness to ensure the results obtained from the CWT analysis, a Maximal Overlap Discrete Wavelet Transform (MODWT) was applied to our original data set consisting of returns series for all six shari'ah indices. In MODWT, the researcher is required to specify the time scales for the returns whereby we had seven scales (1-2 days, 2-4 days, 4-8 days, 8-16 days, 16-32 days,32-64 days and 64-128 days). The correlations between the Malaysian shariah stock market returns with the index returns of its major trading partners are examined using the generated MODWT returns series using R structural programming and the results are shown in the table below.

Table 9: Wavelet correlations of Malaysian shari'ah stock market returns with returns of major trading partners of Malaysia-MODWT Transformations.

MODWT SCALING	China	Singapore	Japan	United States	Thailand
(1-2 days)	0.451	0.443	0.406	-0.018	0.343
(2-4 days)	0.551	0.451	0.443	0.235	0.453
(4-8 days)	0.572	0.487	0.470	0.338	0.548
(8-16 days)	**0.617**	0.555	0.469	0.383	0.498
(16-32 days)	**0.621**	**0.606**	0.405	0.403	0.507
(32-64 days)	**0.694**	**0.760**	**0.654**	**0.770**	**0.625**
(64-128 days)	**0.870**	**0.864**	0.583	**0.747**	**0.838**

Note: *Correlations more than 0.6 is arbitrarily considered to be strong(Najeeb & Masih forthcoming) and are indicated by the values highlighted in bold.The values not highlighted in bold and are between 0.44 to 0.6 indicate moderate correlation.The rest indicate low correlation.*

Interestingly, the results happen to be consistent with the one obtained from the earlier CWT analysis. The shari'ah stock index of China seems to be providing opportunities of portfolio diversification that is not favourable to the Malaysian investors for **all time scales** where the correlations are seen to be strong. Even at the smaller time scales of 1-2 days, 2-4 days and 4-8 days have already exhibited quite low benefits of portfolio diversification due to the correlations with the returns of the Malaysian shari'ah stock index that are near to being strong. Singapore also almost seems to have the same case with China while Japan and Thailand seem to indicate reasonable opportunities of portfolio diversification up to investment horizons of 32 to 64 days. But at the same time, we can also observe from above that United states definitely offers a better opportunity for portfolio diversification for Malaysian Shari'ah investors compared to Singapore, Japan and Thailand from holding periods of 1-2, 2-4, 4-8,8-16 and 16-32 days based on the values of the coefficient of correlations .As a whole, all the shari'ah stock index returns of Malaysia's major trading partners show very strong correlations with Malaysian returns at higher investment horizons of 32-64 days and 64-128 days except for Japan. But even in the case of Japan, the correlation coefficient with Malaysian shari'ah returns was almost close to 0.6 at 64-128 days . Therefore, the findings from the MODWT analysis are in line with ones obtained under the CWT analysis.

6.5 Summary of the results obtained

The empirical results regarding the level of the portfolio diversification benefits for Malaysian shari'ah investors with their major trading partners.The research objectives of this paper has been highlighted under this table and the corresponding results are communicated in a way that distinguishes the level of portfolio diversification benefits into high, moderate or low based on the M-GARCH DCC approach together with the wavelet analysis approach.

Table 10:Portfolio Diversification Benefits for Malaysian Shari'ah Index Investors

	Level of portfolio diversification opportunities(High/Moderate/Low)				
	China	**Singapore**	**Japan**	**USA**	**Thailand**
M-GARCH DCC	Low	Low	Moderate	High	Moderate
Wavelet Transform					
1-2 days	Moderate	Moderate	High	High	High
2-4 days	Moderate	Moderate	Moderate	High	Moderate
4-8 days	Moderate	Moderate	Moderate	High	Moderate
8-16 days	Low	Moderate	Moderate	High	Moderate
16-32 days	Low	Low	High	High	Moderate
32-64 days	Low	Low	Low	Low	Low
64-128 days	Low	Low	Low	Low	Low
128-256 days	Low	Low	Low	Low	Low
256-512 days	Low	Low	Low	Low	Low

6.6 Interpretation of results

From the results obtained from the three different methodologies, it can be seen that shari'ah stock index of China are definitely not suitable for Malaysian investors to include it in their portfolio which can be attributed to some underlying factors. The main underlying factor why Malaysian shari'ah stock market

returns is so highly correlated with shari'ah stock index of China is obviously due to the high intensity of trading activity between these two countries compared to other trading partners as reported by the Malaysian Department Statistics(2013).According to an article written by the News Straits Times, Malaysia remains to be China's top trading partner in Asean with bilateral trade between both countries hitting USD 33.88 Billion in the first quarter of the year 2013 (New Straits Times 2013).

Economic relations between China and Malaysia have also evolved and expanded beyond the area of trade such going into the services sector, particularly the financial sector, tourism and education. Plus, China is one of the top tourist destinations for Malaysians while at the same time, Chinese nationals represent the largest foreign student population in Malaysia's private universities and colleges. Importance of bilateral investment is also increasing, especially with the two recent Government-to-Government agreements, involving the establishment of an industrial park in both countries (BIS 2012).

