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The impact of exchange rate, oil price and gold price on the Kuwaiti stock market: a wavelet analysis

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Abstract

This paper examines the impact of the exchange rate, oil price and gold price on the Kuwaiti stock market using a wavelet analysis, namely, cross-wavelet coherency and partial cross-wavelet coherency. This method is used to test for nonlinear causality and decompose the data into various time frequencies to better understand various investment horizons. These interactions were examined based on daily observations from 02 January 1996 to 28 September 2017. The findings show a positive relationship between stock market and exchange rate in all frequencies. This relationship is being remarkably weak once the impact of oil price is removed. Besides, the correlation between the stock market and oil price is positive in low-frequency bands and will be reduced after eliminating the effect of the exchange rate. Regarding gold price, there is only a negative short-term relationship with the stock market during crisis periods. In summary, the impact of oil price is indirectly positive on the stock market by leading the movement of the exchange rate.

JEL classification: G15, D53, Q02

Keywords: Wavelet, Kuwaiti stock market, Exchange rate, Oil prices, Gold prices

1. Introduction

Exchange rate, oil price and the gold price are considerable concerns due to their significance to market integration, portfolio diversification, cross-hedging, and cross-speculation (Baruník et al., 2016). The empirical analysis of the study includes stock index, exchange rate, oil price and gold price. It is important to state that oil price is due to the nature of the Kuwaiti economy which relies heavily on oil revenue as an engine for its economic system (Khamis and Hamdan, 2016). Furthermore, gold is deemed a store of wealth which is important for investors as a hedging asset.

Employing wavelet analysis through looking at patterns instantaneously in the time and frequency domains is a common practice in economics and finance (Gençay,

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2001; In & Kim, 2006; Altarturi et al., 2016). The main features of this analysis are explained in two points: 1) various investment horizons are important portfolio selection as diversification tools for reducing risks, and 2) various investors target different investment horizons depending on their strategies such as some investors focus on the long time-scale and others prefer the short time-scale.

By adopting wavelets analysis, we can investigate the existence of dynamic relationships across various investment horizons. In this regard, the following questions are explored: To what extent do exchange rate, oil price and gold price co-move with the stock index at different investment horizons? Are correlations among these variables varied at various investment horizons?

This research contributes to the literature in the following ways:

- It focuses on the Kuwaiti stock market which has been overlooked by researchers despite its experience in this field;
- It uses nonlinear causality tests to study the correlation of exchange rate, oil price and gold price on the Kuwaiti stock market due to the nature of financial and economic variables. Most empirical studies used linear relationships (Maghayereh & Al-Kandari, 2007; Hammoudeh & Choi, 2006) which is ineffective because it does not cover certain nonlinear causal relations. Therefore, it is suggested to use the nonlinear method to examine the causality relationships (Chen et al., 2004; Li, 2006; Saiti et al., 2016);
- It uses the wavelet method to decompose the data into various time frequencies which enables us to detect the multiscale nonlinear causality relationships of the exchange rate, oil price and gold price on the Kuwaiti stock market. Most researchers in this field analysed the time series at their original level using cointegration which distinguishes two time-scales (short-term and long-term scales). Therefore, wavelet analysis was conducted to examine the relationship (Altarturi et al., 2016; Maslova et al., 2013; Ng & Chan, 2012); and
- It uses partial wavelet coherence to examine the relationship between stock market and other variables while removing the impact of the common variable which is new to the existing finance literature.

The paper is organised as follows. Part 2 discusses the existing studies that relate to exchange rate, oil price and gold price with the stock index. In part 3, we deliberate on the methodology which suitable to achieve the research objectives. The dataset and empirical findings are discussed in part 4. Part 5 concludes the study which contains implications of the study.

2. Literature review

The stock exchange is one of the main indicators to represent economic strength. It is a platform used by companies to raise funds to expand their activities and contribute to the economy. This section explores the connection between exchange rate, oil price and gold price on the stock index.

2.1. Exchange Rate and Stock Index

The literature on the connection between stock markets and exchange rates has examined the relationship in different regions and countries (Suriani et al., 2015; Yousuf and Nilsson, 2013; Qiao, 1996; Rittenberg,1993).

Suriani et al. (2015) examined the connection between exchange rate and the stock market in Pakistan from 2004 to 2009 and found no correlation between these variables. Additionally, Bhattacharya and Mukherjee (2003) examined the Indian market and found no correlation between the variables. Muhammad and Rasheed (2002) found no significant correlation in four Asian countries over the period from 1994 to 2000. In Sweden, Yousuf and Nilsson (2013) inspected the impact of USD and EUR exchange rates on the stock market performance from 2003 to 2013 and found an insignificant relationship between the markets. In the U.S., Ong and Izan (1999) tested the same relationship and concluded that the connection between them is weak.

In contrast, Soenen and Henniger (1988) found a negative association between the value of the U.S. dollar and stock prices in the U.S from 1980 to 1986. Phylaktis and Ravazzolo (2005) found a positive relationship between the U.S. stock market and foreign exchange markets. Within Asian countries, Pan et al. (2001) studied the impact of exchange rates on seven stock markets in Asia from 1988 to 1998 and found a significant correlation between these variables. Phylaktis and Ravazzolo (2000) analysed five Pacific Basin countries: Hong Kong, Malaysia, Singapore, Thailand and Philippines, from 1980-1998 and found a positive relationship between exchange rate and stock markets. Furthermore, Granger et al. (2000) mentioned that the correlation is positive between the stock market and exchange rate in South Korea and negative in the Philippines during the Asian financial crisis. Also, Mukherjee and Naka (1995) found a negative relationship between the Tokyo Stock Exchange and the exchange rate where the depreciation of Japanese yen against the U.S. dollar improved the stock market.

Researchers did not limit themselves to examining the existence of the correlation or not, but also examined the directional relationship, i.e. whether it is bidirectional or unidirectional. Qiao's (1996) study of Hong Kong, Japan and Singapore over the period from 1983-1994 found a bidirectional relationship in Japan and unidirectional relationship in Singapore. Furthermore, Abdalla and Murinde (1997) found causality in India and Philippines while the results in Pakistan and Korea do not show causality. Griffin and Stulz (2001) examined the impact of the exchange rate on the stock markets in six countries from 1975 to 1997. The impact was less than that exerted on the stock markets in developed countries. In Turkey, Rittenberg (1993) found a unidirectional relationship that runs from price level changes to exchange rate changes, but there is no reverse relation exists.

We observe that the findings of these relationships vary in the previous studies and the existence of various factors such as geographical area, economic conditions, relations with the international world and domestic conditions justify the differences. Furthermore, the trade volume, equity, economic relations and risk assessment contribute to the inconsistency of the results among countries.

