

Examining the causal relationship between the Saudi stock market (TASI) and Oil prices

Mohammed SADOUNI ^{1*}, Djamel KEDDAM ², Fayçal BOUMIMEZ ³

¹Tahri Mohammed University (Algeria), ([Sadouni. @univ-bechar.dz](mailto:Sadouni.@univ-bechar.dz))

² Mohammed Seddik BenYahia University(Algeria), (Keddam_djamel2002@yahoo.fr)

³ Mohammed Seddik BenYahia University (Algeria), (Boumimez.faycal@gmail.com)

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Summary: This study examines the existence of a causal relationship between the Saudi stock market and Oil prices (Brent oil, WTI crude oil, OPEC basket prices). Saudi Arabia is OPEC's largest oil producer. Using a daily dataset covering the period from 2 January 2019 to 30 March 2022, we find that most studies show oil price volatility transmits to stock market volatility. We used the co-integration approach of Johansen-Juselius (1990) and the causality test (Granger, 1969, Sims, 19972). We found the existence of one-way direct Granger causality from the Saudi stock markets (TASI) to oil prices (BRENT and OPEC basket price)

Keywords: TASI ; co-integration ; Oil Prices ; Causality ; OPEC.

Jel Classification Codes : G15

*Corresponding author

I- Introduction :

Crude oil is the world's main source of fuel and the largest overall source of primary energy. In 2020, the world used approximately 88.6 million barrels per day of oil, which amounted to 30.1% of the world's primary energy (**Energy, Statistical Review of World, 2021**). Oil prices play a significant role in the world economy. Moreover, oil price fluctuations are hardly predictable and keep changing because they are affected by many different factors including the current supply of oil as set by OPEC+, oil demand, especially by emerging economies, wars, and economic crisis.

Our paper investigates the impact of oil price fluctuations on Saudi Arabia's stock market. This market is interesting for many reasons. First, Saudi Arabia possesses approximately 17% of the world's proven petroleum reserves. The oil and gas sector accounts for about 50 % of gross domestic product, and about 70% of export earnings (**OPEC, 2020**). Second, Saudi Arabia's stock market has attracted increasing attention in the last two decades. In the light of high oil prices since 2003, Saudi Arabia has known high economic growth rates and plays a crucial role in world energy markets. Hence, its stock markets may be vulnerable to changes in oil prices.

Much recent research examined the relationship between oil prices and stock markets (Barsky and Kilian, 2004; Brown and Yücel (2002); Cunado and Perez de Garcia (2005); Hamilton, 1996, 2003; Hooker, 1996; Kilian, 2008, 2009; Kilian and Park, 2009; Lardic and Mignon (2006, 2008); Wang et al. 2013). Since World War II, crude oil price hikes were

responsible for all the recessions except one in the United States (Bjørnland, 2009). The authors of this study believe that crude oil price plays a vital role in Saudi Arabia's economy. Moreover, many researchers believe that the price of oil is an underlying factor in stock market volatility (Sadorsky, 1999; Cuñado and Perez de Gracia, 2003; Park and Ratti, 2008; Apergis and Miller, 2009; Kilian and Park, 2009; Zhang and Asche, 2014). Some researchers came to the conclusion that there is a positive relationship between crude oil prices and stock markets, while others discovered a negative correlation between crude oil prices and stock markets. (Badeeb and Lean, 2018; Fang and Egan, 2018; Filis et al. 2011; NathSahu et al., 2014; Wang et al., 2013). The majority of previous research on this topic concentrated on industrial countries such as the United States, Canada, Japan, and the United Kingdom. This study is significant because there have been few studies that have focused on studying such relationships in the GCC countries. The current period has seen many changes in international oil prices, especially under several crises such as the coronavirus (covid-19) pandemic in December 2019, and Russia-Ukraine in February 2022. Hence, the authors would like to examine the relationship between crude oil price and the Saudi Arabia stock market. Therefore, we would like to investigate this topic and attempt to answer the following research question:

- What is the relationship between crude oil price and the Saudi Arabia stock market?

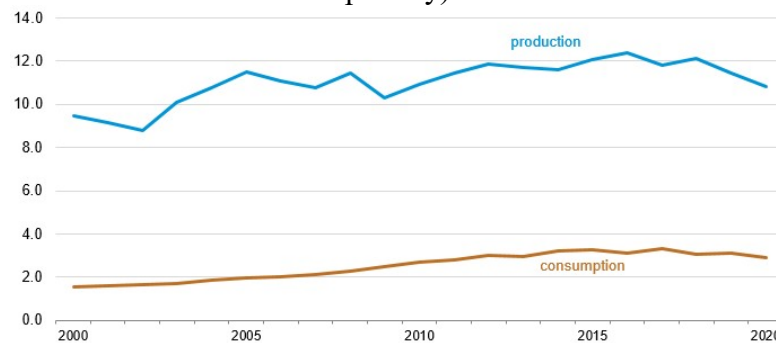
I.1. Saudi Arabia's economy, stock market, and the role of Oil:

