Islamic versus conventional stock market and its co-movement with crude oil: a wavelet analysis

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Abstract

Crude oil market plays an important role in economic development and the price changes give huge impact to the financial markets. In this paper, the relationships between crude oil and stock markets are examined. This study has selected Malaysian Islamic and conventional stock markets as a case study. Financialisation of crude oil and its frequent inclusion into investment portfolios warrant an analysis of the relationship between crude oil and stock market indices at various time scales or investment horizons. Therefore, this paper applies wavelet decompositions to unveil the multi-horizon nature of co-movement and employ daily closing price data of Brent crude oil index and Malaysian Shariah and conventional stock market indices. The results mainly show an evidence of a low degree of co-movement between crude oil prices and Malaysian stock market returns for short term and medium term. However, for the long term, it shows that there is a significant co-movement for crude oil – stock market relationship. Interestingly, Malaysia Islamic stock market and conventional stock market are highly correlated and both show similar patterns for crude oil price co-movements. The findings of this study are of crucial importance for the investors for their diversification benefit as well as for the timing of their investment and disinvestment purposes.

Keywords: crude oil, KLCI, EMAS Shariah stocks, Malaysia, wavelet

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1.0 Introduction

Oil has played an important role in the economic development of the industrialised countries in the world. The economic impact of higher oil prices on developing countries is generally more severe than industrialised countries. International Energy Agency report (2010) that on average developing countries use more than twice as much oil to produce a unit of economic output as do OECD countries. Economic liberalisation of international markets is characterised by an increased level of capital flow and international investment in emerging markets. Given the oil intensity of the emerging economies of today, it is important for global portfolio investors to understand the level of susceptibility of stock prices in these markets to movements in global oil prices.

In globalized financial markets with growing trading volumes and liquidity, the integration and co-movements are becoming stronger in time so that the use of diversification has been becoming more limited. Therefore, examine and research on different types of co-movements and correlations in time is extremely important. In addition to the time dimension of the market dynamics, there are different types of investors who are influenced by such dynamics. The profound understanding of interdependence between crude oil priced makes it possible for investors to make across market hedging decisions and create a balanced portfolio. However, correlation can be highly dynamic where it can change significantly over time and frequencies.

Most of research on financial data is performed in time domain. The oil price specifications usually used in the literature (Mork, 1989; Lee et al., 1995; Hamilton, 1996), implicitly consider that the relevant sphere of analysis of the oil price-stock market relationship is the simple dimension. Despite the application of filters, the use of VAR (Vector Auto Regressive) approach and other standard econometric tools, these constructions only enable to separate short term fluctuations from the time trend. They do not take into account the fact that the factors determining oil price fluctuations, as well as the indicators of the economic activity, all operate at very different time scales. A tool that would provide more suitable information and would allow room for intermediate cycles' sizes would prove very useful in this matter. Even though frequency domain is less popular term in research, but it is possible to meet expressions in the literature such as long-term or short-term relationship responses. Therefore, this study applies analysis of Wavelet Coherence to reassess the relationship between oil prices and stock market prices. This study wants to combine those two approaches into time-frequency domain, which would bring results greatly valuable for investors and other decision makers.

This study contribution to the related literature is in one important principal aspect. There is still little empirical evidence on how oil prices are associated with stock markets in the context of Islamic stock market indices. The investigation of such relationship is thus interesting because the Islamic stock markets have recently become attractive due to the innovation and rapid expansion of Islamic finance, as well as global investors seeking for new international diversification destinations. This paper could also help governments and regulatory authority to make sound decisions when they have regulate stock markets and oil prices policies.

This paper is a case study of Malaysia where to analyse the relationship between the price of Brent crude oil and stock markets in Islamic and non-Islamic indices. This study has chosen FTSE Bursa Malaysia EmasShariah as benchmark of Malaysia Islamic stock market and FTSE Bursa Malaysia KLCI as benchmark of Malaysia non-Islamic stock market. The sample set contains daily observations between 2007 and 2014. The methodology of this study emphasizes the multi-horizon nature co-movement by perform a multi-timescale analysis using Wavelet decompositions to decompose observed variables on a scale-by-scale basis. The main question of this study is to investigate is there any co-movement between oil price and stock market (Islamic and non-Islamic) fluctuations in short-term and long-term in Malaysia.

