



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

# IJRSET

International Journal of Innovative Research in  
**SCIENCE | ENGINEERING | TECHNOLOGY**

# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 11, Issue 2, February 2022

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA

Impact Factor: 7.569

 9940 572 462

 6381 907 438

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# Dynamic Relationship between Crude Oil Future and Gold Future Market – An Indian Perspective

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**ABSTRACT:** The present study investigates the dynamic relationship between Crude oil shocks and Gold Price. The econometric tools like Vector Autoregressive model, Granger Causality Test, Impulse Response test were applied on the time series data of these variable from January 2005 to January 2020. The results of the study exhibit a unidirectional movement from crude oil to gold price. The results signify that Crude oil shock affects the gold price at various lags but Gold price do not influence the Crude oil price. The findings of the study help the investors in making decisions while diversifying their investments.

**KEYWORDS:** Crude Oil, Gold Price, Vector Autoregressive, Granger Causality, Impulse Response Function

## I. INTRODUCTION

With rise in interdependence of global financial markets, the popularity of commodity market increases gradually. Global financial markets become more sensitive towards the shocks in the commodity markets. The unpredictable fluctuation in equity markets, occurrence of unusual events increases the volatility in the return from the investment for global investors. Such fragile investment scenario leads to trigger the interest of investors towards the precious commodities and metals. Caballero et al. (2008) documented the rise of popularity of commodity market not only as an alternative investment option but it also provides a sense of safe return during volatile period. Under the ongoing turmoil financial scenario, gold and oil have emerged as strategic commodities as the horizon of their economic applications stretches in every sphere of life. Regnier (2007) described Crude Oil as the most unstable commodity in the commodity market as its demand and supply fluctuate at global level due to various operational and political events. On the flip side, Sari et al. (2010) observed Gold as the hedging instrument and also a safe investment avenue under volatile business scenario. It has gained its prominence as risk management tool among all the commodities. Investors are using these two categories as to diversify their portfolio diversification. This strategy has raised the question among investor's fraternity whether these two crucial commodities give high return and low risk opportunity for the investors.

The present study is a sincere attempt to examine the dynamic relationship between these commodities. This paper aims to investigate and estimate the impact of oil price shocks on real gold market returns and vice versa to determine whether the existing co-movement emerged from the impact of oil price fluctuations on gold prices or whether these two commodities are merely correlated.

The rest of this research is structured as follows: Section 2 discusses the evidence from the existing literature. Section 3 exhibits the research methodology used and data analysis. Section 4 reports and interprets the empirical results and Section 5 presents the findings and conclusion.

## II. LITERATURE REVIEW

The present section exhibits the extant literature shows the relationship between co-movement of these commodities. Ewing et al. (2006) and Fattouh (2010) investigate the relationship in crude oil and metal commodities and find the presence of asymmetry in the spread adjustment process. Zang et al. (2010) investigate the co-integration and causal relationship between gold and crude oil prices. The study observed a significant positive correlation between gold prices and crude oil prices. The study further finds that the crude oil price shocks Granger causes the movement in gold prices. Baur and McDermott (2010) examine the role of gold in hedging the risk in the global investment. Their study performed an econometric analysis from 1979 to 2009 and finds gold as a hedge and a safe investment avenue for under study European stock markets and the US but the results are not in favour for Australia, Canada, Japan and large



emerging markets such as Brazil, Russia, India and China. Reboredo (2013) examined the oil-gold relationship using copula approach from 2000-2011 and show a positive and significant association. The findings that gold cannot be hedged against oil price fluctuation. Soyta et al. (2009) revealed that investors from developed and developing economies use either oil or gold or use them collectively to diversify their investment portfolios. Melvin and Sultan (1990) observed the effect of oil price shocks on gold prices through analyzing the export revenue channel. The results find that the dominant oil-exporting countries use high revenues from oil sales to invest in gold. Since several countries including oil producers retain gold as an asset in their international reserve portfolios, rising oil prices (and hence oil revenues) may have implications for increases in gold prices. Simakova (2011) observed a long-term relationship between gold and oil prices. Christner and Dicle (2012) and Kumar (2011) investigated a causal relationship between gold and oil prices. Samanta and Zadeh (2012) studied the co-movement between the gold prices and crude oil shocks and found a long-run relationship between these commodities. Ciner, Gurdgiev and Lucey (2013) tested the return relationship between gold price, crude oil shocks and exchange rate volatility. The study finds that long run relationship among the variables and also found gold as safe investment opportunity against exchange rate fluctuations.

The present study aims to validate the linkage between gold price and Crude oil price using Vector Autoregressive Model and Granger Causality test in current rapidly changing economic environment. The findings of the study will help the investors and portfolio managers to make diversified investment decisions.

### III. RESEARCH METHODOLOGY

Monthly data of Crude Oil future and Gold future has been taken from BSE official website. The data from Jan 2005 to Jan 2019 has been taken for the analysis. E-views statistical package has been devised to examine the relationship between these two commodities in future market. Various econometric tools like Unit Root Test, Vector Autoregressive model, Granger Causality and impulse response function have been used as per their appropriateness in the given study.

