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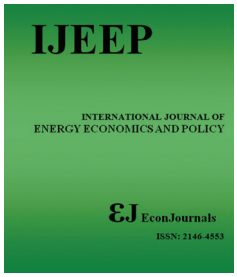

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Analyzing the Relationship between Oil Prices and Gold Prices before and after COVID-19

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ABSTRACT

The main purpose of this study is to investigate the causal relationship between world oil prices and gold prices. For this purpose, the study is divided into two groups and evaluated as pre-pandemic and post-pandemic. The data set required for the study is evaluated on a daily basis and includes the period from January 2011 to June 2022. For the data of the examined variables, the stationary test was carried out by using the Extended Dickey Fuller (ADF) unit root test. In the case of level, it is concluded that the related series are not stationary for these variables. According to the ADF and Johansen cointegration results obtained by applying the first-order difference operation, it was determined that the first-order differences of the variables of interest were stationary, that is, there was no unit root. The Engle-Granger test was used to determine whether there is a long-term relationship between the two variables. The direction of the relationship was tried to be determined by using the Granger causality test. As a result of the study, it was concluded that there is a one-way causality relationship from gold prices to oil prices, before the pandemic.

Keywords: Oil Price, Gold Price, COVID-19
JEL Classifications: E44, G00, L72, C58

1. INTRODUCTION

Petroleum prices have an important role in the sustainable economic development of many countries. Oil-exporting countries always want prices to be high, while oil-importing countries always want prices to be low. Therefore, the fluctuation in oil prices has a significant impact on both developed and developing country economies, which are heavily dependent on oil imports (Selvanathan and Selvanathan, 2022). Oil price is volatile due to disruptions caused by the COVID19 pandemic (Prabheesh et al., 2020).

There is a large literature on the price relationship between gold and oil. Some of these studies were conducted prior to COVID-19 (Soytas et al., 2009; Narayan et al., 2010; Zhang and Wei, 2010; Ewing and Malik, 2013; Bedoui et al., 2019), while others were conducted after the COVID-19 pandemic. (Tanin et al., 2021; Gharib et al., 2021; Selvanathan and Selvanathan, 2022).

According to Aggarwal and Lucey (2007), gold has been an important precious metal for centuries and plays a special role as a store of value, especially in times of political and economic uncertainty. For this reason, it has been stated that gold has a distinct advantage and an outstanding position compared to other metals in the major commodity market (Zhang and Wei, 2010).

However, in uncertain times, both government, business and individual investors are looking for a safe haven where they can invest their money. COVID-19 was also one of such uncertain times, and the safe haven in this process was the gold option for some. However, some studies in the literature show gold as a hedging and safe haven for US, UK and German stocks or bonds (Baur and McDermott, 2010; Baur and Lucey, 2010).

Significant uncertainty in markets around the world has created a risk-averse environment that has led investors to safe-haven assets,

particularly gold (Gharib et al., 2021). Hillier et al. (2006); Kaul and Sapp (2006) found a weak or negative relationship between gold and other assets.

Oil and gold are the most traded commodities in the world. Both gold and oil have high liquidity. These two elements have a worldwide financial impact. Therefore, oil and gold are the main factors leading to economic variables. The volatility in oil and gold prices affects the world economy and financial markets. From this point of view, the aim of this study is to investigate the causality relationship between world oil prices and gold prices.

2. LITERATURE REVIEW

2.1. Oil Prices

Price is one of the most important market factors affecting the behavior of buyers (Huseynli et al., 2018). In another study conducted by Huseynli and Maharammaov (2022), it was stated that consumers may be influenced by price and product information to switch from online channels to offline channels.

Oil is one of the most traded commodities considered to be high risk. Due to high oil demand for global industries, seeing all global industries need fuel, hence fluctuating oil price movements may affect the capital market (Putra and Robiyanto, 2019). World traded West Texas Intermediate (WTI), Brent Bland, OPEC Basket Price, Russian Export Blend etc. There are various types of crude oil such as.

2.2. Gold Prices

Gold is a form of investment with little risk and a fairly stable value, gold is also often used as an antidote to inflation. Some of the advantages of gold as an investment tool are that it has a high level of liquidity that will not be affected by inflation and its value is not determined by the government (Lubis et al., 2021).