The connection between the stock market and the exchange rate was explained by Granger et al. (2000) using the traditional and portfolio approaches. The traditional approach states that changes in exchange rate influence the international competitiveness and trade balance of an economy thereby affecting its real income and output. To simplify, an appreciation of the local currency will affect the exporters, consequently impacting its stock price in the market. This situation could be severe if the economy relies on exports. This means that currency appreciation could show a positive relationship between the exchange rate and stock prices in an import-dominated economy, while the opposite in an export-dominated economy (Tian and Ma, 2010; Yousuf and Nilsson, 2013). Secondly, the portfolio approach claims that the stock market determines the changes in exchange rates where the decrease in stock prices causes a decrease in the wealth of local investors which results in lower demand for money while ensuring lower interest rates.

2.2. Oil Prices and Stock Index

Various studies have examined the relationship between oil price and stock markets (Jones & Kaul, 1996; Papapetrou, 2001). It is important to understand this relationship when the country is exporting or importing oil. In oil-importing countries, if oil prices increase, costs inflate, and profits decrease thereby undermining shareholders' value causing stock prices to decline. The situation differs in exporting oil countries where a positive relationship has been found (Arouri and Rault, 2012). Park and Ratti (2008) examined the impact of oil price shocks on stock returns in the U.S. and 13 European countries over the period from 1986 to 2005. They found that increases in the volatility of oil prices significantly decrease stock returns for many European countries. However, the response of the Norwegian stock market is a significantly positive when an oil prices increase. Apergis and Miller (2009) studied the relationship in eight developed countries and found that the international stock market returns did not respond significantly to oil market shocks. Narayan and Narayan (2010) investigated Vietnam's stock prices during the 2000-2008 period and found that the impact oil prices are statistically positive on stock prices.

Nevertheless, the overall relationship might be ambiguous in some cases. Due to that, researchers investigated the relationship by looking at sectoral reactions when there are oil price fluctuations. In Australia, Faff and Brailsford (1999) found a positive effect on energy-related industries and a negative effect on paper, packaging and transportation industries. In the United Kingdom, El-Sharif et al. (2005) found oil and gas sector equity index increased significantly once oil prices picked up. In Europe and the U.S., Arouri and Nguyen (2010) found that the shock of oil prices can affect the industries differently depending on the nature of the business.

Gulf countries are major international energy market players, and their budgeting is highly dependent on oil price. The non-oil sector also depends on and links to the performance of the oil sector (Khamis and Hamdan, 2016). This leads us to explore the literature to ascertain the impact of oil price on stock exchanges which represent the base of the economy and is deemed the carrier of insurance funds. Hammoudeh and Choi (2006) found that oil prices did not have a direct impact on stock markets when they examined the short-run causality between GCC weekly stock index returns and oil prices. Nevertheless, Maghayereh and Al-Kandari (2007) found that oil prices have a significant negative impact on stock markets over the long period. Furthermore, the results of Arouri and Rault (2012) show that oil prices cause a change in the stock price for all GCC members except Saudi Arabia which is a causal and bidirectional relationship between oil prices and stock market prices. Additionally, Mohanty et al. (2011) found that all stock markets in GCC except the Kuwaiti stock market had a positive relationship with oil price shocks.

Lastly, Khamis and Hamdan (2016) examined stock exchanges of three GCC members against changing oil prices and found negative oil prices tend to have a greater effect on GCC stock markets than positive oil prices. Relating to the sectoral impact, all the sectors in the Saudi stock exchange reacted negatively to negative oil prices. However, oil and gas, industrial and consumer goods sectors were the only sectors affected by oil prices on the Kuwaiti stock exchange. Lastly, the entire Omani market was affected by oil prices except for the industrial sector.

2.3. Gold Prices and Stock Index

Among all commodities, gold is conventionally perceived as a store of wealth and has been a highly conservative investment due to its relative scarcity. Gold is seen as an extremely durable, generally acceptable and easily divisible tangible assent. Investors around the world invest in gold bullion since it is easily portable and measurable and most importantly provides a hedge against inflation, political uncertainty, economic insecurity and slow growth and exchange rate movements (Mahdavi & Zhou, 1997; Ghosh et al., 2004; Capie et al., 2005; Aggarwal & Lucey, 2007; Worthington & Pahlavani, 2007). Gold prices are known to respond quickly to inflationary pressure. Hence, fluctuations in gold prices are of concern to policymakers, investors, financial institutions, central banks, and society at large.

Emerging markets have become an attractive haven of investment for major global financial institutional investors resulting in significant capital inflows from developed markets to emerging markets. However, emerging markets are more vulnerable to negative news and events happening elsewhere which usually results in institutional investments flowing in to or out of the market. This creates an environment of high volatility and uncertainty in these markets. The global stock markets have also been hit by a series of crises and turbulence over the past few decades. These crises have their origin in different economies, but the spill-over effects have been seen in important financial markets around the globe. During these periods, stock markets around the world have shown excessive volatility and drastic drop in its values which has been a cause for concern to regulators, policymakers, financial institutions, portfolio managers, and financial analysts.

Moreover, the uncertainty created in the financial markets due to excess volatility and successive crises has led major market participants to suffer considerably. Hence, portfolio managers and institutional investors need to be cautious while making investment decisions and look for potential hedging instruments. Baur and Lucey (2010) define hedge as an asset that is uncorrelated or negatively correlated with another asset or portfolio on average, especially during times of market stress or crisis since the asset could exhibit a positive correlation in such periods and a negative correlation in normal times. Gold exhibits almost all the properties that serve the criteria to be a hedging instrument. Also, gold is a highly liquid asset, and a well-developed market exists in India where daily trading in gold is possible.

Few studies have examined the significance of gold as a hedge against stocks. Sherman (1982) examines the impact of investment in gold for hedging inflation and for portfolio diversification and finds that gold can enhance the overall rate of return, provide portfolio diversification, and offer flexibility for portfolio managers to counterbalance price deterioration. Sherman (1986) again highlights the diversification benefits of inclusion of gold in a stock portfolio. Jaffe (1989) finds that returns of gold and gold stocks are independent of the returns of common stocks and can be used to diversify a stock portfolio. He finds that including gold in a stock portfolio increases not only the mean returns of the portfolio but also its standard deviation marginally; however, the increased returns compensate for/are more than the increased risk. Chua et al. (1990) also observe similarly that gold bullion can be taken as a meaningful investment for stock portfolio diversification in the long and short runs.

