The links between crude palm oil, conventional and Islamic stock markets: evidence from Malaysia based on continuous and discrete wavelet analysis

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Abstract

The palm oil industry is crucial to the Malaysian economy. It is also becoming more relevant and important globally and plays a key role in the expansion of Islamic Finance. Hence, this study aims to ascertain the relationship between crude palm oil prices (CPO) and the stock market (both conventional and Islamic). This study has selected Malaysia as a case study for its reliance on the palm oil industry as well as its position in Islamic Finance. Furthermore, the potential inclusion of the palm oil industry into investment portfolios also warrants the analysis of the co-movement between crude palm oil and stock market indices over varying investment horizons or time scales. Thus, to accomplish this, the Continuous Wavelet Transformation (CWT) and Maximum Overlap Discrete Wavelet Transformation (MODWT) methods were employed. The results tend to indicate that there exists little relation between CPO price returns and both the Conventional and Islamic stock market returns in the short and medium term. Interestingly enough, in the long term, significant co-movement between the variables start to emerge. This is a compelling finding as it provides new information for the investors to diversify their portfolio and time their investments. The result of this study is also a significant contribution to the pool of knowledge which lacks prominent literature on the link between palm oil, the conventional and Islamic stock markets.

Keywords: crude palm oil prices, EMAS Shariah, KLCI, Malaysia, Wavelet

JEL codes: C58, E44, G15

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The links between crude palm oil, conventional and Islamic stock markets: evidence from Malaysia based on continuous and discrete wavelet analysis

1.0 INTRODUCTION

2017 marks the 100th year anniversary of palm oil in Malaysia. From an ornamental plant to becoming synonymous with Malaysia, palm oil has undeniably become a significant contributor to the country's economy. Covering 5.23 million hectares, palm oil alone occupies 15.8% of Malaysia's total land area and over 70% of its agricultural land. Thus, it is of no surprise that the palm oil industry accounts for approximately 6% of the country's gross domestic product (GDP) and is responsible for directly employing up to 600,000 people, ranging from low-skilled to high-skilled labours. Today, Malaysia is the second largest palm oil producer, behind Indonesia and together, both countries account for 85% of the total global supply chain of palm oil. According to the Malaysian Palm Oil Council (MPOC), Malaysia produced about 29.4% of the world's palm oil output and provides 37% of global exports.

So, what makes palm oil so important? Palm oil is the largest produced vegetable oil in the world reaching 55.7 million tons in 2015 (Khatun et. al, 2017). This is mainly contributed by the fact that the high oil content in palm oil makes it the most efficient vegetable oil crop in the world. On a per hectare basis, palm oil requires ten times less land than other major oil producing crops such as soya, rapeseed, sunflower and coconut. In addition, the palm oil tree is also considered efficient because from one tree, various products can be harvested including palm oil, palm stearin, palm kernel oil, palm kernel olein, palm kernel stearin, palm kernel expeller and palm fatty acid distillate. These products consist of differing chemical properties that allows its versatility and usage in a multirange of consumer goods. According to the World Wildlife Fund, approximately 50% of packaged products in any supermarket contains products of palm oil where palm oil is used primarily in edible products such as cooking oil, margarine, and ice cream while palm kernel oil is mainly for products like soaps, detergents and cosmetics.

However, despite being clearly important globally and more specifically to Malaysia, to the best of our knowledge, there is very minimal to almost non-existent literature on palm oil. There are on the other hand, numerous research revolving around other commodities, such as crude oil, gold and silver. Many of these studies focus on the relationship of the real sector – the commodities market with the financial sector, i.e. the stock market. Furthermore, as Malaysia is becoming an important hub for Islamic Finance, palm oil is also beginning to play

a crucial role towards its expansion through the use of its products such as crude palm oil (CPO), RBD palm olein and plastic resin as underlying assets in Islamic financial transactions. This has been made possible through the Bursa Suq-al-Sila' platform engineered by Bursa Malaysia, the Central Bank of Malaysia and Securities Commission of Malaysia. Hence, it is even more important now for us to understand how palm oil relates to both conventional and Islamic stock markets.

Therefore, this study aims to ascertain the relationship between crude palm oil prices with the stock market in conventional and Islamic indices in Malaysia. The conventional and Islamic stock indices are represented by FTSE Bursa Malaysia KLCI and FTSE Bursa Malaysia Emas Shariah respectively. The data to be analysed ranges from 2007 to 2017 and the methodology employed will be Continuous Wavelet Transformation (CWT) and Maximum Overlap Discrete Wavelet Transformation (MODWT) which would allow us to determine the multi-horizon nature of co-movement through a multi-timescale analysis as it decomposes the observed variable on a scale-to-scale basis. This study was also done on Malaysia specifically because of its obvious position in Islamic Finance as well as the importance of the palm oil industry to its economy.

