



Time-varying Relationship between Oil Prices, Stock Market Performance, and Covid-19 in United States of America, China, and Malaysia: Evidence from Wavelet Approach

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Abstract

The purpose of this paper is to have a better understanding of the reactions to the oil price and stock market performance over a different period of the Covid-19 pandemic from January 2019 to August 2022 (Pre Covid, During Covid, and Post Covid) in the United States of America, China, and Malaysia. In the study, various approaches such as line graphs, descriptive statistics, correlation, wavelet correlation, continuous wavelet transform, and wavelet coherence analysis were used to analyse the decomposition of time series oil and stock market data in different time period. The study provides evidence of positive linear relationships between crude oil prices with the 3 countries' stock markets in pre-covid, during-Covid and post-covid. In addition, both oil price and stock prices have evidence of a lead-lag relationship with each other, which differs in the period of time. The research results will benefit investors for better prediction during future pandemic situations and economic crises.

Keywords: COVID-19, Oil Price, Stock Market, Continuous Wavelet Transform, Wavelet Coherence Analysis

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INTRODUCTION

Coronavirus disease of 2019 (COVID-19) is a contagious disease caused by the SARS-CoV-2 virus. As per Elengoe (2020), Huang et al. (2020), and Wu et al. (2020), the virus first originated in Wuhan, China, in December 2019 in one of China's open-air wet markets, namely the South China Seafood Market. As SARS-CoV-2 spread both within and out of China, it transmitted from one human to another, infecting over 2 million people worldwide. Eventually, the virus became so bad it was deemed a pandemic by the World Health Organization (WHO). Lockdowns were imposed in most of the countries along with consequences. Most economists the world over agreed upon one thing – that the largest crash of the stock market of the 21st century was caused by the worldwide economic shutdown due to the global COVID-19 pandemic.

In Malaysia, the Movement Control Order (MCO) that restricts entries of foreigners has impacted the tourism industry the most. (Foo et al., 2020; Mohamad et al., 2020). Not only the aviation, hotel, and tourism industry, industries like food and beverage, entertainment, sports, and retail were impacted as well. Ultimately, all these factors culminated in Malaysia's economic growth falling to a 10-year low and the threat remains till today. In China, the COVID-19 impacted the Chinese businesses' capital to become fragile, and a bank failure was impending. Measures like promoting small enterprises by providing financial assistance, deferring tax payments, as well as lowering

mortgage interests were implemented by the Chinese government to contain the impact of the pandemic (Dhar, 2020; Huang & Zhao, 2020). The Central Bank, Peoples Bank of China (PBOC), injected over \$240bn into the economy, to increase liquidity (Ozili & Arun, 2020). The COVID-19 pandemic hit China at a time when the economy was exponentially growing, which meant that China's financial markets were still strong and stable, notwithstanding the seriousness of the pandemic. In the United States of America (USA), the lockdown has caused the Real GDP contracted by 3.5% in 2020, which was the first contraction to occur since the 2008 Financial Crisis. As of early 2022, there are around 3 million fewer members of the labour force in America than compared to before the pandemic (Albanesi & Kim, 2021).

The emergence of the COVID-19 pandemic has also amplified the financial volatility of the financial market within the U.S. (Albulescu, 2021; Kong, Sugawara, & Terrones, 2021). However, to curb this issue, the U.S. Federal Reserve (FED) put in place several initiatives – including cutting federal fund rates by 50 basis points and adding over \$3 trillion in additional liquidity (Ozili & Arun, 2020). Hence, the severity of each country's outbreak and the subsequent way they try to curb the pandemic is directly correlated with the performance of each nation's stock market. Markets have become exceptionally unstable and volatile due to the uncertainty caused by the pandemic (Baker et al, 2020; Mishra, Rath, & Dash, 2020). Whilst these countries have initiated policies to minimise damage by inducing liquidity, more stimulus financial packing will be required to revive the economy slowly (Baber, 2020).

A financial market can be defined as any location or system that enables buyers and sellers to trade financial instruments, such as bonds, equities, and international currencies (Pilbeam, 2018). A reasonable estimate of a company's current or market value is in the company's stock prices, which are measured in the stock market. These pieces of information are crucial as they provide decision-makers with valuable insights and information that can guide their decision-making, which can then have a long-term impact on the company's bottom line. However, should a global crisis like the COVID-19 pandemic occur, all global financial markets would face tremendous fluctuations and severe repercussions, especially as there has been a downward trend in share values.

Global stock markets are all interlinked, and a crisis in one part can also influence the stock market in other parts of the world (Ahmed & Rehman, 2020; Morales & Andreosso-O'Callaghan, 2012). Globalisation and countries' reliance on each other has caused susceptibility to crisis the world over. According to Sun and Hou (2018) and Noland & Heginbotham (2019), China is financially unified with most Southeast Asian countries, such as Malaysia, Thailand, and Vietnam. Hence, any shock to the Chinese economy has severe effects not just on China but on the world's economy, as China represents 16% of the world's economy (Fernandes, 2020). According to Ding et al., (2020), there was an average 12% drop off in stock prices worldwide as COVID-19 cases increased worldwide.

On the other hand, crude oil plays such a pivotal role in determining economic stability worldwide, as the price fluctuations of crude oil can affect the economy (Oladosu & Oyewunmi, 2019; Qianqian, 2011). West Texas Intermediate (WTI) futures are ~~can~~ be generated. A decline in oil prices can cause economic growth. For example, a decrease in oil price will directly cause the cost and price of petroleum products to go down, resulting in higher productivity, which would drive faster economic growth. Oil prices are

normally determined by the level of demand and supply of oil and can be used to assess economic stability. However, this can be altered through sources of natural volatility, including but not limited to – geopolitical conflicts and wars, economic and financial slowdowns, terrorist attacks and natural disasters (Novotny, F. 2012). The arrival of the COVID-19 global pandemic has significantly negatively affected the global socio-economic conditions, which in turn, have caused the downfall of the global economy as well as the crude oil industry. The lack of demand during the COVID-19 pandemic caused a decline in crude oil prices due to low demand and a lack of investment in stock markets worldwide. Due to the emergence of COVID-19, worldwide crude oil prices hit their lowest international benchmark since 2002 (Al-Awdahi et al, 2020; Wang, Shao, Kim, 2020).

It is suggested that there is no correlation between economic fluctuations and mortality rates during the COVID-19 pandemic. However, the simultaneous demand and supply shocks stimulated by the mass media reaction, as well as the reaction of the government, could have affected this (Ahmed & Rehman, 2020; Fernandes, 2020). Hence, the objective of the research paper is to emphasise investigating the short, medium, and long term relationship between oil prices – which are measured in the form of Crude Oil West Texas Intermediate (WTI) Futures, the fluctuations in stock market performance – measured in the form of daily stock market performance of the Kuala Lumpur Stock Exchange (KLSE), Shanghai Stock Exchange (SSE), and New York Stock Exchange (NYSE), and COVID-19 (pre-Covid, during-Covid, and post-Covid). Various tests are employed, including the explanatory data analysis, correlation test, wavelet correlation analysis, continuous wavelet transforms, and wavelet coherence test.

Wavelet approach is used in this study as it allows decomposition of time frequency for a detailed analysis in different time scale. The correlation derived from wavelet approach is compared with Pearson approach in examining the strength of relationship with effect of time scales. The paper is structured as follows – the relevant literature review is presented in Section 2, whilst the methodology and empirical methods are shown in Section 3. Next, the findings and results are displayed and discussed in Section 4. Finally, in Section 5, the conclusion is presented with recommendations for future research and implications of the findings.

LITERATURE REVIEW

The relationship between oil price and stock market during the Covid-19 pandemic has been studied by numerous researchers. Results discovered that oil dependent sectors' stock market easily fluctuate according to the environment. This insight is significant for stock market investors, policymakers and regulators not only to stabilise and reevaluate risk management of oil and stock market, but also to prevent further uncertainty and accommodate the upsurge of the pandemic. Sharif, Aloui and Yarovaya (2020) evaluates the relationship of the U.S. between the Covid-19 pandemic, oil price volatility shock, geopolitical risk, economic uncertainties and stock market. Results displayed that long-term negative effect is identified in the country's geopolitical risk, economic uncertainties, and disruption of stock market response. Zhu, Tang, Wei, Dai and Lu (2021) study the relations between oil and the performance of different Chinese stock sectors, such as energy, materials, industrials, financials. Results showed that oil prices affect stock market of different sectors differently. For example, oil and gas independent sectors are

generally not impacted by oil prices. while oil and gas-dependent sectors easily fluctuate depending on the oil prices. Jiang and Yoon (2020) aim to understand better the dynamic co-movement between the stock market of China, India, Saudi Arabia, Russia, Canada and Japan. A feedback relationship is identified between oil and the stock market. Oil price has a significant influence over oil-exporting countries, while the economic structure of oil-importing countries is strongly influenced by crude oil prices. Chien et al. (2021) inspects the relationship between the recent COVID-19 epidemic, stock market and oil price volatility, geopolitical threats, and the ambiguity of economic policy in the United States, Europe, and China. Findings indicate that industrial productivity decreases as the pandemic severity increases. They were causing a drastic decrease in oil demand, the stock market, GDP growth, and electricity demand.

