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SAUDI STOCK MARKET, ENERGY PRICES AND GOLD PRICES: AN EMPIRICAL STUDY OF THEIR DYNAMIC RELATIONSHIP

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ABSTRACT

This study aimed to analyze the relationships among the Saudi stock market, energy prices, and gold prices using daily data for the period from January, 2004, to April, 2015. In this study, the Saudi stock market, oil prices, natural gas prices, and gold prices are analyzed using a Vector Autoregression Model (VAR) and Causality analysis for Saudi Arabia. The results of the VAR suggest that oil and gold prices are significantly affecting the Saudi stock market. The oil prices affect positively and gold prices affecting negatively on Saudi stock market. Therefore, the results of the VAR granger causality suggest that oil and gold prices cause the Saudi stock market. Hence, the results confirm that there is a dynamic relationship between the Saudi stock market, oil prices, and gold prices. These findings may be valuable for investors and policymakers in understanding the dynamic relationship between the Saudi stock market, energy prices, and gold prices.

INTRODUCTION

Oil is the main input in the production of different goods. Thus, when oil prices are changing, it's affects the future cash flows and influences the cost of production. Therefore, stock prices influence oil price changes. Most economists agree that when oil prices change, this leads to changes in the stock market. However, there is no consensus on the trend of this effect. In the event of oil price increases, Saudi Arabia will earn more revenues from oil exports; this must have a positive effect on Saudi stock prices. Moreover, when Saudi Arabia imports products from oil-importing countries, the cost of these imports must increase; this must have a negative influence on Saudi stock prices. Therefore, the relationship between stock prices and oil prices in

Saudi Arabia is ambiguous or unclear [1]. The instability of the Gulf Cooperation Council GCC stock market in relation to changes in oil prices is evidenced by the importance of these countries in the international oil market. These countries represent 47% of the world's oil reserves, produce 20% of all the oil in the world, and represent 36% of the world's oil exports. This shows that there is a powerful relationship between oil price and the Saudi economy [2].

Ersoy [3] examined the relationship between energy consumption and the Turkish stock market using cointegration and causality tests for the period from 1995 to 2011 and found a unidirectional causal relationship from the Borsa Istanbul Stock Exchange (BIST) to energy consumption. Ergun and Ibrahim [4] studied the impacts of a market index, oil prices and natural gas prices on stock prices for energy companies in Turkey from 2005 to 2011 and found that the market index has a perpetual positive impact on the stock prices of energy companies, but that oil and natural gas may have positive impacts one year and negative impacts the next on the stock prices of energy companies.

Bhunia and Mukhuti [5] used a Granger causality test to explore the effect of domestic gold prices on Indian stock exchanges from January 2, 1991, to August 10, 2012 and concluded that there was no relationship or causality between gold prices and Indian stock exchanges. Jawad [6] analysed the effects of oil demand and supply on oil prices using a GARCH (1, 1) model for the period from 1973 to 2011 and found that oil supply had an insignificant effect on oil prices, but that oil demand had a significant effect on oil prices.

Behname [7] examined the relationships between market size, inflation, unemployment, and energy using a short-term Granger model for the period from 1980 to 2009 and showed that oil prices are the reason for inflation and economic growth and that there is a bilateral relationship between market size and unemployment. Therefore, countries that import oil must be willing to decrease the effect of oil volatility on economic growth. Sahu et al. [8] analyses the relationship between oil prices and the Indian stock market from January 2001 to March 2013 and concluded that there was a positive long-run relationship between oil prices and the direction of Indian stock market indices.

Alhayki [9] explored the relationship between stock market returns for Gulf Cooperation Council (GCC) countries and oil prices. The study concluded that the stock markets of Saudi Arabia, the United Arab Emirates, and Bahrain had negative relationships with oil prices, while Qatar, Kuwait, and Oman had positive relationships [9]. Harrathi and Almohaimeed [10] examined the conditional dependencies between oil prices and GCC stock market and portfolio management strategies in situations of structural breaks. They showed that adding structural breaks minimized the persistence of fluctuations. Thus, they achieved conclusive outcomes concerning the conditional dependencies between GCC stock markets and oil prices, finding that these fluctuations reduce both shocks and fluctuation spillover effects.