The main findings of this study suggest that both conventional and Islamic stock markets move in tandem with each other at all frequencies and that they both have similar co-movement pattern with crude palm oil price. The first implication is that, whatever happens to the conventional market, the same thing can be expected to happen with the Islamic stock market. The second implication, although both stock markets have similar co-movements with CPO, it is important to note that for short and medium holding periods, there are no co-movements with CPO except during the crisis in 2008 (only for medium term). However, for the long term, there is significant co-movement between CPO and the two stock markets – and it is especially strong during the crisis of 2008. Thus, this signifies that for long term forecast, should the palm oil industry in Malaysia become volatile, both conventional and Islamic stock market in Malaysia will positively reciprocate

This study also hopes to contribute to the existing pool of knowledge through a number of aspects. Firstly, there is very little literature on the role that palm oil, as a commodity, can play in the economy. Furthermore, to the best of our knowledge, we believe that this would be among the first study on the relationship between palm oil and the stock market, especially Islamic stock market. This is of crucial importance because of the great interest that Islamic

Finance is garnering globally as well as the important role palm oil has in Islamic Finance. Lastly, this study could also help Malaysian policy makers to devise and implement sound decisions pertaining to policies involving the stock market and palm oil such as the National Transformation Programme (NTP).

The following parts of this paper are structured in a way that it starts with **Section 2**, a brief discussion on various literatures relating to both the theoretical background of this study as well as some empirical studies pertaining to the area. **Section 3** outlines the methodology employed in this study and followed by **Section 4**, a discussion on the empirical findings. Lastly, this paper will end with **Section 5** which consists of some concluding remarks and policy implications of the issue at hand.

2.0 LITERATURE REVIEW

In recent times, the relationship between commodity markets and the stock market have garnered great attention. Many studies have been conducted to study the intricacies of this nexus with a large proportion involves the investigation with crude oil. Since there is a lack of literature that includes palm oil in this nexus, we will be extrapolating the ideologies behind those applied to crude oil onto palm oil. Therefore, in this section, we will be discussing the underlying theoretical framework and review the existing body of knowledge.

2.1 Theoretical Underpinning

From a financial and economic standpoint, theory indicates that the price of an asset depends on its expected discounted cashflows. Hence, any shocks or factors that affect these expected discounted cashflows would have substantial impact on the price of assets. An important factor that would have this effect is the price of oil. For example, since oil is a function of production, the hike in oil price would be reflected on an increased cost. This in turn constrict profits which eventually diminishes shareholders value. Thus, reducing stock prices. Nevertheless, a number of studies such Bjorland (2009) and Jimenez-Rodriguez (2009) argues that the relationship between the effect of oil price onto the stock market is indirect. The effect of changes in oil price is translated into changes in macroeconomic indicators. They argued that for oil producing and exporting countries, an increase in oil price brings about a positive impact. This is attributable to a higher income which in turn expand expenditures and

investments. Therefore, a flourishing economy generates better productivity and lower employment to which stocks react positively, i.e. increase in price.

Narrowing this argument to the context of our study, it greatly applies to the case of palm oil and Malaysia. Since, palm oil is one of Malaysia's main exports besides oil, changes in price of palm oil would also impact the Malaysian economy because out of all the palm oil produced in Malaysia, only 15% is consumed domestically while the remaining 85% is exported. In addition, since Malaysia host the largest and third largest public listed palm oil companies in the world, i.e. Sime Darby Berhad and Felda Global Ventures Holdings Berhad and other large companies control up to 60% of Malaysia's palm oil plantations, undoubtedly, we can hypothesise that palm oil prices would have a significant impact on the Malaysian stock market.

2.2 Empirical Review

There are also no empirical studies on palm oil as to reiterate the point that there is a lack of exploration in this area. Hence, we will be reviewing works relating to crude oil to which we believe would be similar in nature with crude palm oil.

For the case of crude oil price changes, even though they are considered as an important factor for understanding fluctuations in stock prices, the direction of such a relationship is not clear. For example, Kling (1985) found that crude oil price increases are associated with stock market declines, but Chen et al (1986) suggested that oil price changes actually have no effect. Similarly, even though Jones and Kaul (1996) observed a stable negative relationship between oil price changes and aggregate stock returns, Huang et al (1996) discovered no negative relationship between stock returns and changes in the price of oil futures. In terms of Canadian studies, Sadorsky (2001) noted a positive relationship between changes in oil price and the Toronto Stock Exchange oil and gas index, while Boyer and Filion (2007) found a similar relationship by using a sample of oil and gas companies.