The Saudi stock market is the oldest in the region, having been established in 1985 under the supervision of the Saudi Arabian Monetary Agency (SAMA, the central bank), supplanting the informal broker-based system that had been in place since the first half of the 20th Century. The government's decision to establish an exchange came in response to rapid growth in the number of Saudi Arabian joint-stock companies, which had proliferated during the 1970s as the kingdom's economy matured. In 2001, the commencement of Tadawul accelerated the trading volume in Saudi stock and correspondingly led to the establishment of a new official Saudi stock market index, TASI (Tadawul All Share Index). The latter is a major stock market index which tracks the performance of all companies listed on the Saudi Stock Exchange. The index has a base value of 1000 as of 1985 and it was reorganized on June 30, 2008.

Saudi Arabia holds 17% of the world's proven oil reserves. It is the largest exporter of crude oil in the world and maintains the world's largest crude oil production capacity at nearly 12 million barrels per day. Saudi Arabia is the largest crude oil producer in OPEC and it's one of the key members of the OPEC+ agreement. However, it reduced production in order to rebalance the global oil market, reduce record-high oil inventory levels, and stabilize volatile crude oil prices in 2020 as a result of the economic downturn and restriction measures taken due to the global

COVID-19 pandemic. Saudi Arabia initially reduced its production by 3.1 million barrels per day (b/d) as part of the OPEC+ agreement that began in April 2020.⁵ Saudi Arabia has increased production each month since February 2021, and, by October 2021, its production returned to an estimated 9.8 million b/d, similar to the level at the beginning of 2020 (figure 1)

Figure (1) Saudi Arabia's petroleum and other liquids production and consumption (million barrels per day)



The Source; US Energy Information Administration (EIA), 2021

Saudi Arabia's budget reached 254 billion dollars in 2022 (SAR 955 billion), reflecting the kingdom's strong resolution and plans to achieve stability and economic diversification, as well as create employment opportunities for its people in accordance with the Kingdom's Vision 2030 objectives. Saudi wealth funds are expected to spend hundreds of billions of riyals on the local economy in the coming years, even as the government's direct expenditure drops. Following the economic downturn and volatile oil prices seen in 2020, the oil price has since recovered in 2021, rising from an average of US\$50 in early 2021 to approximately US\$120 in March 2022 as a result of the Ukraine war and economic sanctions imposed on Russia. The increase in oil prices is expected to help in the Kingdom's recovery and diversification plans.

Table (1): Saudi Arabia's economy, stock market, and Oil (2019-2020)

	Market Capitalisation (\$ billion)	number of listed companies	Market Capitalisation (% GDP)	GDP current market prices (m \$)	crude oil exports (1,000 b/d)	Oil (% GDP)	Proven oil reserves (% world reserves)
2019	2406.8	199	306 .1	792 967	7 038,1	24 .24	17.2%
2020	2427.2	203	346.6	700 118	6 658,6	-	17.2%

The Source: all figures are obtained from Arab Monetary Fund, OPEC, World Bank

According to Table(1), the number of exchange-listed companies increased from 199 in 2019 to 203 at the end of 2020, with a total market capitalization of US\$ 2427.2 billion. Saudi Arabia has the world's second-largest oil reserves, with 297.5 billion barrels, accounting for approximately 17% of the world's proven petroleum reserves. The oil and gas sector accounts for about 50 % of gross domestic product and about 70 % of export earnings. The Gross Domestic Product (GDP) in Saudi Arabia was worth 700.12 billion US dollars in 2020, according to official data from the World Bank. The GDP value of Saudi Arabia represents 0.62 % of the world's economy.

I. 2. Literature Review:

The literature review develops a theoretical background for the study through a review of relevant theories. The financial literature is quite rich with respect to empirical studies that investigate the impact of oil prices fluctuations on the economy as well as the stock market returns. There is no agreement on this matter. Research results differ according to the methodology used, the model, the data, the sample, and the period. Some empirical studies have concluded that oil has a negative impact on the economy and stock market of the country if the country is an oil-importing country while it has a positive impact if the country is an oil-exporting country.

Basher and Sadorsky (2006) carried a research on the relationship between oil price risk and emerging stock markets. They examined the impact of oil price changes on emerging stock market returns from 1973 to 2005 using the international multi-factor model and the international capital asset pricing model (CAPM). They found that there is strong evidence that oil price risk affects stock market returns in emerging markets. This study is unique in that it examines the inherent risks associated with changes in oil prices on emerging stock markets, as well as the relationship between this risk and other risks such as total and market risks.