Almohaimeed and Harrathi [2] examined the transmission of volatility and the correlations between the stock market, sector indexes (including banking, telecom, industrial and cement) and oil prices using daily data for the period from January 3, 2009, to March 21, 2012, and employing a multivariate GARCH model. They found that oil prices had a negative volatility spillover impact on sector stock returns. In particular, the study found an impact of volatility transmission between sector stock returns and the stock market for all sectors except the telecom sector. Kalyanaraman [1] studied the relationship between stock prices and oil prices with structural breaks and found a significant positive correlation.

Changes in oil prices represent one of the most important factors for understanding fluctuations in the Saudi stock market [9]. Several studies have examined the relationship between oil prices and the stock market of the GCC countries and Saudi Arabia in particular. Some have found that there is a relationship between oil prices and the Saudi Arabian stock market, such that the Saudi stock market is influenced by oil price changes [11-14]. Others have found that the Saudi stock market is not affected by oil price changes [15, 16]. Therefore, this study aimed to analyze the relationships among the Saudi stock market, energy prices, and gold prices using daily data for the period from January, 2004, to April, 2015

METHODOLOGY

Variables and Data Sources

In this research, the selected variables are oil West Texas Intermediate (WTI) prices, natural gas prices, gold prices, and the Saudi stock market. The data used in this study start in January 2004 and run until April 2015 on a daily basis. All of the data are collected from the Bloomberg database.

Model

This study used a cointegration test, a vector auto-regression (VAR) model, and Granger causality test to examine the relationship or impact of oil prices, natural gas prices, and gold prices on the Saudi stock market (and vice versa). These steps were applied following a study of the descriptive statistics and the unit root test.

Unit Root Test

This test is used to determine whether variables are stationary or not. If variables are non-stationary, they are tested again as unit roots by taking their first differences. A stationary series has no unit root property. However, a non-stationary series faces a regression problem. Therefore, the results of the regression do not reflect the true relationship. Thus, an Augmented Dickey-Fuller (ADF) Unit Root Test was used.

Johansen's Cointegration Test

Johansen's cointegration test is used to calculate cointegrating regressions in order to understand the long-run equilibrium relationships between variables. Thus, if two variables have equilibrium or a long-term relationship, these variables can be considered to be cointegrated.

Vector Autoregression Model

The VAR model was presented by Sims [17] as a method to examine the impacts of oil prices, natural gas prices, and gold prices on the Saudi stock market (and vice versa). All VAR models are endogenous variables, and each variable is explained by the lags of it and the other variables. The VAR model is one of the most successful and flexible models for analyzing multivariate time series, and it is useful in describing the dynamic behaviors of economic and financial time series and for forecasting. The VAR model is commonly used to forecast systems of interrelated time series, and it is used in analyzing the impact of random disturbances on the variables.

Granger Causality Test

According to Granger [18], the Granger causality test provides an appropriate analysis of noncointegrated variables. When variables are cointegrated, an error correction model proposed by Engle and Granger [19] must be used to explore the short- and long-term causal relationships among the variables; this revised model is called the Vector Error Correction Model VECM. Therefore, the Granger causality test is a test for determining whether one time series is useful in forecasting another.

RESULT AND DISCUSSION

Descriptive Statistics

Descriptive statistics summarize numerical data. Table 1 shows the descriptive statistics, including the max and min values for the variables TASI, WTI, Gas, and Gold, are not stable during the period of this study. The maximum value of Gas is 30%, and the minimum value is -16%; this indicates instability. Skewness measures whether variables are distributed symmetrically or not; the variables here are distributed symmetrically because all of the variables are skewed positively and to the right. Kurtosis measures whether the distribution of variables is flat or peaked. The variables here have a relatively peaked distribution; thus, they follow a platykurtic distribution. The Jarque-Bera test shows that the data follow a normal distribution; therefore, the null hypothesis is rejected at the 1% level of significance.