Smith (2002) tests the short-run, and long-run relationship of gold prices and stock exchange returns adducing a weak negative relation between stock indices and gold prices in the short-run and no relation in the long-run. Ghosh et al. (2004) examine the significance of gold as a hedge against political uncertainty, inflation, and currency risks. Capie et al. (2005) use more than thirty years of weekly data (from January 1971 to February 2004) to assess the extent to which gold serves as a hedge against sterling-dollar and yen-dollar exchange rates and observe the time-varying inelastic relationship between gold and these exchange rates. Their findings indicate that gold exhibits the exchange rate hedge property to the degree that appears to be dependent on macroeconomic and political events. Hillier et al. (2006) examine the role of precious metals such as gold, platinum, and silver as investment instruments in the financial market using daily data from 1976 to 2004. They find low correlations between these precious metals and stock market returns, which indicate that these metals can provide diversification benefits for stock portfolios. They also find that these precious metals exhibit hedging ability particularly during the period of crashes and crisis. Gilmore et al. (2009), used daily time series for the sampling period from 1996-2007 and found that the stock market index was linked with gold mining companies' price index in the long-run and that both variables influence each other in the short-run.

Sumner et al. (2010) and Gaur and Bansal (2010) confirmed that, in periods of crisis, falling stock market results always in rising gold prices. Baur and Lucey (2010) investigate the constant and time-varying relations between the U.S., U.K. and German stock and bond returns and gold returns to explore whether gold can act as a hedge and a safe haven. They found that, on average, gold is a hedge against stocks and a safe haven in extreme stock market conditions. Baur and McDermott (2010) explored the impact of gold price on the financial market for the 1979-2009 period. The result illustrated that gold acts as a hedge and a safe haven in the stock market of the U.S. and most European countries. Batten et al. (2010) found a significant impact of gold price volatility on the financial market returns.

According to Ibrahim and Baharom (2011), the emerging interest in gold in times of crises stems from its historical use as a medium of exchange and standard of value with a stable purchasing power over time. He asserts that gold can provide a safe haven to investors or can at least be used to diversify portfolio risk. Wang et al. (2011) assert that except the U.S., long-term equilibrium relationships exist among gold prices, oil prices, exchange rates and stock prices after examining the short-term and long-term interactions between gold price, exchange rate, oil price and stock market indices in US, Germany, Japan, Taiwan and China. Yahyazadehfar and Babaie (2012) found a significant relationship between stock market prices and gold prices and state that the stock market is a reason for increasing gold rate. Yahyazadehfar and Babaie (2012) confirmed that gold price could greatly affect stock prices on the Tehran Stock Exchange. The estimated long-run relationship shows that there is a negative relationship between gold and stock prices. Mensi et al. (2013) studied the correlation and volatility transmission across commodities such as gold, oil, and equity market. The results of their study revealed that S&P500 price affects the gold and oil price volatility. Bhunia and Mukhuti (2013) inspected the relationship between domestic gold price and stock price return using Granger test and found the bidirectional causality between gold price and stock price return. Arouri et al. (2015) made use of the VAR-GARCH model to investigate the effect of gold price volatility on the stock market returns in China for the period from 2004-2011. Their results demonstrated evidence of significant impact of gold price volatility on China's stock market return

3. Methodology

The wavelet technique is used in this paper instead of time series due to its ability to analyse both time domain and frequency domain. Time domain analysis, i.e. time series analysis examines the development of an economic factor with the consideration of time, where period changes keep the time frequency constant so as to examine the tentative features of the factor at a given frequency. On the other hand, frequency domain analysis, i.e. spectral analysis, studies the development of the factor with regards to frequency, where frequency changes with keeping time constant examine the factor feature over the frequency spectrum (Altarturi et al., 2016, 2018; Sakti et al., 2018).

Unlike Fourier and spectral analysis, wavelet analysis decomposes an original time series data to many scales and does not require stationarity of the variables (Aguiar-Conraria & Soares, 2014; Madaleno & Pinho, 2012). It is essential to mention that most of the economic and financial variables are non-stationary in which every variable contains three features: trend, seasonal, and random components. By changing the variable stationary, trend component, i.e. long-term effect, will be removed from the variable (Altarturi et al., 2016, 2018).

Gençay et al. (2001) suggested two kinds of wavelet, i.e. father wavelet (S) and mother wavelet (D). S presents the smooth and low frequency, i.e. trend component, while D describes the detailed and high frequency, seasonal and random components. S and D are explained as:

$$S_{N,k}(z) = \int_{-\infty}^{\infty} \tau_{N,k} f(z) dz \tag{1}$$

$$D_{n,k}(z) = \int_{-\infty}^{\infty} \vartheta_{n,k} f(z) dz \ \ (n = 1,2, \dots, N) \tag{2}$$

where $S_N(z)$ represents smooth approximations and $D_n(z)$ represents detailed approximations. The highest-level approximation $S_N(z)$ is the smooth, while the details $D_1(z)$, $D_2(z)$, …, $D_n(z)$ are linked with oscillations of length 2-4, 4-8,..., 2^N-2^{N+1}.

3.2. Wavelet Coherency

Wavelet coherency is a suitable method to identify any likely interaction among two varibles via studying scale space and time intervals. This method improves correlation analysis by exposing intermittent correlations between two variables and their significant correlation relationship within time domain and scale space (Aguiar-Conraria & Soares, 2014; Bhuiyan et al., 2018a, 2018b). Furthermore, this method adequately represents the causal relationship between the two variables (Benhmad, 2012). Consequently, wavelet coherence can find, more efficiently, the correlation among oil prices, gold prices, and the value of USD. This method is useful to apply on relationship analysis researches (Ng & Chan, 2012; Grinsted et al., 2004). The wavelet coherency.is given by Torrence and Webster (1999) as:

$$R_n^2(s) = \frac{\left|\forall\left(s^{-1} W_n^{XY}(s)\right)\right|^2}{\forall\left(s^{-1}\left|W_n^X(s)\right|^2\right)\forall\left(s^{-1}\left|W_n^Y(s)\right|^2\right)} \tag{3}$$

where $R_n^2(s)$ is the squared wavelet coherency value and $\forall$ is a smoothing operator determined as $\forall(W) = \forall_{scale}(\forall_{time}(W_n(s)))$, in which $\forall_{scale}$ denotes smoothing over the wavelet scale axis and $\forall_{time}$ indicates smoothing in time.

3.1.1. Higher Order Coherency: Partial wavelet coherence

When three variables, or more, are specified to determine who is the leader among them and to assess the association between two of them, it is central to consider the influence with the other variables. In this perspective, there is similarity with the Fourier spectral situation, Mihanovic et al. (2009) used partial wavelet coherence to examine a correlation between two variables after removing the effect of a common variable in marine sciences.