Prabheesh, Padhan and Garg (2020) discuss the oil price and stock market nexus of the oil-importing Asian countries during the COVID-19 period, including China, India, Japan and Korea. The research states that oil prices and stock market prices have a small but positive correlation during the COVID-19 pandemic. Albulescu (2020) investigates the relationship between COVID-19, Oil prices, EPU (Economic Policy Uncertainty) and VIX (Financial Volatility Index). The study found that COVID-19 had a negative and significant impact on international oil prices but an even more impactful towards the VIX and EPU oil prices. As the COVID cases increases, the oil price decreases because the slowdown of economic activities means that there is less demand for oil, causing speculators and investors to stop investing in the energy sector.

Gharib, Meftteh-Wali, Serret and Ben Jabeur (2021) discussed the impact of the Covid-19 pandemic on crude oil prices to investigate dynamic bubbles of oil prices and estimate the crash time of oil prices. Results indicate that crude oil prices are significantly driven by bubbles, while price dynamics indicate self-reinforced behaviours among traders through the pandemic period. Le, Le and Le (2021) examine the historical oil price fluctuation during the Covid-19 pandemic and their causes. Results show that the increase in Covid-19 flu cases, U.S. economic policy uncertainties, and stock market volatility has contributed to the drop in WTI crude oil prices. While low oil prices benefit consumers and businesses, the stability of crude oil prices impacts the oil industry and the functioning of the global economy.

Khalifaoui, Solarin, Al-Qadasi, and Ben Jabeur (2022) explore the dynamic causal effect of the Covid-19 pandemic in significant oil importing and exporting countries in relation to oil price changes, stock market volatility and economic uncertainties. It is evident that the pandemic has a severe time frequency impacts on oil prices in both oil import and export countries. Yan, Cao, and Gao (2022) investigate the volatility spill over global crude oil markets and stock markets pre and post-pandemic. Oil prices have a positive correlation with nations' stocks and stock market indexes; oil prices and equity indexes have a weak relationship on the micro level but greater on the macro level. As the financial crisis and globalisation increase, a two-way ripple effect exists between the five equities market and the world's largest oil market.

Wang, Shao, and Kim (2022) investigate the connection between COVID-19 and the correlations between crude oil and future agriculture markets. It is found that COVID-19 has significantly affected the demand for commodity markets as the worldwide economy has major slowdowns. Crude Oil prices hit their lowest international benchmark

in COVID-19 pandemic years among the last 18 years. Chiou and Lee (2009) explore the effects of oil prices on stock returns. It can be seen from this paper that there is an unexpected asymmetric impact on S&P 500 returns from high fluctuations in oil prices.

Mugableh (2017) studies the effects of oil prices on stock returns. This research paper focuses on the composite price index data of the KLSE, SSE, PSE, SET, and West Texas Intermediate (WTI) crude oil prices. It can be seen from this test that the fluctuations in global oil stock prices only have a significant impact on KLSE and SET. Novotný (2012) discusses the relationship between the U.S. dollar exchange rate as well as the Brent crude oil price over the past decade. It can be seen from this study that there is a positive effect between the relationship between Brent crude oil prices and the U.S. dollar exchange rate. Several other sources of natural volatility can also affect this, including geopolitical influences, business cycles and speculative activities.

Lee and Zeng (2011) investigated the association between actual stock returns and natural oil price shocks in the G7 nations. It is found that U.S. and U.K. have an asymmetric effect on the real stock returns on oil price shocks. The negative oil price shocks have a positive impact on real stock returns. This caused investors to be more optimistic about future stock returns. Mahmoudi and Ghaneei (2022) discussed the effect of the crude oil industry on the Toronto Stock Exchange (TSX). The results found that crude oil for TRX has a negative impact on the bull market and a positive impact on the bear market. It also found that the crude oil and stock index are not cointegrated in the long run. As Canada is one of the largest oil exporters, the stock market has relatively less impact than other countries.

Gogineni (2010) discussed the relationship between Swedish and Norwegian stock markets and crude oil prices. It is found that both countries' stock markets have a positive relationship with the crude oil price. The exchange rate is found to be negative correlated with the crude oil price. Crude oil affected both the stock market and the exchange rate. Ogiri, Amadi, Uddin and Dubon (2013) studied the relation between Nigeria's stock market performance and Brent crude oil prices. The finding shows that the crude oil price fluctuations will have an impact on the stock market where the Nigeria government can have implications that are able to archive sustainable economic development in the long run. The fluctuation of crude oil affects the stock market and indirectly affects the GDP, interest rate and exchange rate (EXR). ...

METHODOLOGY

Data

The data used for this assignment are the daily stock market performance of the United States of America, Malaysia, and China. The stock market performance data is measured by using the New York Stock Exchange Composite (NYSE), Kuala Lumpur Composite Index (KLSE), and Shanghai Stock Exchange (SSE) for the USA, Malaysia and China, respectively. The daily oil prices (WTI) were used for this study as well, collected in the form of Crude Oil WTI Futures. Oil price plays an important role in indicating the economic health as productivity is affected by oil price, while the stock prices' performance impacts the demand of oil. The historical data of the prices of these stock indexes and oil prices were collected from Investing.com. To gain a more comparable result, all the

data were converted into log returns and represented by L.R throughout the analysis. The formula used in this study is as below, where X represents the variables WTI, KLSE, NYSE, and SSE; and t represents time:

$$LR(X)=LR(X_t/X_{t-1})$$

The time data collected is from 1st January 2019 to 31st August 2022, and the dataset was separated into 3 separate time periods to signify 3 different time periods in relation to COVID-19. The 'pre-COVID' period refers to dates ranging from 1st January 2019 to 31st December 2019, while the 'during COVID' period refers to data from 1st January 2020 to 28th February 2021. Lastly, the 'post COVID' period data is collected from 1st March 2021 to 31st August 2022. The reason the data is separated as mentioned, is because this study aims to find out how the stock market and oil prices react differently in relation to Covid-19.

COVID-19 was declared a pandemic by WHO on 11th March 2020 (Cucinotta & Vanelli, 2020). Hence, the data from the year 2019 will be named pre covid. The paper by Salisu, Ebuh, and Usman (2020) also used data from a similar period to measure the performance of the stock market before covid. The data on COVID covers the year 2020 as it was the year that was impacted the most by COVID, which is also used in the paper by Gao, Ren, and Umar (2022). As we are analysing the data using wavelet approach, it is better for the period of data collection to be longer, in this case, at least one year of daily data for all different periods. The line charts for the log return of collected data are available in section 4.1, while the descriptive statistics of the data, including mean, maximum, minimum, standard deviation and number of observations, are attached in 4.2. Correlation analysis is used in this study on the degree of 2 variables moving together over time.

The strength of the linear relationship between the oil prices and the respective stock market prices of China, Malaysia and the USA is analysed. The correlation analysis is done by dividing the covariance of the variables by their independent standard deviation. Similar analysis was used in the study by Wang et al., (2020), where it was used to find the correlation between the crude oil prices and agricultural futures. The result of the study yields the p-value, which represents the relationship between the two variables, where it is between -1 to 1. The analysis was conducted on the E-views application. For each time period, the analysis was conducted three times to study the relationship between oil prices and individual country stock prices. A total of nine observations is obtained and attached in section 4.3.

WAVELET ANALYSIS

Three different types of wavelet analysis were conducted for this study, which are Wavelet Correlation, Continuous Wavelet Transform, and Wavelet Coherence.

Wavelet Correlation

Wavelet correlation studies the degree of how oil and stock prices move together over time by decomposing data into the short run period, medium run period, long run period, and very long run period. This approach was also used in the study by Raza, Sharif, Wong, and Karim (2017), where it was used to study the correlation between tourism

development and CO2 emission. In this case, the Wavelet scale 1 to 4 days is a short run period, 4 to 8 days is a medium run period, 8 to 16 days is a long run period, and 16 to 32 days is a very long run period. The results of the study are attached in 4.5.

Continuous Wavelet Transformation (CWT)

The continuous wavelet transforms analysis studies the similarity between the time-varying signal in different time frequencies. The data is decomposed into different periods where 1 to 8 days is a short run period, 8 to 16 days is a medium run period, 16 to 32 days is a long run period, and 32 to 64 days is a very long run period. This test was used by Sharif et al. (2020) to study the nexus between oil prices and the stock market. This test is conducted 9 times as the data for oil price and stock prices of the three different countries are conducted separately in three different time periods. The results and interpretation of this study are attached in 4.6.