The main findings of this study prove that Malaysia Islamic stock market and conventional stock market have similar patterns against with the co-movement of crude oil prices. The correlations of these two stock markets are strong, which means what happen to conventional stock markets will be the same as Islamic stock markets. Refer to the multi-scale analysis, results show a low degree of co-movement crude oil prices and Malaysia stock market returns for short term and medium term. During these time frequency, the co-movements are significant only during the 2008 global financial crisis and 2014 year end U.S crude oil crisis. However, for the long term, it shows that there is a significant co-movement between the crude oil prices and stock markets.

The remaining part of the study is organized as follows: Section 2 and 3 reports a summary of the theoretical and empirical literature review respectively. Sources of data and methodology are presented in Section 4. The results and their interpretations are described in Section 5. Finally, the study wraps up with concluding remarks and policy recommendations in Section 6.

2.0 Literature review – theoretical

Economic theory suggests that any asset price should be determined by its expected discounted cash flows (Fisher 1930; Williams 1938). Thus, any factor that could alter the expected discounted cash flows should have a significant effect on these asset prices. Consequently, any oil price increase would result to increased costs, restraining profits and in greater extend, would cause a decrease in shareholders' value. Hence, any oil price increase should be accompanied by a decrease in the stock prices. Many authors argue that oil price effect on stock markets is an indirect effect and it is fed through the macroeconomic indicators. According to Bjorland (2009) and Jimenez-Rodriguez and Sanchez (2005), an oil price increase is expected to have a positive effect in an oil exporting country, as the country's income will increase. The consequence of the income increase is expected to be a rise in expenditure and investments, which in turn creates greater productivity and lower unemployment. Stock markets tend to respond positively in such event.

LeBlanc and Chinn (2004) and Hooker (2002) prove that for an oil-importing country, any oil price increase will tend to have the opposite result. Oil price increase will lead to higher cost of productions, as oil is one of the most important production factors (Arouri& Nguyen 2010; Backus &Crucini 2000; Kim &Loungani 1992). The increase cost will be transferred to the consumers, which will in turn, lead to lower demand and thus consumer spending, due to higher consumer prices; Bernanke (2006), Abel & Bernanke (2001), Hamilton (1996), and Barro (1984). Lower consumption could lead to lower production and thus increased unemployment; Lardic&Mifnon (2006), Brown &Yucel (2002), and Davis &Haltiwanger (2001). Stock market would react negatively in such case; Sadorsky (1999), and Jones &Kaul (1996).

Oil is one of the most important production factors in an economy. Not surprisingly, a growing theoretical and empirical literature has been devoted to the study of oil and its impact on the economy. Rising oil prices lead to higher production costs which affect inflation, consumer confidence and therefore economic growth. Several studies report a clear negative correlation between energy prices and aggregate output or employment. For instance, Hamilton (1983) and Giser& Goodwin (1986) demonstrate that rising oil prices are responsible for recessions. Rotemberg& Woodford (1996) estimate that a 10% increase in oil prices leads to an average GDP decline of 2.5% five or six quarters later. Jones et al. (2004) estimate that the oil price-GDP elasticity (the ratio of percentage change in GDP to percentage in oil price) is around -0.06. However, Lee et al. (1996), Hamilton (1996), Huntington (1998), among others, report an asymmetric relationship between oil prices and the macroeconomic. Rising oil prices seem to decrease the aggregate economic activities more than falling oil prices stimulate them. Furthermore, Barnanke (1983) &Pinkyck (1991) show that large oil price movements increase uncertainty about future prices and thus cause delays in business investments. Nevertheless, Hooker (1996) indicated that the correlation between oil prices and economic activity appears to be much weaker in data since 1985, so the suggestion that oil shocks contribute directly to the economic downturn remains controversial.

The connection between oil and stock prices appears to be quite natural. Theoretically, the value of a firm is the present value of expected future cash flows. Rising oil prices affect the future cash flows of a firm, either negatively or positively depending on whether the firm is producing or consuming oil. In addition, oil prices also affect interest rates in the economy via inflation and monetary policy of the central bank. Rising oil prices lead to high inflation which increases interest rates. Furthermore, the central bank often uses monetary policy to fight inflation. This further increases interest rates, lead the discount rate of the firm also increases and increasing in discount rate leads to lower stock price.