Other than that, the growth of Information Technology(IT) Infrastructure and the production sharing in Malaysia-China trade is strengthening .Coming from this matter, it is important for Malaysia to further capitalize on China's booming demand for high-end parts and components that feed into its assembly plants, to maintain China as its big customer. Technological capacity also needs to be enhanced in Malaysia in order to reap benefits from mutual trade dependence(Yeoh & Devadason 2007)

Furthermore, China serves as a sourcing market for Malaysia due to the factor of having the source of cheap components and parts. However, more often than not, Chinese imports to Malaysia are intermediate or capital goods which feeds into the production lines of Malaysian manufacturers like in the manufacturing of shoes.The shifting of the actual labour-intensive shoe-making to China and adding the value-added finishing touches (such as branding) can lead to lower labour cost, lesser capital outlays, and higher profit margin can be enjoyed by Malaysian shoe makers while at the same time devote more attention to marketing .(IDE-Jetro-Seri 2004).

By now, it is already clear that Malaysian shari'ah investors should avoid investing in shari'ah stock index of China which happens to be Malaysia's top trading partner since it would give them minimal benefits of portfolio diversification based on the factors outline above.

Astonishingly,Karim and Karim (2008) found results which indicated that Malaysia stock market influences Singapore in the short run or during short investment horizons. Other studies such as Meera et. al (2009) also indicated that there was a long run relationship between Malaysian and Singaporean stock markets. Possible explanations for Malaysia shari'ah stock market returns being highly correlated with returns of Singaporean shari'ah stock markets even for short investment horizons can be closely related to the geographical proximity and historical ties between them. As we all know, Singapore is Malaysia's neighbouring country and based on history, Singapore used to be a part of Malaysia. Being geographically related and historically tied to Singapore, Malaysia would be more familiar with Singapore's trading and investment activities Malaysia's size is definitely larger than Singapore enabling to engage in more manufacturing activities to produce products such as electronics palm oil and other agricultural products which will then be exported to Singapore (Trading Economics 2013). As a matter of fact, Malaysian companies use Singapore as a test bed for their products and services to ensure market acceptability, competitiveness and sustainability prior to venturing into other foreign markets (Borneo Post 2011).This explanation is in line with empirical study done

by Janakiramanan and Asjeet(1998) which discovered that countries that are geographically close should exhibit high levels of integration which may induce higher correlations.

Other than that, on a year on year basis, oil domestic exports of Singapore expanded by 1.7 per cent in October 2013, after the preceding month's 29.5 per cent growth indirectly meaning that Malaysia influenced Singapore by being its purchaser for oil (International Enterprise Singapore 2013). Not to forget, Singapore and Malaysia are members of the ASEAN congress which aims to remove trade barriers between members causing stronger bilateral trade between them (Karim & Karim 2012) resulting in higher correlation between both nations which is consistent with Masih and Masih(1999) and Bracker et. al (1999)

Looking now at the relationship between Malaysia and Thailand through the moderate correlations between their shari'ah stock markets during short invest horizons of 8-16 days, 16-32 days in the 2008 Global Financial Crisis period, we can relate this to the study of Meera et. al (2009) which discovered that there was a long-run relationship between Malaysia and Thailand in the south east Asian region. But if we were to focus on the long term investment horizons, then correlations with Malaysia became very strong for the whole period of the study, be it before, during and after the crisis.

One of events that took place which led to the moderate correlations between Thailand and Malaysia is the formation of a committee on the Joint Development Strategy for Border Areas (JDS) back in 2004 during the bilateral meeting between the Prime Ministers of Malaysia and Thailand, which had the purpose to undertake joint planning and implementation of development projects along the border areas(Asian Development Bank n.d.).

Relating to increasing correlations which are still moderate during political tensions at short investment horizons as shown under wavelet coherency analysis, Nimkhunthod's (2007) study found that Thai stock market reacts to some of its political activities. During Thailand's December 2013 political unrest, such an event has sent Thailand's main stock index down 9.8 percent in the previous two months, the world's second-worst performer in that time after the Philippines (Yuvejwattana 2013). Probably when Thailand was facing such issues, the government was seeking some help from neighbouring countries like Malaysia in terms of seeking advice on how to overcome and handle such problems that may lead to increased correlations between Thailand stock markets and Malaysian stock markets. Seeing the political issue from another angle, investors who have investments in Thailand may feel worried about their investments being affected by the political uncertainty which will make them shift their investments to a safer haven such as Malaysia which entails some level of interdependency between the Thailand stock market and the Malaysian stock market. But at the end of day, they may not get as much diversification benefits since Malaysia is correlated with Thailand. As a lesson, short term shari'ah investors should not invest in Thailand during political tensions or in any country for that case.

Synthesizing the discussions made under the correlations between returns of the Thailand and Singaporean shari'ah stock indices with the Malaysian shari'ah stock index returns, such relations or integrations were evident in studies of Karim and Karim (2012) which focused on examining the dynamic linkages or integration that existed between the ASEAN countries that included Malaysia,Thailand and Singapore and two other ASEAN countries which were Indonesia and Phillipines but in this case they were based on conventional stock indices.