Table 1. Results of The Descriptive Statistics

	TASI	**WTI**	**GAS**	**GOLD**
N	1821	1821	1821	1821
Mean	0	0	0	0
SD	0.02	0.03	0.04	0.02
Min	-0.19	-0.19	-0.16	-0.14

Max	0.17	0.22	0.3	0.11
Skew	0.94	0.07	0.6	0.44
Kurtosis	11.57	5.48	4.77	9.21
Jarque- Bera* **	10454.18	2288.78	1839.66	6517.67
Probability	<2e-16	<2e-16	<2e-16	<2e-16

Notes: ***Significant at the 1% level

Univariate Analysis

The R correlation coefficient measures the direction and strength of the relationship between two variables in a scatterplot. This R ranges from -1 to +1. If (R) is -1, this indicates a negative perfect relationship. If R is +1, this indicates a positive perfect relationship. Finally, if R is 0, there is no relationship. According to Table 2, the relationship between TASI and WTI and WTI with TASI is equal to 2.9%, indicating that there is a positive relationship. Furthermore, the relationships between TASI and Gas and Gas with TASI is equal to -0.17% indicating that there is a negative relationship and TASI with Gold and Gold with TASI is equal to -1.41%. Hence, there is a negative perfect relationship. However, WTI has a positive and weak relationship with Gas and Gas with WTI is equal to 0.24% and a positive and weak relationship with Gold I equal to 0.30%. Also, Gold with WTI has a positive and weak relationship. Gas and Gold and Gold with Gas have a positive relationship is equal to 6.9%. Hence, the correlations among the variables include there is positive and weak and perfect negative relationships.

Table 2. Correlations Among the Variables

	TASI	**WTI**	**GAS**	**GOLD**
TASI	1	0.029755	-0.00178	-0.01416
WTI	0.029755	1	0.244777	0.306975
GAS	-0.00178	0.244777	1	0.069595
GOLD	-0.01416	0.306975	0.069595	1

Test Of Stationary Augmented Dicky-Fuller (ADF) Unit Root Test

The ADF test is used to determine whether variables are stationary or not. If variables are non-stationary, they are tested again for unit roots by taking their first differences. A stationary series has no unit root property. Table 3 shows that cannot reject the null hypotheses (H_0 = The selected variables are non-stationary variables). Hence, the series includes a unit root. Thus, all variables are non-stationary in the two models (intercept and trend and intercept) because all the variables have p-values greater than 5%. The TASI, WTI, NAT _GAS, and GOLD series are all nonstationary at level, taking the variables into first differences.

Table 3. Results Of The Augmented Dicky-Fuller (ADF) Unit Root Test (In Level)

Variables	**Trend**	**Trend and intercept**
TASI	[0.3210] -1.924805 (1)	[0.5633] -2.067089 (1)
WTI	[0.1796] -2.277183 (0)	[0.6359] -1.934328 (0)
NAT_GAS	[0.5633] -2.067089 (1)	[0.1610] -2905064 (0)
Gold	[0.6307] -1.302157 (0)	[0.9295] -1.087348 (0)

Notes: [] MacKinnon (1996) p-values, () lag lengths for ADF

Table 4 shows that all variables are stationary in their first differences (i.e., the series is stationary at first differences). The variables are integrated of order one (1) or designated as I (1). Hence, the null hypotheses (H_0 = The selected variables are non-stationary variables) can be rejected, since all variables have p-values less than 5%. In sum, all variables from the ADF test are stationary at first differences.