Onour (2007) investigated the long-term and short-term determinants of volatility in GCC stock markets. Because the GCC countries are major oil producers in the world, their stock markets are likely to be linked to changes in oil prices. He used data from 1989 to 2006 and applied the Garch-M model along with the Generalized Method of Moments (GMM) technique. He found out that short-term stock market returns are sensitive to unobservable speculative factors. However, long-term stock market returns are highly sensitive to oil price changes.

Arouri & Rault (2010) investigated the relationship between oil prices and stock markets in Gulf Corporation Council (GCC) countries. They applied a panel-data approach to treat a weekly dataset covering the period from 7 June 2005 to 25 May 2010. They discovered strong statistical evidence that the causal relationship is consistently bi-directional for Saudi Arabia only.

Yi-Hao et al (2011) examined the relationship between crude oil and twenty countries' stock market prices from January 1988 to August 2008. Using the copula method, they investigate the asymmetric dependence structure of both oil price and stock price. The study found that an asymmetric dependence exists between crude oil prices and major international stock markets, but the degree of dependence differs in different periods (stable or rise) and also differs in different countries (developing/ developed, European/Asian, or net exporters/net importers).

Arouri and Rault (2012) examined the long-term relationship between oil prices and the stock market in GCC using, for the first time for this purpose, the bootstrap panel co-integration techniques, and the Seemingly Unrelated Regression (SUR) method. They analysed monthly data over the period from January 1996 to December 2007. They found a strong correlation between oil prices and stock markets in the GCC countries. This indicates that, with the exception of Saudi Arabia, increases in oil prices always have a positive impact on stock prices in all GCC countries. Therefore, the study demonstrates that there is a relationship between oil price and stock returns. However, the researchers pointed out that the long-run relationship between oil price and stock markets can be different from one country to another depending on the economic structure.

Ready (2012) conducted a study adopting a new simple method to classify the changes in oil prices according to whether they were driven by demand or supply over a long period of time (1986 – 2011). Ready concludes that demand stocks were positively correlated with market returns while supply stocks were negatively correlated with market returns. The researcher observed that the supply shocks (changes in oil prices) had a significant impact on oil-producing companies. The study also concludes that oil supply shocks have a significant impact on US, and world stock prices and hence the world economy. He does, however, point out that oil price shocks primarily affect consumers rather than oil-consuming companies. This study has been useful as it provides a technique for studying oil price shocks and their effects on domestic and world economies, especially in short-period terms.

Hasan and Mahbobi (2013) tested the impact of oil prices on the Canadian stock market from January 1990 to August 2011 using the cause-effect relationship. The data was gathered from international oil prices and the Toronto Stock Exchange (TSX). The researchers applied the Granger causality test, LA-VAR testing, and generalized impulse response functions. The results of the study show that the impact of oil prices on the TSX became stronger in recent years than it was 18 years ago. After the recent North American financial markets slump in late 2008, the influence of the exchange rate difference between the Canadian and US dollars on the Canadian stock market has decreased. This has left oil prices as the most influential force on the Canadian stock market.

Masood Mashkoor Siddiqui & Muhammad Nabee (2013) investigated the impact of oil prices fluctuations on the performance of stock markets in Pakistan. They took KSE-100 Index as a sample for analysis. In addition to the oil price, exchange rate, and foreign private portfolio

investment, they also analysed the significance of political stability in the determination of stock market performance. The results revealed that the oil prices, exchange rate, and foreign private portfolio investment have a positive correlation with stock market performance while a democratic setup is found to have a negative impact on the stock market.

Alhayki (2014) examines the impact of international oil prices on the stock market in GCC countries using the wavelet analysis model. The data was collected on a monthly basis from May 2005 to December 2011. According to the findings of the data analysis, not all GCC stock markets react to oil prices in the same way. The relationship between oil price and the stock market was found to be negative in the cases of Bahrain, UAE, and KSA whereas it was positive in the cases of Kuwait, Qatar, and Oman. The study also proved that the shorter the period, the lower the correlation between oil price and stock market returns is and that long-run results usually indicate that oil price has an influential power over stock market returns. However, the correlation was bidirectional in all GCC countries except for Bahrain.

Abdulrahman Adnan Alqattan& Ahmed Alhayky (2016) examined the impact of oil price change in GCC countries in the short and long term, to assess the consequences of the change of stock market prices as a result of oil price change in GCC countries and examined the influence of stock price change in the local economies of GCC countries. Using the Auto-Regressive Distributive Lag Model (ARDL) to analyze monthly data from November 2006 to February 2015, they found that there is no evidence for co-integration between oil prices and stock markets in all GCC countries except for Oman where co-integration proved to exist.