To further strengthen the results obtained under this study especially under the wavelet coherency analysis, Karim and Majid (2010) found that markets of Malaysia, Singapore and Thailand were moving towards more integration especially following the 1997 financial crisis which could linked to our study when the correlations were high at long investment horizons for the returns of shari'ah stock indices of Singapore and Thailand with the Malaysian shari'ah stock index returns.Therefore, Malaysian shari'ah investors shall avoid from putting too much investments in shari'ah stock indices of its major south east Asian trading partners which are Singapore and Thailand but relatively, Thailand may pose less danger since the strength of correlations were more moderate compared to Singapore .

Discussing about the Japanese shari'ah stock index, the Japan-Malaysia free trade agreement (FTA) was signed in 2005 and implemented from 2006 with the expectation that it would further enhance the trade and investment relationship between the two countries which would make researchers assume or expect correlations of Japanese shari'ah stock markets to be as equal to other major trading partners like Singapore and Thailand due to the additional benefits amid advancement in the dimension and coverage of economic regionalization and globalization (Rahman et. al 2008) . However, research suggests that the trade agreement and other tools for expanding trade between Malaysia and Japan are substantially losing effectiveness which may contribute to not so high correlations between Japanese shari'ah stock market returns with Malaysian shari'ah stock market returns. Rahman et. al (2008) unraveled that during the first two years of this FTA, there was no significant influence on bilateral trade between the Malaysia and Japan. This research indicates that the agreement is still at a fledgling stage, and has limited scope for influencing and revamping mutual trade together with not having sufficient evidence that the formation of a free trade agreement or bloc is not necessarily an effective tool for enhancing trade between partner countries (Rahman et. al 2008).Nevertheless, this enables Malaysian investors to invest in the Japanese shari'ah stock markets and hopefully gain some level of portfolio diversification benefits rather than no benefits at all.

Not to forget about the March 2011 Earthquake that caused a Tsunami to hit Japan that year, correlations of Japan with the Malaysian shari'ah stock market returns were quite considerable in that period especially at medium investment horizons. This cannot really be comprehended by the normal human mind who would think that such natural disasters would cause inter-linkages between Malaysia and Japan to be adversely affected caused by disruption in the highly integrated supply chain through cross border production networks between japan and Asian economies like Malaysia , in which Japan accounts for about 10 to 15 percent of value-added production in Malaysia (Danninger & Kang 2011).Such natural disasters are considered as black swan events since they cannot be predicted and they are contained within the outliers under bell curve (Taleb 2007). Moreover, high correlations during the periods of natural disasters can be linked to the bearish trend in the Japanese stock markets which takes into account the Tsunami and the earthquake that tends to cause a information and volatility spillover in the markets that stemmed out from psychological effects of the market players following the bearish condition in Japanese markets(Kabir et. al 2013).

Lastly, we look at the weak correlations between the United States shari'ah stock index returns with the Malaysian shari'ah stock index returns shown by the results under the M-GARCH DCC analysis. Also under the wavelet coherency analysis and MODWT analysis, weak correlations were also found between United States and Malaysia during the short investment horizons. One of the underlying reasons why this could happen is the geographical locations between these two nations that are on different sides of the globe. We can deduce in an opposite way that further geographical locations may lead to lower correlations by referring

to the earlier explanation about the close geographical proximity of Malaysia and Singapore which had caused higher correlations between them (Janakiramanan and Asjeet 1998)

By relatively comparing the correlations of Japan and United states with Malaysia, we can relate to studies done by Yusof and Majid (2006) that examined the long-run co-movement between the Malaysian stock market with United States and Japan over the periods, before, during and after the 1997 Asian financial crisis and the results indicated that the Japanese stock markets significantly move with the Malaysian stock market compared to the United States stock market for the post crisis period. Another study done by Majid et. al (2008) also discovered that Malaysia was more dependent on Japan rather than the United States . From the linkage of our results to the these two studies, it is no surprise that United states shari'ah stock index returns correlate at a lower level with Malaysian shari'ah stock market returns compared to Japanese shari'ah stock market returns.

As for the longer investment horizons, correlations or returns were strong between the United States and Malaysia for the whole period studied under the wavelet coherence analysis. In fact for all the returns of the shari'ah stock markets returns of Malaysia's trading partner, correlations between them and Malaysia were found to be high which is in conformity with Karim and Majid (2010) who found that markets of Malaysia, Singapore and Thailand were moving towards more integration especially following the 1997 financial crisis. Such findings are also in line with the reports of United Nations Development Programme in 2009 which stated it is natural that growth in Asian countries has been highly correlated with the US growth cycle over the last decade. The correlation is relatively strong for Malaysia, Philippines and Thailand. The average correlation of growth rates of 14 Asian economies with the US economy increased from 0.1% during 1990-1996 to 0.4% during 2000 to 2007(Chibber et. al 2009). Therefore, if the Malaysian investors were to invest in the United States, diversification benefits can arise when they invest during investment horizons which are shorter than 32-64 days.