Nowadays, the majority of the countries have turned the focus of their monetary policy on inflation stability putting an effort to the absorption of any shocks that could cause inflationary pressure, e.g. oil price shocks (Bernanje et al. (1997); Blanchard &Gali (2007); Lescaroux& Mignon 2008). Furthermore, due to increase in productivity, investments and renewable energy sources, firms are able to absorb increased production input costs without the need of price increases (International Energy Agency 2010). Wage flexibility plays an important role on the reduced impact of oil price shocks, as well. Nordhaus (2007) suggested that due to the greater wage flexibility in some countries, responses to oil shocks tend to be more neoclassical rather than Keynesian. Similar evidence was adduced by Blanchard and Gali (2007). Neoclassical theory, in contrast to the Keynesians, argues that effect on output is much smaller and thus oil price shocks should have minimum impact on stock markets today, as well.

3.0 Literature review – empirical

On the issue of the effect of oil price shocks on stock market returns, it has been investigated by a number of researchers. Jones and Kaul (1996), Sadorsky (1999) and Ciner (2001) report a significant negative connection, while Cgen et al. (1986) and Juang et al. (1996) do not. A negative association between oil price shocks and stock market returns has been reported in several recent papers. Nandha& Faff (2008) find oil prices rises have a detrimental effect on stock returns in all sectors except mining and oil and gas industries. O'nell et al. (2008) find that oil price increases lead to reduced stock returns in the United States, the United Kingdom and France. Park &Ratti (2008) report that oil price shocks have a statistically significant negative impact on real stock returns in the U.S. and 12 European oil importing countries, Nandha& Faff (2008) review aork on the effect of oil price on equity prices. Recent papers have focused on the effect of oil price for stock market risk as in Basher &Sadorsky (2006). Kilian& Park (2007) report that only oil price increases driven by precautionary demand for oil over concern about future oil supplies negatively affect stock prices. Gogineni (2007) finds that industry stock price returns depends on demand and cost side reliance on oil and on size of oil price changes. Research on the effect of oil prices on stock prices parallels a larger literature on the connection of oil price shocks with real activity. Much of this research has been influenced by Hamilton's (1983) connection of oil price shocks with recession in the U.S. Hamilton's finding has been elaborated on and confirmed by Mork (1989), Lee et al. (1995), Hooker (1996), Hamilton (1996, 2003) and Gronwald (2008), among others Cologni&Manera (2005), Kilian (2008), Jimenez-Rodriguez & Sanchez (2005), Cunado& Perez de Gaecia (2005) and Lee et al. (2001) have confirmed a negative link between oil price shocks and aggregate activity for other countries. Huntington (2005), Barsky&Kilian (2004) and Jones et al. (2004) provide reviews on the effect of oil shocks on the aggregate economy. The research in the two areas is clearly connected, since oil price shocks influence stock prices through affecting expected cash flows and discount rates. Oil price shocks can affect corporate cash flow since oil is an input in production and because oil price changes can influence the demand for output in industry and national levels. Oil price shocks can affect the discount rate for cash flow by influencing the expected rate of inflation and the expected real interest rate. The corporate investment decision can be affected directly by changes in the latter and by changes in stock price relative to book value.

Mounting evidence suggests a negative relationship between oil prices and stock market returns. Jones &Kaul (1996) were the first to reveal the negative impact oil price on stocks markets, which occurs due to the fact that oil price is a risk factor for stock markets. Other authors, such as Filis (2010), Chen (2009), Miller &Ratti (2009), Nandha& Faff (2008), O;neill, Penn & Terrell (2008), Park &Ratti (2008), Driesprong, Jacobsen &Maat (2008), Ciner (2001) and Gjerde&Saettem (1999) have also provide evidence towards such as negative relationship. Sadorsky (1999) argued that oil price volatility has also an impact on stock returns. Oberndorfer(2009) seconds that opinion in his study on the effect of oil price volatility on European stock markets. A negative relationship between the volatilities of oil price returns and three stock market sectors returns in U.S. (namely: technology, health care and consumer services) was identified by Malik & Ewing (2009), using Autoregressive Conditional Jumo Intensity (ARJI) model, found evidence that oil price volatility negatively influence the S&P500 index. More importantly, their study concluded that periods of increased oil price volatility tend to cause unexpected asymmetric negative effects on S&P500 returns. Hammoudeh& Li (2008) provided an interesting finding in this area of concern. They suggested the major events that cause changes in oil prices tend to increase the stock market volatility of the GCC countries. In addition, Arouri& Nguyen (2010) used two-factor GARCH model to examine the effect of oil prices on European sectors' returns rather than only on aggregate stock market index returns. They concluded that oil prices thend to exercise a significant influence on various European sectors (such as: oil and gas, financials, industrials and utilities, among others). However, the magnitude and the direction of the effect differ from one sector to another, specifically for the oil-exporting countries. Arouri&Rault (2011) employed a bootstrap panel cointegration technique and a seemingly unrelated regression (SUR) method and provided evidence that positive oil price shocks have positive impact on the stock market performance of GCC countries. Similar results were also documented by Bashar (2006). Hammoudeh&Aleisa (2004), on the other hand found a bidirectional relationship between oil prices and stock markets, in oil-exporting countries.