Like partial correlation, partial wavelet coherence is a method to calculate wavelet coherence between two series, x and y, after eliminating the impact of their common variable, z. Therefore, comparable to the traditional correlation coefficient, it can be sensed from wavelet coherence as a localised correlation in the time–scale space (Grinsted et al. 2004). As expressed in equation (3), wavelet coherence between x and y, y and z, and x and z can be written as

$$R_n^{XY}(s) = \frac{|\forall(s^{-1}W_n^{XY}(s))|}{\forall(s^{-1}|W_n^X(s)|)\forall(s^{-1}|W_n^Y(s)|)} \tag{4}$$

$$(R_n^{XY})^2(s) = R_n^{XY}(s) \times R_n^{XY}(s)^* \tag{5}$$

$$R_n^{YZ}(s) = \frac{|\forall(s^{-1}W_n^{YZ}(s))|}{\forall(s^{-1}|W_n^Y(s)|)\forall(s^{-1}|W_n^Z(s)|)} \tag{6}$$

$$(R_n^{YZ})^2(s) = R_n^{YZ}(s) \times R_n^{YZ}(s)^* \tag{7}$$

$$R_n^{XZ}(s) = \frac{|\forall(s^{-1}W_n^{XZ}(s))|}{\forall(s^{-1}|W_n^X(s)|)\forall(s^{-1}|W_n^Z(s)|)} \tag{8}$$

$$(R_n^{XZ})^2(s) = R_n^{XZ}(s) \times R_n^{XZ}(s)^* \tag{9}$$

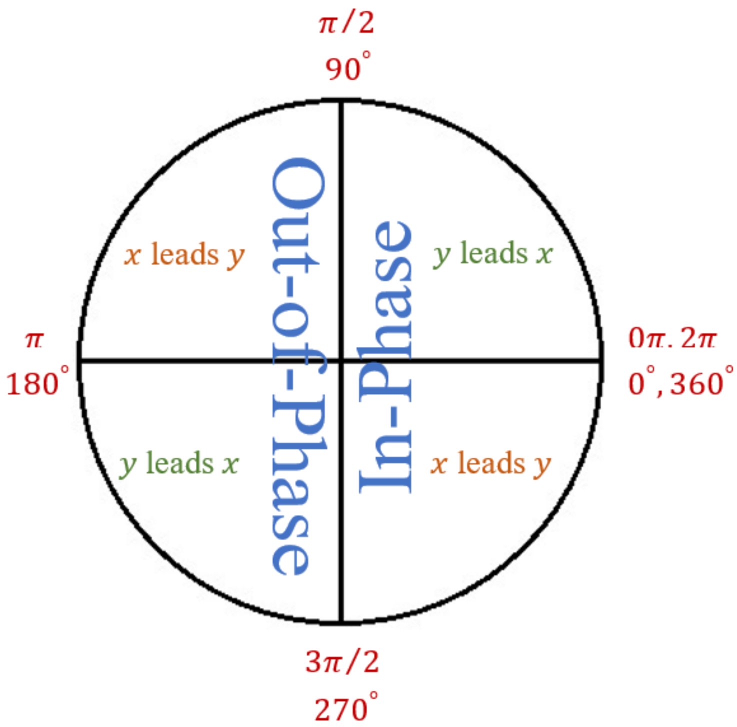
According to Mihanovic et al. (2009), the concept of partial wavelet coherence can be extended from simple linear correlation. Therefore, the partial wavelet coherence squared between x and y after eliminating the impact of z, can be defined as

$$PR_n^{XYZ^2}(s) = \frac{\left|R_n^{XY}(s) - R_n^{XZ}(s) \times R_n^{XY}(s)^*\right|^2}{(1 - R_n^{XZ}(s))^2 (1 - R_n^{ZY}(s))^2} \quad (10)$$

where $PR_n^{XYZ^2}(s)$ is the squared partial wavelet coherency value which ranges from 0 to 1, like simple wavelet coherence. In that case, if the partial wavelet coherency value is a low squared while it was a high squared at wavelet coherence, it means that the two time series, x and y, are not significantly correlated on that given time frequency space. Also, it denotes that time series z affects the variance of x and y, and contrariwise for the opposite case. If both $PR_n^{XYZ^2}(s)$ and $PR_n^{XZY^2}(s)$ are significant, means that both y and z are significantly having an impact on x. The coherences found in this method does not depend on the number of input time series.

The value of wavelet coherence and partial wavelet coherency varies between 0 and +1 which depict all features of the correlation, by wave method, between two non-stationary time variables at a specific time over particular scale (Tonn et al., 2010; Akoum et al., 2012). The arrow's angle, θ_{xy}, of the wavelet coherence and partial wavelet coherence is known as a phase difference, which shows the correlation type and causality relationship where indicate cause-effect relationship by showing leads-lag between two-time series, x and y. Zero phase difference indicates that the time series x and y move simultaneously at specific time space and scale space. When $\theta_{xy} \in (3\pi/2, 2\pi)$ $and \in (0, \pi/2)$ x and y move in-phase, i.e. same direction, while when $\theta_{xy} \in (\pi/2, \pi)$ $and \in (\pi, 3\pi/2)$ x and y move out-of-phase, i.e. opposite direction. Regarding leader variable, x leads y if $\theta_{xy} \in (\pi/2, \pi)$ $and \in (3\pi/2, 2\pi)$, i.e. the arrow indicates to right down or left up, whereas y leads x if $\theta_{xy} \in (0, \pi/2)$ $and \in (\pi, 3\pi/2)$, i.e. arrow indicates right up or left down. The Figure 1 shows the phase difference among time series x and y.