Wavelet Coherence

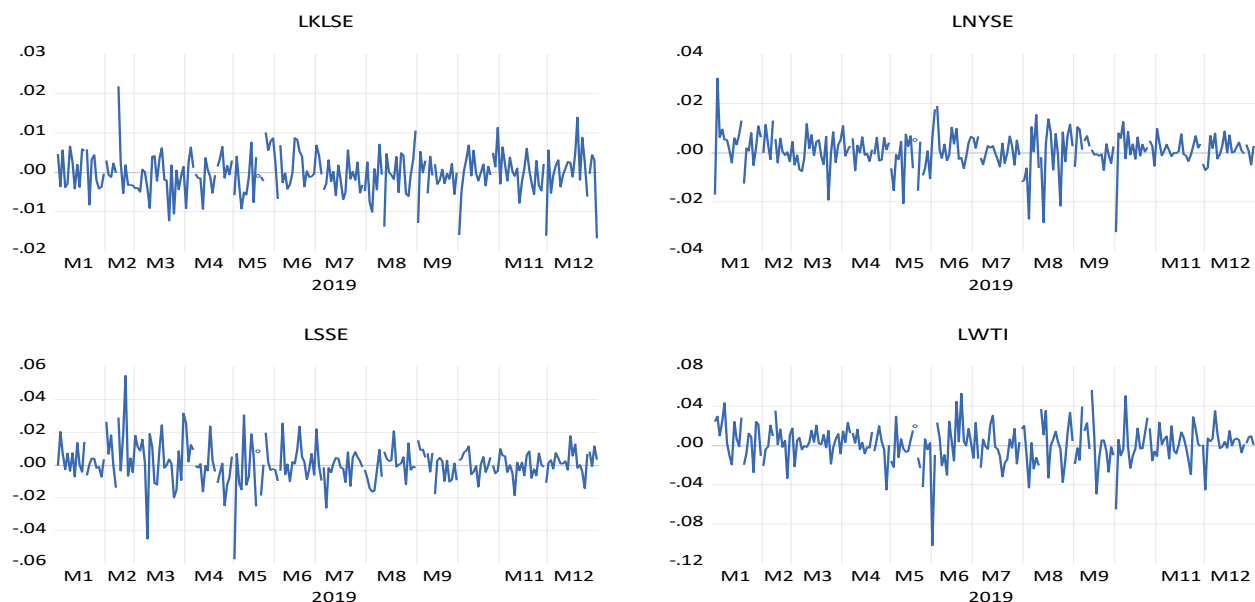
Wavelet coherence is conducted to study the phase difference between oil and stock prices to find out the lead-lag relationship between these two variables. As the data for our study is time series data, the relationship between oil prices and stock market prices can be analysed through time scales (Sharif et al., 2020). The results and interpretation of this study are attached in 4.7. For this analysis, R language programming was used to analyse and visualise the charts.

DATA ANALYSIS AND INTERPRETATIONS

Line Graph

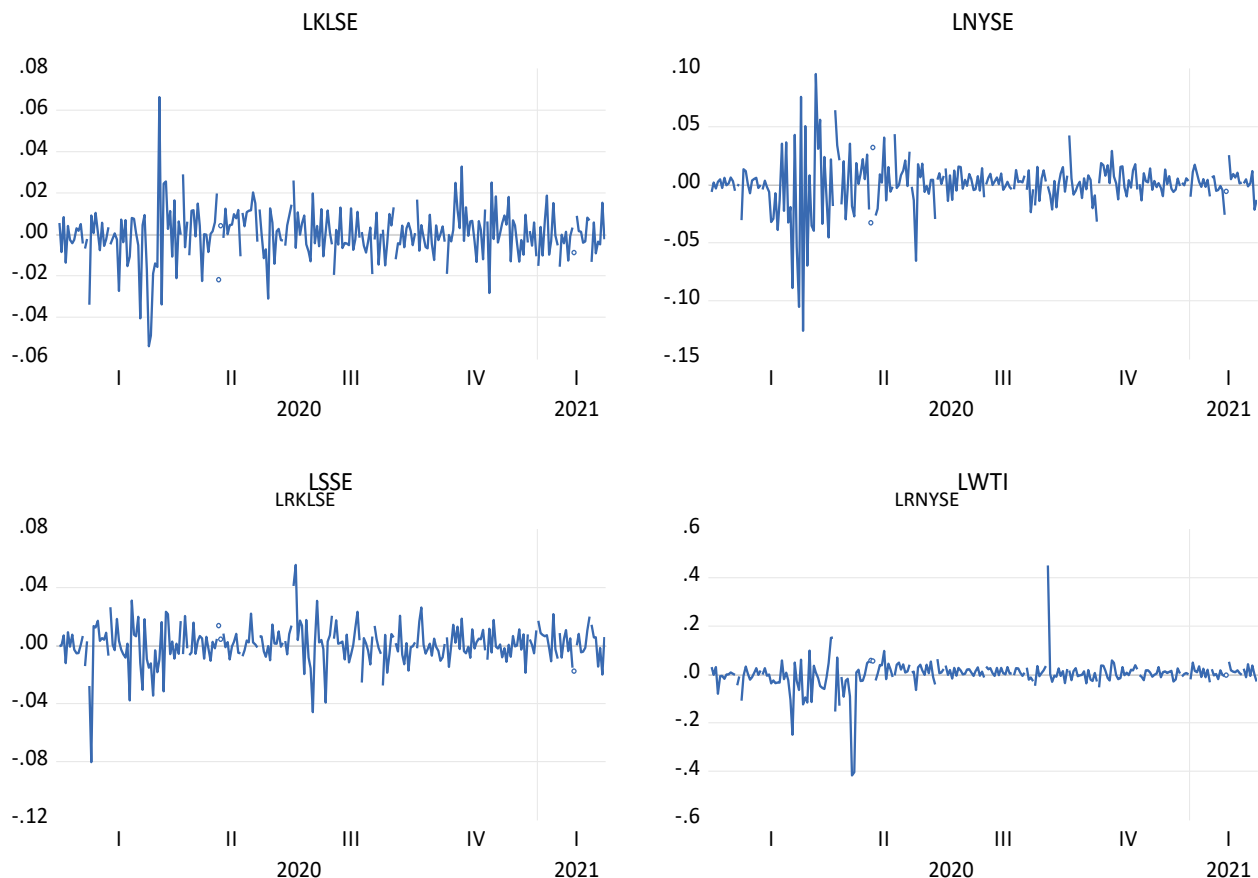
The line graph shows the trend over time for the log return series of 3 countries' stock prices and oil price. The significant fluctuations are determined and interpreted.

Pre Covid



LRKLSE showed the most significant fluctuation in February (M2) and December (M12). LRSSE has a significant fluctuation in January (M1) and August (M8) to September (M9). LRSSE shows significant fluctuation in the first half of the year, especially during February (M2), March (M3), and May (M5). LRWTI has a lesser fluctuation and shows significant fluctuation only in May (M5) and September (M9).

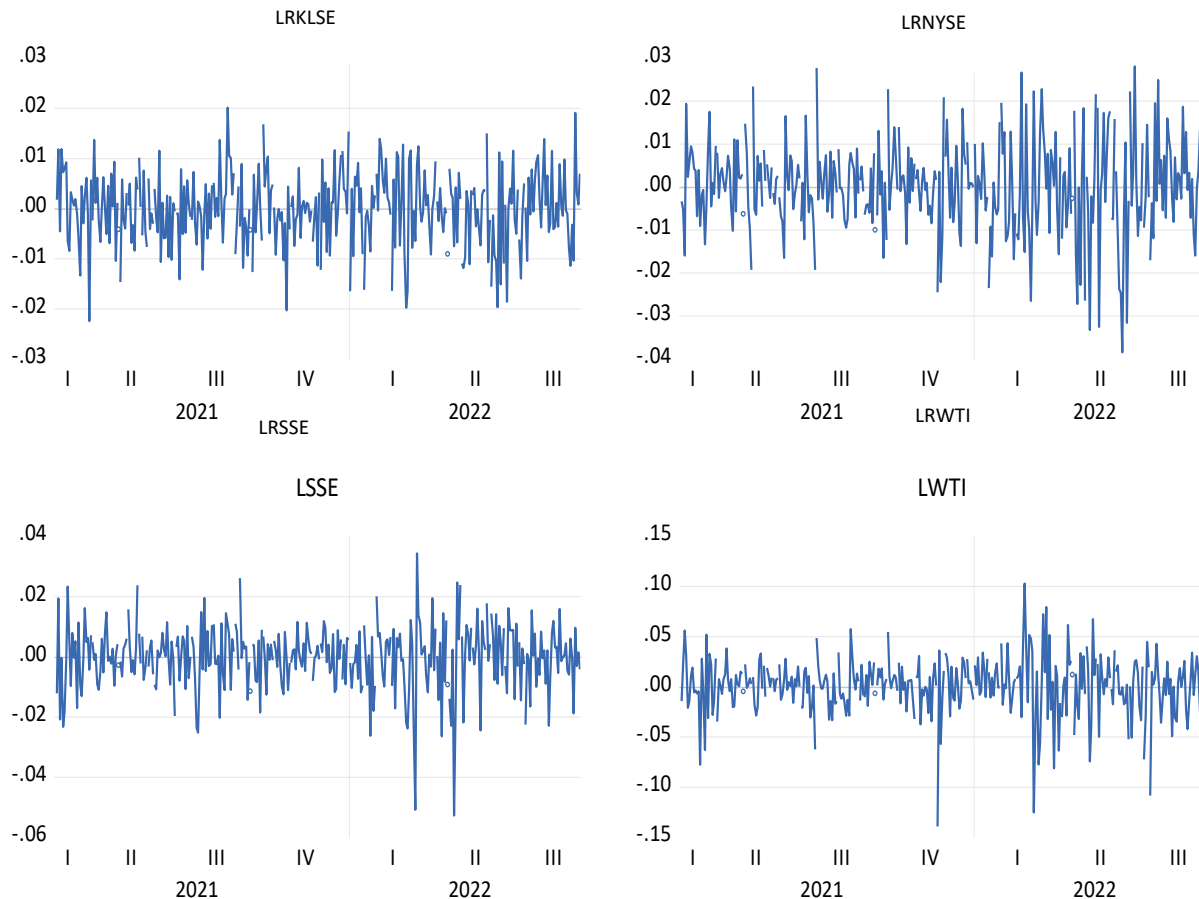
During Covid



LRKLSE showed the most significant fluctuation in February 2020 (QI 2020) and fluctuated less throughout the period. Similarly, LRSSE had a significant fluctuation in February 2020 (QI 2020) only. LRSSE shows significant fluctuation in January (QI) and June (QII) 2020. LRWTI has the least fluctuation and shows significant fluctuation only in January, February, March (QI) and August (QIII) 2020.

