



Wavelet Coherence Analysis on Crude Oil Prices And Stock Market Prices of Retail Companies In Malaysia

Nurin Amira Arezan Norizam, Norhaiza Ahmad*

Department of Mathematical Sciences, Faculty of Science, Universiti Teknologi Malaysia

*Corresponding author: norhaiza@utm.my

Abstract

In order to understand market behavior, extensive research has been conducted on the relationship between crude oil prices and retail company stock prices. However, most of these studies have overlooked the frequency-varying correlations of stock prices and focused solely on their temporal aspects. The objective of this research is to analyze the co-movement between two different time series: the stock price returns of selected retail companies in Bursa Malaysia and crude oil prices, using the Wavelet Coherence method. Wavelet coherence is particularly well-suited for analyzing nonlinear and nonstationary data, which are common in many real-world applications. This analysis utilizes monthly stock price return series and crude oil prices from January 2018 to December 2022. The results indicate a strong co-movement between oil prices and the stock volume index returns of retail companies from January 2020 to June 2022, as well as from January 2018 to March 2019. The co-movement is found to be more pronounced in the long term, and stock price returns are sensitive to higher oil prices resulting from demand shocks. Different markets have the potential to lead or lag other markets at varying scales, which may attract international and local investors.

Keywords: wavelet coherence; co-movement;

1. Introduction

In recent years, there has been increased debate and research on the connection between the stock market and the price of crude oil, particularly in Malaysia. The measurement of this dynamic relationship is important for portfolio management, asset allocation, and risk management. The price of oil has been a topic of extensive research due to its significant impact on the global economy. Fluctuations in oil prices can lead to inflation or recession and affect the cost of production, consumer confidence, and financial markets. Previous research has shown a correlation between rising oil prices and recessions, especially in the United States.

The relationship between stock market returns has also become a significant focus for academic scholars. Studies have explored this connection to better understand market behavior and develop investment strategies, risk management techniques, and portfolio optimization methods. However, most of these studies focus on the temporal aspect of index returns and overlook the importance of frequency-varying characteristics in their relationships.

A stock market index is a single number calculated from the prices of multiple stocks, serving as a benchmark for portfolios like mutual funds. Indices also enable the creation of investment products, providing investors exposure to markets or groups of stocks, especially in barriers to investment. Over the past twenty years, stock indices have evolved from economic indicators to more technical functions, reflecting investors' feelings about the economy.

Crude oil is a crucial component of Malaysia's national industry. Although Malaysia's crude oil production has been volatile, it is expected to continue declining until the end of 2022. The Malaysian stock market, known as Bursa Malaysia, is an important bourse in the ASEAN region. In 2022, Bursa Malaysia was recognized as the stock exchange with the best Islamic listing options. Understanding the relationship between crude oil prices and stock prices in the Malaysian market is essential for analysis and decision-making.

The objective of this study is to analyse the behavior of Malaysian retail stock prices and crude oil prices from 2018 to 2022 using descriptive statistics. Additionally, the study aims to identify the co-movement between retail stock prices and crude oil prices using the wavelet coherence method, which captures frequency-varying features. The goal is to describe the relationship between retail company stock prices and crude oil prices. In order to achieve the objectives, we consider daily returns of Syariah Compliant Equities Prices in consumer products and services in Malaysia, and crude oil prices in Malaysia from the period 2018 to 2022. We will determine and describes the co-movement between two different time series data using the wavelet coherence analysis method.

2. Materials and methods

Wavelet coherence is a method that takes information from both the time domain and the frequency domain and combines them (Pal & Mitra, 2019). According to the Fourier spectral approaches, the wavelet coherence (WTC) is defined as the ratio of the cross-wavelet spectrum to the product of the spectrum of each series. It is also treated as the local correlation, both in terms of time and frequency, between two time series that are denoted by the notation $x(t)$ and $y(t)$. In accordance with Torrence and Webster (1999) (as cited in Tiwari et al., 2021), we define the WTC of two time series using the $W_x(\tau, s)$ and $W_y(\tau, s)$ wavelet transformations as the absolute value squared of the smoothed cross-wavelet spectrum, which is then normalised by the smoothed wavelet power spectra:

$$R^2(\tau, s) = \frac{|S(s^{-1}W_{xy}(\tau, s))|^2}{S(s^{-1}|W_x(\tau, s)|^2) \cdot S(s^{-1}|W_y(\tau, s)|^2)} \quad (1)$$

where S denotes a smoothing technique across time as well as frequency (scale), and $0 \leq R^2(\tau, s) \leq 1$ smoothing distance. A value of $R^2(\tau, s)$ that is close to 1 indicates that the two underlying time series are dependent on one another for a certain frequency.