Figure 1: Phase difference circle



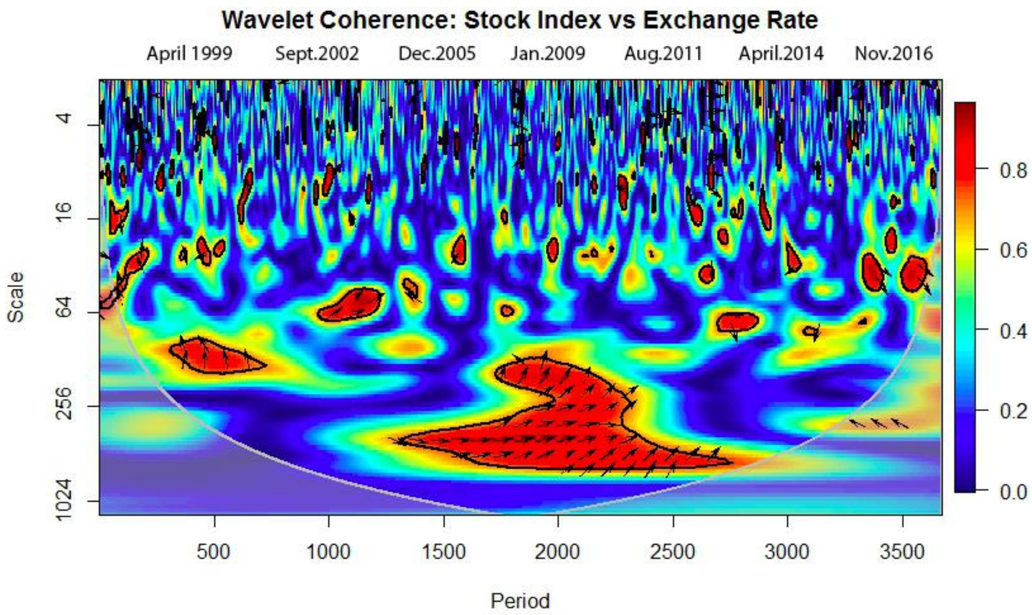
4. Data and empirical findings

To examine the interactions of KWD/USD real exchange rate, oil prices and gold prices on the Kuwaiti Stock Index, daily observations from 02 January 1996 to 28 September 2017 were collected from the DataStream. Since oil and gold are priced internationally in USD, therefore the KWD/USD exchange rate is selected among the variables to examine its effect on the stock market. The dataset includes oil prices represented by Crude Oil Prices: West Texas Intermediate (WTI), gold prices represented by Gold Fixing Price (closing price) in the London Bullion Market based on the USD, and the KWD/USD real exchange. Zhang et al. (2008) stated that the nominal price should be considered as the significant basis of the final price. This study, therefore, used the change in nominal log data to conduct the analysis.

Our results will discuss the relationship of KWD/USD real exchange rate, oil prices and gold prices on the Kuwaiti Stock Index. To understand the correlation between these variables, wavelet coherence and partial wavelet coherence were applied which exhibit the lead-lag relationship and the dynamics of co-movement among the variables concerning time and frequency domains.

In respect to the coherence of stock index and exchange rate, Eq. (3) was estimated and the empirical results are plotted in Figure 2. The horizontal axis is tied to period, i.e. time, while the vertical axis linked to scale, i.e. frequency in day units. The colour gradation indicates cohesion varying from 0, navy blue, to +1, dark red. The areas with warmer colours denote a significant interrelationship while areas with colder colours mean lower dependency and the insignificant relationship between two series. The arrow angels, i.e. phase difference, indicate the movement direction and lead–lag relationship such as aforementioned.

Figure 2: The cross-wavelet coherency: stock index and exchange rate, 1996 - 2017



Per the coherency function, Figure 2 shows a significant interrelation between stock index and exchange rate in different horizons. It shows that there is a positive relationship where both of them move in the same direction, indicating that stock index was lagging with a cyclical effect, which is in line with the traditional approach. We can observe that the red region dominates the low frequencies starting from 2004 until the beginning of 2013. In other words, exchange rate leads the stock market where an appreciation of the KWD currency will most likely increase the company's profit and will reflect positively on its stock price. Additionally, in the case of KWD's depreciation, the stock prices may fall due to the fear of investors that depreciation hits growth and profitability of the firms. This finding is similar to Granger et al. (2000) and Phylaktis and Ravazzolo (2000; 2005).

After eliminating the impact of the oil price on the stock index-exchange rate relationship, Eq. (10) was estimated to find the partial coherence of stock index and exchange rate relationship as shown in Figure 3. There is a different result compared to cross-wavelet coherency whereby the blue regions were dominating in all frequencies. After removing the effect of the oil price, the coherence of the stock index and exchange rate are remarkably low. It means that the stock index and exchange rate are not significantly correlated. Also, it denotes that oil price leads the impact on the variance stock index and exchange rate. This result signifies the dominant role of oil price, indicates that oil price is the main factor driving the movement of the USD. Therefore, oil price leads the exchange rate.

Figure 3: The partial cross-wavelet coherency: stock index and exchange rate | oil price

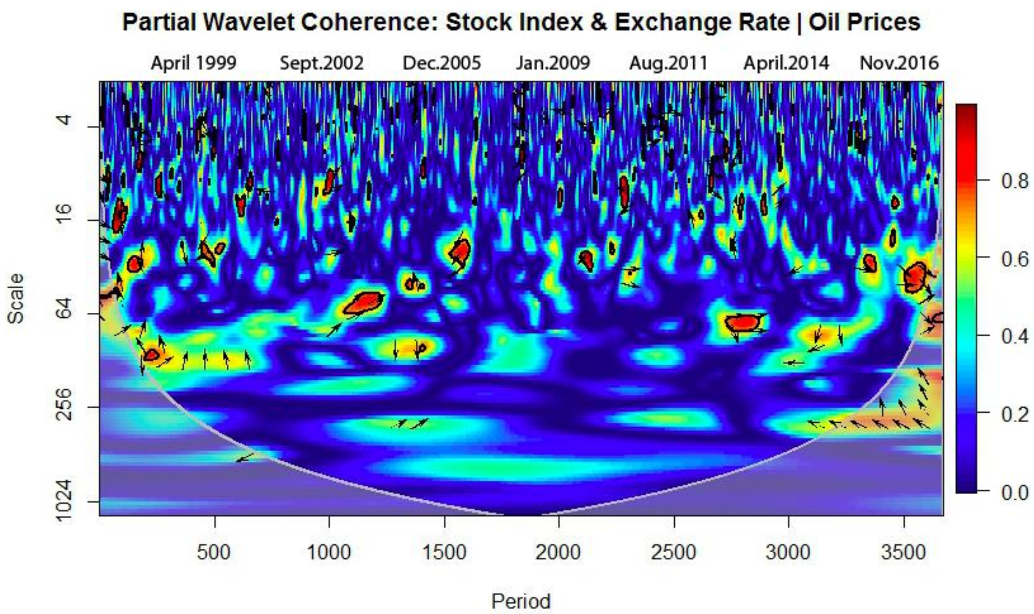


Figure 4 illustrates the partial cross-wavelet coherency of the relationship between the stock index and exchange rate after eliminating the impact of gold price. Partial cross-wavelet coherency provides evidence in line with cross-wavelet coherency in which the relationship between these variables is not affected even after eliminating the impact of gold price.