Badeeb& Lean (2018) the relationship between crude oil prices in the Middle East, used monthly data from 1996 7 to 2016, found a negative relationship in the long run.

PetterHälldahl&Mohammad RefaetRahman (2020) (Petter Hälldahl, 2020) examined the relationship between crude oil prices and the Swedish and Norwegian stock markets. Using linear regression models they found that the Swedish stock market and Norwegian stock market both have a positive relationship with the crude oil price.

II– Methods and Materials:

This section provides a background of the main concepts used in our study.

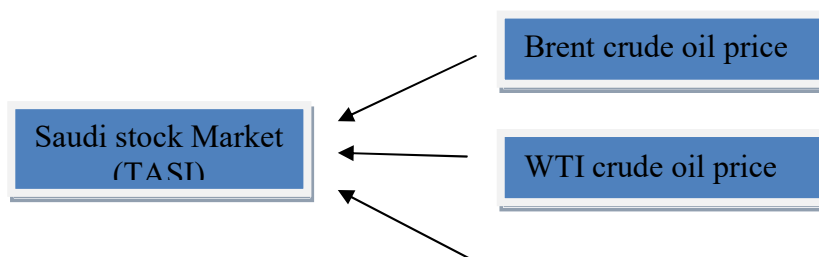
II.1. Sample and Data:

The study sample consists of daily data for the Saudi Stock Market General Index (TASI: Tadawul All Share Index) and oil prices (Brent oil, WTI crude oil, OPEC basket) from 02 January 2019 to 30 April 2022. There are 773 observations for each variable.

Brent Crude is more ubiquitous, and most oil is priced using Brent Crude as the benchmark, akin to two-thirds of all oil pricing. The preferred measure and pricing model is West Texas Intermediate. The price of the latter (WTI) is slightly lower than that of Brent. The OPEC Basket is a weighted average of oil prices from the different OPEC members around the world. We collected the daily data of stock market indices (TASI), Brent, and WTI crude oil from INVESTING. Whereas the OPEC basket was obtained from the OPEC database. In order to analyze data and test hypotheses, we used the Eviews-10 statistical program.

An analysis model has been developed to clarify the structure of the study with the dependent variable which is the Saudi stock market (TASI). The main independent variables are Brent oil price, WTI oil price and OPEC basket price.

Figure (2) :Analysis model



OPEC basket price

The Source: By Authors

II.2. Formulation of hypothesis :

In this study hypotheses are formulated based on previous research of the relationship between oil price and stock market. The hypotheses are based on that oil prices are independent variables and the stock market in Saudi Arabia is the dependent variable, so we can formulate the following hypotheses:

H1: There is a positive relationship between oil prices and the stock market in Saudi Arabia

Thus, the null hypothesis is that there is no relationship between oil prices and the stock market in Saudi Arabia

II.3. Methodology:

This study applies the co-integration approach of Johansen-Juselius (1990) and the causality test (Granger, 1969; Sims, 1972). This procedure allows for the testing of long-run relationships between study variables.

3.1. Granger Causality Tests Effect

Several studies have been devoted to the study of causality between variables (Granger, 1969; Sims, 1972). Furthermore, we carried out the Granger causality test where Granger (1969) proposed a time series data based approach in order to determine causality. For example if we want to explore the causal relationship between oil prices (p_t) and US exchange rate against the euro (y_t)

$$p_t = \sum_{i=1}^n \alpha_i p_{t-i} + \sum_{i=1}^n \beta_i y_{t-i} + \varepsilon_t$$

$$y_t = \sum_{i=1}^n \lambda_i p_{t-i} + \sum_{i=1}^n \delta_i y_{t-i} + \varepsilon_t$$

With n the number of lags

If β_i coefficients are jointly significantly different from zero, the Granger test suggests that oil prices (p_t) is a cause of US exchange rate against the euro (y_t) if λ_i is jointly significantly different from zero, the Granger test suggests that US exchange rate against the euro (y_t) is a cause of oil prices (p_t).

If the two causalities are verified, we can conclude the return causality "feedback causality" between the two variables.

3.2. Causality Test and Cointegration Variable

The relationship causality between different time series is based as following steps:

3.2.1. Unit Root Tests

The vector error correction model results to lead us to examine the stationary of the series. A stochastic process is stationary if its first and second moments are constant.

Analytically, y_t is stationary if:

$$E(y_t) = \mu \quad \forall t$$

$$E[(y_t - \mu)(y_{t-h} - \mu)] = \Gamma_y(h) = \Gamma_y(-h)^t$$

With $\Gamma_y(h)$ is a finite covariance matrix.

Dickey-Fuller (DF) tests is that the non-stationary statistical series. In other words, this test detects the presence or absence of a unit root.