Other studies concentrate their interest in the investigation of the oil price shock origin, i.e. demand-side or supply-side shock. These studies include Hamiton (2009), Lescaroux& Mignon (2008), Barsky&Kilian (2004) and Terzian (1985). The origin of an oil price shock is an important component when studying the relationship between oil prices and stock markets. In particular, Lascaroux& Mignon (2008) suggest that supply-side shocks could be related to higher oil price volatility, although it may not be the only reason. Demand-side shock deriving from industrialization of countries such as China could have a significant impact. He also voiced the opinion that lack of immediate response of oil-supply to a large scale increase in oil-demand could result to a demand-side shock. Kilian& Park (2009) advocated that demand-side oil price shocks influence stock prices more than the supply-side oil price shocks. Demand-side oil price shocks exercise a negative influence on stock prices due to the precautionary demand for crude oil, which echoes the uncertainty of future oil supply availability. However, they suggested that if the demand-side oil price shock is driven by global economic expansion, then higher oil prices will cause a positive effect on stock prices, which is in-line with Hamilton's (2009) views.

Another study regarding only the Chinese market is made by Cong et al. (2008). This paper investigates the interactive relationship between oil price shocks and Chinese stock market using multivariate vector auto-regression. Oil price shocks do not show statistically significant impact on the real stock returns of most Chinese stock market indices, except for manufacturing index and some oil companies. Increase in oil volatility may increase the speculations in mining index and petrochemicals index, which raise their stock returns. Both the world oil price shocks and China oil price shocks can explain much more than interest rates for manufacturing index. As for GCC stock markets, Akoum et al. (2010) consider data from six oil-countries of GCC and two non-oil countries, over the period 2002 – 2009. Their result is that for a long period of time the stock returns in these countries have not shown strong correlation with crude oil prices, but this behaviour has changed from 2007 onwards, as they observed stronger correlations. Meanwhile, Abu Zarour (2008) investigated the effect of sharp increases in oil prices on stock market returns for five of the six GCC countries. Using VAR analysis and daily data from mid-2001 to mid-2005, he concluded that sharp oil price increases can predict GCC stock market prices, expect for Abu Dhabi stock market.

All that said, a wealth of literature suggests that there is no relationship between oil price and stock markets; for example Cong, Wei, Jiao, Fan (2008), Haung, Masulis, and Stoll (1996) and Chen, Roll, and Ross (1986). Concerning the oil-exporting countries, Al-Janabi, Hatemi-J, and Irandoust (2010) used bootstrap test for causality appropriate for non-normal financial data with time varying volatility and concluded that GCC stock markets are efficient with regard to oil prices, i.e. oil prices do not tend to affect these stock markets and this oil prices cannot be used as predictors for the GCC stock markets, specifically for oil-importing countries. Al-Fayoumi (2009) found no evidence that oil price shocks affect the stockmarkets. Other authors suggest that oil prices do not seem to have any effect in the economy after the 1980s (Bernanke, Gertler& Watson 1997; Blanchard &Gali 2007; Hooker 1996, 2002; Lescaroux& Mignon 2008; Nordhaus 2007). Miller &Ratti (2009) concluded that oil price effects are insignificant after 1999 due to oil price bubbles which have taken place since the early 2000. Jammazi&Aloui (2010 and Apergis& Miller (2009) painted the same picture suggesting that oil prices do not affect stock market performance. Such conclusions could originate from the fact that oil prices are not any more a significant source for economic downturn, as was suggested by Hamilton (1983).

4.0 Data and methodology

4.1 Data

We collect daily data for Malaysia Islamic stock market indices which is FTSE Bursa Malaysia EmasShariah and Malaysia non-Islamic stock market indices which is FTSE Bursa Malaysia KLCI. Unlike the majority of previous studies which employ low frequency data (yearly, quarterly, monthly and weekly), we use daily data in order to adequately capture the rapidity and intensity of the dynamic interactions between oil and stock prices. The data are collected over the period from 1st January 2007 to 31st December 2014. The Brent spot prices are used to represent the international crude oil market since they usually serve as reference prices for prising crude oil and many other derivatives products using oil as underlying asset. All prices from both markets (oil and stocks) been extracted from Datastream. The descriptive statistics for the daily returns are summarized in Table 1.