On the contrary, some recent studies indicated that the debate on the oil-stock market nexus is far from settled. For instance, Gorton and Rouwenhorst (2006) found evidence that the equities of commodity-based companies cannot serve as substitutes for commodity futures because they have a much higher correlation with the equity market than with commodity futures. Likewise, Kilian and Park (2009) reviewed the impact of oil price shocks on the US stock market and found that the effect depended on whether the change in the price of oil is

driven by demand or supply shocks in the oil market. Moreover, Miller and Ratti (2009) analyzed the long-run relationship between the crude oil price and international stock markets. They observed that there is a change in the relation between real oil price and real stock prices in the last decade compared to earlier years, suggesting an unstable relationship over time. Additionally, Zhu et al (2011) examined the long-run relationship between oil prices and stock markets for the OECD and a panel of non-OECD countries using a panel threshold cointegration approach. Their results showed that a long-run relationship holds and that long-run Granger causality exists in both directions. Furthermore, Narayan and Sharma (2011) examined the relationship between oil price and stock returns for 560 US firms. They discovered that oil price increases have a positive effect in the returns of firms belonging only to the energy and transportation sectors and this effect is manifested with a lag. In addition, Wang et al (2013) investigated the response of stock markets to oil shocks across different countries that are either net exporters or net importers. They identified that supply shocks in oil have no or short-lived impact while aggregate demand shocks have a stronger significant impact in oil-exporting countries.

In the case of the relation between crude oil price on Islamic stock indices however, Abdullah et. al. (2015) investigated the impact of crude oil price with Islamic stock indices in the South East Asian countries including Malaysia, Singapore, Indonesia and Philippines. By conducting Multivariate GARCH – Dynamic Conditional Correlation, they found that the Malaysian Islamic stock indices show the lowest volatility, reflecting Malaysia as a stable and largest market in the Islamic capital market. Besides that, Malaysian Islamic stock index return is also the second least correlated with the crude oil price while the Philippine Islamic stock index return is the least correlated.

3.0 METHODOLOGY

3.1 Data

The variables used in this study includes crude palm oil price (CPO), FTSE Bursa Malaysia Emas Shariah (ES) and FTSE Bursa Malaysia KLCI (KLCI). For the intended use of this study, the data collected were daily spot prices of CPO and daily stock price of the two indices, spanning from 3rd January 2007 until 15th May 2017 (over 9 years). All data collected were denominated in Ringgit Malaysia (RM) to avoid the occurrence of errors or inconsistencies. The daily price index of ES and KLCI were sourced from Datastream at the INCEIF terminal and the daily spot price of CPO were collected from data provided by the

Malaysia Palm Oil Board (MPOB). The FTSE Bursa Malaysia Emas Shariah Index was selected to represent Islamic or Shariah-compliant stocks while the FTSE Bursa Malaysia KLCI which consist of the 30 largest companies on Bursa Malaysia based on market capitalisation represents the non-Islamic or conventional stocks. A list of all the variables is as shown in Table 1. However, prior to conducting the analysis, the returns were collected using the following formula;

$$(\log\left(\frac{\rho_{t+1}}{\rho_t}\right)) * 100\%$$

*where ρ is the index value

Variable	Description
CPO	Index return of crude palm oil price
ES	Index return of FTSE Bursa Malaysia Emas Shariah
KLCI	Index return of FTSE Bursa Malaysia KLCI

Table 1: DescriptionTable 1: Description of Variables

3.2 Continuous Wavelet Transformation (CWT)

The CWT maps the original time series, which is a function of just one variable time-separate into function of two different variables such as time and frequency. The CWT maps the series correlations in a two-dimensional figure that allows the researcher to easily identify and interpret patterns or hidden information. The analysis of correlation between two CWT is generally known as the wavelet coherence. These figures would indicate the extent of correlation between two variables with both time and time scale/frequency changing.

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 xt 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/√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:

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

The Morlet wavelet is a complex sine wave within a Gaussion envelope, while GƆ0 is the wave number. Commonly, the results are obtained with a particular choice of GƆ0equal 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:

$$(WPS)_x(\tau, s) = |W_x(\tau, s)^2| \tag{3}$$

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:

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

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:

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

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 comovement

between two variables of interest. Similar to the squared coefficient correlation, R2(Ʈ,S) is in a range between 0 and 1 with a high (low) value indicating a strong (weak) comovement.

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:

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

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

3.3 Maximum Overlap Discrete Wavelet Transformation (MODWT)

According to literature, both Discrete Wavelet Transform (DWT) and Maximal Overlap Discrete Wavelet Transform (MODWT) can decompose the sample variance of a time series on a scale-by-scale basis via its squared wavelet coefficients. However, the MODWT-based estimator has been shown to be superior to the DWT-based estimator (Percival 1995; Gallegati 2008). Therefore, we are going to apply Maximal Overlap Discrete Wavelet Transform (MODWT) in our study.

Whitcher et al. (2000) extended the notion of wavelet variance for the maximal overlap DWT (MODWT) and introduced the definition of wavelet covariance and wavelet correlation between the two processes, along with their estimators and approximate confidence intervals.