Post Covid

LRKLSE shows a major fluctuation in March 2021 (QI 2021), July and September 2021 (QIII 2021), January 2022 (QI 2022), May 2022 (QII 2022), and August (QIII 2022). LRSSE fluctuates drastically throughout the period, where the most significant is in April and May 2022 (QII 2022). LRSSE shows a significant fluctuation in February and March (QI 2022). LRWTI has the least fluctuation and shows significant fluctuation only in October 2021 (QIV 2021) and January 2022 (QI 2022).



DESCRIPTIVE STATISTICS

Before Covid, there were 224 observations in the time-series data for 3 stock prices. The mean of LTKLSE is -0.0002, with a standard deviation of 0.005. The mean of LRNYSE is 0.0009, with a standard deviation of 0.007. The mean of LRSSE is 0.001, with a standard deviation of 0.012. The mean of LRWTI is 0.001, with a standard deviation of 0.019. During Covid, the number of observations increased to 257 records. The mean of LTKLSE is -0.00006, with a standard deviation of 0.012. The mean of LRNYSE is 0.00027, with a standard deviation of 0.022. The mean of LRSSE is 0.0006, with a standard deviation of 0.013. The mean of LRWTI is 0.0002, with a standard deviation of 0.061. In the Post Covid period, the number of observations increased to 338 records. The mean of LTKLSE is -0.00001, with a standard deviation of 0.007. The mean of LRNYSE is 0.00007, with a standard deviation of 0.011.

The mean of LRSSE is -0.0002, with a standard deviation of 0.011. The mean of LRWTI is 0.0012, with a standard deviation of 0.028. Generally, as the number of observations increase from one period to another, the standard deviation, maximum and minimum values increase from Pre Covid to During Covid and decrease again in the Post Covid period. The trend of the mean varies among the variables, with stock prices showing a decreasing trend and oil price fluctuating. This signifies that the prices of both oil and

stock are not stable in times of a pandemic like Covid-19, as the environment is changing rapidly daily with the government economic policies and the number of cases.

Correlation

The probability value (p-value) will be interpreted based on 2 hypotheses formed:

Table-1 : Descriptive Statistics			
	Pre-COVID	During COVID	Post COVID
LRKLSE			
Mean	-0.000218	-0.0000606	-0.000106
Minimum	-0.016796	-0.054047	-0.022422
Maximum	0.021875	0.066263	0.020119
St. Dev	0.005185	0.012538	0.007322
No of Obs	224	257	338
LRNYSE			
Mean	0.000896	0.00027	-0.0000779
Minimum	-0.032336	-0.125977	-0.038405
Maximum	0.030182	0.095637	0.02803
St. Dev	0.007455	0.02228	0.010736
No of Obs	224	257	338
LRSSE			
Mean	0.00095	0.000584	-0.000283
Minimum	-0.057455	-0.080391	-0.05268
Maximum	0.054493	0.055543	0.034244
St. Dev	0.011831	0.013393	0.010656
No of Obs	224	257	338
LRWTI			
Mean	0.001349	0.0000235	0.001276
Minimum	-0.101692	-0.417654	-0.139086
Maximum	0.056507	0.45084	0.102714
St. Dev	0.019523	0.061403	0.028438
No of Obs	224	257	338

H_0 = stock price and oil price has no significant correlation

H_1 = stock price and oil price has a significant correlation

If the p-value is less than 5% (0.05), H_0 will be rejected, and vice versa. From the analysis, it shows that there is a positive linear relationship between LRKLSE and LRWTI, LRNYSE and LRWTI, as well as LRSSE and LRWTI for all 3 periods (PreCovid, During Covid, and PostCovid). The strength of the relationship between stock price and oil price throughout 3 time periods is interpreted. The strength of the positive linear relationship between LRKLSE and LRWTI is weak (0.168) before Covid and gets weaker during Covid (0.065) and after Covid (0.018), where they are close to no relationship (0). There is less fluctuation between LRNYSE and LRWTI with a moderate-weak positive linear relationship, which is 0.223 before Covid, 0.301 during Covid, and 0.236 after Covid. The relationship between

LRSSE and LRWTI is weak before Covid (0.125), declines to close to no relationship during Covid (0.062), but grows to a weak relationship after Covid (0.170).

LRKLSE and LRWTI has a significant correlation before Covid but not during Covid and after Covid. LRNYSE and LRWTI has a significant correlation throughout 3 periods. No significant relationship is found between LRSSE and LRWTI before and during Covid, but is found after Covid. This result demonstrates that the influence of oil price towards stock prices is inconsistent depending on the stock indices.

Table-2: Results of Correlation Analysis						
Correlation	Pre-COVID		During COVID		Post COVID	
LRKLSE						
Probability	LRWTI	LRKLSE	LRWTI	LRKLSE	LRWTI	LRKLSE
LRWTI	1	0.168035 (0.0118)	1	0.064733 (0.3012)	1	0.018482 (0.7349)
LRKLSE	0.168035 (0.0118)	1	0.064733 (0.3012)	1	0.018482 (0.7349)	1
LRNYSE						
Probability	LRWTI	LRNYSE	LRWTI	LRNYSE	LRWTI	LRNYSE
LRWTI	1	0.222623 (0.0008)	1	0.300883 (0)	1	0.236303 (0)
LRNYSE	0.222623 (0.0008)	1	0.300883 (0)	1	0.236303 (0)	1
LRSSE						
Probability	LRWTI	LRSSE	LRWTI	LRSSE	LRWTI	LRSSE
LRWTI	1	0.124626 (0.0626)	1	0.0615 (0.3261)	1	0.16952 (0.0018)
LRSSE	0.124626 (0.0626)	1	0.0615 (0.3261)	1	0.16952 (0.0018)	1

Wavelet Correlation

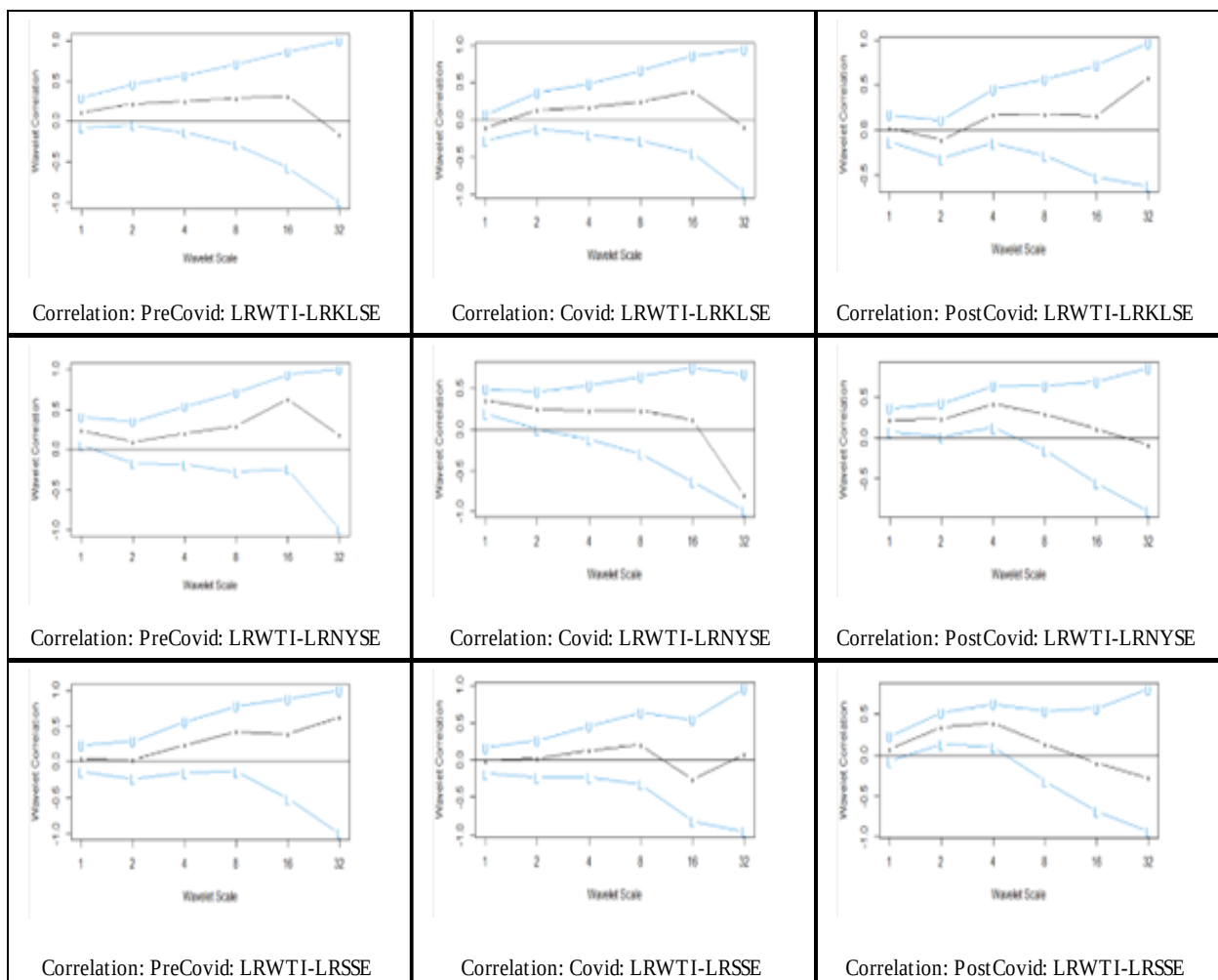
In brief, there is not much strong positive or negative linear relationship between oil price and stock prices. A negative linear relationship mostly occurs during a long run period or very long run period, but there are still exceptions that can occur in the other period.