Figure 4: The partial cross-wavelet coherency:
stock index and exchange rate | gold price

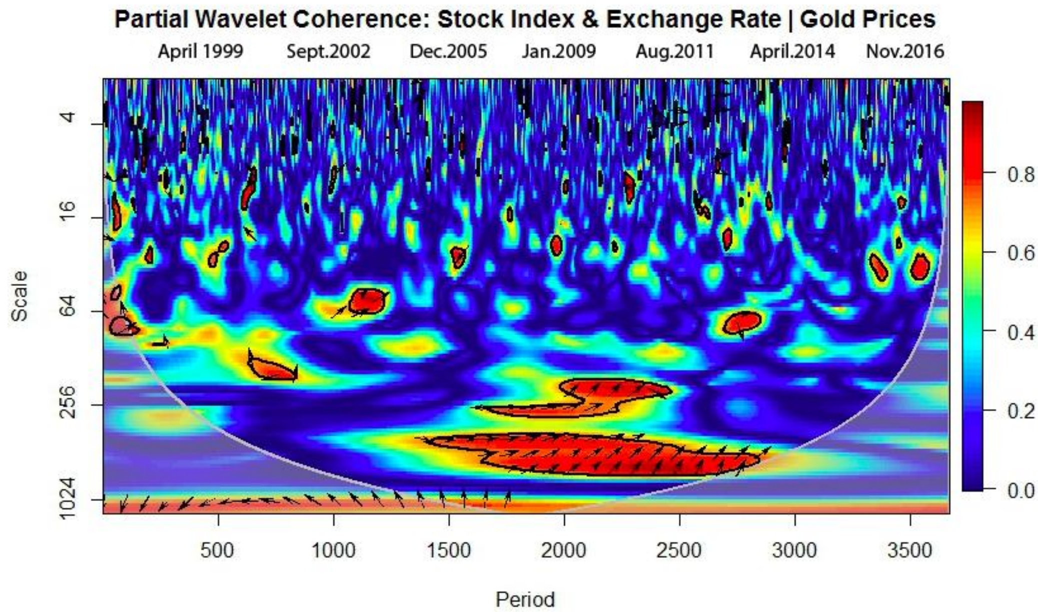
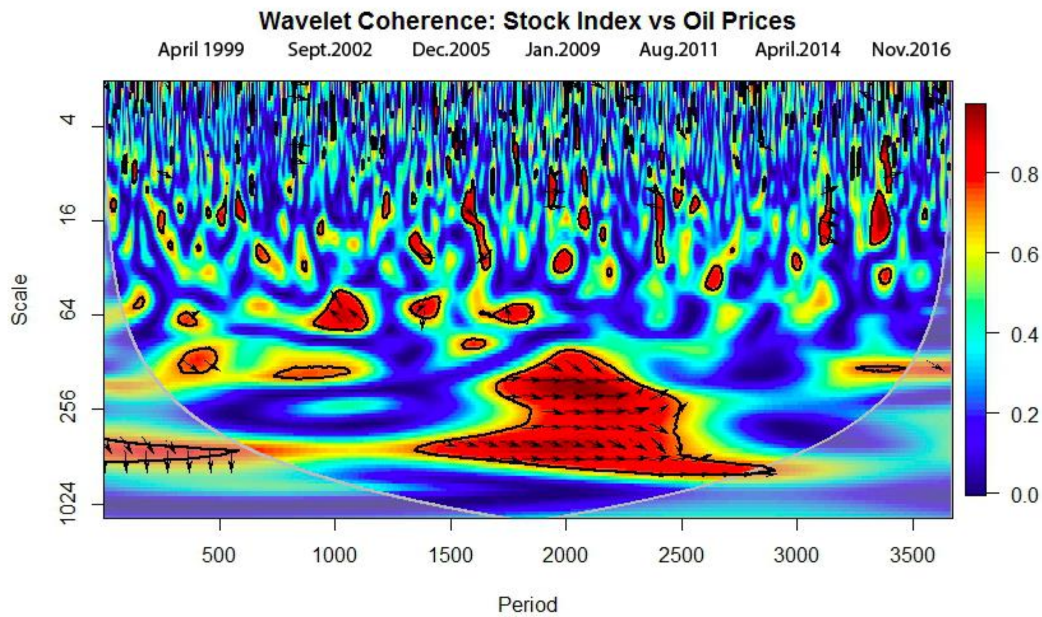


Figure 5: The cross-wavelet coherency: stock index and oil price, 1996 – 2017



The relationship between the stock index and oil price is explained in Figure 5. It is observed that the relationship is positive significant at different frequencies, in particular from 2004 to 2013. Significant coherences were found in low-frequency bands, medium and long-term, and the phase difference points at 0π or 2π which means in-phase, i.e. positive relationship, where there is no obvious lead–lag relationship. This result is similar with Arouri and Rault (2012) and Narayan and Narayan (2010) in terms of positivity and supports the result of Hammoudeh and Choi (2006) in regards to the indirect impact.

Figure 6 illustrates the partial cross-wavelet coherency of the relationship between the stock index and oil price after eliminating the impact of exchange rate. Partial cross-wavelet coherency shows more blue area compared to cross-wavelet coherency in low frequencies. The blue regions were dominating in low-frequency in Figure 6, indicating that the value of Eq. (10), $PR_n^{StockOilXRT^2}$, is a low squared while the value of Eq. (3), $R_n^{StockOil^2}$, was a high squared at wavelet coherence. It means the impact of oil price on the stock index is indirect through the exchange rate.

Figure 6: The partial cross-wavelet coherency: stock index and oil price | exchange rate