To determine the magnitude of the association between two series of observations X and Y on a scale-by-scale basis the notion of wavelet covariance has to be used. Following Gençay et al. (2001) and Gallegati (2008) the wavelet covariance at wavelet scale j may be defined as the covariance between scale j wavelet coefficients of X and Y, that is $\gamma XY,j = Cov[\acute{\omega}_{j,t}^{x}\ \acute{\omega}_{j,t}^{y}]$

An unbiased estimator of the wavelet covariance using maximal overlap discrete wavelet transform (MODWT) may be given by the following equation after removing all wavelet coefficients affected by boundary conditions (Gallegati 2008),

$$\tilde{\gamma}_{XY,j} = \frac{1}{\tilde{N}_j} N - 1 \sum_{t=L_{J-1}}^{N-1} \tilde{\omega}_{j,t}^{X} \tilde{\omega}_{j,t}^{Y}$$

Then, the MODWT estimator of the wavelet cross-correlation coefficients for scale j and lag τ may be achieved by making use of the wavelet cross-covariance, $\gamma_{\tau}xy,j$, and the square root of their wavelet variances $\sigma_{x,j}$ and $\sigma_{y,j}$ as follows:

$$\tilde{\rho}_{\tau,XY,j} = \frac{\tilde{\gamma}_{\tau,XY,j}}{\tilde{\sigma}_{X,j}\tilde{\sigma}_{Y,j}}$$

The wavelet cross-correlation coefficients $\rho_{\tau xy,j}$, similar to other usual unconditional crosscorrelation coefficients, are between 0 and 1 and offers the lead/lag relationships between the two processes on a scale-by-scale basis.

Starting from spectrum $S_{\omega x,j}$ of scale j wavelet coefficients, it is possible to determine the asymptotic variance Vj of the MODWT-based estimator of the wavelet variance (covariance). After that, we construct a random interval which forms a 100(1 − 2p)% confidence interval. The formulas for an approximate 100(1 − 2p)% confidence intervals MODWT estimator robust to non-Gaussianity for $v_{x,j}^2$ are provided in Gençay et al. (2001) and Gallegati (2008). According to empirical evidence from the wavelet variance, it suggests that Nj = 128 is a large enough number of wavelet coefficients for the large sample theory to be a good approximation (Whitcher, Guttorp et al. 2000; Gallegati 2008).

4.0 EMPIRICAL FINDINGS & DISCUSSION

4.1 Continuous Wavelet Transformation (CWT)

Wavelet coherence is an efficient tool that allows us to study when and what scales examined the time series co-movement. The output is a contour plot with the time domain (number of trading days) is represented by the x-axis and the frequency domain (investment horizon) by the y-axis. Besides that, the frequency domain also indicates period whereby, the higher the frequency, the lower the period. The curved line below the plot on the other hand shows the 5% significance level which was estimated using Monte Carlo simulations. Therefore, this method allows us to investigate the co-movement between CPO and the two stock indices.

The interpretation of output relies on the colour of the regions. The colour ranges from blue to red with blue regions indicating low or no co-movement while red regions indicate significantly strong co-movement between the time series. Another form of interpretation also revolves around the phase arrows. The phase arrow shows the relative phasing of time series at a given scale. The phase arrows are interpreted based on their directions whereby, if arrows are pointed to the right, it indicates that the time series are in-phase (positively correlated); arrows pointing to the left indicates antiphase or the time series are negatively correlated. When the arrows point up, it shows the second variable leads the first variable whilst arrows pointing down indicates the first variable leads the second variable.

Horizontal Axis	Date
500	January 2009
1000	January 2011
1500	February 2013
2000	March 2015
2500	April 2017

Table 2:Description of Horizontal Axis

Figure 1 represents the estimated continuous wavelet transform and phase difference as well as the co-movement between Index return of FTSE Bursa Malaysia Emas Shariah and crude palm oil price returns. We can observe that for the lower frequency period, i.e. 2 to 16 days, there was not much co-movement between the two variables as indicated by the pattern of mostly blue region. Moving on to the mid frequency period, i.e. 16 to 64 days, there was significant co-movement between the two variables especially in the earlier months of 2009. The arrows also indicate that they were positively correlated, and that CPO leads ES during

this period. We believe this sudden co-movement was a result of the 2008 Global Financial Crises (GFC). As the global oil prices declined during this period, so did palm oil prices and the price of ES also followed suit. At high frequency periods, i.e. 64 days and above, the findings suggest that there was a significant co-movement between CPO and ES especially during the GFC period. Hence, based on these findings we can conclude that Malaysian Shariah Stock Index co-move with crude palm oil prices in the long term but not in the short term. Therefore, as investors with exposures to palm oil, they should consider this relation in their decision making and should they want to diversify by investing in ES, they should not keep it more than 64 days.