As a wrap up for all the above mentioned explanations, the results which are presented in the summarized version of the findings are in conformity with the previous literature consisting of theoretical and empirical work. In short, Malaysian shari'ah investors who have allocated their investments across shari'ah stock markets of Malaysia's major trading partners such as China , Singapore and may not be able to derive portfolio diversification benefits for all the investment horizons except for the very short investment horizons of 2 to 4 days. But for investments in Thailand and Japan, depending on their investment horizons especially at 4-8, 8-16 days and 16-32 days, portfolio diversification benefits may be at a moderate level but for United States shari'ah stock index, portfolio diversification benefits can be gained at a great level from very short investment horizons up until below investment horizons of 32-64 days. At the end of the day, at stock holding periods that are more than 32 or 64 days will usually result in higher correlations in all shari'ah stock markets in this study that yields minimal portfolio diversification benefits .

7.0 Conclusion

This study examines the correlations between the Malaysian stock index returns and the returns of the shari'ah stock indices of its major trading partners namely, China, Singapore,Japan, United States and Thailand which can imply the extent of the potential diversification benefits among these shari'ah indices for the Malaysian shar'iah investors. Daily data spanning from November 2007 to December 2013 was used

together with employing the M-GARCH DCC techniques and also wavelet approaches consisting of CWT and MODWT analysis which produced results that are coherent with one another. The study found that Malaysian shari'ah investors who have allocated their investments in major trading partners like China and Singapore may not experience great diversification benefits for almost all investment horizons. At the same time, investing in shari'ah stock indices of major trading partners like Thailand and Japan pose moderate diversification benefits up to before investment horizons of 32-64 days and longer. Instead, portfolio diversification benefits are greater if Malaysian shari'ah investors invest in the US shari'ah stock index except during long investment horizons. Speaking about the long run implication for all shari'ah indices, stock holding periods exceeding 32 days would lead to very strong correlations, producing minimal benefits of portfolio diversification. Taking into account on the above explanations, consistent reassessment of stock exposures and investment horizons of more than 32 days should be done more frequently, for example in every month or two for the Malaysian shari'ah investors(Najeeb & Masih forthcoming). Thus, globalisation and even trade ties seems to have impacted the correlation between these shari'ah stock markets especially for Malaysia with China and Singapore . Overall the results of this study supports the previous empirical literatures that stock markets have strong integration after the crisis period resulting in lesser diversification benefits from participating in the market and trade does matter for stock market interdependence as what was found by Karim and Majid (2010). The findings of this paper are expected to have significant implications for Malaysian shari'ah investors and portfolio managers because the understanding of return correlations among the shar'iah stock indices is important for diversifying portfolios into other markets for higher risk-adjusted returns(Paramati et. al 2012). Such results are also essential for even government authorities regarding the allocations and stock index policies at different investment horizons which will be discussed in the next section.

8.0 Policy Implications

For the purpose of policy making, any shocks in the major trading partners should be taken into consideration by the Malaysian Authorities in order to formulate macro stabilisation policies that pertain to its stock market as ignorance to do so may result in a contagion effect. The extent of effectiveness of the Malaysian macroeconomic policies in dealing with its shari'ah stock market imbalances will rely heavily on the extent of financial integration of each of its major trading partners . Since the Malaysian shari'ah stock index is interconnected with the markets of its major trading partners ,but not really with the United States, then Malaysia cannot be isolated or insulated from foreign shocks and thus, the scope for independent monetary policy will be reduced. Furthermore, the advantage of effective diversification among these markets of the major trading partners excluding the United States can no longer be achieved and the Malaysian shari'ah stock index together with its major msjor trading partners are perceived as one market set by investors intending to invest in the long run period (Meera et. al 2009).In other words, Malaysia cannot serve as a potential market for international portfolio diversification for those who have a short investment horizon with regards to its to its major trading partners except for the United States.

Now it is evident that the correlation of the Malaysian shari'ah stock index returns with its major trading partners reflects the limitation attributed to the pursuit of interdependent policy especially the financial policy. This limitation then brings about the need for policy coordination in Malaysia to mitigate the impact of financial fluctuations. If Malaysia intends to exploit the advantages of greater economic interdependence,

trade and investment barriers would need to be lifted in addition to better policy coordination. Given this shari'ah index returns correlation of Malaysia with is major trading partners, policy makers may want to use this issue as a solid reason to establish a monetary union among its trading partners especially the ones from Asia which we think will not happen in the near future as it is highly debated (Meera et. al 2009)

By the same token, the degree of diversification benefits between the Malaysian shari'ah stock market with its major trading partners will definitely have important bearings on the formulation of policies of multinational corporations. The reason being is that an idea of the exchange rate risks between these countries can be known through the identification of the long run relationship or co-movement among these stock markets at different time intervals. Acquiring such knowledge would enable the managers of these multinational companies to mitigate international risks and manage the economic, transaction and translation exposure of the corporation (Karim and Majid 2010).

9.0 Limitations and recommendations for future research

This study can be further enriched in the future by looking at other groups of trading partners, for instance, Middle Eastern, Asian, European and South American Trading partners instead of just taking the countries from the top of the list of the trading partners.