Most correlation experiences an increasing trend and either fall or rises during a long run and very long run period.

Pre Covid

The correlation between LRWTI and LRLSE is positive-weak (0.2) in the short run period; getting closer to positive-moderate (0.25 and 0.3) in the medium run period and long run period; but declines to negative-weak (-0.1) in the very long run period. The correlation between LRWTI and LRYSE is positive-weak (0.3 and 0.1) in the short run period; slightly increases to positive-weak (0.35) in the medium run period, and increases sharply to positive-moderate (0.6) in the long run period; before declines back to positive-weak (0.1) in the very long run period.

The correlation between LRWTI and LRSSE is close to no relationship at first and gains a positive-weak (0.3) linear relationship in the short run period; increases significantly to positive-moderate (0.5 and 0.45) in the medium run period and long run period; and rises slightly to positive-moderate (0.7, close to a strong positive linear relationship) in the very long run period. In short, the 3 stock prices have a positive weak to moderate linear relationship with the oil price for most of the time period.



During Covid

There is a negative-weak (-0.1) and positive-weak (0.2) linear relationship between LRWTI and LRKLSE in the short run period. It shows an increasing trend but still a positive-weak (0.3) linear relationship in the medium run period; and significantly rises to a positive-moderate (0.45) linear relationship in the long run period; but declines to negative-weak (-0.1) in the very long run period. The linear relationship between LRWTI and LRNYSE is positive-moderate to weak (0.4 and 0.3) in the short run period; remains positive-weak (0.3) in the medium run period, and diminishes slightly to close to no relationship (0.1) in the long run period; before declines drastically to negative-strong (-0.8) in the very long run period.

The correlation between LRWTI and LRSSE is close to no relationship at first (0 and 0.1) in the short run period; it increases to positive-weak (0.2) in the medium run period; but falls to negative-weak (-0.2) in the long run period; and returns to close to no relationship (0.05) in the very long run period. Thus, the 3 stock prices have a positive weak to moderate linear relationship with the oil price in most of the short run period and medium run period, and have a negative weak-strong linear relationship in the long run or very long run period.

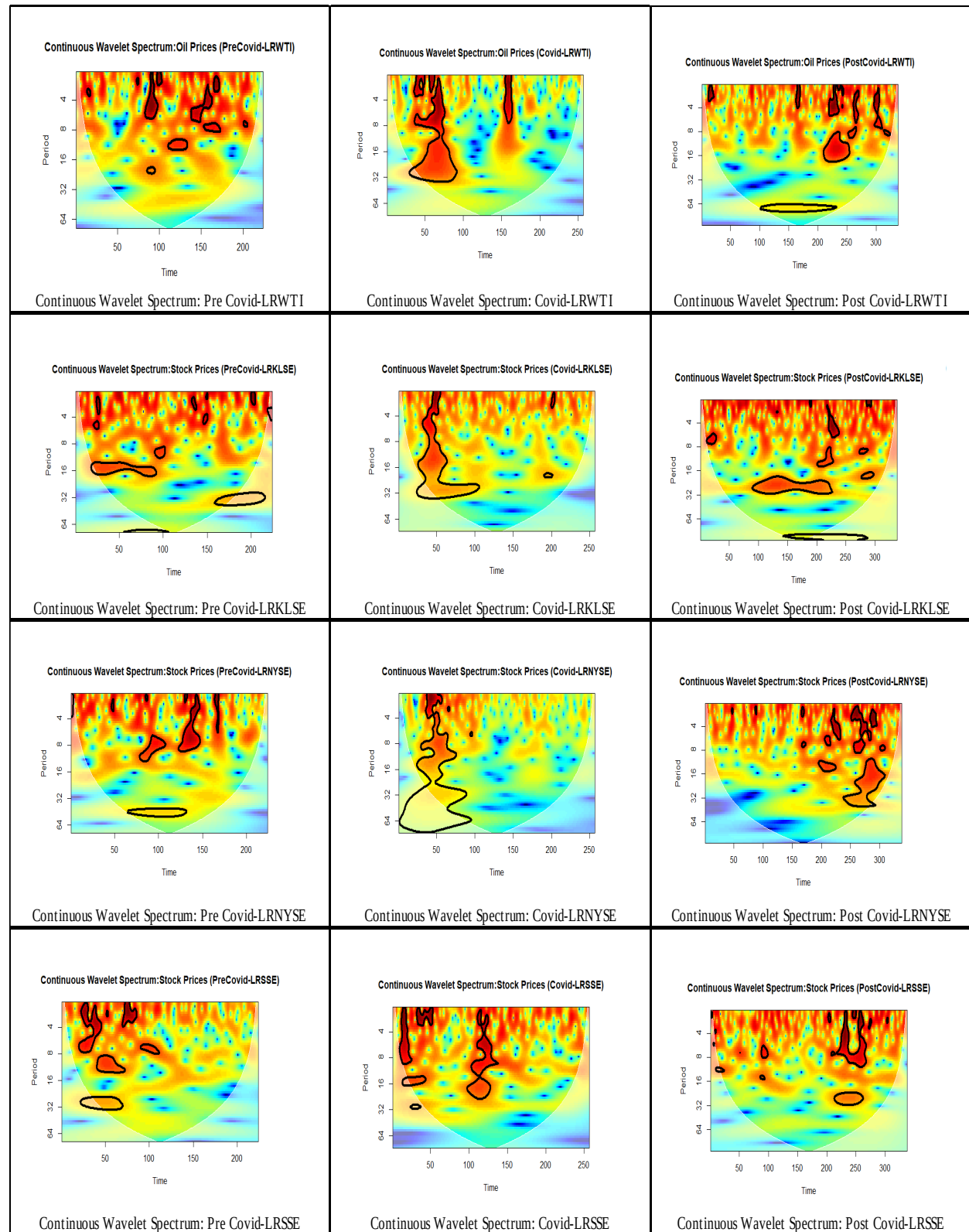
Post Covid

There is no linear relationship (0) and negative-weak (-0.1) linear relationship between LRWTI and LRKLSE in the short run period. It remains a still positive-weak (0.2) linear relationship throughout the medium run period and long run period; and finally rises radically to a positive-moderate (0.6) linear relationship in the very long run period. The linear relationship between LRWTI and LRNYSE is positive-weak to moderate (0.3 and 0.4) in the short run period; beginning to show a decreasing trend to positive weak (0.3) in the medium run period; drops steadily to close to no relationship (0.1 and -0.2) in the long run period and the very long run period.

The correlation between LRWTI and LRSSE is close to no relationship at first (0) but increases to positive-moderate (0.4) in the short run period; diminishing continually to positive-weak (0.1) in medium run period; and negative-weak (-0.1 and -0.3) in the long run period and the very long run period. Thus, LRKLSE experiences an increasing correlation from no relationship (short run period to long run period) to a positive moderate linear relationship with LRWTI in the very long run period. LRNYSE and LRSSE experience a positive weak to a moderate linear relationship with LRWTI from the short run period to the medium run period, but a negative weak to the moderate linear relationship in the long run or very long run period.

Continuous Wavelet Transform

Generally, there are more strong variations observed in the short run period, and the strength of significance declines as the period increase. Significant variation does not always occur in long run periods and very long run periods, and mostly are steadier compared to short run periods. The variation is spread across time, from Pre Covid to Post Covid.



