A STUDY OF COINTEGRATION OF GOLD MARKET OF THE EMERGING AND DEVELOPED ECONOMIES

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Abstract

Gold, which is considered to be the most precious metal (Bilal, Talib, Haq, Khan, & Naveed, 2013), from ancient times has been considered as a very conservative investment. Studies examining the utility of gold have found evidence in favour of gold as a source of the hedge (Narayan, Narayan, & Zheng, 2010; Bampinas & Panagiotidis, 2015), diversification (Ibrahim, 2012; Hoang, Lean, & Wong, 2015), as well as a safe haven in times of adverse market movements (Ciner, Gurdgiev, & Lucey, 2013; Bredin, Conlon, & Potì, 2015). This paper attempts to study how global gold price trends impact domestic gold prices and domestic gold price trends contemplate in international gold markets. The study has been based on 3157 observations of daily data recorded over a period of 13 years – from March 2005 to December 2018 – to show the relationship between the USA and India's gold market. This paper fills the need for empirical evidence for the short and long-term interrelation between India and USA gold markets and the results show no evidence of a long-term association between Indian and COMEX gold spot prices.

Keywords: Indian Gold, COMEX Gold, Cointegration, Granger Causality, Global, Gold Market

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1. INTRODUCTION

The globalization and commercialization of the world have created a space for interconnected markets. International markets have been studied by many researchers for the presence of interdependency (Agmon, 1972; Byers & Peel, 1993; Richards, 1995; Cheung & Mak, 1992; Huang, Yang, & Hu, 2000; Belke & Keil, 2016). The economic and political integration of stock markets results in the financial integration of markets (Voronkova, 2004). The financial integration brings higher growth through free-flowing capital in different countries, which then leads to high net returns for investors' portfolios. Thus, it would not be wrong to state that financial integration is a way towards ensuring the economic development of a nation. There are two optimistic gains arising from financial integration: first, to diversify risk, and second, to increase the effectiveness of a capital market.

In the modern globalized world, capital markets are more integrated than ever. This shift has brought an increased flow of capital all over the world and opened new economic opportunities for investors and arbitrageurs to diversify their portfolios and achieve better economic returns. Foreign flows of capital can be increased around the world through financial amalgamation to motivate an economic outlook regarding growth and integration. It includes containing or reducing the risks that arise due to financial, economic, and political uncertainties existing among and across international borders (Borensztein, De Gregorio, & Lee, 1998).

With the development of the information and communication technology sector, information inefficiency between nations, and even continents, is a thing of the past. The rapid advancements in the ICT (information and communications technology) sector have led to fair price discovery amongst all asset classes; and also transformed communication and information-sharing, which has globalized trade and business significantly. The intense interconnectivity of global trade and capital investment is reflected in the increasing interdependence between international markets. The rise and fall in one market have immediate and direct consequences on other markets in the world as well. The same was reflected in a study by Kearney and Patton (2000), which showed that volatility in the world equity market is predominantly affected due to volatility in Japanese/US stock markets, instead of European stock markets.

The financial turmoil in global markets has attracted a large number of participants in the gold market. Here, gold serves as a hedge against financial shocks in a diversified portfolio while providing high returns at a reduced level of risk. Further, since gold also functions to provide exposure for stabilizing currency fluctuations, it has an important role in emerging markets. It then comes as no surprise that in times of financial turmoil, gold has generated much interest among market participants in different countries. Thus, several millions of buyers and sellers are now acting simultaneously to the news regarding the gold market. Gold's hedging properties and a negative beta value also play a part in establishing its prominence in investment portfolios.

In relation to its hedging functions, physical gold has the same properties as Gold – index exchange-traded funds, or ETFs (Pullen, Benson, & Faff, 2014). Like any other large commodity market, there is a well-established market for gold as well, in which abnormal returns can be expected to balance out or disappear gradually. There are seven markets in the world where gold is traded today – these markets include COMEX (New York), Istanbul, Shanghai exchanges, Tokyo (TOCOM), London OTC market, India (MCX), and Dubai. The difference in their geographical positions also influences price discovery and spot prices in gold trading, often without any obvious political or macroeconomic links (Lucey & Li, 2015; Ivanov, 2013; Pavabutr & Chaihetphon, 2010). Studies have proved the interdependency of these markets in terms of daily trading and found that some markets can have a greater effect on others making them dominant (Laulajainen, 1990). Similarly, studies also show the presence of feedback and volatility among these markets in relation to each other, often in symmetry (Xu & Fung, 2005).