Base models of the construction of this test are:

$$\begin{aligned}\Delta y_t &= (\phi_1 - 1)y_{t-1} + \varepsilon_i \\ \Delta y_t &= (\phi_1 - 1)y_{t-1} + \beta + \varepsilon_i \\ \Delta y_t &= (\phi_1 - 1)y_{t-1} + \beta + \partial t + \varepsilon_i\end{aligned}$$

By using the statistical Student's

$$t = \frac{\widehat{\phi_1} - 1}{\sigma_{\widehat{\phi_1}}}$$

unit root test using:

$$\begin{cases} H_0: |\phi_1| = 1 \\ H_1: |\phi_1| < 1 \end{cases}$$

To get a broader view, Dickey-Fuller took an autoregressive process of higher order known as the Augmented Dickey-Fuller (ADF). This test is represented as a following:

$$\begin{aligned}\Delta y_t &= (\phi_1 - 1)y_{t-1} + \sum \theta_i \Delta y_{t-i} + \varepsilon_i \\ \Delta y_t &= (\phi_1 - 1)y_{t-1} + \sum \theta_i \Delta y_{t-i} + \beta + \varepsilon_i \\ \Delta y_t &= (\phi_1 - 1)y_{t-1} + \sum \theta_i \Delta y_{t-i} + \beta + \partial t + \varepsilon_i\end{aligned}$$

3.2.2. Cointegration

The main objective of this paper is to assess not only the pairwise nature of causality among the variables, but, also the short run and long run dynamic impact as well, we tested for cointegration using two well known approaches: the one developed by Engle and Granger (1987) and the other one by Johansen (1988).

3.2.2.1. Engel - Granger Method

The Engle-Granger test is a procedure that involves an OLS estimation of a pre-specified cointegrating regression between the variables. This was followed by a unit root test performed on the regression residuals previously identified. We applied the Engle-Granger two-step procedure:

Step 1: Static regression between integrated variables.

Step 2: Test to verify the residual stationary.

This procedure has some weaknesses, as the test is sensitive to which variable is used as a conditioning left-hand-side variable, which is problematic in the case of more than two variables.

3.2.2.2. Johansen method

Johansen developed the maximum likelihood estimator for cointegration analysis. Johansen's cointegration test is used as a starting point in the vector autoregression (VAR) model. The vector autoregression model of order p

(VAR (p)) is constructed as a following equation:

$$\Delta y_t = \prod y_{t-1} + \sum_{i=1} \Gamma_i \Delta y_{t-i} + C + \varepsilon_i$$

The number of cointegrating relationship of the system is based on determining the rank of the matrix \prod . Three cases are distinguished:

- If rank $\prod = 0$, then the matrix \prod is null and the VAR model to writing as a VAR in difference.
- If rank $\prod = n$, then the matrix \prod is full rank and y_t is stationary.
- If $0 < \text{rank } \prod = r < n$, then there are r cointegrating relationship between the process which consists Y_t .

The Likelihood ratio is the ratio that gives the LR statistic defined as follows:

$$LR = -T \sum_{i=r+1}^K \log(1 - \lambda_i) \quad \text{for } r = 0, 1, \dots, K-1$$

With T: The number of observations

λ : The eigenvalue of the matrix Π

K: number of variables

r: rank of matrix Π

The number of cointegrating relationship is determined by through a sequential procedure. The decision rule is as a following:

- If rank $\Pi=0$ ($r=0$), we test the hypothesis $H_0: r=0$ against $H_1: r>0$, if LR is greater than the critical value, we reject H_0 and we move to the next step.

- We test the hypothesis $H_0: r=1$ against $H_1: r>1$ if H_0 is rejected, we proceed to the next test.

- If after rejecting the various hypotheses H_0 , the last step, we test $H_0: r=K-1$ against $H_1: r=K$.

3.3. An Error Correction Model

For interpret the vector error correction model found in the different regression equations. Indeed, an error correction model (ECM) can detect the dynamics of short-term and long term of a variable around its stationary equilibrium value. Thus, for an adjustment error correction requires that the sign of the coefficient of the residual is negative and statistically significant. In this regard, the higher the absolute value of the coefficient is higher, faster we reach the long-run equilibrium.