Table 4. Results Of ADF Unit Root Test (In First Difference)

Variables	**Trend**	**Trend and intercept**
TASI	[0.0000] -38.79308 (0)	[0.0000] -38.78983 (0)
WTI	[0.0000] -43.24066 (0)	[0.0000] -32.36834 (1)
NAT_GAS	[0.0000] -42.66900 (0)	[0.0000] -42.65844 (0)
Gold	[0.0001] -45.49682 (0)	[0.0000] -45.50527 (0)

Notes: [] MacKinnon (1996) p-values, () lag lengths for ADF.

Selecting The Optimum Lag Length

This study determines the most suitable lag length for conducting the Johansen cointegration test. It also determines the optimum lag length through the Akaike information criteria (AIC), the Hannan-Quinn information criteria (HQC), the Schwarz information criteria (SIC), and the Final Prediction Error (FPE).

In selecting the optimum lag length for TASI, the AIC criteria and FPE provide higher lag lengths of -7.66988 and 0.000467 respectively, while the SIC and HQC provide lower lag lengths of -7.66221 and -7.66605 respectively. Hence, the appropriate selection lag for TASI is -7.66221 and -7.66605 for SIC and HQC respectively, since cannot risk under-parameterization or over-parameterization with higher lags.

In selecting the optimum lag length for WTI, the AIC criteria and the FPE provide higher lag lengths of -7.16734 and 0.000771 respectively, however the SIC and HQC provide lower lag lengths of -7.16116 and -7.165 respectively. Hence, the appropriate lag for WTI is -7.16116 and -7.165 for SIC and HQC respectively, since cannot take the risk of under-parameterization or over-parameterization with higher lags.

In selecting the optimum lag length for NAT_GAS, the criteria for the AIC, HQC, SIC and FPE for NAT_ GAS indicate a lower lag length of -6.42871, -6.42647, -6.42263 and 0.001615 respectively.

In selecting the optimum lag length for Gold, the criteria for the AIC, HQC, SIC and FPE of Gold indicate a lower lag length of -8.30598, -8.30374, -8.29991 and 0.000247 respectively. After identify the lag lengths for all variables, this study chose the optimum lag length indicated for HQC and SIC because their optimum lag length is the minimum value.

Multivariate Analysis Test Of Cointegration

This test provides useful information on whether energy prices, the Saudi stock market and gold prices are linked in the long run. If two variables have equilibrium or a long-term relationship, can infer that they are cointegrated. If the variables are cointegrated, a VECM is run; however, if the variables are non-cointegrated, a VAR is run. Table 5 and Table 6 show whether these variables are cointegrated or not and whether the four variables have a long-term association. The trace statistics and max Eigen statistics tests show that the four variables are not cointegrated, since the [] p-values for both tests are greater than 0.05%. For example, for the first model in the trace statistics test, the P-value was 0.6303 (63.03%, which is more than 0.05%). Further, the trace statistics were equal to 31.66958, which is less than the critical value of 47.85613. Furthermore, the first model in the max Eigen statistics test had a p-value of 0.3057 (30.57%, which is greater than 0.05%]. Further, the max Eigen statistics were equal to 20.52892, which is less than the critical value of 27.58434. This analysis test concludes that there is no long-term association among the variables. Thus, VECM cannot be run because not all of the variables are cointegrated. Hence, the unrestricted VAR model will be run.

Table 5. Results of Cointegration Test (Trace Statistics)

Hypothesized No. of Equation	**Trace Statistics**	**0.05 Critical Values**	**Probe [ ]**
Non	31.66958	47.85613	0.6303
At most 1	11.14066	29.79707	0.9577
At most 2	4.849884	15.49471	0.8246
At most 3	1.026832	3.841466	0.3109

Notes: The trace rest indicates no cointegration at the 0.05 level.

*denotes rejection of the hypothesis at the 0.05 level.

[] Mackinnon-Haug-Michelis (1999) p-values.