It is used as a gold financial standard in many countries (Robiyanto, 2018). The advantages of gold as an investment tool are: it is not affected by inflation, high liquidity levels and pricing is not interfered with by the government (Putra and Robiyanto, 2019). Since 1968, the world gold price has been standardized on the London gold market, known as the London Gold Fixing system.

2.3. Pre-COVID-19 Studies in the Literature

Jones and Kaul (1996) examined the effects of changes in oil prices, which are reflected in stock returns, on the national economy in the USA and Canada. Kavussanos and Marcoulis (1997), on the other hand, examined the stock market perception of risk factors on the profitability of oil refinery companies during the 1984-1995 period in their study.

In a study by Sadorsky (2001) the Canadian oil and gas industry, in a study by Siliverstovs et al., (2005), the degree of integration of natural gas markets and their relationship with oil price, Chen et al., (2005), on the other hand, examined the long- and short-term relationships between the crude oil and refinery gasoline spot markets and their future markets.

A study by Malik and Hammoudeh (2005) investigated the volatility and shock transmission mechanism between the US stock, the global crude oil market, and the stock markets of Saudi Arabia, Kuwait and Bahrain. Xu and Fung. (2005) examined the information flow in the US and Japanese markets for gold, platinum and silver futures contracts and found that the volatility spillover between the two markets is strong, but the US market plays the leading role.

Boyer and Filion (2007) examined the financial determinants of Canadian oil and gas companies' stock returns, while Ewing and Thompson (2007) examined the empirical relationship between oil prices and consumer prices, unemployment, and stock prices.

Tully et al. (2007) analyzed the macroeconomic shocks to gold spot and futures markets and found that the US dollar is an important macroeconomic variable that affects gold price volatility, Nakamura and Small (2007) examined both daily gold price and crude oil price data and found that the initial differences were either independently distributed random variables or time-varying random variables.

Adam and Tweneboah (2008) examined the impact of the rise in oil prices on Ghana's stock prices. According to the results of the study conducted by Park and Ratti (2008) on the USA and twelve European countries, it was revealed that the increases in oil prices affected the stock returns negatively, while the stock markets in Norway, an oil exporting country, responded positively to the increases in oil prices. Nandha and Faff (2008) examined the short-term link between oil prices and thirty-five data stream global industries and found that increases in oil prices have a negative impact on everyone, not just the oil and gas industries.

Scholtens and Wang (2008) examined the oil price sensitivities and oil risk premiums of oil and gas firms traded on the NYSE and found that the returns on oil stocks are positive with the stock market returns and the increase in spot crude oil prices, but the firm's book book It has been revealed that there is a negative correlation with the market rate. Nandha and Brooks' (2009) study of thirty-eight countries found that oil prices in advanced economies have some effect on the returns of the transport sector. In a study by Jalil et al., (2009), the effect of oil price shocks on the Malaysian stock market was examined, and as a result of the study, it was determined that a change in oil price(s) did not have a significant effect on the stock market in both the short and long run.

As a result of Oberndorfer's (2009) study, it was examined and revealed that oil price negatively affected European oil and gas stock returns. Arouri and Nguyen (2010) examined the relationship between oil and stock markets and, according to the findings of the study, it was found that the responses of stock returns to changes in oil prices differ greatly depending on the sector of activity. Horng and Chyan (2010) examined the volatility of periods of high and

low oil prices as a threshold for Singapore and Hong Kong stock market returns. As a result of the study, it has been revealed that the Singapore and Hong Kong stock markets mutually affect each other and the dynamic conditional correlation and bivariate asymmetric model are appropriate in evaluating the relationship between them.

A study by Galvani and Plourde (2010) examined futures for crude oil, natural gas, and unleaded gasoline. The results of the research found that futures for crude oil, natural gas and unleaded gasoline did not improve the performance of representative energy stocks in terms of return on risk, but reduced the overall risk exposure of passive equity investors. A study by Ravichandran and Alkhathlan (2010) examined the effect of oil prices on the GCC stock market. Negi et al., (2011) examined the long-term relationships between rising oil prices and stock market prices in India and China, and as a result of the study, it proved that there is a long-term relationship between oil prices and stock market prices for both countries.