Pre Covid

50	25 March 2019
100	18 June 2019
150	30 August 2019
200	22 November 2019

There are a few times where significant variation is found in the short run period in LRWTI, oil price's Continuous Wavelet Spectrum. It consists of a very significant variation in January, May, June, and November 2019. Variations in August and September 2019 are a little less significant compared to the previous variation. In the medium run period, there is a medium fluctuation in July 2019. A steadier variation was found in the long run in May 2019. No fluctuations are identified in the very long run period. The Continuous Wavelet Spectrum in LRKLSE shows that there are small but very significant fluctuations in February, August, and November 2019 in the short run period. In the medium run period, there is a medium fluctuation from February to May 2019. The variation is steady in the long run period. It showed a little significant fluctuation in the very long run period in August 2019.

In the case of LRNYSE, there are small but very significant fluctuations in the short run period in March, May, September 2019. A slight decrease in variation significance is observed in July 2019 short run period. In the medium run period, the significance of variation declined even further to medium significant from May to June 2019. There is no variation observed in the long run period. In the very long run period, a significant but much steadier variation arises from April to July 2019. Variations of LRSSE occurred mostly in the first half of the year. In the short run period, a very significant variation was detected in February and May 2019. In the medium run period in March 2019, the variation is significant but lesser than in the short run period. The significance declined further to little significance in the long run period in March 2019. There is no significant variation detected in the very long run.

During Covid

50	23 March 2020
100	15 June 2020
150	01 September 2020
200	23 November 2020
250	09 February 2021

The Continuous Wavelet Spectrum shows that there are very significant fluctuations in the short run period in March, April, and September 2020. The significance in fluctuations decreased to a medium significant in the medium run period in April and May 2020, as well as the long run period from March to May 2020. There is no fluctuation observed in the very long run period. LRKLSE experiences most fluctuations at the same time with different degrees. In the short run period, there is a strong significant fluctuation in March and November 2020. In the medium run period, there is a moderately significant fluctuation from February to April 2020. In the long run period, there is a weak significant fluctuation from March to June and November 2019. There is no significant fluctuation observed in the very long run period.

Similarly, in the case of LRNYSE, there is a strong to moderate significant variation in March 2019 in the short run period. In the medium run period, there is a moderately significant variation from February to May 2019. The significant fluctuation is steadier and weaker in the long run from March to May 2019. There is no significant fluctuation observed in the very long run period. LRSSE experienced very significant variation in the short run period in January, February, and July 2019. In the medium run period, there was slightly less fluctuation in July 2019, and a medium significant variation was observed in February 2019. In the long run period, there is a medium significant variation in July 2019. There is also no significant fluctuation observed in the very long run period.

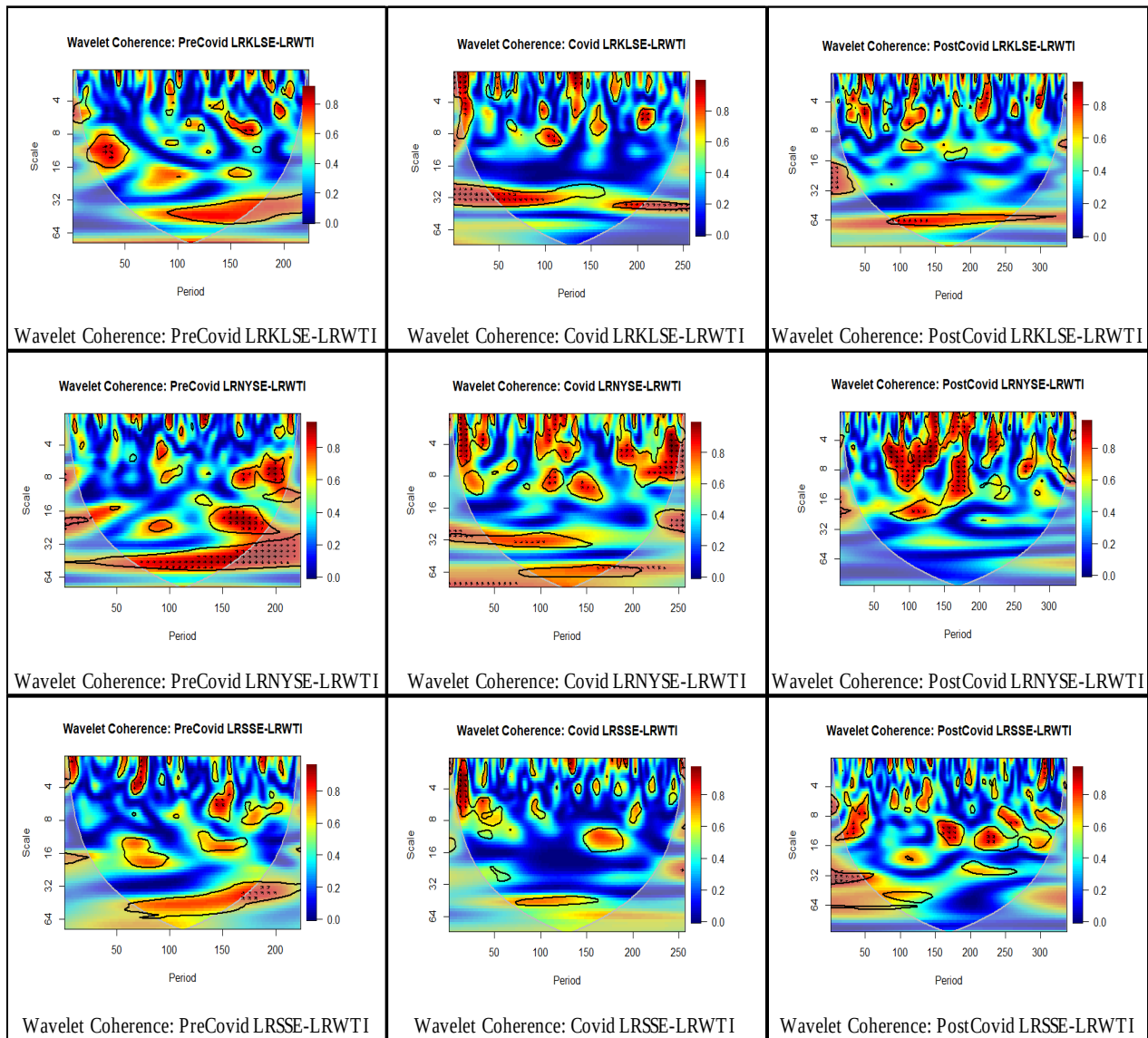
Post Covid

50	19 May 2021
100	05 August 2021
150	01 November 2021
200	19 January 2022
250	11 April 2022
300	05 July 2022

LRWTI's continuous wavelet spectrum shows that very significant fluctuations occurred in April and December 2021, February, March, May, and July 2022. There are also slightly less but still significant fluctuations in July and August 2022. In the medium run period, there is a significant medium fluctuation from February to April 2022. There is also significant fluctuation observed in the long run period. There is a weak and steadier significant fluctuation identified in the very long run period from August 2021 to March 2022. There is a very significant fluctuation in the short run period of LRKLSE in February 2022. A slightly less but still very significant fluctuation is identified in April 2021 in the short run period. In the medium run period, there is a medium significant fluctuation in January and February 2022. In the long run period, there is a medium to less significant fluctuation from August 2021 to February 2022. There is also very little significant fluctuation from November 2021 to January 2022.

Most fluctuations of LRNYSE occurred in the year 2022. In the short run period, there are noticeable, very significant variations in February, April, May, and June 2022. In the medium run period, there is a medium significant variation identified in January, April, May, June, and July 2022. In the long run period, there is a medium to weak significant variation in May and June 2022. In the very long run period, there is a weak significant variation from April to June 2022. In the case of LRSSE, very significant variation is determined in the short run from February to April 2022. There is also a medium significant variation in the short run period in August 2021. In the medium run period, there is a medium significant variation from March to May 2022. In the long run period, there is a weak significant variation from February to April 2022. The interpretation of arrows and phases are as:

Right and upward arrow	Oil price is leading stock price positively.
Left and upward arrow	Stock price is leading oil price negatively.
Left and downward arrow	Oil price is leading stock price negatively.
Right and downward arrow	Stock price is leading oil price positively.

Wavelet Coherence

In brief, the wavelet coherence is observed mostly in LRNYSE, then LRSSE and LRKLSE. The relationship between LRNYSE and LRWTI is most significant. Both in-phase and anti-phase is observed in the visualization with various lead-lag relationship happened in different time period.

Pre Covid

50	25 March 2019
100	18 June 2019
150	30 August 2019
200	22 November 2019

Wavelet Coherence of LRWTI and LRKLSE shows that in the short run period, in June 2019, LRWTI is leading LRKLSE negatively. In the August and September 2019 short run period, LRKLSE is leading LRWTI positively. In the medium run period, during February 2019, both variables are leading and lagging positively. There is no significant wavelet coherence in the long run period and very long run period.

In the short run period, there is a significant fluctuation in July 2019, where LRNYSE is leading LRWTI positively. Throughout the months from September to December 2019, in the short run period, sometimes LRWTI is leading LRNYSE, and sometimes there is no lead-lag relationship. From August to November 2019, in the long run period LRWTI is leading LRNYSE positively. In the very long run period, there is a positive in-phase from May to September 2019, where sometimes LRWTI is leading LRNYSE positively and sometimes there is no lead-lag relationship.

