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Analyzing the effects of global oil, gold and palladium markets: Evidence from the Nasdaq composite index

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A B S T R A C T

The capital market is one of the most critical pillars of financial markets, which plays an important role in countries' economies. With the increasing development of international trade and the free flow of capital, financial asset prices spread to other assets. The extend is increasing with the expansion of communication networks as well as the close connection of financial markets to each other. Therefore, the state of a market is not only specific to itself but also affects other financial markets. Global oil, gold, and basic metal prices, including palladium, significantly influence the American financial markets. Due to the importance of the Nasdaq index for investors' investment decisions, this study analyzes the impact of oil, gold, and palladium metal prices on the Nasdaq index monthly between 2016 and 2021. Based on the final model, the oil and gold markets significantly impact the Nasdaq index, while palladium has a less significant impact.

1. Introduction

Achieving economic growth and development is one of the most critical concerns facing all societies and governments. Capital markets are one of the tools available to achieve this goal. A country's stock market is one of the most significant financial and economic elements since it forms an integral part of the financial market. This market plays an essential role in providing financial and capital facilities for the economic growth and development of the country. Stock markets play several vital roles, including increasing capital, providing investors with services, providing an index for financial health, and affecting economic development (Arestis, Demetriades, & Luintel, 2001). Due to the unification of financial markets through the free flow of international investment and global trade, the fluctuations in global prices of financial assets affect the total value of other financial markets as well. Capital markets play an essential role in the development process of developed countries. As a specialized market, this market regulates financial assets. Stocks, bonds, and derivative instruments are traded on this market daily. Stocks are one of the essential elements traded in this market among these sectors (Naceur & Ghazouani, 2007). The importance of the stock market is evident from there. A significant correlation exists between the stock price index and the unemployment rate, providing further evidence of the importance of the stock market. The exchange rate and the oil price are among the factors that affect the stock price index. It can be said that the fluctuations of the whole stock market index are affected by the exchange rate fluctuations and the crude oil price. The total index of a previous period has the most significant impact on the total index of the stock market (Kilian & Park, 2009). As one of the most important financial measures of the American economy, the Nasdaq index includes large American companies involved in electronic services, such as Apple and Tesla. General indexes are one of the most significant elements of analyzing a stock market's trend. This research aims to investigate the impact of global oil, gold, and palladium markets on the Nasdaq

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index. For this purpose, the world price of oil, an ounce of gold, and an ounce of palladium have been used as independent variables, and the total index of the Nasdaq stock exchange has been used as a dependent variable.

2. Research background

2.1. Theoretical Foundations

The financial markets are one of the most important sources of financial resources in the economy of any country in order to expand its economic activities. It is crucial to consider the state of the stock market index when examining the markets of different countries, which is a criterion for the decision-making of actual and legal investors. Since shares of financial institutions, industrial, and production units are traded on the stock market, the stock price index is highly efficient from the point of view of both small and prominent investors. Capital markets are generally considered to be the fundamental part of every economic. Regarding the role and importance of research, the following can be said: In light of the direct impact of fluctuating oil, gold, and palladium prices on the NASDAQ index, as well as their influence on the various industrial units that participate in this exchange, it is necessary to understand the extent and impact of such factors. In order to understand this impact, the Nasdaq index is the first and most effective indicator (Morema & Bonga-Bonga, 2020). There is no doubt that oil is one of the essential elements in global strategy as well as a critical driver of production in every country. Mostly there has been a significant negative correlation between crude oil price returns and stock exchange return fluctuations. These explanations exist for exchange rate fluctuations and stock exchange index returns. It can be said that the stock market index of each country indicates the state of its financial markets and the dynamics of its economy (Kumar, Choudhary, Singh, & Singhal, 2021). A decrease in the index generally means economic stagnation, and its increase means economic prosperity or inflation. Generally, today, indices are receiving a great deal of interest in the financial world because they make it possible to compare the efficiency of different portfolios (Otieno, Ngugi, & Muriu, 2018).