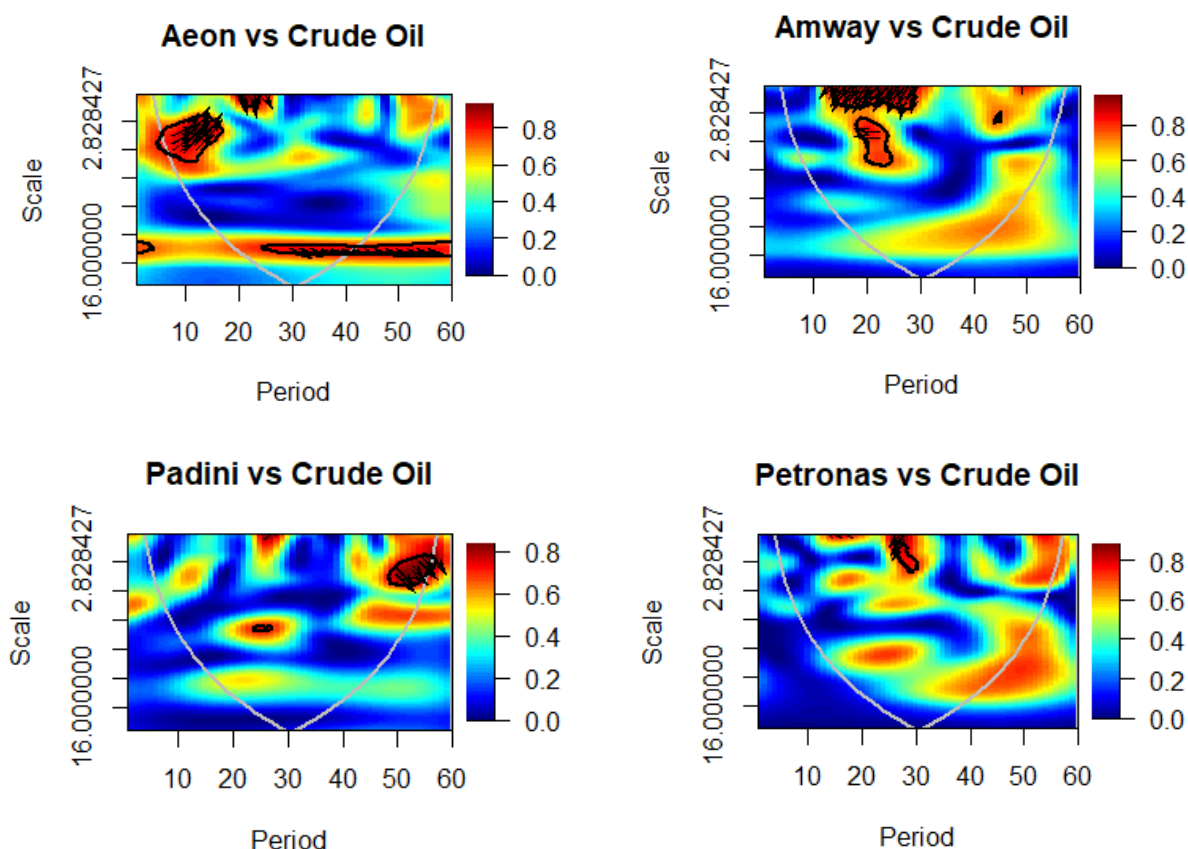
Because the wavelet coherence coefficient is a squared number, it is possible that it will not be possible to separate the positive correlation from its opposite negative correlation. Therefore, (Torrence and Compo, 1998; Pal & Mitra, 2019) proposed a method for distinguishing between positive and negative coherence by looking for signals of deferments in the oscillation of the underlying time series. This would allow the researchers to determine whether kind of coherence was present. The difference in phase between wavelet coherence may be represented as follows:

$$\phi(\tau, s) = \tan^{-1} \left(\frac{\Im\{S(s^{-1}W_{xy}(\tau, s))\}}{\Re\{S(s^{-1}W_{xy}(\tau, s))\}} \right) \quad (2)$$

where \Im stands for an imaginary operator and \Re for a real part operator. In this piece, we provide a bi-dimensional map in which the results of the wavelet coherence phase difference are shown by black arrows. When two underlying time series show a positive correlation, the wavelet coherence phase difference will eventually become zero for a given scale. This will be shown by arrows pointing in the correct direction. On the other hand, arrows will point in the other direction when two underlying time series have a negative correlation with one another (also known as being in anti-phase with one another). When comparing two series, an arrow pointing downward indicates that the first series is ahead of the second series by $\frac{\pi}{2}$ and vice versa.