	BRENT OIL	EMAS	KLCI
Mean	-2.73E-05	0.000262	0.000228
Std. Dev.	0.016329	0.008368	0.007913
Skewness	-0.233071	-1.606287	-1.268808
Kurtosis	7.063629	23.04654	18.84192
Jarque-Bera	1454.845 (0.000)	35842.86 (0.000)	22383.6 (0.000)

Table 1: Descriptive Statistics of Daily Brent Oil Price Returns for EmasShariah and KLCI Stock Returns from 1st January 2007 to 31st December 2014.

The average daily returns on the stock market indices are both positive. Surprisingly throughout the observation period, Brent crude oil average prices are negative which mean it is highly volatile. The asymmetric property of any distribution is indicated by the skewness where the findings show that all returns of stock indices and Brent oil prices are negatively skewed. The descriptive analysis shows the values of kurtosis are all more than 3, indicating that the Brent oil prices and returns of both stock indices are not normally distributed. Accordingly, the Jarque-Bera test statistics strongly reject the null hypothesis of normality for all series.

4.2 Methodology

This study follow the studies of Grinsted et al. (2004) and Aguiar-Conraria and Soares (2011), which apply wavelet coherency in the form of continuous wavelet transform on the return series in order to capture co-movement in time-frequency space. The continuous wavelet transform of a time series x_t with respect to ψ is a function of two variables given by the following convolution:

$$W_x(\tau, s) = \int_{-\infty}^{+\infty} x(t)\bar{\psi}_{\tau,s}(t)dt = \frac{1}{\sqrt{s}}\int_{-\infty}^{+\infty} x(t)\bar{\psi}\left(\frac{t-\tau}{s}\right)dt, \quad (1)$$

Where the bar denotes the complex conjugate, τ is the time decomposition or translation parameter controlling its location, s is the scale or dilation parameter that controls the width of the wavelet, and $1/\sqrt{s}$ is a normalization factor to make sure that the wavelet transforms are comparable across scales and time series.

In terms of the mother wavelet, the most frequent choice is the Morlet wavelet, which is given by:

$$\psi_{\omega_0}(t) = \pi^{-(1/4)} e^{j\omega_0 t} e^{-(t^2/2)} \quad (2)$$

The Morlet wavelet is a complex sine wave within a Gaussion envelope, while ω_0 is the wave number. Commonly, the results are obtained with a particular choice of $\omega_0$equal to 6 as it provides a good balance between time and frequency localization (see, for example, Grinsted et al., 2004). Aguiar-Conraria and Soares (2011) mention that the Morlet wavelet is frequently used mainly due to four properties: (1) the three sensible ways of converting wavelet scales into frequencies are equal; (2) it has optimal joint time-frequency concentration; (3) the time radius and the frequency radius are equal; (4) it is an analytic wavelet.

Similar to Fourier analysis, several interesting features can be obtained in the wavelet domain. We can define the wavelet power spectrum as:

$$(WPS)_x(\tau, s) = |W_x(\tau, s)^2| \quad (3)$$

This measures the relative contribution at each time and each scale to the time series' variance. Similarly, we can define the cross-wavelet spectrum as:

$$W_{xy}(\tau, s) = W_x(\tau, s)\overline{W_y}(\tau, s), \quad (4)$$

Where these are wavelet transforms of two time series *x(t) and y(t).* The cross-wavelet spectrum can be decomposed in real and imaginary parts, since the mother wavelet is in general complex. We define the cross wavelet power as $|Wxy(\tau,S)|$, which depicts the local covariance between two time-series at each time and frequency. On the other hand, the wavelet coherency has the major advantage of being normalized by the power spectrum of the two time series. As in Fourier analysis, we can define the wavelet coherency of the two given series *x(t)* and *y(t)* as:

$$R_{x,y}(\tau, s) = \frac{|s(W_{xy}(\tau, s)|}{\sqrt{s(|(W_{xx}(\tau, s)|s(|(W_{yy}(\tau, s)|)}} \quad (5)$$

Where S denotes a smoothing operator in both time and scale. We can use wavelet squared coherency to measure the co-movement of two time series over time and across frequencies. Such a wavelet-based measure allows for a richer description of the co-movement between two variables of interest. Similar to the squared coefficient correlation, $R^2(\tau,S)$ is in a range between 0 and 1 with a high (low) value indicating a strong (weak) co-movement. Hence, by observing the counter plot of the above measure, we can identify the regions in time-frequency space where the two time series move together and, specifically, assess both time and frequency varying features of the co-movement. We will rely on Monte Carlo simulations for statistical inference.