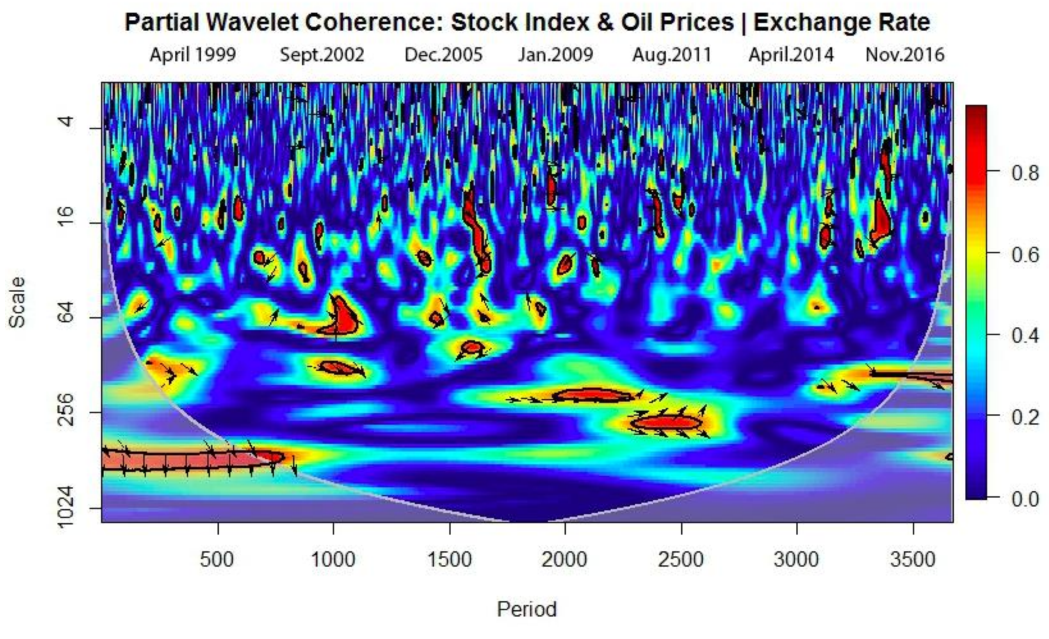


Figure 7 illustrates the partial cross-wavelet coherency of the relationship between the stock index and oil price after eliminating the impact of gold price. Partial cross-wavelet coherency provides evidence in line with cross-wavelet coherency in which the stock index-oil price relationship is not affected even after eliminating the impact of gold price.

Figure 7: The partial cross-wavelet coherency: stock index and oil price | gold price

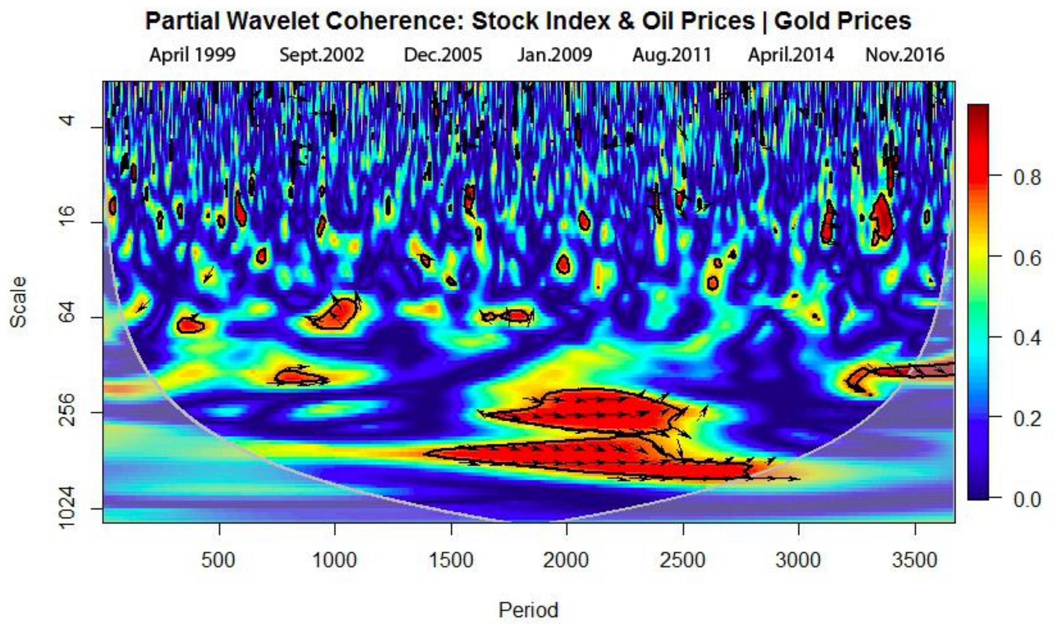
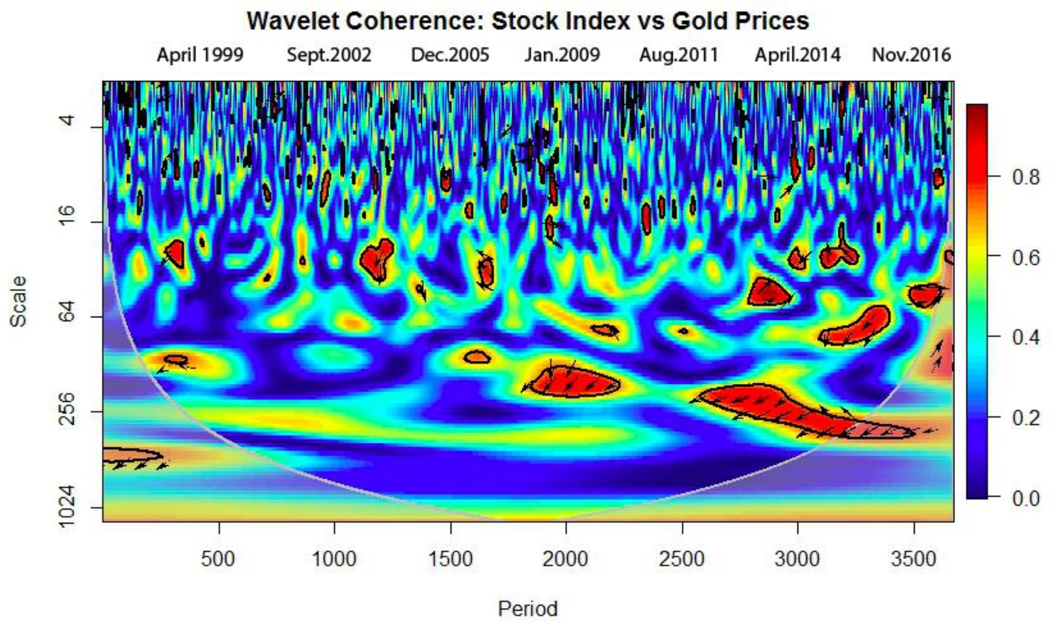


Figure 8: The cross-wavelet coherency: stock index and gold price, 1996 – 2017



The wavelet coherency between stock index and the gold price are shown in Figure 8. A significant negative coherency in various scales, short, 16 – 64 days and medium, 64 – 256 days, was detected where gold leads the effect on the stock index. A negative connection confirmed that, particularly in periods of crisis, investors always run away to gold market when the stock market is down. This result is supported by Sumner et al. (2010), Gaur and Bansal (2010) and Smith (2002).