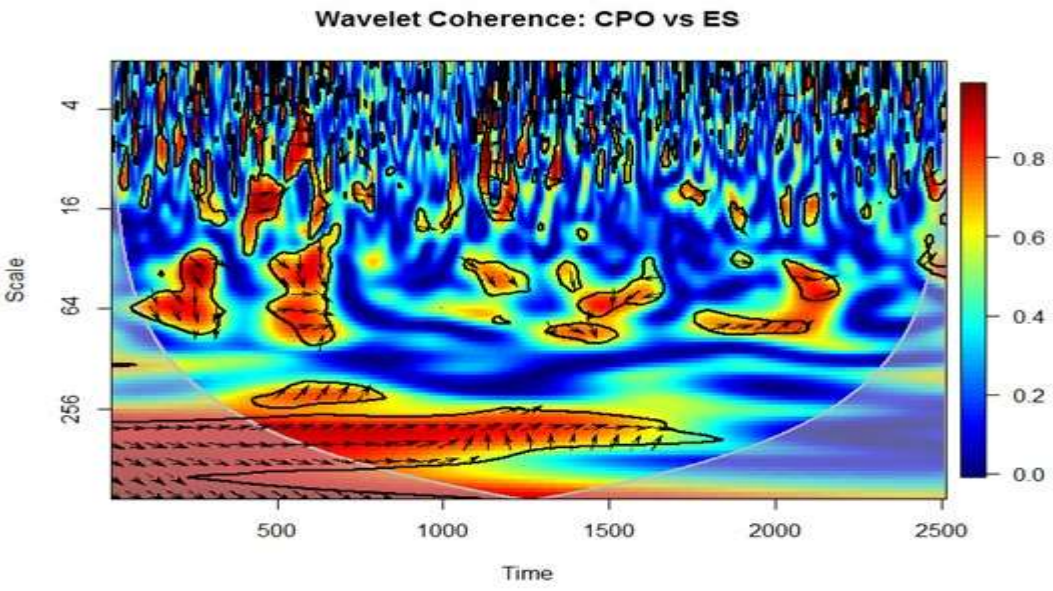

Figure 1:Continuous Wavelet Transform for CPO and ES

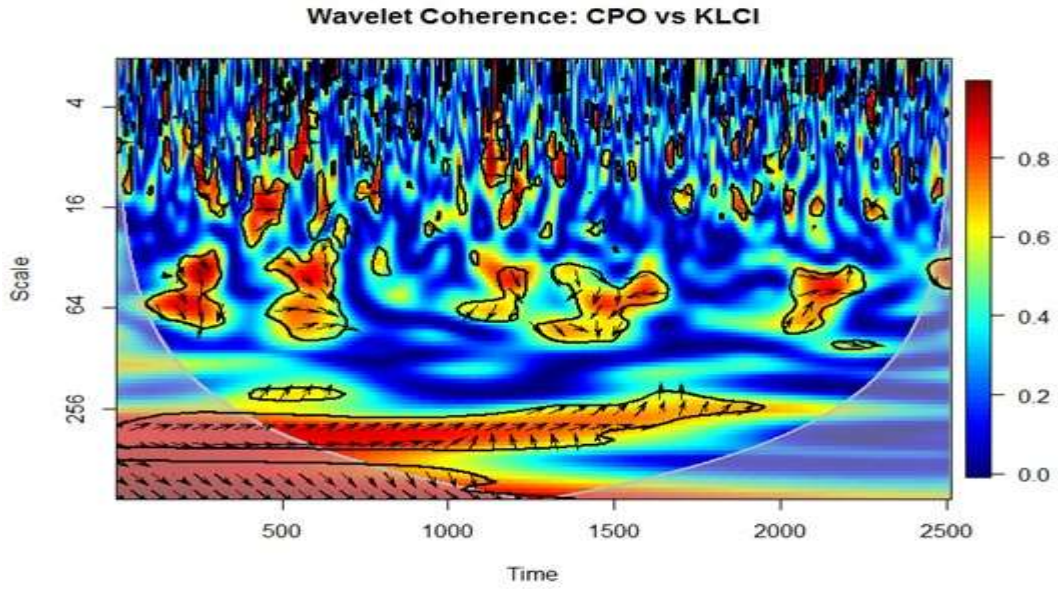

Figure 2: Continuous Wavelet Transform for CPO and KLCI

Figure 2 represents the estimated continuous wavelet transform and phase difference as well as the co-movement between Index return of FTSE Bursa Malaysia KLCI and crude palm oil price returns. From the bigger picture, we can see that the relation of Malaysian Conventional Stock index relates similarly to CPO as its Islamic counterpart. We can observe that for the lower frequency period, i.e. 2 to 16 days, there was not much co-movement between the two variables as indicated by the pattern of mostly blue region. Moving on to the mid frequency period, i.e. 16 to 64 days, there was significant co-movement between the two variables especially in the earlier months of 2009. The arrows also indicate that they were positively correlated, and that CPO leads ES during this period. We believe this sudden co-movement was a result of the 2008 Global Financial Crises (GFC). As the global oil prices declined during this period, so did palm oil prices and the price of KLCI also followed suit. It is also important to note that at around mid 2013, the two variables co-moved significantly but in the opposite direction. At high frequency periods, i.e. 64 days and above, the findings suggest that there was a significant co-movement between CPO and KLCI especially during the GFC period. Hence, based on these findings we can conclude that Malaysian Conventional Stock Index co-move with crude palm oil prices in the long term but not in the short term. Therefore, as investors with exposures to palm oil, they should consider this relation in their decision making and should they want to diversify by investing in KLCI, they should not keep it more than 64 days.