Since this study focused only at shari'ah stock indices, then future studies may attempt to investigate a more comprehensive perspective by doing a comparison of portfolio diversification benefits that arises between the conventional stock indices and the shari'ah stock indices (Saiti et. al 2013).

Other than that, further studies can also be carried on this matter by considering an analysis based on the comparison on sectors for example, construction, finance and agriculture in Malaysia with its major trading partners. This enables us to see in more detail about the co-movements of the sectors which then allows the shari'ah investors to minimize their risks in a way that is more efficient (Najeeb, Bacha & Masih forthcoming).

10.0 References

Adam,S. 2013, *Malaysia-Singapore Bonding All Business in Lee-Najib Thaw*. Available from: <http://www.bloomberg.com/news/2013-04-29/malaysia-singapore-bonding-proves-all-business-in-lee-najib-thaw.html>.

Aloui, C & Hkiri, B. 2014, 'Co-movements of GCC emerging stock markets: new evidence from wavelet coherence analysis', Economic Modelling, Vol. 36, 421-431.

Ali,S, Butt,BZ & Rehman,K. 2011, 'Comovement between Emerging and Developed Stock Markets: An Investigation Through Cointegration Analysis', *World Applied Sciences Journa*l 12(4): 395-403, 2011. Available from: < http://www.idosi.org/wasj/wasj12%284%29/2.pdf> .

Asian Development Bank n.d., *Expanding Horizons: A Study on the Development of the Indonesia, Malaysia, Thailand Growth-Triangle Economic Connectivity Corridors*.Available from: < http://www.imtgt.org/Documents/Studies/expanding-horizons-study.PDF> .

Askari,H, Iqbal,Z, Krichene,N & Mirakhor A. 2012, *Risk Sharing in Finance:The Islamic Finance Alternative*, John Wiley & Sons (Asia) Pte. Ltd. ,Singapore.

Assidenou,KE, 2011, 'Cointegration of Major Stock Market Indices during the 2008 Global Financial Distress', *International Journal of Economics and Finance*, 3(2), Available from: < http://ccsenet.org/journal/index.php/ijef/article/view/7451> .

Banks for International Settlements, 2013, *Zeti Akhtar Aziz: Renminbi trade settlement and investment in Malaysia – future prospects*. Available from: < http://www.bis.org/review/r120927a.pdf> .

Bollerslev, T, 1990, 'Modelling the coherence in short-run nominal exchange rate: A multivariate generalized ARCH approach', *Review of Economics and Statistics*, 72, 498-505. Available from: < http://www.jstor.org/discover/10.2307/2109358?uid=3738672&uid=2&uid=4&sid=21103878399727> .

Borneo Post, 2011, *Malaysia-Singapore trade to perform positively despite sluggish global economy, says Matrade*. Available from: <http://www.theborneopost.com/2011/12/31/malaysia-singapore-trade-to-perform-positively-despite-sluggish-global-economy-says-matrade/#ixzz2mBcHN2h5> .

Bracker, K, Dockling,DS & Koch, PD. 1999, 'Economy Determinants of Evolution in International Stock Market Cointegration', *Journal of Empirical Finance*, 6, 1-27.

British Broadcast Channel 2014, *Thailand Profile*. Available from: < http://www.bbc.com/news/world-asia-15641745>

Capiello, R , Engle, RF & Sheppard, K. 2003, 'Asymmetric Dynamics in the Correlations of Global Equity and Bond Returns', *European Central Bank Working Paper Series*,Working Paper No. 204 .Available from: < http://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp204.pdf>

Carlson,M. 2007, 'A Brief History of the 1987 Stock Market Crash with a Discussion of the Federal Reserve Response', *Finance and Economics Discussion Series*, Division of Research and Statistics and Monetary Affairs, Federal Reserve Board, Washington,DC.Available from: <http://www.federalreserve.gov/pubs/feds/2007/200713/200713pap.pdf> .

Celik, S. 2012, 'The more contagion effect on emerging markets: The evidence of DCC-GARCH model', *Economic Modelling*, 29, 1946-1959.

Chibber, A, Ghosh, J & Palanivel, T. 2009, *The Global Financial Crisis and the Asia-Pacific region A Synthesis Study Incorporating Evidence from Country Case Studies*. Available from: < http://www.undp.org.my/uploads/undp%20regional%20synthesis%20report%20on%20the%20global%20financial%20crisis%20and%20the%20asia%20pacific%20region.pdf>

Click, RW and Plummer, MG. 2003, 'Stock market integration in ASEAN after financial crisis', *Working Paper Series*,Vol. 2003-06. Available from: < http://file.icsead.or.jp/user03/928_236.pdf>

Danninger,S & Kang, K. 2011,'Shaken to the core: The economic impact of the disaster in Japan is far reaching', *International Monetary Fund Finance and Development Journal*, June, 48(2), Available from: < http://www.imf.org/external/pubs/ft/fandd/2011/06/pdf/danninge.pdf>