The use of a complex-valued wavelet is a major advantage, as we can compute the phase of the wavelet transform of each series. By computing the phase difference, we can obtain information about the possible delays of the oscillations of the two series as a function of time and scale/frequency. The phase difference can be defined as:

$$\phi_{x,y}(s,\tau) = \tan^{-1}\left(\frac{\Im(W_{xy}(s,\tau))}{\Re(W_{xy}(s,\tau))}\right) \quad (6)$$

The information of the signs of each part is to determine the value of ϕ_{xy}€ [-π, π]. A phase difference od zero indicated that the time series co-movement at the specified frequency; if ϕ_{xy}€ [0, π/2], then the series move in a phase with time series y leading x; ϕ_{xy}€ [-π/2,0] indicates a leading role of x; a phase difference that is π (or –π) will be an anti-phase relation; if ϕ_{xy}€ [π/2, π], then x is leading; time series y is leading if ϕ_{xy}€ [-π, -π/2].

The use of wavelets assists in addressing the issues raised by Bodart and Candelon (2009), since we can observe the causal structure better than with static correlation. This allows us to take into account the underlying dynamic structure and deal with the problem of asymmetry. In addition, the frequency domain allows us to observe for causality at varying frequencies, offering a simple way to differentiate contagion from interdependence.

5.0 Empirical findings

5.1 Wavelet Coherence Analysis: Co-movement of Brent Crude Oil and Malaysia Stock Markets

The research on co-movement of commodities and stock markets has been discussed in several papers. Starting with Aguar-Conraria&Soares (2011), they used the WTC to analyse the co-movement between S&P500 and oil prices. Their dataset included monthly returns for the period starting in July 1954 and ending in December 2010, by using Wavelet Partial Coherence with controlling variables. They concluded that there was a significant co-movement in mid 1970s, mid 1980s, and early 1990s. Another paper written by Vacha&Barunik (2012) is studying the co-movement between crude oil, gasoline, heating oil and natural gas. Based on their results, they concluded that co-movement varied a lot during the analysed period, which started in 1993 and ended in 2010. Moreover, the co-movement did not vary only in time but also in terms of frequencies.

Wavelet Coherence is an efficient tool to study when and what scales examined time series co-movement. Following figures depict the Wavelet Coherence into a contour plot. The time domain is represented by x-axis and the frequency domain by y-axis. In addition, the frequency domain is represented by the period, i.e. the higher the frequency, the lower the period. This study focuses on the co-movement between two stock indices and crude oil.

The interpretation of the figures is based on the colour of regions; blue regions mean that there is low or even no co-movement. Meanwhile, the red regions mean that there is a significant co-movement between time series. As a result of this, the study can obtain very detailed results based on the time domain and the frequency domain at the same time. Another important indicator to interpret the result is the phase arrows which show the relative phasing of time series at given scale. If the arrows are pointing to the right, it means that time series are in-phase (positively correlated), meanwhile opposite arrows direction means anti-phase (negatively correlated). If they are pointing up then the second variable is leading the first one. If the arrows pointing down then it means the first variable is leading the second one.

The results of Figure 1 represent Malaysia stock markets and its co-movement with Brent crude oil. The wavelet coherence revealed very similar patterns of co-movement for both stock markets- Islamic stock market (EMAS) and conventional stock market (KLCI) against the price of Brent crude oil. Firstly, the study observes that throughout the observation period, EMAS and KLCI did not co-move with crude oil significantly for the lower frequency of 2 to 8 days. This can be shown clearly through the figure, where both patterns mostly in blue regions. However, crude oil and EMAS stock market became moderately significant in August 2011 and the arrows show a signal of positively correlated. Start from mid-2012 until 2014, the arrows turn to the left where it shows that Islamic stock market and oil price are negatively correlated. For KLCI stock market, it shows the same patterns as EMAS stock market. However, the arrows give a signal of positively correlated slightly earlier compare to EMAS stock market, which it occurs in early 2011.