Figure 3 represents the co-movement between Index return of FTSE Bursa Malaysia Emas Shariah and Index return of FTSE Bursa Malaysia KLCI. From our observations, it is evident that the co-movements between these two indices are highly significant for all frequency. Both indices are also positively correlated. Furthermore, this also explains why our results on the co-movements of these indices with CPO were very similar in nature. This points to us that the Islamic Index does not allow diversification and we assume that the Shariah screening process conducted on these stocks prevent the index from being disadvantageous relative to its conventional counterpart.

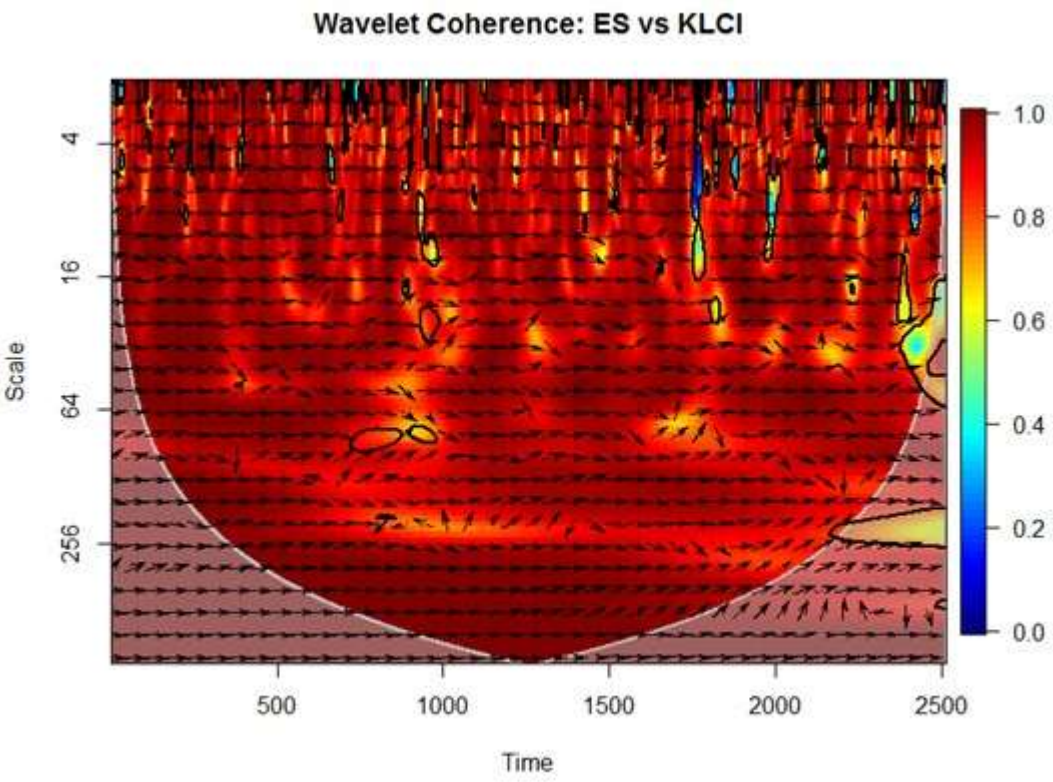

Figure 3:Continuous Wavelet Transform for ES and KLCI

4.2 Maximum Overlap Discrete Wavelet Transformation (MODWT)

MODWT was also applied to the data to determine the robustness of our findings from our wavelet CWT analysis. Unlike CWT, MODWT requires the time scales for the returns to be specified. Results for the MODWT was generated using R structural programming. The individual cross-correlation functions correspond to – from bottom to top – wavelet scales λ1 …….., λ8 which are associated with changes of 1-2, 2-4, 4-8, 8-16, 16-32, 32-64, 64-128 and

128-256 days. The red lines bound approximately 95% confidence interval for the wavelet cross-correlation. If the curve is significant on the right side of the graph, the second variable is leading. However, if the curve is significant on the left side, it is the opposite. If both 95% confidence levels are above the horizontal axes, it is considered as significant positive wavelet cross-correlation but if both are below, it is considered as significant negative wavelet cross-correlation.

Here, we report the MODWT-based wavelet cross-correlation between the CPO and ES and CPO and KLCI with Figure 4 and Figure 5 respectively. Figure 4 indicates wavelet cross-correlation between CPO and ES. From the figures, we can observe that at wavelet level 8 which is associated with 128-256 days, the graph skewed to the right hand side with significant negative value implying that the stock index leads CPO. Similar findings were obtained in Figure 5 for CPO and KLCI.