In the short run period in January 2019, LRWTI is impacting LRSSE positively. During April 2019, in the short run period, the majority of LRSSE is impacting LRWTI negatively, but sometimes LRWTI is impacting LRSSE positively. In August 2019, LRSSE was impacting LRWTI negatively. In November 2019, LRWTI is impacting LRSSE negatively. There is no significant lead-lag relationship in the medium run and long run period. In the very long run period, LRWTI was impacting LRSSE positively in September 2019. The rest of the months are not significant as they fall outside the cone of influence.

During Covid

50	23 March 2020
100	15 June 2020
150	01 September 2020
200	23 November 2020
250	09 February 2021

In the short run, in January 2020, sometimes LRWTI impacts LRKLSE positively, and sometimes there is a positive relationship, but lead-lag roles are uncertain. In March, June, and August 2020, LRWTI is impacting LRKLSE negatively. In November 2020, LRWTI is impacting LRKLSE positively. In the medium run period in June 2020, there is an in-phase positive relationship where LRKLSE is leading LRWTI. In the long run period from March to June 2020, LRKLSE is impacting LRWTI positively. In the very long run period in November 2020, there is a positive relationship but fails to identify the lead-lag relationship between oil and stock price.

An in-phase relationship is found in the short run period between LRNYSE and LRWTI. In January 2020, sometimes LRWTI impacts LRNYSE positively, and sometimes there is a positive relationship, but lead-lag roles are uncertain. LRWTI is impacting LRNYSE positively in February and November 2019; while LRNYSE is impacting LRWTI positively in May, July, August, and December 2020. In January 2021, there is a positive but uncertain lead-lag relationship. In the medium run period, LRWTI is impacting LRNYSE positively during June, May, and September 2020. There is no significant wavelet coherence observed in the long run period. In the very long run period, LRNYSE is impacting LRWTI positively in May

and June 2021; and LRNYSE was impacting LRWTI negatively in September 2021. Wavelet coherence between LRWTI and LRSSE occurs only in the short run period. In January and March 2020, LRSSE is impacting LRWTI positively. In August, there is a negative relationship between oil and stock price, but the lead-lag relationship is not defined. In November 2020, LRWTI is impacting LRSSE negatively.

Post Covid

50	19 May 2021
100	05 August 2021
150	01 November 2021
200	19 January 2022
250	11 April 2022
300	05 July 2022

Wavelet coherence between LRWTI and LRKLSE occurs mainly in the short run period and very long run periods. In the short run period, in April 2021, LRWTI is causing LRKLSE negatively. In May and August 2021, it is uncertain of the lead-lag roles, but there is a negative relationship. In September 2021 and July 2022, LRKLSE is causing LRWTI positively. In February 2022, there is an out-phase negative relationship between oil and stock prices, and both LRWTI and LRKLSE are causing each other. In the very long run period, LRWTI is causing LRKLSE positively. LRNYSE and LRWTI have a positive relationship most of the time. In the short run period, LRNYSE is causing LRWTI positively in July 2021.

In August and September 2021, LRWTI is causing LRNYSE positively. In October 2021, sometimes the LRWTI impacts LRNYSE positively, and sometimes there is a positive relationship, but lead-lag roles are uncertain. In December 2019, sometimes both variables are causing each other positively, and sometimes the lead-lag relationship is not determined. In February 2022, LRWTI is causing LRNYSE negatively. In July 2022, LRNYSE is causing LRWTI positively. In the medium run period in August 2021, LRWTI is causing LRNYSE positively. In December 2021 and April 2022, a positive uncertain lead-lag relationship is identified. In the long run relationship in August 2021, LRNYSE is causing LRWTI positively. There is no significant phase difference observed in the very long run period.

In the short run period in May 2021, LRSSE is causing LRWTI positively. In July 2022, sometimes the LRSSE impacts LRWTI positively, and sometimes there is a positive relationship, but lead-lag roles are uncertain. In the medium run period in April 2021, LRWTI is causing LRSSE negatively. In December 2021 and April 2022, LRSSE is causing LRWTI positively. In February 2022, LRWTI is causing LRSSE positively. There is no significant lead-lag relationship in the long run period and very long run period as the majority of the arrows fall out of the cone of influence....

CONCLUSION

This paper investigated the relationship between oil price and the stock prices in Malaysia, the United States of America, China and the Covid-19 pandemic. A positive linear relationship between oil price and stock prices is proved regardless of the Covid-19 situation. Changes in oil price impact stock prices. When the time period is

decomposed, a negative linear relationship mostly occurs during the long run. Most correlation experiences an increasing trend at first, then either fall or rise during the long run. More stronger variations occurred in the short run compared to medium and long run. The wavelet coherence is most significant in LNYSE, then LRSSE and LRKLE.

POLICY IMPLICATIONS

Our research on the oil and stock market performance offers vital information for examining the financial effects of the pandemic on the costs of significant resources and the general stability of the global financial system and economy. Empirical findings from our research alert individuals to be mindful of market fluctuation as they are catastrophe-prone and unbalanced over time. Adverse oil prices movement will have a significant impact on production costs and corporate earnings. Since the stock market is thought to predict future economic activity, the pandemic has evidently affected oil prices, stock market indices, and the economic uncertainty for both the oil-importing and oil-exporting economies. Implementation of policy and action can be taken to accelerate, assist and alleviate economic recovery (Le et al., 2021). Businesses may incorporate this knowledge into their hedging strategies, especially if they anticipate future losses. Investors will also be able to adjust their hedging strategies in accordance with market volatility and the relationship between time and investment horizons. Data on oil stock relationships can be utilised by portfolio managers to predict future linkage, forecast stock price movements and build equity strategies (Yan, et al., 2022; Khalfaoui, et al., 2022). Our findings and policy implication aid the prevention of economic catastrophe and can be applied to future pandemic scenarios.

DIRECTION OF FUTURE RESEARCH

With the enhanced knowledge of oil prices and stock market performance, oil-dependent and oil-exporting countries are now able to make educated judgments on oil prices and stock matters. However, our research is limited to the effects of the covid-19 pandemic on 3 countries (Malaysia, China, United States). Future research may build on this work by analysing different pandemic and economic crises' short, medium and long-term consequences of oil and stock interaction. Subjects can be widened to more countries, the effect on oil importing and exporting countries or even the difference of impact on developing, developing and third world countries. ...

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REFERENCES

- Ahmed, R., & Rehman, A. (2020). The COVID-19 pandemic: A global catastrophe. *Journal of Public Affairs*, 20(4), e2309. <https://doi.org/10.3390/nu15010088>
- Al-Awadhi, A. M., Alsaifi, K., Al-Awadhi, A., & Alhammadi, S. (2020). Impact of COVID-19 on the crude oil prices and stock markets: evidence from selected GCC countries. *Heliyon*, 6(10), e05342. <http://dx.doi.org/10.1016/j.heliyon.2020.100326>
- Albanesi, S., & Kim, J. (2021). Effects of the COVID-19 Recession on the U.S. Labor Market: Occupation, Family, and Gender. *Journal of Economic Perspectives*, 35(3), 3–24. <https://doi.org/10.1257/jep.35.3.3>
- Albulescu, C. T. (2021). COVID-19 and the United States financial markets' volatility. *Finance Research Letters*, 38, 101699. <https://doi.org/10.1016/j.frl.2020.101699>
- Baber, H. (2020). Spillover effect of Covid19 on the Global Economy. *Transnational Marketing Journal*, 8(2), 177–196. <https://doi.org/10.33182/tmj.v8i2.1067>
- Baker, S. R., Bloom, N., Davis, S. J., Kost, K. J., Sammon, M. C., & Viratyosin, T. (2020). The unprecedented stock market impact of COVID-19. *The Review of Asset Pricing Studies*, 10(4), 742–758. <https://doi.org/10.3386/w26945>
- Chien, F., Sadiq, M., Kamran, H. W., Nawaz, M. A., Hussain, M. S., & Raza, M. (2021). Co-movement of energy prices and stock market return: environmental wavelet nexus of COVID-19 pandemic from the USA, Europe, and China. *Environmental Science and Pollution Research*, 28(25), 32359–32373. <https://doi.org/10.1007/s11356-021-12938-2>
- Chiou, J. S., & Lee, Y. H. (2009). Jump dynamics and volatility: Oil and the stock markets. *Energy*, 34(6), 788–796. <https://doi.org/10.1016/j.energy.2009.02.011>
- Cucinotta D, Vanelli M. (2020). WHO Declares COVID-19 a Pandemic. *Acta Biomed*. <https://doi.org/10.23750/abm.v91i1.9397>
- Dhar, B. K. (2020). Impact of COVID-19 on Chinese Economy. *Economic Affairs*, 9(3/4), 23–26. <http://dx.doi.org/10.6084/m9.figshare.16761442.v1>
- Ding, W., Levine, R. E., Lin, C., & Xie, W. (2020). Corporate Immunity to the COVID-19 Pandemic. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.3578585>
- Elengoe, A. (2020). COVID-19 outbreak in Malaysia. *Osong public health and research perspectives*, 11(3), 93–100. <https://doi.org/10.24171/j.phrp.2020.11.3.08>
- Fernandes, N. (2020). Economic Effects of Coronavirus Outbreak (COVID-19) on the World Economy. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.3557504>
- Foo, L. P., Chin, M. Y., Tan, K. L., & Phuah, K. T. (2020). The impact of COVID-19 on tourism industry in Malaysia. *Current Issues in Tourism*, 24(19), 2735–2739. <https://doi.org/10.1080/13683500.2020.1777951>
- Gao, X., Ren, Y., & Umar, M. (2022). To what extent does COVID-19 drive stock market volatility? A comparison between the U.S. and China. *Economic Research-Ekonomska Istraživanja*, 35(1), 1686–1706. <https://doi.org/10.1080/1331677X.2021.1906730>
- Gharib, C., Meftteh-Wali, S., Serret, V., & Ben Jabeur, S. (2021). Impact of COVID-19 pandemic on crude oil prices: Evidence from Econophysics approach. *Resources Policy*, 74, 102392. <https://doi.org/10.1016/j.resourpol.2021.102392>
- Gogineni, S. (2010). Oil and the stock market: An industry level analysis. *Financial Review*, 45(4), 995–1010. <https://doi.org/10.1111/j.1540-6288.2010.00282.x>
- Huang, C., Wang, Y., Li, X., Ren, L., Zhao, J., Hu, Y., ... & Cheng, Z. (2020). Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *The Lancet*, 395(10223), 497–506. [https://doi.org/10.1016/S0140-6736\(20\)30183-5](https://doi.org/10.1016/S0140-6736(20)30183-5)