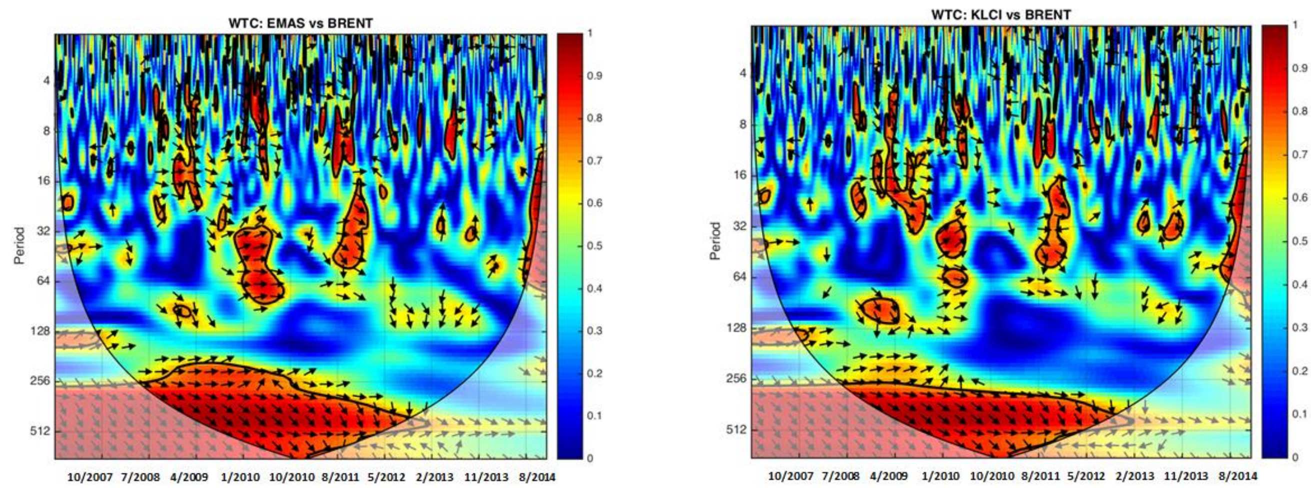

Figure 1:Continuous Wavelet Transform. The Co-movement of Malaysia Stock Market Returns (EmasShariah and KLCI) and Brent Oil Price Returns

Secondly, the study observes the results in moderate frequency which is at 8 to 64 days. The patterns for EMAS stock market and KLCI stock market have more blue regions which interpret that there is no co-movement in this time-frequency. However, there is some strong positive correlation during 2008 to 2011. This significant co-movement might due to the impact of global financial crisis during year 2008. At the end of year 2014, the outcome of U.S. crude oil crisis leads to significant of co-movement between crude oil and Malaysia stock markets. During the U.S crude oil crisis, the prices of crude oil were sharply decrease and these significant co-movement shows that during that period, Malaysia stocks market indices also decreased.

Thirdly at higher time frequency which is at 256 to 512 days, the study observed a very significant co-movement with crude oil, the patterns for EMAS and KLCI stock market provide almost similar results. EMAS stock market co-movement happen a bit earlier, before 256 days. This study concludes that for Malaysia stock market, either Islamic or non-Islamic both co-movements with oil prices are highly significant at long term. Crude oil prices are always fluctuated, thus investor should consider this factor in order to invest in stock market for long term.

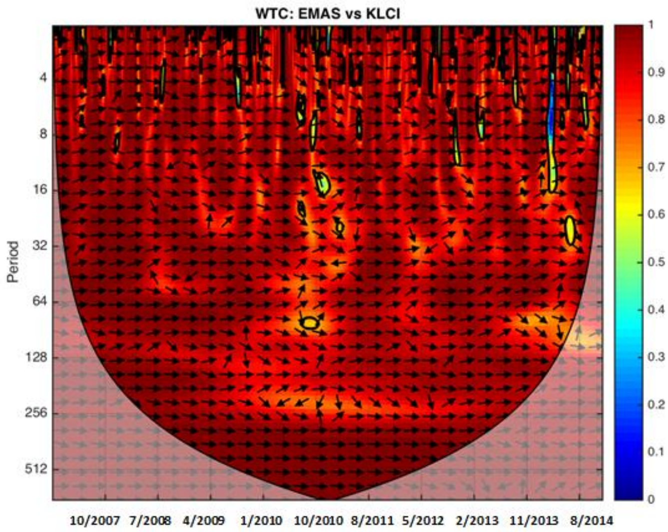

Figure 2: Continuous Wavelet Transform. The Co-movement of Malaysian Stock Market Returns (EmasShariah and KLCI)

Looking at Figure 2, the co-movement between Islamic stock market and non-Islamic stock market, it provides clear information that their co-movements are highly significant for all frequency. This is supported by the result from Figure 1 where both stock markets mostly have the same patterns. The study assumes that the Shariah screening has adopted the principle of tolerance so that Islamic investors would not be at a disadvantage when they want to comply with Islamic rules in their investment. Therefore, as a result, the co-movements of Islamic and non-Islamic stock market more or less tend to be similar.