2.2. Literature Review

In this field, researchers have conducted many studies; among them, Reddy (2012) presented a regression model to examine the effect of inflation and gross domestic product in the Indian market on capital return. Mo et al. (2018) used a non-linear Granger method to investigate the price of gold, the dollar, and oil to analyse the behaviour of the markets in pre-crisis conditions and during financial crises. Tursoy and Faisal (2018) examined the influence of gold and crude oil prices on the Turkish investment market, using a discontinuous autocorrelation distribution to estimate short-and long-term returns. Mensi et al. (2022) studied the relationship between Covid-19 and the prices of oil and gold in the investment market; this research indicates that there is a stronger correlation between oil prices and capital markets and that it is stronger than expected during the Coronavirus epidemic. Singhal et al. (2019) examined how the world oil price, the world gold price, and the exchange rate affect the capital market of Mexico and concludes that the world gold price has a positive impact on the capital market and the world oil price has a negative impact. Pan and Mishra (2018) examined the direct impact of the development of the capital market on economic growth and used the single root method to study China's financial market during the financial crisis. Shabbir et al. (2020), as part of their study, examined the effect of global oil and gold prices on the financial markets of Pakistan. Using the dickey-fuller test, they concluded that with the increase in global oil and gold prices, the capital market index of this country could also decrease. Consequently, the economy of this country experiences inflation due to this decrease. Jain and Biswal (2016) used a GARCH model to investigate the relationship between oil prices, gold prices, currency exchange rates, and the capital market and found that these parameters significantly impacted the financial market. In a study by Partalidou et al. (2016), the impact of currency, basic metals, and oil prices on the capital market was investigated and they found that there was a direct correlation between these parameters and the Dow Jones index. Raza et al. (2016) examined the asymmetric effects of gold, oil prices, and their fluctuations on emerging markets. Using a non-linear model, they concluded that the increase in the gold price and the oil price has a significant negative effect on the economic growth of these countries. Mhd Ruslan and Mokhtar (2021) using a Garch model based on the daily data of the last four years, examined the effect of stock market fluctuations on shipping costs. Das (2021) explored the relationship between time series between oil price, stock returns, and exchange rate and used a 3-year period to conclude that oil price significantly impacted the Indian economy. Bashir et al. (2021) investigated the macroeconomic sensitivity and its level of volatility by studying the New York Stock Exchange and using a Garch model to analyse an 18-year interval. Wang et al. (2020) investigated how it is possible to predict future oil prices. Mollick and Sakaki (2019) dealt with the effect of the exchange rate of 14 emerging economies on the oil price and used the mean-variance risk measure and the autocorrelation vector to model their research. Zhang (2016) investigated large shocks to the correlation between oil and global markets. Moreover, it has taken advantage of mixed dynamic correlation to investigate the consequences of the global shock of the Iraq war.

2.3. literature review table

In this section, we investigate the relevant article in this area, after searching all of article we can understand that oil is most important parameter in this area. All of the result has shown in Table1.

Table 1
The summary of the past studies

	Authors (years)	Independent parameter							Case study
		Oil	Gold	Gas	US	Inflation	GDP	Exchange	
1	Mensi et al. (2022)	✓	✓						S&P500
2	Das (2021)	✓						✓	Indian stock market
3	Kumar et al. (2021)	✓	✓	✓				✓	Indian stock market
4	Wang et al. (2020)	✓							S&P500
5	Morema et al. (2020)	✓	✓						South African market
6	Singhal et al. (2019)	✓	✓					✓	Mexico stock market
7	Shabbir et al. (2020)	✓	✓						Pakistan stock market
8	Otieno et al. (2018)					✓			Kenya stock market
9	Mollick and Sakaki (2019)	✓						✓	USA stock market
10	Mo et al. (2018)	✓	✓		✓				USA stock market
11	Tursoy and Faisal (2018)	✓	✓						Turkey stock market
12	Jain and Biswal (2016)	✓	✓					✓	Indian stock market
13	Partalidou et al. (2016)	✓	✓						USA stock market
14	Raza et al. (2016)	✓	✓						Emerging stock market
15	Zhang (2016)	✓							USA stock market
16	Reddy (2012)					✓	✓		Indian stock market
17	(Kilian & Park, 2009)	✓							USA stock market

3. Model Structure and Statistical Analysis

In this research, the following model is estimated using EViews10 software.

$$NAI_t = \beta_0 + \beta_1 COP_t + \beta_2 GP_t + \beta_3 PAP_t + u_t \quad (1)$$

The definition of model variables is as follows:
NAI: NASDAQ Index
COP: Crude Oil Price
GP: Gold Price
PAP: Palladium Price

3.1 Statistical analyses

In this study, monthly statistical analyses have been conducted. Monthly data related to the Nasdaq stock index (NAI), crude oil price (COP), gold price (GP), and palladium metal price (PAP) from January 2016 to December 2021. The data is extracted from the Yahoo Finance database.