In their study, Ilori and Adeniyi (2012) found that the growth in the oil sector in Nigeria was inversely proportional to the growth in the industrial sector. Lee et al., (2012) analyzed the sector stock prices and oil prices of the G7 countries between 1991 and 2009 and found that oil price shocks did not significantly affect the composite index in each country. However, it was determined that stock price changes in Germany, England and the USA led to the changes in oil prices. Bagh and Das (2017) micro-examined twelve identified stocks of the oil and gas sector based on six different parameters comparing the performance of the company in the context of risk and return factors over the last 5 years in India. As a result of his study, Dutta (2017) found that the new energy stock market is highly sensitive to the impact of the crude oil price volatility index. As a result of a study by Shabbir et al., (2019), it was found that gold and oil prices have a significant impact on the stock market.

2.4. Post-COVID-19 Studies in the Literature

In a study by Tanin et al., (2021), they examined the relationships between seven leading exchange rates and gold prices using daily data from January 2017 to April 2021. The results of the study revealed that gold is a safe-haven asset for investors during COVID-19. A study by Gharib et al., (2021) examines the causal relationship between crude oil and gold spot prices to assess how the economic impact of COVID-19 is affecting them. As a result of the article, which analyzed West Texas Light crude oil (WTI) and gold prices from January 2010 to May 4, 2020, common light boom periods were determined in the WTI and gold markets.

In a study by Selvanathan and Selvanathan (2022), using daily data, the impact of COVID-19 on oil and gold prices was examined. According to the results of the study, it was found that the number of COVID-19 cases and deaths plays an important role in influencing oil and gold prices. A study by Lubis, Alfarisi and Adrianto (2021) examined changes in crude oil prices, gold prices and exchange rates on the basis of the Jakarta Composite Stock Price Index (JCI) during the COVID-19 pandemic from March 2020 to March 2021. It has been determined that there is no significant effect on JCI, while gold price has a significant positive effect on JCI and exchange rate.

A study by Marwanti and Robiyanto (2021) analyzed the effects of oil and gold price volatility on stock returns in Indonesia by comparing before and during the COVID-19 pandemic. The results of the study proved that volatility in oil and gold prices did not affect stock returns in the two periods. A study by Huang and Wu (2021) examined the asymmetric spillover effects of the COVID-19 pandemic in the oil and gold markets. As a result of the study, it was found that a negative information shock in the oil market has a greater effect on gold yield volatility than a positive shock, and this asymmetric spillover effect intensifies during the pandemic.

Huang and Wu (2021) investigated the effects of oil and gold price (in USD) during the COVID-19 outbreak period from June 2018 to June 2021 and reported that only oil market volatility had a one-way effect. Volatility in the gold market did not have a significant impact on the oil market. In a study by Asaad (2021), he examined the interactions between oil price, gold price, exchange rate and stock price represented by the ISX60 index under the Iraqi stock market prior to the global COVID-19 pandemic. As a result of the study, the results of the causal short-run model in the COVID-19 period showed that the effect of oil price, gold price and exchange rate was insignificant with the Iraqi stock market.

3. RESEARCH METHODOLOGY

3.1. Purpose of the Studey

The aim of this study is to investigate the causal relationship between world oil prices and gold prices before and after COVID-19. For this, Granger analysis was carried out on the data on oil and gold prices for the period January 2011-June 2022.

3.2. Data Set

The data required for the analysis were obtained from ivesting.com. The data required for the analysis were examined on a daily basis. The main purpose of the data covering the period from 2011 to 2022 (first 6 months) is to measure whether the changes in oil prices and gold prices are the cause of each other. In the study, the Granger method was preferred to measure causality. Before proceeding to Granger analysis, stages such as Johansen cointegration, ADF test, VAR model were made. The logarithmic series of the variables used were included in the analysis. In this study, which is divided into pre-covid and post-covid, the relationship between the data has been tried to be seen more clearly.