Daubechies,I. 1992, *Ten Lectures on Wavelets*, vol. 61 of CBMS-NSF Regional Conference Series in Applied Mathematics, SIAM, Philadelphia, PA, Available from: < https://docs.google.com/file/d/0Bzl8fDcnIt--Y2ZmMzlhYjUtOGZjMC00OTNiLWI0YTctNjE3OGI1M2U3OTA5/edit?pli=1>

Department of Statistics Malaysia, 2013, *Malaysia's trade with its major trading partners*. Available from: < http://www1.treasury.gov.my/data/le/jp3_3.pdf>

Engle, RF. 2002, 'Dynamic Conditional Correlation:A Simple Class of Multivariate Generalized Autoregressive Conditional Heteroskedasticity Models', *Journal of Business and Economics Statistics,* 20(3), 339-350.Available from:< http://www.cass.city.ac.uk/__data/assets/pdf_file/0003/78960/Week7Engle_2002.pdf>

Engle,RF 2001, 'GARCH 101: The Use of ARCH/GARCH Models in Applied Econometrics', *Journal of Economic Perspectives*, 15(4), 157–168. Available from: < http://www.cmat.edu.uy/~mordecki/hk/engle.pdf>

Engle, RF & Sheppard, K 2001, 'Theoretical and Empricial Properties of Dynamic Conditiional Correlation Multivariate GARCH', *National Bureau of Economic Research,* Working Paper 8554. Available from: < http://www.nber.org/papers/w8554.pdf>

Fama, E. 1970, 'Efficient Capital Markets: A Review of Theory and Empirical Work', *Journal Of Finance*, Vol. 25(2), 383-417. Available from: < http://efinance.org.cn/cn/fm/Efficient%20Capital%20Markets%20A%20Review%20of%20Theory%20and%20Empirical%20Work.pdf>

Gencay, R, Selcuk, F and Whitcher, B. 2001, 'Differentiating intraday seasonalities through wavelet multi-scaling', *Physica A*, No. 289, pp. 543–556. Available from:< http://www.sfu.ca/~rgencay/jarticles/pa-seasonal.pdf>

Glosten, GR, Jaganathan , R & Runkle, E 1993, 'On the Relation between the expected Value and the Volatility of the Nominal excess Return on Stocks',*The Journal of Finance*, 48(5), 1779-1801. Available from: < http://www.econ.pdx.edu/faculty/KPL/readings/GJR93.pdf>

Hussin, MYM, Muhammad,F, Hussin,MFA ,Awang, SA & Abu,MF 2012, 'Macroeconomic Variables and Malaysian Islamic Stock Market: A Time Series Analysis', *Journal of Business Studies Quarterly*, 3(4), 1-13. Available from: < jbsq.org/wp-content/uploads/2012/06/JBSQ_June2012_1.pdf>

In, F & Kim, S. 2013,'Methodology: Introduction to Wavelet Analysis' in *An introduction to wavelet theory in finance*. World Scientific Publishing, Singapore.

Institute of Developing Economies - Japan External Trade Organization & Socio-Economic & Environmental Research Institute 2004, *Trade, Investment & Economic Cooperation Between China and Southeast Asia: The Case of Malaysia*. Available from: < http://penanginstitute.org/v3/files/occational_papers/FinalReport.pdf>

International Enterprise Singapore 2013, *Singapore's External Trade*. Available from: < http://www.iesingapore.gov.sg/~/media/IE%20Singapore/Files/Publications/Singapore%20Trade%20Statistics/Monthly%20Trade%20Statistics/2013/Monthly20Trade20Report2020Oct202013External.pdf>

Janakiramanan,S & Asjeet, SL. 1998, 'An empirical examination of linkages between Pacific Basin stock markets*',* *Journal of International Financial Markets,Institutions and Money*, 8, 155-173.Available from: <http://ideas.repec.org/a/eee/intfin/v8y1998i2p155-173.html>.

JP Morgan n.d., *Non-normality of Market Returns :A framework for asset allocation decision-making*. Available from: <http://www.jpmorganinstitutional.com/blobcontent/42/35/1159384839488_Non_normality_long.pdf> .

Kabir,SH, Masih, AMM, & Bacha,OI, , 'Are Islamic equities Immune to Global Financial Turmoil ?An Investigation of the Time Varying Correlation and Volatility of Islamic Equity Returns', *Australian Journal of Basic and Applied Sciences*, 7(7), 686-701. Available from: < ajbasweb.com/old/ajbas/2013/may/686-701.pdf>

Karim,MAA & Rosly,SA. 2011, 'Islamic Banking in Malaysia -Unchartered Waters', *Asian Economic Policy Review*, 6(2), 301-319. Available from: <http://onlinelibrary.wiley.com/doi/ 10.1111/j.17483 131.2011.01208.x/abstract> .

Karim,BA, Majid,MS & Karim,SA. 2009, 'Cointegration of Stock markets among Malaysia and its Major Trading Partners',*FEB Working Paper Series No. 0903*,*Universiti Malaysia Sarawak*.Available from: < www.feb.unimas.my/index.../23_59752c4f9c045d872d7fdc42224e69b4> .