Table 2
Descriptive Statistics

	NAP	COP	GP	PAP
Mean	8570.414	55.29306	1470.431	1472.958
Median	7602.155	53.755	1321.15	1320.35
Maximum	15644.96	84.65	1967.6	2924.9
Minimum	4557.95	18.84	1115	495.6
Std. Dev.	3189.081	12.72005	256.5584	697.3236
Skewness	0.88433	0.09909	0.580049	0.391262
Kurtosis	2.628686	3.169411	1.737068	1.811731
Jarque-Bera	9.798106	0.203926	8.822473	6.072981
Probability	0.007454	0.903063	0.01214	0.048003
Sum	617069.8	3981.1	105871	106053
Sum Sq. Dev.	7.22E+08	11487.78	4673379	34524474
Observations	72	72	72	72

The Jarque-Bera test statistic is used to test the normality of the data. If this statistics is less than 5.99 or the significance level is greater than 0.05, then the data have an almost normal distribution. Based on the significance level of the data, it appears that the data follows a normal distribution.

3.2 Covariance between variables

The covariance between all 2 variables can be seen in Table 2.

Table 3
The covariance between all two variables

	NAP	COP	GP	PAP
NAP	10028983	22382.371	687149.48	1829314
COP	22382.371	159.55252	431.33935	2019.218
GP	687149.48	431.33935	64908.035	155965.4
PAP	1829313.6	2019.2176	155965.42	479506.6

3.3 Linear correlation and correlation coefficient

The correlation coefficient is a statistic that measures the strength of the linear relationship between two variables. R represents the correlation coefficient, which ranges between -1 and 1. Values of -1 and 1 indicate negative and positive correlations, respectively. In other words, the closer these values are to zero, the less intense the correlation between these two will have.

Table 4
Correlation coefficient

	NAP	COP	GP	PAP
NAP	1	0.5595331	0.8516743	0.834185
COP	0.5595331	1	0.1340349	0.230852
GP	0.8516743	0.1340349	1	0.88406
PAP	0.8341851	0.2308522	0.8840601	1

The non-diagonal elements display the correlation coefficient between the explanatory variables. Correlation coefficients between explanatory variables indicate that they are positively correlated. By taking into account their logarithm, it is possible to reduce some of the co-linearity between explanatory variables, as shown in Table 5.

Table 5
The correlation coefficient of the logarithm of the explanatory variables

	LOG(NAP)	LOG(COP)	LOG(GP)	LOG(PAP)
LOG(NAP)	1	0.4672824	0.85665	0.894769
LOG(COP)	0.4672824	1	0.0633712	0.233216
LOG(GP)	0.85665	0.0633712	1	0.863446
LOG(PAP)	0.8947693	0.2332161	0.8634463	1

4. Initial estimation of the model and tests

4.1. Initial linear regression model estimation

In order to estimate the model, we used the Eviews10 software. Below are the results:

Table 5
Initial estimation of linear regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-10591.32	1019.582	-10.38790	0.0000
COP	109.4777	8.258569	13.25626	0.0000
GP	8.239522	0.852416	9.666084	0.0000
PAP	0.673972	0.319418	2.110001	0.0385
R-squared	0.931805	Mean dependent var		8570.414
Adjusted R-squared	0.928797	S.D. dependent var		3189.081
S.E. of regression	850.9727	Akaike info criterion		16.38459
Sum squared resid	49242513	Schwarz criterion		16.51107
Log likelihood	-585.8452	Hannan-Quinn criter.		16.43494
F-statistic	309.7148 (0.0000)	Durbin-Watson stat		1.043862

The estimation of regression equation coefficients is represented in model 2.

$$NAI_t = -10591.32 + 109.4777COP_t + 8.239522GP_t + 0.673972PAP_t \quad (2)$$

4.2. Regression Significance Test

A hypothesis test is performed to determine the significance of the whole regression using the F statistic:

H_0 presents an insignificant regression, while H_1presents a significant regression. Generally, if the test statistics is less than 0.05%, the significance of the whole regression is accepted. Considering that the *F*-statistics has a possible value of zero, the null hypothesis that the regression is not significant is rejected. In addition, the *F*-statistics equals 309.7148, which exceeds the significance limit, indicating that the null hypothesis is rejected. The value of R^2 is equal to 0.931, which means that 93% of the changes in the model are affected by the explanatory variables. The explanatory power of the model is 93%. The regression standard deviation is estimated to be 850.9727, which represents the amount of dispersion of observations around the regression line. It illustrates the average deviation between the actual and predicted values of the model. In terms of the sign, the obtained coefficients for the model variables are also consistent with the theoretical foundations. Gold, oil, and palladium affect the model, as expected, but from this model, it can be concluded that the increase in the price of each of these will result in a rise in the Nasdaq index.