In this vein, researchers have found that foreign gold prices can contain relevant information regarding the forecast of stock prices in India (Kumar & Kumar, 2018). The volatility of gold prices in India was influenced by gold price changes in the US. Researchers have also discovered that Indian gold price volatility is leveraged and heavily influenced by the changes in US gold prices (Natchimuthu, Ram Raj, & Hemanth, 2017). There has been proof of a high correlation between Indian and global COMEX markets (Rathod, 2014) and a solid association between these precious-commodity markets forms an interesting area of study.

There is a vast scope to integrate the Indian stock market with the other countries (Agarwal, 2000). Thus, the present paper aims to analyze the connection between Indian gold prices and COMEX gold prices. This paper seeks to provide how global gold price trends impact domestic gold prices and also how domestic gold price trends contemplate in international gold markets. The originality of the present paper lies in its presentation of a long-term frame and the quantitative analysis that provides useful insights on the historical trends of Indian gold prices and COMEX gold prices. It further provides returns appropriation of gold for Indian markets with minimum acceptable risks. The present study shall have great practical implications for any hedgers, speculators, and arbitrageurs for managing their risk in a better way and attaining maximum returns on investments. Based on the insights of this study, the investors/arbitrageurs can also deploy various spread strategies to achieve better returns due to fair price discovery between Indian gold prices and COMEX gold prices.

The rest of the paper is structured as follows. Section 2 reviews the relevant literature. Data and methodology are explained in Section 3. Section 4 presents the empirical results and findings, and the paper concludes in Section 5.

2. LITERATURE REVIEW

This section presents an overview of existing research regarding gold price causalities, arbitrage in spread trades, and inter-dependency between different stock markets. The section also includes an introduction to the framework used in the research paper and provides the research methodology used in the paper. Dheeriya (1993) has studied the interdependent relationship between 17 stock market indices through the use of a causality test. The author examined the periods both before and after the crucial 1987 crash and found that there was a structural shift because of the crash in the interrelationship of global stock markets. As per the study, the markets in the UK and the USA are highly influential in comparison to other key markets like France, Japan, or Canada. However, the study also found that a majority of these markets react to movements occurring in other markets, whether past or present. Richards (1995) has studied the long-term returns in different markets to establish the level of cointegration. The researcher has argued that the strong indication of cointegration in previous studies was a result of a failure in accounting for small independent values while utilizing the Johansen multivariate method of estimation. The alternative test for cointegration presented in the study leads to the conclusion that stock market indices include both components: country-specific, as well as a common global component. Bhalla et al. (2000) have presented the view that for the short term, there was a strong correlation between the markets in the US and Europe, and between Asian and Indian stock markets. However, when the same is attempted to be translated into the long term, the correlation

weakens to a considerable extent. Huang et al. (2000) have presented the causality and cointegration among stock markets based in Japan, the USA, and the South China Growth Triangle. The researchers have not found any evidence regarding cointegration among the studied stock markets, other than the Shenzhen and Shanghai indices. The study found that price fluctuations in the US markets are useful in foreseeing next-day price fluctuations in Hong Kong and Taiwan. The daily returns between US and Hong Kong stock markets are synchronous, and there exists solid feedback between Shanghai and Shenzhen stock exchanges.