The model error correction reads:

$$\Delta p_t = \alpha_1 z_{t-1} + \text{Lagged}(\Delta p_t, \Delta y_t) + \varepsilon_{1t}$$

$$\Delta y_t = \alpha_2 z_{t-1} + \text{Lagged}(\Delta p_t, \Delta y_t) + \varepsilon_{2t}$$

With z_{t-1} the error correction term to resulting from estimating the cointegrating relationship, ε is the error term stationary

$$|\alpha_1| + |\alpha_2| \neq 0.$$

3.4. Causality Test

The causality test based on the model vector error correction has the advantage of providing a causal relationship even if no estimated coefficient of lagged variables used is significant. Thus, an error correction model after processing can be rewritten as following equations:

$$\Delta p_t = \alpha + \sum_{i=1}^K \lambda_i \Delta p_{t-i} + \sum_{i=1}^K \delta_i \Delta y_{t-i} + \theta Z_{t-i} + \varepsilon_t$$

$$\Delta y_t = \beta + \sum_{i=1}^K \phi_i \Delta y_{t-i} + \sum_{i=1}^K \varphi_i \Delta p_{t-i} + \psi Z_{t-i} + \mu_t$$

From these both equations, p_t does not cause y_t the sense of Granger if $\varphi_i = \psi = 0$, y_t does not cause p_t if $\delta_i = \theta = 0$.

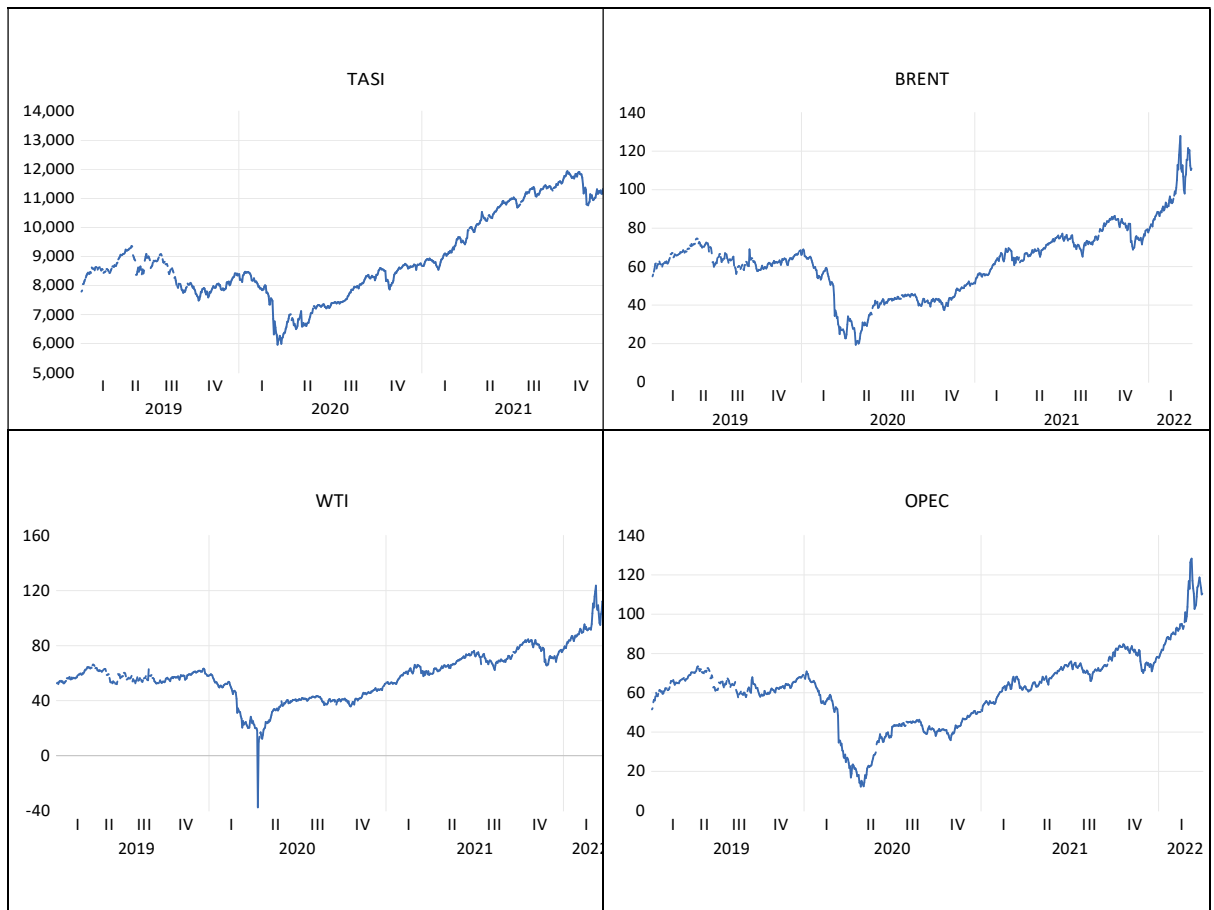
cointegration cannot be rejected.