5.2 *Wavelet MODWT Analysis: The Robustness test of Brent Crude Oil and Malaysia Stock Markets*

As test for robustness to ensure the results obtained from the wavelet CWT analysis, a Maximal Overlap Discrete Wavelet Transform (MODWT) was applied to the original data set consisting of returns for Malaysia Islamic and conventional stock indices. In MODWT, it required to specify the time scales for the returns whereby this study had eight time scales (2-4 days, 4-8 days, 8-16 days, 16-32 days, 32-64 days, 64-128 days, 128-256 days, 256-512 days). The correlations between Malaysia stock market returns with crude oil prices are examined using the generated MODWT returns series using R structural programming and the results are shown in the Table 2 below.

Table 2: MODWT Transformation – (i) Correlation of Malaysia Stock Market Returns (EmasShariah and KLCI) and Brent Oil Price Returns. (ii) Correlation of Malaysia Stock Market Returns (EmasShariah and KLCI)

MODWT Scaling	**EMAS vs BRENT**	**KLCI vs BRENT**	**EMAS vs KLCI**
2 – 4 days	-0.03052	-0.02380	**0.95840**
4 – 8 days	0.24542	0.23431	**0.96215**
8 – 16 days	0.36918	0.34490	**0.96909**
16 – 32 days	0.31703	0.33218	**0.96533**
32 – 64 days	0.32273	0.26547	**0.96088**
64 – 128 days	0.19343	0.18723	**0.96470**
128 – 256 days	0.46218	0.45509	**0.94597**
256 – 512 days	**0.65450**	0.48674	**0.97208**

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 earlier CWT analysis. Malaysia Islamic stock market and non-Islamic stock market are highly correlated. The MODWT result shows that for all time scales, the correlations are strong which is more than 0.9 and almost 1.0. The correlation results between crude oil prices and stock markets – EMAS and KLCI show almost the same results for all time scales. As expected, among all time scales, the results show that at higher time scales of 128-512 days the correlations are moderate. EMAS Shariah stock market is slightly higher compare to KLCI stock market. This is especially at highest time scales of 256-516 days where the correlation on Islamic stock market is 0.6545 and it is seen to be strong.

In CWT analysis, the results appear in diagram. Therefore the study unable to observed the results clearly, except for the patterns where it provides almost the same patterns for the co-movements. However, in MODWT analysis, this study able to observed the co-movements and correlations of crude oil prices with Malaysia stock markets clearer with numerical results. After all, the findings from the MODWT analysis are in line with ones obtained under the CWT analysis.

6.0 Conclusions

This study examines the co-movements of crude oil prices with the stock markets for Islamic and conventional indices. The focus of this study is on Malaysia stock market. Daily data spanning from January 2007 to December 2014 was used together with employing wavelet approaches consisting CWT and MODWT analysis which produced results that are coherent with one another. The wavelet coherent allows the study to decompose a signal into various time scales without losing time related information and to capture the various time scales at which the factors that influence the oil price operate. It is important in revealing that the nature of the oil price and stock market relationship is not the same through all time scales. Therefore this multi-scale analysis can help unravel the changes that can occur in such relationship when various timescales are considered.

The results from wavelet CWT analysis and MODWT analysis for this study are consistent. The main findings of this study prove that Malaysia Islamic stock market and conventional stock market have similar patterns against with the co-movement of crude oil prices. The correlations of these two stock markets are strong, which means what happen to conventional stock markets will be the same as Islamic stock markets. Refer to the multi-scale analysis, results show a low degree of co-movement crude oil prices and Malaysia stock market returns for short term (frequency fluctuations between 2 days to 8 days) and medium term (frequency fluctuation between 8 days to 64 days). During these time frequency, the co-movements are significant only during the 2008 global financial crisis and 2014 year end U.S crude oil crisis. However, for the long term (frequency fluctuations between 256 days to 512 days), it shows that there is a significant co-movement between the crude oil prices and stock markets. This result indicated that for long term forecast, when crude oil markets become volatile, Malaysia stock markets will positively correlated. Therefore, although crude oil prices do not have co-movement to the stock markets for short term and medium term, as investors they still have to adjust and beware with their portfolios strategy based on their multi investment horizons.

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