Figure 9: The partial cross-wavelet coherency:
stock index and gold price | exchange rate

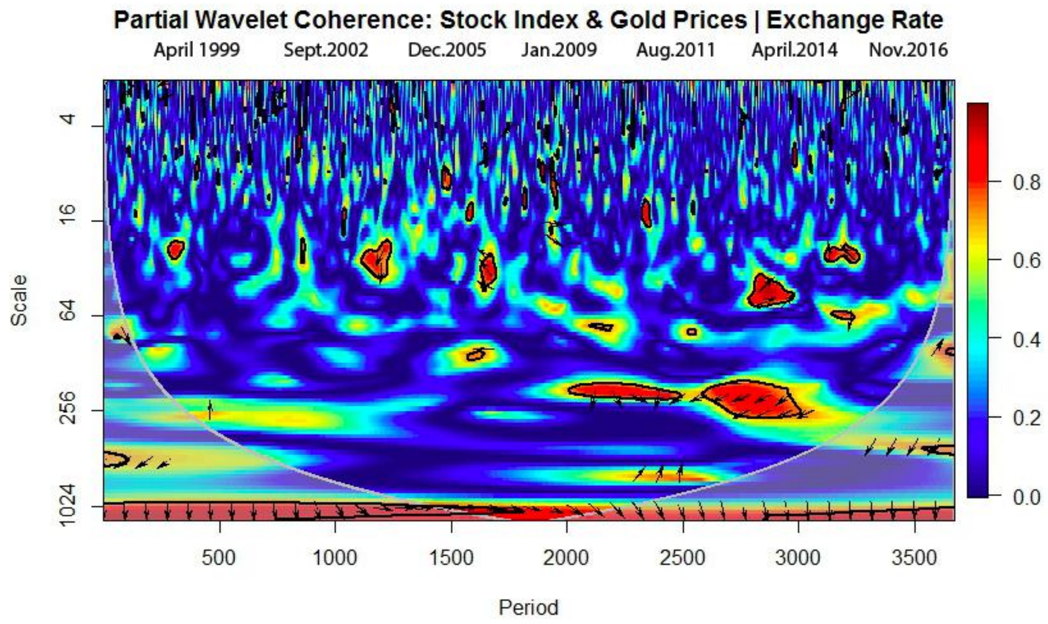
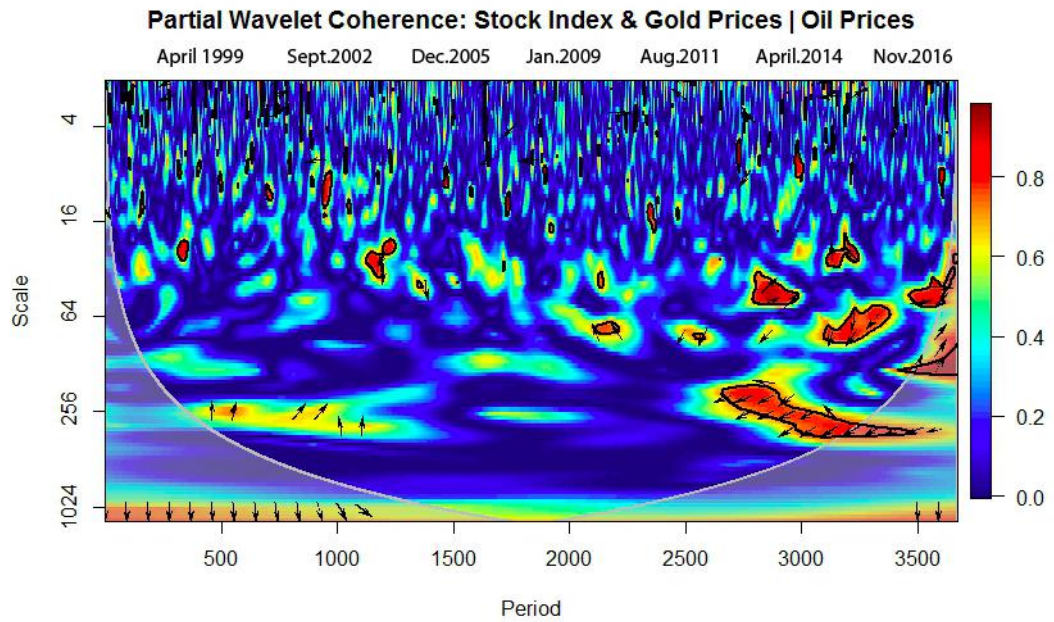


Figure 10: The partial cross-wavelet coherency: stock index and gold price | oil price



Figures 9 and 10 show there is no difference in impact after removing the effect of the exchange rate in the partial cross-wavelet coherency between stock index and gold price. In short, gold effects negatively the stock index in high and medium frequency.

5. Conclusion

This paper investigates the impact of the exchange rate, oil price and gold price on the Kuwaiti stock market by adopting a wavelet analysis consisting of cross-wavelet coherency and partial cross-wavelet coherency. This method is used to test for nonlinear causality and decompose the data into various time frequencies to improve investors' decision making by understanding the investment horizons. To examine these interactions, daily observations from 02 January 1996 to 28 September 2017 were collected from the DataStream, due to the need for many observations when using the wavelet method.

The paper records various findings: 1) the relationship between stock market and the exchange rate is positive by using cross-wavelet coherency and is in line with the traditional approach (Granger et al., 2000; Phylaktis & Ravazzolo, 2000; 2005). However, after applying partial wavelet and eliminating the effect of oil price, we find the correlation between the stock market and the exchange rate is remarkably low. Because oil price is the main factor driving the movement of the USD, the oil price leads to exchange rate. Furthermore, we remove the impact of gold price in the same relationship and the result does not change, which means its effect is not significant in the stock index-exchange rate relationship; 2) The correlation between the stock market and oil price is positive in cross-wavelet coherency, particularly in low-frequency bands. Moreover, we do not find a clear lead–lag relationship throughout the sample period. Our result is supported by Arouri and Rault (2012) and Narayan and Narayan (2010) in terms of positivity and supports the result of Hammoudeh and Choi (2006) in terms of the indirect impact. Nevertheless, the results of partial wavelet after removing the effect of exchange rate show less significant correlation which means the impact of oil price on the stock index is indirect through the exchange rate. In addition, removing gold price's effect, the relationship will remain the same; and 3) Using cross-wavelet coherency, the link between stock market and gold price shows a negative correlation in short-term. Particularly in crisis periods, investors move to the gold market for a safe haven (Sumner et al., 2010; Gaur & Bansal, 2010; Smith, 2002). Interestingly, removing the impact of both exchange rate and oil price we reach to the same finding as cross-wavelet coherency.

In short, oil price leads the movement of exchange rate while exchange rate positively impacts the Kuwaiti stock market. This means that oil price indirectly affects the stock market through the exchange rate. Furthermore, there is no long-term relationship between stock market and gold price, but in the short-run, the gold market attracts investors during crisis periods.

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