3. Results and discussion

The wavelet coherence analysis revealed important findings regarding the co-movement between retail company stock prices and crude oil prices. The analysis was conducted in the time-frequency domain, with higher coherence values represented by brighter colors or higher intensity levels, indicating stronger synchronization between the two time series.



The white contour represents the 5% significance level derived from Monte Carlo simulations utilising the phase-randomized surrogate series. The cone of influence, where peripheral effects may distort the image, is represented by a paler hue. The range of the power colour code is from blue (low power) to red (high power). The Y-axis represents frequency or magnitude, and the X-axis represents the investigated time period (observation 60 corresponds to January 2018 to December 2022). Arrows indicate the phase disparities between the two series. The variables are in-phase if the arrows pointing to the right point in the same direction and have cyclical effects on each other. If the arrows point to the right and up, the first market index is leading (it causes the second index). If the arrows point downwards, the first index is behind schedule. Left-pointing arrows indicate that the variables are anti-phase (have anti-cyclical effects on one another). If the arrows point left and up, the first index is ahead, and if they point left and down, it is behind.

Figure 1 Wavelet coherence analysis for two time series data between retails company which are Aeon Co M Bhd, Amway Malaysia Holdings Bhd, Padini Holdings Bhd, Petronas Dagangan Bhd and crude oil price.

The analysis showed that the co-movement between the stock index series of Aeon Co M Bhd and crude oil prices was relatively strong from January 2020 to October 2022, particularly at a 3-month scale. The right-pointing arrow pointing upwards indicated a positive correlation, with Aeon stock prices leading the association. This suggests that during the period of economic crisis and financial turmoil, Aeon's stock prices influenced the movement of crude oil prices.

In contrast, the co-movement between Amway Malaysia Holdings Bhd stock prices and crude oil prices was minimal, except at the scale of 0 to 3 months from January 2018 to January 2019. The left pointing down arrow indicated a negative correlation, with Amway stock prices being led by crude oil prices in the long term.

For Padini Holdings Bhd, the co-movement with crude oil prices was observed at the lower scale of 0 to 3 months, indicating a low-frequency relationship. This was particularly notable from January 2018 to March 2018 and April 2022 to October 2022. The arrows confirmed that Padini's stock prices led the movement of crude oil prices during the period of economic recovery. However, from January 2018 to March 2018, there was no clear leading or lagging relationship between the two time series.

The co-movement between Petronas Dagangan Bhd stock prices and crude oil prices was weakly correlated, with significant coherence observed at short time periods and scales. The stronger coherence was found at a 0 to 2.83-month scale from August 2019 to October 2020, indicating that Petronas Dagangan's stock prices were led by crude oil prices. Another notable co-movement occurred from June 2019 to May 2020 at a scale of 8 months, with Petronas Dagangan stock prices leading the movement of crude oil prices.

Overall, these findings provide insights into the co-movement between retail company stock prices and crude oil prices, with different degrees of correlation observed across various time periods and scales.

Conclusion

This article demonstrates the value of wavelet analysis in investigating the variability of non-stationary time series. The study focuses on the co-movement between the stock market volume index of Malaysia's retail companies and crude oil prices. Wavelet coherence analysis is used to model the co-movement over a period of January 2018 to December 2022. The findings indicate that the co-movements vary over time and different scales. The study suggests a weak connection between retail companies and crude oil prices in the medium to long term, likely due to the integration of Malaysia's economy with the global economy. The presence of volatility in the co-movement during the economic downturn, particularly in the COVID-19 era, is evident. Overall, the results suggest no relationship between the retail companies and crude oil prices, possibly influenced by the impact of the economic downturn in 2020-2021. The results of the wavelet coherence approach offer a suitable signal of the efficient investment choice to the investors and policy makers, which will aid the investors in achieving the appropriate understanding of Shariah-compliant market behaviour in Bursa Malaysia.

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