- Huang, Y., & Zhao, N. (2020). Generalized anxiety disorder, depressive symptoms and sleep quality during COVID-19 outbreak in China: a web-based cross-sectional survey. *Psychiatry research*, 112954. <https://doi.org/10.1016/j.psychres.2020.112954>
- Jiang, Z., & Yoon, S. M. (2020). Dynamic co-movement between oil and stock markets in oil-importing and oil-exporting countries: Two types of wavelet analysis. *Energy Economics*, 90, 104835. <https://doi.org/10.1016/j.eneco.2020.104835>
- Khalfaoui, R., Solarin, S. A., Al-Qadasi, A., & Ben Jabeur, S. (2022). Dynamic causality interplay from Covid-19 pandemic to oil price, stock market, and economic policy uncertainty: evidence from oil-importing and oil-exporting countries. *Annals of Operations Research* 313(1), 105-143. <https://doi.org/10.1007/s10479-021-04446-w>
- Le, T.-H., Le, A. T., & Le, H. C. (2021). The historic oil price fluctuation during the Covid-19 pandemic: What are the causes? *Research in International Business and Finance*, 58, 101489. <https://doi.org/10.1016/j.ribaf.2021.101489>
- Lee, C. C., & Zeng, J. H. (2011). The impact of oil price shocks on stock market activities: Asymmetric effect with quantile regression. *Mathematics and Computers in Simulation* 81(9), 1910-1920. <https://doi.org/10.1016/j.matcom.2011.03.004>
- Mahmoudi, M., & Ghaneei, H. (2022). Detection of structural regimes and analyzing the impact of crude oil market on Canadian stock market: Markov regime-switching approach. *Studies in Economics and Finance* 39(4), 722-734. <https://doi.org/10.1108/SEF-09-2021-0352>
- Mishra, A. K., Rath, B. N., & Dash, A. K. (2020). Does the Indian Financial Market Nosedive because of the COVID-19 outbreak, in comparison to after Demonetisation and the GST? *Emerging Markets Finance and Trade*, 56(10), 2162-2180. <https://doi.org/10.1080/1540496x.2020.1785425>
- Mohamad, M., Ahmad, N., & Ismail, M. N. (2020). The impact of COVID-19 on the Malaysian tourism industry: A preliminary insight. *Current Issues in Tourism*, 1-5.
- Morales, L., & Andreosso-O'Callaghan, B. (2012). The current global financial crisis: Do Asian stock markets show contagion or interdependence effects? *Journal of Asian Economics*, 23(6), 616-626. <https://doi.org/10.1016/j.asieco.2012.09.002>
- Mugableh, M. I. (2017). World oil price volatility and stock returns fluctuations: evidence from Southeast Asian equity markets. *Science International*, 29(4), 759-762. https://www.researchgate.net/publication/318897616_WORLD_OIL_PRICE_VOLATILITY_AND_STOCK_RETURNS_FLUCTUATIONS_EVIDENCE_FROM_SOUTHEAST_ASIAN_EQUITY_MARKETS
- Noland, M., & Heginbotham, E. (2019). China's economic statecraft in Asia: Growing Chinese investment in the region. Peterson Institute for International Economics.
- Novotný, F. (2012). The Link Between the Brent Crude Oil Price and the U.S. Dollar Exchange Rate. *Prague Economic Papers*, 21(2), 220-232. <https://doi.org/10.18267/j.pep.420>
- Ogiri, I. H., Amadi, S. N., Uddin, M. M., & Dubon, P. (2013). Oil price & stock market performance in Nigeria: An empirical analysis. *American Journal of Social and Management Sciences* 4(1), 20-41. <http://www.scribbr.org/AJSMS/PDF/2013/1/AJSMS-4-1-20-41.pdf>
- Oladosu, G., & Oyewunmi, O. A. (2019). The impact of crude oil price fluctuations on the Nigerian economy. *International Journal of Energy Economics and Policy*, 9(3), 88-95.
- Ozili, P. K., & Arun, T. (2020). Spillover of COVID-19: Impact on the Global Economy. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.3562570>
- Pilbeam, K. (2018). *Finance and financial markets*. Bloomsbury Publishing. [https://books.google.com.my/books?hl=en&lr=&id=ihTHEAAQBAJ&oi=fnd&pg=PP1&dq=Pilbeam,+K.+\(2018\).+Finance+and+financial+markets.+Bloomsbury+Publishing.&ots=SBbfSc8AOA&sig=CQycAITLDGUHfOJKCXBI5sSkk](https://books.google.com.my/books?hl=en&lr=&id=ihTHEAAQBAJ&oi=fnd&pg=PP1&dq=Pilbeam,+K.+(2018).+Finance+and+financial+markets.+Bloomsbury+Publishing.&ots=SBbfSc8AOA&sig=CQycAITLDGUHfOJKCXBI5sSkk)
- Prabheesh, K. P., Padhan, R., & Garg, B. (2020). COVID-19 and the oil price-stock market nexus: Evidence from net oil-importing countries. *Energy Research Letters*, 1(2), 13745. <https://doi.org/10.46557/001c.13745>
- Qianqian, Z. (2011). The Impact of International Oil Price Fluctuation on China's Economy. *Energy Procedia*, 5, 1360-1364. <https://doi.org/10.1016/j.egypro.2011.03.235>

- Raza, S. A., Sharif, A., Wong, W. K., & Karim, M. Z. A. (2017). Tourism development and environmental degradation in the United States: evidence from wavelet-based analysis. *Current Issues in Tourism*, 20(16), 1768-1790. <https://doi.org/10.1080/13683500.2016.1192587>
- Salisu, A. A., Ebu, G. U., & Usman, N. (2020). Revisiting oil-stock nexus during COVID-19 pandemic: Some preliminary results. *International Review of Economics & Finance*, 69, 280-294. <https://doi.org/10.1016/j.iref.2020.06.023>
- Sharif, A., Aloui, C., & Yarovaya, L. (2020). COVID-19 pandemic, oil prices, stock market, geopolitical risk and policy uncertainty nexus in the U.S. economy: Fresh evidence from the wavelet-based approach. *International Review of Financial Analysis*, 70, 101496. <https://doi.org/10.1016/j.irfa.2020.101496>
- Sun, J., & Hou, J. W. (2018). Monetary and Financial Cooperation Between China and the One Belt One Road Countries. *Emerging Markets Finance and Trade*, 55(11), 2609–2627. <https://doi.org/10.1080/1540496x.2018.1540976>
- Wang, J., Shao, W., & Kim, J. (2020). Analysis of the impact of COVID-19 on the correlations between crude oil and agricultural futures. *Chaos, Solitons & Fractals*, 136, 109896. <https://doi.org/10.1016/j.chaos.2020.109896>
- Wu, F., Zhao, S., Yu, B., Chen, Y. M., Wang, W., Song, Z. G., ... & Zhang, Y. Z. (2020). A new coronavirus associated with human respiratory disease in China. *Nature*, 579(7798), 265-269. <https://doi.org/10.1038/s41586-020-2008-3>
- Yan, R., Cao, F., & Gao, K. (2022). Determining the COVID-19 effects on spillover between oil market and stock exchange: a global perspective analysis. *Environmental Science and Pollution Research*, 29(44), 66109–66124. <https://doi.org/10.1007/s11356-022-19607-y>
- Zhu, P., Tang, Y., Wei, Y., Dai, Y., & Lu, T. (2021). Relationships and portfolios between oil and Chinese stock sectors: A study based on wavelet denoising-higher moments perspective. *Energy*, 217, 119416. <https://doi.org/10.1016/j.energy.2020.119416>



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