Table 6. Results of Cointegration Test (Maximum Eigen Statistics)

Hypothesized No. of Equation	Max Eigen Statistic	0.05 Critical Values	Probe [ ]
Non	20.52892	27.58434	0.3057
At most 1	6.290777	21.13162	0.9764
At most 2	3.823052	14.26460	0.8775
At most 3	1.026832	3.841466	0.3109

Notes: The max Eigen statistic test indicates no cointegration at the 0.05 level.

*denotes rejection of the hypothesis at the 0.05 level.

[] Mackinnon-Haug-Michelis (1999) p-values.

VAR Analysis

The VAR analysis examines the impact of oil prices, natural gas prices, and gold prices on the Saudi stock market (and vice versa). VAR analysis is one of the most successful and flexible models for analyzing a multivariate time series, and it is useful for describing the dynamic behaviors of economic and financial time series and for forecasting. The VAR is commonly used for forecasting systems of interrelated time series and is used in analyzing the impact of random disturbances on the variables.

Table 7 shows the results of the VAR estimates, which provide four regression models that are the independent of DTASI (-1) (i.e., the independent variable of the first difference of TASI lag one and the dependent variables of TASI, WTI, NAT_GAS, and Gold, as well as the same for the other variables of WTI, NAT_GAS, and Gold). Each regression model has five coefficients; however, it is important to know the P-values, which must be estimated in Least Squares.

Table 7. Results of VAR Estimates

	DTASI	DWTI	DNAT_GAS	DGOLD
DTASI (-1)	0.092525	-0.00019	1.33E-05	-0.002464
	(-0.02333)	(0.00023)	(-2.80E-05)	(-0.00192)
	[3.96599]	[-0.81363]	[0.47320]	[-1.28630]
DWTI (-1)	6.08093	-0.039769	-0.001791	-0.370283
	(-	(-	(-0.00306)	(-

	2.53538)	0.02531)		0.20817)
	[2.39843]	[-1.57109]	[-0.58442]	[-1.77874]
DNAT_GAS (-1)	-16.54008	0.339324	0.002461	1.177947
	(20.0294)	(-0.19997)	(-0.0242)	(-1.64455)
	[-0.82579]	[1.69687]	[0.010169]	[0.71627]
DGOLD (-1)	-0.62717	0.006427	0.000234	-0.052291
	(-0.29904)	(-0.00299)	(-0.00036)	(-0.02455)
	[-2.09731]	[2.15272]	[0.64695]	[-2.12974]
C	2.562691	0.011685	-0.002523	0.46143
	(-4.86432)	(-0.04856)	(-0.00588)	(-0.39939)
	[0.52683]	[0.24060]	[-0.42916]	[1.15533]

Notes: Standard errors in () and T-statistics in []

DTASI = C (1) *DTASI (-1) + C (2) *DWTI (-1) + C(3)*DNAT_GAS(-1) + C(4)*DGOLD(- 1) + C(5)C(2). Saudi stock market TASI, as the dependent variable is influenced by oil prices and gold prices because the p-values are not more than 5%.

DWTI = C(6) *DTASI(-1) + C(7)*DWTI(-1) + C(8)*DNAT_GAS(-1) + C(9)*DGOLD(-1) + C(10). The variables here (TASI and NAT GAS) are not affecting to oil prices because all p-values are more than 5%. Only GOLD is affecting to oil prices, since its p-value is less than 5%.
DNAT_GAS = C(11) *DTASI(-1) + C(12)*DWTI(-1) + C(13) *DNAT_GAS(-1) + C(14)*DGOLD(-1) + C(15). Here, none of the variables (i.e., TASI, WTI, or Gold) is affecting to NAT_GAS because all of the p-values are greater than 5%.

DGOLD = C(16) *DTASI(-1) + C(17)*DWTI(-1) + C(18)*DNAT_GAS(-1) + C(19)*DGOLD(-1) + C(20). None of the variables (i.e., TASI, WTI, or NAT_GAS) is affecting to Gold because all of the p-values are greater than 5%. Therefore, the VAR results indicate that oil and gold prices significantly affect the Saudi stock market and that gold prices affect oil prices.