4.3. Drawing and analyzing the graph of actual and estimated independent values

As it is obvious in Fig. 1, the graphs of the actual values of the dependent variable and the estimated values are very close, which indicates the appropriate estimation of the regression model.

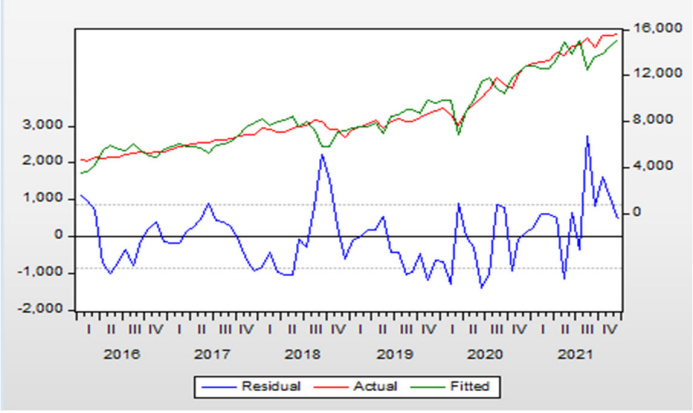

Fig. 1. Chart of actual and estimated values

4.4. Classical Hypothesis Testing

4.4.1. Durbin-Watson autocorrelation test

One of the classical assumptions of the ordinary least-squares (OLS) is the absence of autocorrelation between residuals. As we know, violating this assumption causes incorrect results or regressions. Durbin-Watson's test is one way to test for the existence of autocorrelation in a model. Of course, the use of this test has model assumptions, which are mentioned below:

A) The regression model has an intercept elevation.

B) The independent variables of the model are non-random.

C) The entered model should not contain a delayed dependent variable.

According to Durbin-Watson, the hypothesis is as follows:

H_0 has no autocorrelation, while H_1 has autocorrelation. All three of these conditions are present in the model under review. Also, considering the initial estimation table of the model, Durbin Watson's statistic is equal to 1.043, which is outside the range of 1.8 to 2.2, indicating that the null hypothesis is rejected and that the model has first-order autocorrelation.

4.4.2. Breusch-Godfrey autocorrelation test

It is important to note that Durbin-Watson's test is for first-order autocorrelation and does not test for other types of auto-correlations. For the test to test the autocorrelations of other orders as well, a general test is considered capable of testing the autocorrelation of the r order. The Hypothesis of the test are as follows: In the case of H0, there is no autocorrelation, and in the case of H1, there is autocorrelation.

Table 6
Breusch-Godfrey test

Heteroskedasticity Test Breusch-Pagan-Godfrey			
F-statistic	7.614694	Prob. F (3,65)	0.0002
Obs*R-squared	18.72379	Prob. Chi-Square (3)	0.0003
Test Equation:			
Dependent Variable: RESID			
Method: Least Squares			
Included observations: 72			
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	448.8901	951.2567	0.471892	0.6386
COP	-3.529302	7.597364	-0.464543	0.6438
GP	-0.271694	0.780380	-0.348156	0.7288
PAP	0.097694	0.294181	0.332087	0.7409
R-squared	0.260053	Mean dependent var	1.78E-12	
Adjusted R-squared	0.191750	S.D. dependent var	832.8004	
S.E. of regression	748.7104	Akaike info criterion	16.16675	
Sum squared resid	36436870	Schwarz criterion	16.38809	
Log likelihood	-575.0029	Hannan-Quinn criter.	16.25486	
F-statistic	3.807347	Durbin-Watson stat	1.883788	
Prob(F-statistic)	0.002596			

According to the value of the F-statistic and also the significance level, which is less than 0.05, represented in Table 6, the null hypothesis of no autocorrelation is rejected and the model has the third autocorrelation.

4.4.3. Residual Normality Test

One of the assumptions related to the number of errors is that the number has a normal distribution. All the tests related to the constancy of the coefficients are based on the assumption of normality of the residuals. If the sentence has a normal distribution with a zero mean, it is symmetrically distributed around its mean.