3.3. Analysis Method

The data set required for the study includes a period of approximately 12 years. The data set used in the analysis was obtained daily. As the year 2022 continues, the first 6-month period is included in the study. In the study, which was analyzed with the Granger method, the causality between oil prices and gold prices was tried to be investigated.

The stationarity of the series used in econometric models, in other words, whether the series analyzed are stationary or not, significantly affects the results of the empirical model. In cases where the series are stationary, there is no permanent effect of any shock and the series fluctuates around a fixed long-term average. On the other hand, non-stationary series do not tend to return to their deterministic path in the long run, and a shock occurring in the current period permanently affects the long-term values of the series (Özata and Esen, 2010; Huseynli and Huseynli, 2022). For these reasons, it is necessary to test the stationarity of the series to be analyzed. While performing the Granger causality analysis, Augmented Dickey Fuller (ADF) test, which is widely used in the literature, was used to examine whether the series contain unit roots.

Developed by Granger in 1969, causality analysis is one of the most widely used methods to detect the existence of causal relationships between time series (Karaca, 2003). Granger causality analysis is used to test the direction of causality between the series, in other words, whether there is any relationship between the current value and the past values of the series (Bayrakdaroğlu and Nazlıoğlu, 2009). In the Granger causality analysis and in order to test the causality relationship between these two variables, a VAR (Vector Autoregressive) model is estimated as follows (Bayrakdaroğlu and Nazlıoğlu, 2009).

$$\Delta Y_t = \alpha_{12} + \sum_{i=1}^{T_{11}} \beta_{11i} \Delta Y_{t-1} + \sum_{j=1}^{T_{12}} \beta_{12i} \Delta X_{t-j} + \varepsilon_{12t} \quad (1)$$

$$\Delta X_t = \alpha_{22} + \sum_{i=1}^{T_{21}} \beta_{21i} \Delta X_{t-1} + \sum_{j=1}^{T_{22}} \beta_{22i} \Delta X_{t-j} + \varepsilon_{12t} \quad (2)$$

In the above equations, the difference operator, T lag length and β are the parameters to be estimated, the error term. In order to test whether there is a Granger causality relationship from variable to variable in Equation 1, Wald test or test is applied to the hypothesis. If the hypothesis is rejected, it is concluded that there is a Granger causality relationship from variable to variable (Bayrakdaroğlu and Nazlıoğlu, 2009).

4. ANALYSES AND RESULTS

Testing for pre-pandemic and post-pandemic data indicates that the data are not stationary from the level value. In this case, the acceptability of the H0 hypothesis is valid. Levels of stationarity results are given in Table 1. In both periods, it is observed that the probability values of the data are >0.05 and they are not stationary.

In order to make the non-stationary data stationary, a retest was performed and results were obtained where the data were stationary at the first level. As a result of the stagnation made in accordance with oil prices and gold prices, the probability values in both variables are <0.05 ($P \leq 0.05$), which indicates stationarity. At the same time, the fact that the absolute values are greater than the test-critical values at each significance level is an indicator of stationarity. The stationary values of the series are given in Table 2.

As a first step, the VAR model was established by using the level values of the variables and the appropriate lag number was determined with the help of Akaike (AIC), LL, LR, FBE, SC and HQ information criteria. Information on suitable delay numbers is given in Table 3. The level with the most stars indicates the appropriate delay length. The appropriate lag length determined for pre-pandemic values was found to be four, and the appropriate lag length for post-pandemic values was found to be two.

As the last step, Granger analysis was started. Granger results for oil prices and gold prices are given in Table 4.

According to the results of the analysis, when the pre-pandemic values are examined, a unilateral causality relationship is observed from gold prices to oil prices. In other words, the volatility in gold prices in this process causes the formation of oil prices, Granger. There is no effect from oil prices to gold prices in one-sided causality. The second part of the analysis carried out for the post-COVID-19 period shows us that there is no causal relationship between these values. In other words, there is no Granger relationship between these variables.