Causality Analysis

The Granger test provides an appropriate analysis when variables are non-cointegrated. Therefore, the Granger causality test determines whether one time series is useful in forecasting another. Table 8 demonstrates the results of the VAR Granger Causality/Block Exogeneity Wald Test.

Null Hypothesis, H_0: There is no causal relationship between the variables.

Alternative Hypothesis, H_1: There is a significant causal relationship between the variables.

Table 8. Results Of The VAR Granger Causality/Block Exogeneity Wald Test

Model	**Dep variables**	**Ind variables**	**Chi-sq**	**Probability**	**Values Implication**
1	TASI	WTI	5.7525	0.0165	Causality
		NAT_GAS	0.6819	0.4089	NO Causality
		GOLD	4.3987	0.036	Causality
2	WTI	TASI	0.6620	0.4159	NO Causality
		NAT_GAS	2.8794	0.0897	
		GOLD	4.6342	0.0313	Causality
3	NAT_GAS	TASI	0.2239	0.6361	NO Causality
		WTI	0.3416	0.5589	
		GOLD	0.4185	0.5177	
4	GOLD	TASI	1.6546	0.1983	NO Causality
		WTI	3.1639	0.0753	
		NAT_GAS	0.5130	0.4738	

In the first model, when the TASI is the dependent variable and WTI, NAT_GAS and GOLD are independent variables, only two variables can cause TASI: WTI and GOLD. Hence, can reject the null hypothesis and accept the alternative hypothesis, since the probability values are less than 5% (1.65%, 3.6%, respectively). However, NAT_GAS cannot cause TASI; thus, cannot reject the null hypothesis because the probability is more than 5% (40.89%).

In the second model, when the WTI is the dependent variable and TASI, NAT_GAS and GOLD are independent variables, only one variable (GOLD) can cause WTI; hence, can reject mull hypothesis and accept the alternative hypothesis because the probability is less than 5% (3.31%). However, TASI and NAT_GAS cannot cause WTI; hence, cannot reject the null hypothesis because the probability is more than 5% (41.59% and 8.97%, respectively).

In the third model, when NAT_GAS is the dependent variable and TASI, WTI and GOLD are independent variables, the results show that these variables cannot cause NAT_GAS. Thus, cannot reject the null hypothesis because the probability is greater than 5% (63.61%, 55.89%, and 51.77%, respectively).

In the fourth model, when GOLD is the dependent variable and TASI, WTI and NAT_GAS are independent variables, the results show that these variables cannot cause GOLD; thus, cannot reject Null hypothesis because the probability is greater than 5% (19.83%, 7.53%, and 47.83%, respectively). This study concludes that oil and gold prices can cause the Saudi stock market. Furthermore, Gold can cause oil prices. However, natural gas cannot cause the Saudi stock market, oil and gold prices.

CONCLUSION

This study used VAR analysis and Causality analysis to examine the dynamic relationships between energy prices, gold prices and the Saudi stock market. The evidence of this research provides a comprehensive understanding of the dynamic relationships between the Saudi stock market, energy prices, and gold prices in Saudi Arabia. Since Saudi Arabia is a major world energy market player, its stock market is likely to be sensitive to changes in energy and gold prices. The VAR results indicate that oil and gold prices significantly affect the Saudi stock market. Also, the oil prices affect positively and gold prices affecting negatively on Saudi stock market. Therefore, the results of the VAR granger causality suggest that oil and gold prices cause the Saudi stock market. These results confirm that there is a dynamic relationship between the Saudi stock market, oil prices, and gold prices. During the study period, oil prices were declining; thus, gold prices increasing. As a result, gold prices reacted negatively with the Saudi stock market (such that, as the gold prices increased, the Saudi stock market decreased). This is a good indicator for investors and portfolio managers to include energy prices, stock market prices and gold prices in their portfolios to reduce risks.

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