III- Results and discussion :

III.1 Graphs and descriptive statistics :

1- Graphs:

Figure (3) : Historical price movement of oil prices, Saudi stock market (TASI)



2- Descriptive statistics:

The descriptive statistics of stock induces are presented in Table 2, Both the table cover the summary statistics, namely sample means, minimums, maximum, medians, standard deviation (SD), skewness, kurtosis, TASI has registered highest mean and standard deviation during the period , while OPEC has registered highest kurtosis during the period. Table (2)

Table (2) : Descriptive statistics of variables

	TASI	BRENT	WTI	OPEC
Mean	9192.988	62.3746	58.2428	61.5072
Median	8658.950	63.6100	57.9700	63.2600
Maximum	13101.36	127.9800	123.7000	128.2700
Minimum	5959.690	19.3300	10.0100	12.2200
Std. Dev.	1679.170	17.7132	17.9966	18.6444
Skewness	0.5201	0.2794	0.3530	0.0899
Kurtosis	2.2298	3.8444	3.8338	4.0668
Jarque-Bera Probability	53.9638 0.0000	33.0324 0.0000	38.4497 0.0000	37.6991 0.0000
Observation	773	773	773	773

III.2 Unit Root Tests:

The first result of this study is the examination of the stationarity of our variables. In other words, it refers to unit root tests of stationarity of time series. For this, all series were analyzed with the three basically used models in ADF tests which are the model with intercept and linear trends, the model with only constant and the free one from constant and linear trend. According to the tests (ADF), the existence of a unit root at levels and stationarity in first differences, they prove that the time series are integrated into order 1 or are **I(1)** at level 1% significance. The results are shown in Table 03, all series are stationary at the first difference while they aren't at level, this result suggest the existing of a potential co-integration relationship between our variables

Table (3): Augmented Dickey–Fuller test

	Model	Series in level		Series in first difference		
		ADF Stat.	P-Vale	Model	ADF Stat.	P-Vale
TASI	Constant & Trend	-0.8373	0.9606	Constant & Trend	-25.2918	0.0000
	Constant	0.7338	0.9928	Constant	-25.2236	0.0000
	None	1.9061	0.9868	None	-25.1175	0.0000
BRENT	Constant & Trend	-0.8124	0.9629	Constant & Trend	-26.9369	0.0000
	Constant	-0.0418	0.9534	Constant	-26.8781	0.0000
	None	-1.0833	0.9290	None	-25.8526	0.0000
WTI	Constant & Trend	-1.0659	0.9326	Constant & Trend	-33.8025	0.0000
	Constant	-0.0133	0.9561	Constant	-33.7563	0.0000
	None	1.0520	0.9237	None	-33.7134	0.0000
OPEC	Constant & Trend	-0.7756	0.9661	Constant & Trend	-24.2872	0.0000
	Constant	-0.0974	0.9478	Constant	-24.2339	0.0000
	None	1.0857	0.9281	None	-24.2004	0.0000

III.3 Johansen Cointegration Tests:

The second result obtained by the study is the co-integration analysis. i.e., the issue co-integration of the time series. However, to apply the cointegration test of Johansen (Johansen, 1991), it is necessary to examine the lag length determination first in a VAR representation. It is based on the appropriate lag length selection procedure that is based on the most commonly used selection criteria: (Akaike information criterion; AIC - Hannan-Quinn information criterion; SC - Schwarz information criterion). This procedure is necessary because the results become biased if an wrong selection of lag length occurs.

Then the optimal lag length is determined based on a VAR representation, the results are reported in table 04. Finally, the VAR with 2 lags is established according to Schwarz Criterion. The Johansen co-integration test is to determine the number of co-integration equations in the VEC model and trace statistics show that there are two co-integration relationships among the 4 variables selected (table 05).

Table (4): Selection of optimal lag order

Lag	AIC	SC	HQ
0	34.8526	34.8768	34.8619
1	23.1535	23.2748	23.2002
2	22.8375	23.0559*	22.9216
3	22.7834	23.0988	22.9048
4	22.7784	23.1909	22.9372
5	22.7742	23.2837	22.9703
6	22.6753	23.2819	22.9088

7	22.6289	23.3325	2.8997*
8	2.5997*	23.4003	22.9079

* indicate the smallest value of the Criterion

Table (5): Johansen tests for cointegration:

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Critical Value	Prob.**
None *	0.1150	181.2311	47.8561	0.0000
At most 1 *	0.0955	86.9659	29.7970	0.0000
At most 2	0.0122	9.5378	15.4947	0.3180
At most 3	3.68E-06	0.0028	3.8414	0.9549

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

III.4 Error Correction model:

The ECM of TASI Index and oil prices (Brent, WTI and OPEC) can be established now. According the ECM establishment described above (eq xx), the estimated Vector Error Correction model is given in table 6 as follow:

Table (6) : Estimation Results of long and short-term Relationship between Variables