#### ADF Test

Augmented Dickey- Fuller (1979) test was applied to examine whether the data series under study is stationary or not

Null Hypothesis – Series has Unit Root

#### Granger Causality

The Granger causality (1969) investigates the appropriateness of one time series in predicting the other time series.

#### Vector Autoregressive (VAR) Test

Yoshizaki and Hamori, (2013) documented that VAR model is used to examine the influence of past value of one variable and other variables on the current value of itself.

$$Y_{1,t} = \alpha + \beta_1 Y_{1,1-t} + \beta_2 Y_{2,1-t} + \epsilon_{1,t}$$

### IV. DATA ANALYSIS

Table – I Unit root test (Augmented Dickey Fuller Test)

	Zero Level	
	t-statistics	P value
Crude oil Future	-5.246	0.001
Gold Future	-3.554	0.037

Source: Author's Own Compilation (E-Views Results)

The statistics depicted in the above table indicate that the p value for both the series is below 0.05. It rejects the null hypothesis station unit root exists. It signifies that unit root does not exist in the under-study series. It means both the series are stationary.

As both the series are stationary at level, there is no need to apply Johnsen-Cointegration test. Vector Autoregressive(VAR) model is the appropriate model to examine the dynamic relationship between the future markets of both the commodities.



To use the VAR model, you must first determine the optimum lag at which the test should be run. The optimum lag is calculated using the lag length criterion.

**Table 2 - Lag Length Criteria**

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-382.8499	NA	0.271862	4.373295	4.409323	4.387907
1	32.54347	816.6256	0.002535	-0.301630	-0.193546*	-0.257792
2	42.79574	19.92202	0.002362	-0.372679	-0.192538	-0.299614*
3	49.27612	12.44527*	0.002296*	-0.400865*	-0.148667	-0.298575
4	50.59906	2.510582	0.002367	-0.370444	-0.046190	-0.238928

\* indicates lag order selected by the criterion

Source: Author's Own Compilation (E-Views Results)

The statistics depicted in the above table investigate the optimum lag for applying the VAR model. As per the statistics under Akaike Information Criterion (AIC), the optimum lag is 3.

**Table 3 - Vector Auto Regressive Result**

	CRUDE_OIL_FUTURE	GOLD_PRICE_FUTURE
CRUDE_OIL_FUTURE(-1)	1.022186 (0.07712) [ 13.2546]	0.295842 (0.08917) [ 3.31788]
CRUDE_OIL_FUTURE(-2)	0.104997 (0.11570) [ 0.90751]	-0.493087 (0.13377) [-3.68606]
CRUDE_OIL_FUTURE(-3)	-0.187333 (0.07552) [-2.48062]	0.239315 (0.08732) [ 2.74080]
GOLD_PRICE_FUTURE(-1)	0.018218 (0.06680) [ 0.27271]	0.789706 (0.07724) [ 10.2243]
GOLD_PRICE_FUTURE(-2)	-0.089023 (0.08140) [-1.09359]	0.139248 (0.09412) [ 1.47945]
GOLD_PRICE_FUTURE(-3)	0.089940 (0.06190) [ 1.45293]	-0.049726 (0.07157) [-0.69476]
C	0.674020 (0.35230) [ 1.91320]	1.288595 (0.40733) [ 3.16349]
R-squared	0.953281	0.903049
Adj. R-squared	0.951632	0.899628
Sum sq. resids	6.970978	9.318998





S.E. equation	0.202499	0.234132
F-statistic	578.1261	263.9118
Log likelihood	35.09177	9.400253
Akaike AIC	-0.317421	-0.027121
Schwarz SC	-0.191811	0.098489
Mean dependent	16.02076	16.11844
S.D. dependent	0.920752	0.739015

Source- Author's Own Compilation (E-views Results)

**VAR Model Equations**

$$\text{Crude Oil Future} = 1.022 * \text{Crude Oil Future (-1)} + 0.104 * \text{Crude Oil Future (-2)} - 0.187 * \text{Crude Oil Future (-3)} + 0.018 * \text{Gold Price Future (-1)} - 0.089 * \text{Gold Price Future (-2)} + 0.0899 * \text{Gold Price Future (-3)} + 0.674$$

$$\text{Gold Price Future} = 0.295 * \text{Crude Oil Future (-1)} - 0.493 * \text{Crude Oil Future (-2)} + 0.239 * \text{Crude Oil Future (-3)} + 0.789 * \text{Gold Price Future (-1)} + 0.139 * \text{Gold Price Future (-2)} - 0.049 * \text{Gold Price Future (-3)} + 1.288$$