Karim,BA & Majid,MS. 2010, 'Does trade matter for stock market integration' ,*Studies in Economics and Finance*, 27(1), 47-66. Available from: <www.emeraldinsight.com/1086-7376.htm> .

Karim, BA & Karim,ZA 2012, 'Integration of Asean-5 Stock Markets: A revisit', *Asian Academy of Management Journal of Accounting and Finance*, 8(2), 21-41.Available from: < web.usm.my/journal/aamjaf/vol%208-2.../AAMJAF8-2-2012(21-41).pdf. <

Khan,TA 2011, 'Cointegration of International Stock Markets: An Investigation of Diversification Opportunities', *Undergraduate Business Review*: 8(1), Article 7. Available from: < http://www.minneapolisfed.org/mea/contest/2011papers/Khan.pdf> .

Khoon,GS & Lim,MM. 2010, *The Impact of the Global Financial Crisis: The Case of Malaysia*. Available from: <http://www.twnside.org.sg/title2/ge/ge26.pdf> .

Lanza , A, Manera, M & McAleer, M 2006, 'Modelling dynamic conditional correlations in WTI oil forward and futures returns', *Finance Research Letters* .

Lebo,MJ & Box-Steffenmeier,JM 2008, 'Dynamic Conditional Correlations in Political Science', *American Journal of Political Sciences*, 52(3), 688-704.

Lee,J & Crowley,P. 2004, *The Co-movement between Output and Prices :Evidence from Canada* Available from:< http://faculty.tamucc.edu/jlee/research/WP20042b.pdf>

Madaleno, M & Pihno, C. 2010, 'Relationship of the Multiscale Variability on World Indices', *Revista De Economia Financiera*, 20, 69-92.

Madaleno,M & Pinho,C 2012. 'International stock market indices comovements: a new look,' *International Journal of Finance & Economics*, John Wiley & Sons, Ltd., 17(1), pages 89-102.Available from: < http://ideas.repec.org/a/wly/ijfiec/v17y2012i1p89-102.html>

Majid, MSA, Meera, AKM, & Omar, MA 2008, 'Interdependence of ASEAN-5 stock markets from the US and Japan', *Global Economic Review*, 37(2), 201-225. Available from: < econpapers.repec.org/RePEc:taf:glecrv:v:37:y:2008:i:2:p:201-225>

Masih, AMM & Masih,R. 1999,'Are Asian Stock Market Fluctuations Due Mainly to Intra-Regional Contagion Effects? Evidence Based on Asian Emerging Stock Markets', *Pacific-Basin Finance Journal,* 7, 251-82. Available from: < http://ideas.repec.org/a/eee/pacfin/v7y1999i3-4p251-282.html>

Meera,AK, Omar,MA, Aziz,H & Majid,MS. 2009, 'Dynamic linkages among ASEAN-5 emerging stock markets', *International Journal of Emerging Markets*, 4(2),160-184.Available from: <www.emeraldinsight.com/1746-8809.htm>

Menon,NR,Subha,MV & Sagaran,S. 2009, 'Cointegration of indian stock markets with other leading stock markets', *Studies in Economics and Finance,* 26(2), 87-94. Available from: <www.emeraldinsight.com/1086-7376.htm>

Mishkin, FS. 2011. 'Over the Cliff: From the Subprime to the Global Financial Crisis', *Journal of Economic Perspectives,* 25(1): 49-70. Available from: < http://pubs.aeaweb.org/doi/pdfplus/10.1257/jep.25.1.49> .

Najeeb, Syed F., Bacha, O. And Masih M. 2014, 'Does Heterogeneity in Investment Horizons affect Portfolio Diversification? Some Insights using M-GARCH –DCC and Wavelet Correlation Analysis', *Emerging*

Markets Finance and Trade (forthcoming).

News Straits Times 2013, *Malaysia remains China's top Asean trade partner* . Available from: < http://www.nst.com.my/latest/malaysia-remains-china-s-top-asean-trade-partner-1.284763>

Nimkhunthod, MW 2007, *An Impact of Political Events on the Stock Exchange of Thailand.* Available from:<mif.bus.tu.ac.th/02/getFileDownload.php?path=file_doc/...pdf>

Paramati,SR , Gupta, R & Roca, E 2012, 'A Dynamic Analysis of the Integration of the Australian Stock Market with Those of its Trading Partners', *25th Australasian Finance and Banking Conference 2012*. Available from: < http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2136962>

Pesaran,B & Pesaran,MH June 2007, 'Modelling Volatilities and Conditional Correlations in Futures Markets with a Multivariate t Distribution', *Cesifo Working Paper No. 2056 Category 10: Empricial and theoretical Methods July 2007*. Available from: < http://ideas.repec.org/p/ces/ceswps/_2056.html>

Pesaran, B & Pesaran, MH 2009. *Time Series Econometrics using Microfit 5.0*. Oxford: Oxford University Press.