Cointegrating Eq:	CointEq1		CointEq2	
TASI(-1)	1		0	
BRENT(-1)	0		1	
WTI(-1)	-432.1842		-0.3647	
	[-10.5989]		[-7.3869]	
OPEC(-1)	319.5797		-0.6043	
	[8.22358]		[-12.8433]	
C	-3685.763		-3.9553	
Error Correction:	D(TASI)	D(BRENT)	D(WTI)	D(OPEC)
CointEq1	-0.0098	-0.0001	-1.79E-05	-0.0001
	[-4.0018]	[-3.8243]	[-0.3132]	[-6.5108]
CointEq2	-1.0016	-0.1575	0.0262	0.1107
	[-0.4653]	[-3.9567]	[0.5249]	[4.2282]
D(TASI(-1))	0.0693	0.0017	0.0001	0.0010
	[1.8842]	[2.5849]	[0.2078]	[2.4270]
D(TASI(-2))	-0.0426	-0.0007	0.0001	0.0007
	[-1.1535]	[-1.1649]	[0.1471]	[1.5891]
D(BRENT(-1))	-2.6883	0.0114	0.0817	0.4922
	[-1.0030]	[0.2304]	[1.3129]	[15.096]
D(BRENT(-2))	-2.8895	-0.0115	-0.0152	0.2193
	[-1.0430]	[-0.2255]	[-0.2369]	[6.5077]
D(WTI(-1))	1.0721	0.0400	-0.2348	0.0567
	[0.5927]	[1.1971]	[-5.5910]	[2.5778]
D(WTI(-2))	0.5873	-0.0356	-0.0584	-0.0065
	[0.3382]	[-1.1087]	[-1.4488]	[-0.3094]

D(OPEC(-1))	2.7048 [0.8866]	0.0711 [1.2615]	0.1469 [2.0739]	-0.2355 [-6.3451]
D(OPEC(-2))	2.5640 [1.17001]	-0.0621 [-1.5336]	-0.0936 [-1.8402]	-0.0805 [-3.0201]
C	6.1833 [1.8928]	0.0625 [1.0358]	0.0815 [1.0746]	0.0292 [0.7368]

t-statistics in brackets; significant coefficients in bold.

It can be seen from Table 06, that in the long run, the WTI impact negatively and significantly the TASI while the OPEC affect positively and significantly the TASI. However, The ECM expounds that the coefficient of the of adjustment is 0.0098, it means that the deviation of the TASI values from the long run equilibrium will be adjusted about 0,98% at the next time. that is to say that the total adjustment will happen in 102 days.

III.5 Causality Test :

Table(7) shows the existence of one-way direct Granger causality from the Saudi stock markets to oil prices. direct Granger causality from the Saudi stock markets (TASI) to oil prices (BRENT and OPEC basket price) . In fact, the null hypothesis of absence of causality is strongly rejected. Our empirical results confirm those of Bjørnland (2009) and Basher et al. (2018) and Zhang and Asche (2014) suggest that changes in the Saudi stock markets, which should reflect changes in the Saudi economy, significantly cause changes in OPEC oil prices and BRENT price.

Table(7): Granger Causality Tests between variables

Null Hypothesis:	Obs	F-Statistic	Prob.
BRENT does not Granger Cause TASI	771	0.09721	0.9074
TASI does not Granger Cause BRENT		9.62106	7.E-05
OPEC does not Granger Cause TASI	771	0.38643	0.6796
TASI does not Granger Cause OPEC		30.1289	3.E-13
OPEC does not Granger Cause BRENT	771	1.64904	0.1929
BRENT does not Granger Cause OPEC		320.958	6E-102

IV- Conclusion:

This paper examines the causal relationship between Saudi stock market (TASI) and Oil prices, using various econometric techniques consisting of stationarity, cointegration, and causality analysis. This study is carried out using daily data of the Tadawul All Share Index (TASI) and Oil prices (Brent oil, WTI crude oil, OPEC basket prices 01/02/2019 to 03/30/2022. By using ADF test to ensure stationarity, it becomes apparent that the variables are stationary at first difference.

Subsequently, the cointegration test used implies that there are two significant long run relationship at 5% critical value between the four variables, as can be observed from the Trace Test as well as the Maximum Eigenvalue Test in table (4). The results obtained indicates that the tested relationship holds in the long run, and we found the existence of one-way direct Granger causality from the Saudi stock markets (TASI) to oil prices (BRENT and OPEC basket price)

So, this paper supports the hypothesis that there is a positive relationship between oil price and Saudi stock market as there has been evidence found in this research. In Saudi Arabia economy, an increase in oil price has a stimulating impact on the stock market which is consistent with the prior studies on oil exporting countries. This result is in line with previous researchers such as, Bjørnland (2009), Basher et al. (2018) and Zhang and Asche (2014)

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