**Table 4 - VAR Statistics P- value**

Crude Oil Future			Gold Future		
	t-statistics	Prob.		t-statistics	Prob.
Crude Oil Future (-1)	13.254	0.000*	Crude Oil Future (-1)	3.317	0.001*
Crude Oil Future (-2)	0.907	0.364	Crude Oil Future (-2)	-3.686	0.000*
Crude Oil Future (-3)	-2.480	0.013*	Crude Oil Future (-3)	2.740	0.006*
Gold Price Future (-1)	0.272	0.785	Gold Price Future (-1)	10.224	0.000*
Gold Price Future (-2)	-1.093	0.274	Gold Price Future (-2)	1.479	0.139
Gold Price Future (-3)	1.452	0.147	Gold Price Future (-3)	-0.694	0.487
Constant	1.913	0.056	Constant	3.163	0.001
R- Squared	0.953		R- Squared	0.903	
Adjusted R-Squared	0.951		Adjusted R-Squared	0.899	
F-Statistics	578.12		F-Statistics	263.91	

Source- Author's Own Compilation (E-views Results)

\*Significance at 5% level

The results of t-statistics and p- values show whether both the series influence each other or not. In case of Crude Oil future, the statistics show that the current value of crude oil futures is influenced by value of crude oil future at lag 1 and lag 3 because at both lag 1 and lag 3, the statistics (p-value < 0.05 and t-statistics > ± 1.96) rejects the null hypothesis. Gold future does not have any significant influence on crude oil future as null hypothesis is accepted due to the statistics (p-value > 0.05 and t-statistics < ± 1.96).

In case of Gold Future, Null hypothesis, for Crude Oil future at lag 1, lag 2, lag 3 and for gold future at lag 1, is rejected at 5% level of significance (p-value < 0.05 and t-statistics > ± 1.96). It means the current value of gold future is significantly influenced by past values of Crude oil future. Whereas past values of Gold future do not affect the current value of gold future. High value of R-square (0.953) and adjusted r-square (0.951) indicate the fitness of model. High value prove that the given model is fit and valid.

**Table 5 - Granger Causality Test**

Null Hypothesis	F-Stat	Prob.
GOLD_PRICE_FUTURE does not Granger Cause CRUDE_OIL_FUTURE	0.87034	0.4577
CRUDE_OIL_FUTURE does not Granger Cause GOLD_PRICE_FUTURE	5.58784	0.0011*

Source- Author's Own Compilation (E-views Results)

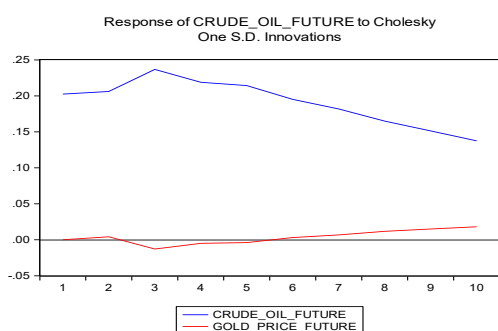
\*Significance at 5% level.



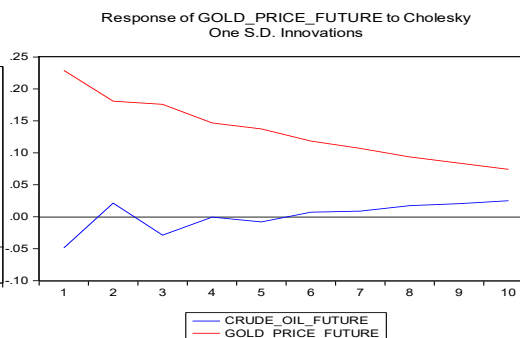
Granger Causality test indicates the direction of causality in the given series. The results indicate the existence of unidirectional causality among the given series. The p-value statistics shows that gold future (p-value>0.05) does not show any causality towards crude oil future whereas crude oil future (p-value<0.05) shows the causality towards gold price. It means the shocks in the past values of crude oil may cause the shocks in the current value of gold future.

### Impulse Response Function

Graph 1 – Crude Oil Future



Graph 2 – Gold Future



The above impulse response graphs depict the change in the movement of one variable with 1σ shock in other variable. The first graph indicates that with 1 σ shock in gold future, there is not significant movement in crude oil future whereas in second graph, a significant movement is shown in gold future with 1 σ shock in crude oil future.

### V. FINDINGS AND CONCLUSION

The present paper finds the dynamic relationship between the Crude Oil future and Gold Future in Indian Derivative markets. The main analysis was performed for the period Jan 2005 to Jan 2020. The association between the two variables was expressed graphically and algebraically. The results of the present study indicate the significance influence of crude oil future on gold future. The shocks in past value of crude oil leads to develop the shocks in present value of Gold future. But the flip side of this fact is not true.

The major reason behind the influence of crude oil future on gold future is the prominence role of crude oil in any economy. It drives the overall economy in context of production, electricity generation, transportation, agriculture and other sectors. Any rise in crude oil price may lead to increase the inflation in economy that further create bubbles in the demand of Gold as it is considered as hedging commodity against inflation.

The results signifies its implications for global portfolio diversification as it implies that both the commodities should not be used simultaneously for portfolio diversification as the significant influence of Crude oil future on Gold Future. By investing in both the commodities in future market will not lead to gain a good return for the investors.

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