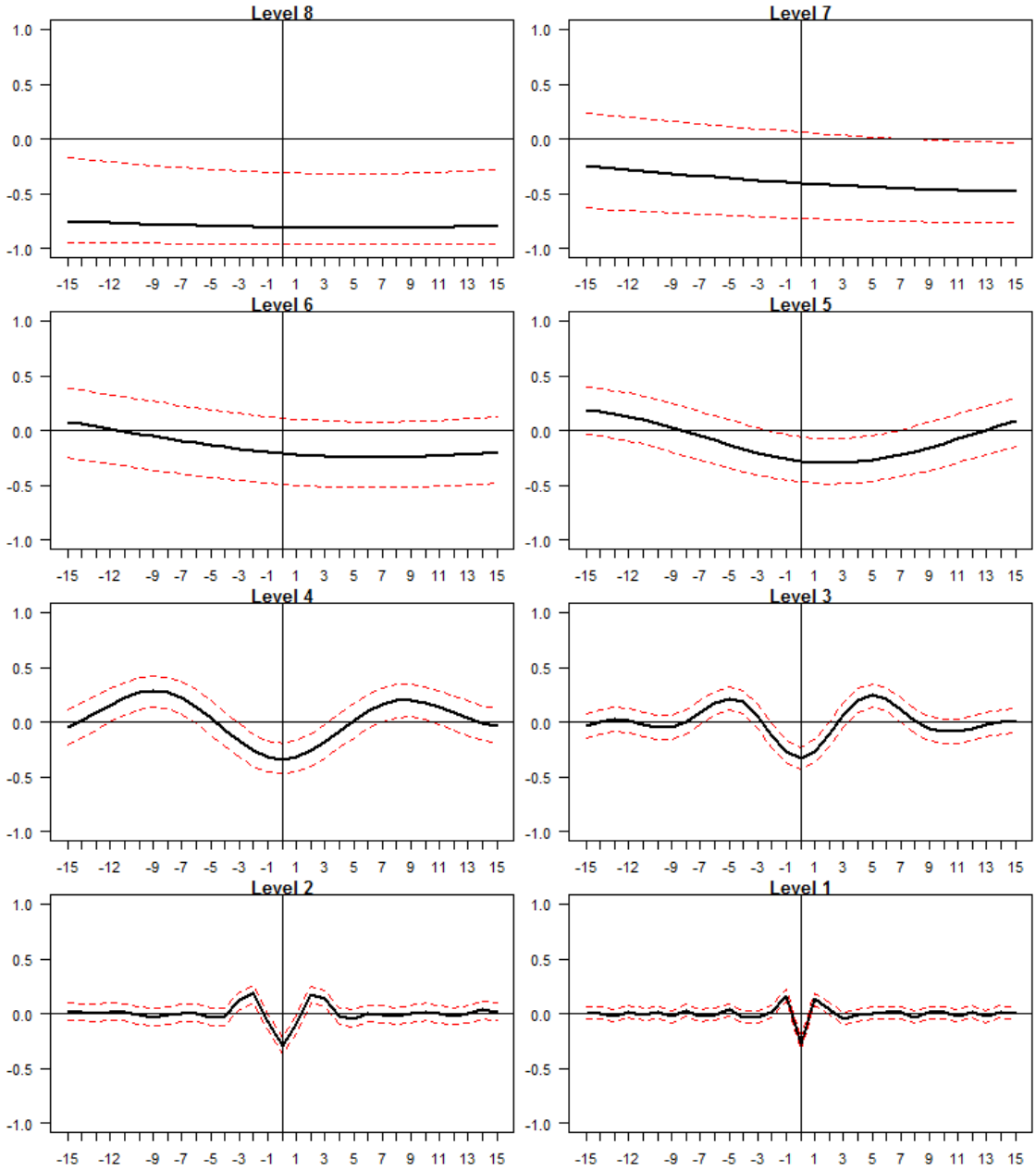

Figure 4:Maximum Overlap Discrete Wavelet Transformation – CPO vs. ES

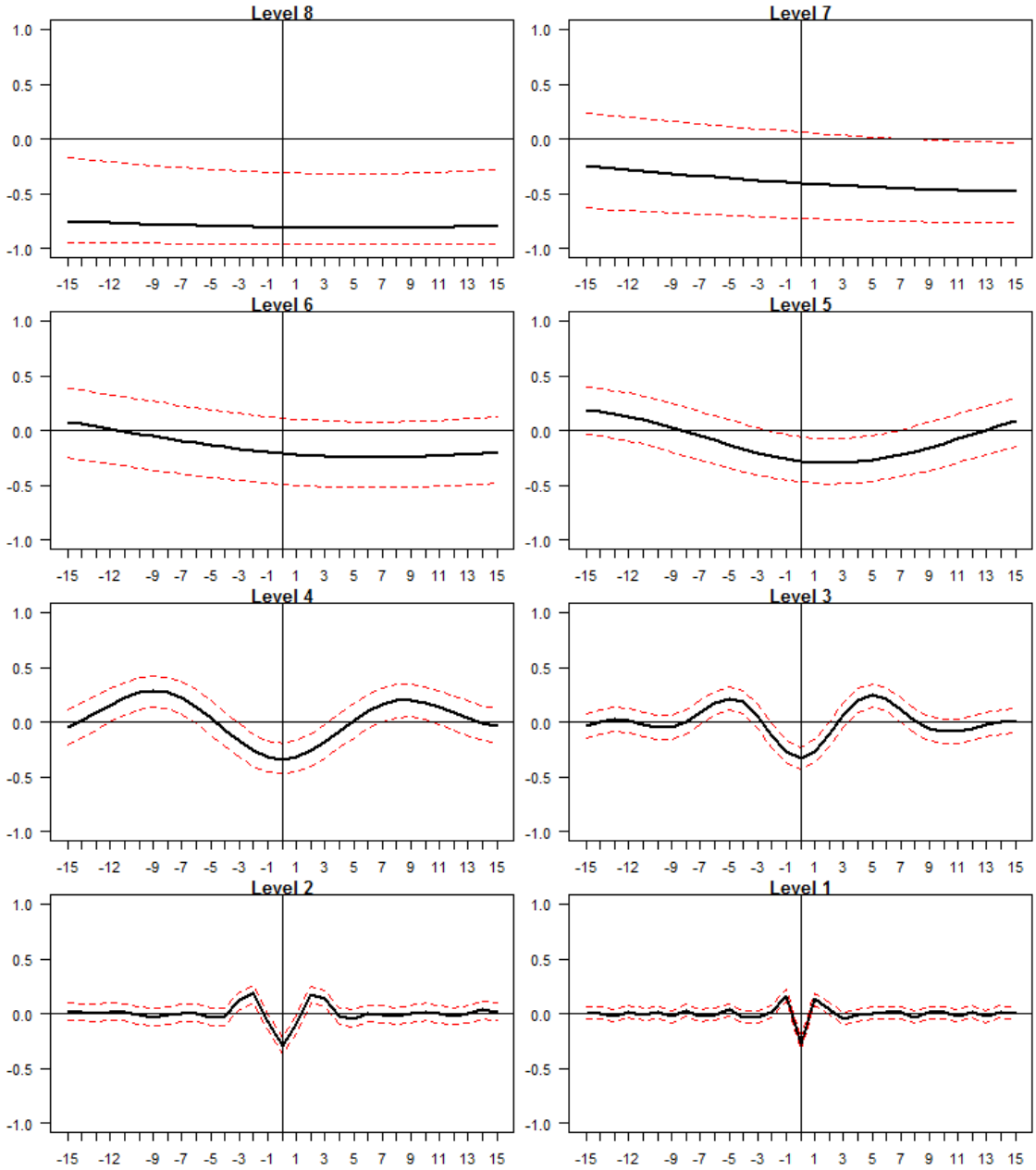

Figure 5: Maximum Overlap Discrete Wavelet Transformation – CPO vs. KLCI

5.0 CONCLUSION, IMPLICATION & LIMITATION

This study was conducted with the main goal of ascertaining the co-movement between crude palm oil price returns with the index returns of two stock indices, namely FTSE Bursa Malaysia Emas Shariah and FTSE Bursa Malaysia KLCI. Daily data from January 2007 up until mid-May 2017 were used and the methods CWT and MODWT were employed. The Wavelet coherence, the main methodology for this analysis decomposes a signal into various time scales without losing time related information and at the same time identifying the various time scales at which the factors that influence the CPO price operates. It is found that the

relationship between CPO and the stock market in Malaysia, albeit conventional or Islamic is not the same throughout all the time scales. Thus, this multi-scale analysis can help clarify the changes that can occur in such relationships when various timescales are considered.

Our findings from both methods came to the same conclusion. Firstly, we found that both the conventional and Islamic stock markets are strongly correlated with each other. Secondly, the co-movements of these stock markets towards price of CPO were similar in nature. The first implication is that, whatever happens to the conventional market, the same thing can be expected to happen with the Islamic stock market. The second implication, although both stock markets have similar co-movements with CPO, it is important to note that for short and medium holding periods, there are no co-movements with CPO except during the crisis in 2008 (only for medium term). However, for the long term, there is significant co-movement between CPO and the two stock markets – and it is especially strong during the crisis of 2008. Thus, this signifies that for long term forecast, should the palm oil industry in Malaysia become volatile, both conventional and Islamic stock market in Malaysia will positively reciprocate. Therefore, in our humble opinion, these findings are of crucial importance to investors, especially those with exposures to palm oil for this would allow them to properly strategize according to their investment horizons.

Nevertheless, this study may not be entirely comprehensive. In this study, we only considered one commodity and two stock markets. Future studies may include the other products from the palm oil industry as well as other stock market from the neighbouring ASEAN and Asian region as this is where the demand for palm oil is high. Lastly, we sincerely hope that this study and its findings would be able to contribute to the growing importance of the palm oil industry as knowledge in this nexus is still relatively scarce. Any shortcomings and unintended errors in this study is a reflection of the author alone.

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