Portfolio Theory, n.d., *An overview of Harry Markowitz portfolio selection work.*Available from: <http://portfoliotheory.co.uk/>

Rahman, KM, Molla, RI & Murad,MW 2008, 'Japan-Malaysia Free Trade Agreement: Expectations and Achievements', *Journal of Comparative International Management*,Vol. 11, No.1,. Available from: < http://journals.hil.unb.ca/index.php/jcim/article/view/11162/11896>

Reboredo,JC & Rivera-Castro,MA 2013, 'A wavelet decomposition approach to crude oil price and exchange rate dependence,' *Economic Modelling* , vol. 32, pp. 42-57.

Reboredo,JC & Rivera-Castro,MA 2014, 'Wavelet-based evidence of the impact of oil prices on stock returns', *International Journal of Economics and Finance* , vol. 29, pp. 145-176.

Roubini, N, Pesento,P & Corsetti,G 1998, 'What Caused The Asian Currency and Financial Crisis?Part1: A Macroeconomic Review',*National Bureau of Economic Research Working Paper.* Available from: <http://www.nber.org/papers/w6833.pdf?new_window=1>

Rua, A & Nunes,LC 2009, 'International co-movement of stock market returns: a wavelet analysis', *Journal of Empirical Finance*, Vol. 16, pp. 632-639.Available from: <http://www.bportugal.pt/en-US/BdP%20Publications%20Research/WP200904.pdf>

Saiti,B ,Masih,AMM & Dewandaru, G 2013, 'A Wavelet-based Approach to Testing Shari'ah compliant stock Market Contagion : Evidence from the ASEAN Countries' , *Australian Journal of Basic and Applied Sciences*, Vol. 7, No. 7, pp. 268-280. Available from: < http://connection.ebscohost.com/c/articles/89992705/wavelet-based-approach-testing-shariah-compliant-stock-market-contagion-evidence-from-asean-countries> .

Saiti,B & Masih AMM, 'Estimation of Dynamic Conditional Correlations of Shariah-Compliant Stock Indices through the Application of Multivariate GARCH Approach', *Australian Journal of Basic and Applied Sciences*, Vol. 7, No. 7, pp. 259-267.Available from: < ajbasweb.com/old/ajbas/2013/may/259-267.pdf>

Sarif, E 2011, Solid growth in 2 decades. The Star:StarBiz, 7 on 28 June 2011.

Suwailem, S 2013, 'Risk in a turbulent world:Insights from Islamic Finance' in *Islamic Finance The New Regulatory Challenge*, John Wiley and Sons Singapore Pte. Ltd., Singapore,pp.77-92

Taleb,NN 2007, *The Black Swan:The Impact of the highly improbable* ,Penguin Books Limited, London, England. Available from: <http://digilib.gmu.edu/dspace/bitstream/1920/6561/1/214-944-1-PB.pdf>

Tiwari, AK, Mutascu, M & Andries, AM. 2013, 'Decomposing time-frequency relationship between producer price and consumer price indices in Romania through wavelet analysis', *Economic Modelling*, 31, 151-159.

Torrence, C & Webster, PJ. 1999, 'Inter-decadal changes in the ENSO-monsoon system', *Journal of Climate* , 12, 2679-2690. Available from: <http://www.ccpo.odu.edu/~klinck/Reprints/PDF/torrenceJClim99.pdf> .

Trading Economics 2013, *Malaysia Exports*.Available from:< http://www.tradingeconomics.com/malaysia/exports> .

Trading Economics 2014, *Malaysian Trade Surplus Shrinks Slightly in December* . Available from: < http://www.tradingeconomics.com/articles/02072014111635.htm>

Tresor Economics 2012, *The impact of Japan's earthquake on the global economy*. Available from : < http://www.tresor.economie.gouv.fr/File/371985>

Tse, Y K & Tsui, AKC. 2002, 'A Multivariate Generalized Autoregressive Conditional Heteroscedasticity Model with Time-Varying Correlations', *Journal of Business and Economic Statistics, American Statistical Association*, 20(3), 351-362. Available from: <www.researchgate.net/...A...with.../d912f509b15cfa5293.pdf . <

Vacha, L, Barunik, J 2012, 'Co-movement of energy commodities revisited:evidence from wavelet coherence analysis', *Energy Economics*, 34, 241-247.Available from:< http://arxiv.org/pdf/1201.4776v1.pdf>

Yeoh,EKK, Devadason, E. 2007, *Emerging Trading Nation in An Integrating World: Global Impacts and Domestic challenges of China's Economic Reform*.Available from: <http://cmsad.um.edu.my/images/ics/emerging/chapter7.pdf>

You, L & Daigler,RT. 2010, Is international diversification really beneficial?, *Journal of Banking & Finance* , 34, 163-173.

Yusof, R. and Majid, M. 2006, 'Who moves the Malaysian stock market – the US or Japan? Empirical evidence from the pre-, during, and post-1997 Asian financial crisis', *International Journal of Business*, 8(3), 367-406.Available from: < http://gamaijb.mmugm.ac.id/e-journal/index.php/gamaijb/article/view/140>

Yuvejwattana,S. 2013, *Thai Protesters Surround Yingluck's House as She Tours North, Bloomberg.* Available from: < http://www.bloomberg.com/news/2013-12-21/thai-opposition-decision-on-election-participation-risks-crisis.html>