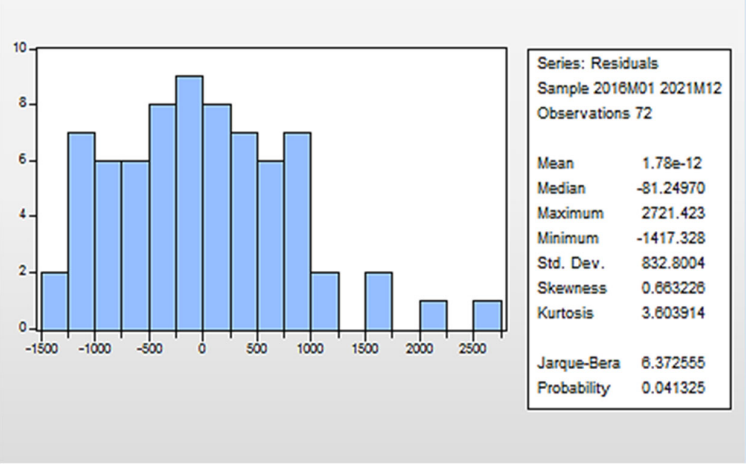

Fig. 2. Residual normality test

Since the Jarque-Bera statistics is lower than 9.77, the assumption of normality of the residuals is not rejected, which shows that the final model can follow normal distribution.

4.4.4 In-sample prediction

As it is obvious in Fig. 3, the graphs of the actual values of the dependent variable and the estimated values are very close, which indicates the appropriate estimation of the regression model

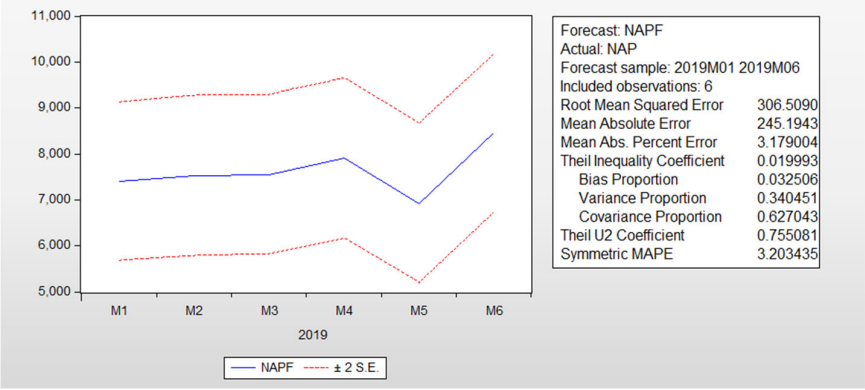

Fig. 3. In-sample prediction

4.5 Final estimation of the model

According to residual normality test in Fig 2, we cannot reject our initial estimation that final model can follow normal distribution. So, the distribution of the data was first discovered by fitting curves and then using the Generalized Linear Model, the final model was presented. Table 7 summarizes the results of the proposed method where we remove the palladium parameter effect from model since it does not have any significant effect on Nasdaq Index.

Table 7
generalized linear model

Variable		Coefficient	Std. Error	Z-Statistic	Prob.
C		-12172.33	708.5381	-17.17950	0.0000
GP		9.830898	0.407040	24.15215	0.0000
COP		113.7050	8.209841	13.84984	0.0000
Mean dependent var	8570.419	S.D. dependent var		3189.081	
Sum squared resid	52466430	Quasi-log likelihood		-588.1604	
Deviance	760383.0	Deviance statistic		52466430	
Restr. deviance	7.22E+08	Hannan-Quinn criter		16.45889	
Prob (Quasi-LR stat)	0.000000	Pearson SSR		760383.0	
Pearson statistic	760383.0	Dispersion		1.000000	

The final estimation of regression equation coefficients is represented in model 3.

$$NAI_t = -12172.33 + 113.7050COP_t + 9.830898GP_t \quad (3)$$

5. Conclusion and summary

This study has aimed to examine the factors affecting the Nasdaq Stock Exchange. The study investigated the effect of oil, gold, and palladium price on Nasdaq index. We use monthly data from January 2016 to December 2021 using finance.yahoo.com. According to the results of the analysis, Nasdaq index was positively affected by international crude oil price and gold price and the effect of oil price was more than gold price while the palladium price had neutral effect on it. The result of the study is a good experiment for policymakers and investors. Globalization and technological advancement have made the world financial markets very well integrated and an increase in volatility may spread from one sector to another and from one financial market to another. Since the research study focuses on Nasdaq index, it can be extended to other economies as well.

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