Table 1: Level values of series

Before covid-19				
	Petrol price		Gold price	
	t-statistics	Possibility	t-statistics	possibility
ADF testing statistics	−0.900939	0.7884	−2.036492	0.2712
Test critical values				
1%	−3.433123		−3.433160	
5%	−2.862651		−2.862667	
10%	−2.567407		−2.567416	
After Covid-19				
	Petrol price		Gold price	
	t-statistics	Possibility	t-statistics	possibility
ADF testing statistics	−1.488609	0.5390	−1.183809	0.6831
Test critical values				
1%	−3.440014		−3.440259	
5%	−2.865695		−2.865803	
10%	−2.569040		−2.569098	

Table 2: First difference values of series

Before Covid-19				
	Petrol price		Gold price	
	t-statistics	Possibility	t-statistics	possibility
ADF testing statistics	−50.81127	0.0001	−44.20988	0.0001
Test critical values				
1%	−3.433123		−3.433161	
5%	−2.862651		−2.862668	
10%	−2.567407		−2.567416	
After Covid-19				
	Petrol price		Gold price	
	t-statistics	Possibility	t-statistics	possibility
ADF testing statistics	−23.45446	0.0000	−22.91327	0.0000
Test critical values				
1%	−3.440029		−3.440291	
5%	−2.865702		−2.865817	
10%	−2.569044		−2.569106	

Table 3: Appropriate delay length

Before Covid-19						
Lag	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	−1671.088	NA	0.016023	1.542016	1.547254	1.543931
1	12082.19	27468.54	5.03e-08	−11.13013	−11.11442*	−11.12439
2	12093.09	21.74099	5.00e-08	−11.13649	−11.11030	−11.12691*
3	12095.57	4.949760	5.00e-08	−11.13509	−11.09843	−11.12168
4	12101.51	11.82722*	4.99e-08*	−11.13688*	−11.08974	−11.11964
After Covid -19						
Lag	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	−146.3914	NA	0.005455	0.464449	0.478408	0.469867
1	2937.461	6138.748	3.55e-07	−9.175151	−9.133274*	−9.158896*
2	2944.158	13.29015*	3.52e-07*	−9.183594*	−9.113799	−9.156501
3	2945.064	1.792217	3.56e-07	−9.173910	−9.076197	−9.135981
4	2948.001	5.789565	3.57e-07	−9.170581	−9.044950	−9.121814

*indicates the appropriate lag length for the relevant test

Table 4: Granger causality test

Hypotheses	F-value	Probability value (P)	Decision at 5% significance level
Before Covid-19			
Changing gold prices is the reason for oil prices changing	6.669352	0.0356	Acceptable
Change in oil prices is the reason why gold prices change	0.071007	0.9651	Rejected
After Covid-19			
Changing gold prices is the reason for oil prices changing	2.250994	0.3245	Rejected
Change in oil prices is the reason why gold prices change	0.004672	0.9977	Rejected

5. DISCUSSION AND CONCLUSION

At the beginning of the study, the main aim was to investigate the causal relationship between world oil prices and gold prices. The study was divided into two groups and examined as pre-pandemic and post-pandemic. The data set required for the study is evaluated on a daily basis and covers the years 2011-2022 (including the first 6 months). For the data of the examined variables, the stationary test was carried out by using the Extended DickeyFuller (ADF) unit root test. In the case of level, it is concluded that the related series are not stationary for these variables. According to the ADF and Johansen cointegration results obtained by applying the first-order difference operation, it was determined that the first-order differences of the variables of interest were stationary, that is, there was no unit root. The Engle-Granger test was used to determine whether there is a long-term relationship between the two variables. According to the test results, it was concluded that the series examined were not cointegrated, that is, there was no long-term equilibrium relationship between the series. At the same time, the direction of the relationship was tried to be determined by using the Granger causality test. As a result of the study, it was concluded that there is a one-way causality relationship from gold prices to oil prices, before the pandemic.

In summary, this study reveals how the price of gold moves with oil price fluctuations, and helps to shed light on the changes that occurred before and after COVID-19. It should also be noted that during the pandemic period, the gold price increased by 20.4% from January 1, 2020 to March 31, 2022 (USA Gold, 2022). In the same period, it was observed that the price of gold increased significantly as COVID-19 cases increased. (Gautam et al., 2022).

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