Tabak and Lima (2003) have studied the causality and cointegration among stock markets in the USA, and Latin/Central America (including Chile, Argentina, Colombia, Brazil, Mexico, and Venezuela). The researchers have found that while there was enough evidence of short-term causality, there was no proof of cointegration. There was clear Granger causality between the stock market of Brazil with other stock markets in Latin America. Panda and Acharya (2011) have studied the Indian stock market in relation to the US and major Asian stock markets. The study has been conducted during 2001-2008, a key period in the Indian stock economy, which was affected by the continuous movement of funds by FIIs (foreign institutional investments) across the globe. The researchers have employed Granger causality, vector autoregression (VAR), Johansen-Juselius cointegration tools, and found that there was evidence of an integrated relationship between Indian and US stock markets. Rehman and Hazazi (2014) have studied the stock markets of Saudi Arabia and their affiliation with the stock markets in Gulf Cooperation Council countries like the UK, the US, and Japan. The study employs the use of Pearson's correlation, Johansen cointegration, and pair-wise causality tests, and unit root tests to point to the growing rate of correlation that has emerged over time among the studied markets. The study also points to a plummet in the volatile nature of TASI, i.e., the Saudi Index. Belke and Keil (2016) have studied quarterly data available between the periods of 1980-2009 through the use of the VAR model. The researchers have analyzed the impact of output, cross-border financial transactions, monetary liquidity, and commodity prices on short-run and long-run dynamics. Ogbonna, Iheanacho, and Okere (2018) examined the African stock market over the period of February 2004 to July 2016. Using Johansen cointegration, vector autoregressive, and multivariate GARCH approach. The result shows that no bivariate cointegration exists between Nigeria and any of the stock markets being studied, and the multivariate cointegration confirms the result of Hung (2019), who found that the volatility in the Chinese market considerably affects other markets. The researcher found that in the case of stock returns, the relationship between China and other markets seems to be remarkable during and post the global financial crisis.

This study sought to empirically evaluate causativeness between the Indian and USA gold markets. The extant literature in relation to issues like stock market volatility, the relation between different market stocks, the relation between gold and stock market but there is a dearth of studies on the relation between Indian and USA gold markets. Since this issue is of critical importance, the present paper provides an intensive analysis on the topic to overcome the current gaps in the literature.

3. RESEARCH METHODOLOGY

As regards the causality test method, most causality studies since the late 1980s employ unit root tests to examine the stationarity properties of variables, perform cointegration analysis, mostly following the Johansen (1988, 1991) procedure, and formulate a vector error correction (VEC) model in order to capture both long-run and short-run sources of causality between the variables. In this paper, Granger-causality analysis has been carried out in order to assess whether there is any potential predictability power of one indicator for the other.

3.1. Data source

In the present study, secondary data has been used to achieve its objective of identifying the correlation between the USA and India's gold markets. Gold prices are the spot prices of the gold commodity taken from the World Gold Council. On the basis of the cost-of-carry model, the financial theory provides that the futures contract price is determined by the underlying asset's spot price, where futures price refers to the sum of the said spot price and the cost of its storage. In the study, a 13-year long period was chosen – starting from March 2005 to December 2018. The study uses daily data collected during this period, including 3157 observations, to portray a broader view of the connection between these two variables. The price of gold in the US was collected in US dollar per troy ounce. This rate was then converted into the price per gram and was expressed in US dollar.

3.2. Model specification

The econometric Granger causality model has been used in this study to identify the impact of gold markets in India and the US upon each other. The following hypotheses, for cointegration and causality, have been tested according to the chosen model.

H1: Whether there is bidirectional causality between the US gold market and the Indian gold market.

H2: Or unidirectional causality among the two variables.

H3: Or no causality between the US gold market and the Indian gold market.

H4: Or a long-running relationship between the USA gold market and the Indian gold market.

Model specification mentioned below as:

Model 1

$$INDIA's\ Gold\ Rate = f\ (USA's\ Gold\ Rate) \quad (1)$$

The interconnection between the *USA's Gold Rate* and *INDIAN's Gold Rate* has been manifested by the below-mentioned model:

Model 2

$$INDIA's\ Gold\ Rate = u + v_t\ USA's\ Gold\ Rate + \varepsilon_t \quad (2)$$

The model has been employed with a base assumption that the other variables except *Gold* remain constant. While ε_t is the error term, u and v variables denote the coefficient and the slope of regression. The regression coefficient used here, i.e., v depicts the change in dependent variable due to change in one unit of the predictor variable. The error term (ε_t) has been incorporated in the given equation (2) to accommodate other factors that could affect the gold rate. The study has used Gauss-Markov (GM) assumptions; it includes that the dependent and independent variables in the study (*INDIA's Gold Rate* and *USA's Gold Rate*) are linearly co-related. Moreover, it is assumed that the estimators u, v are free from bias with the expected value of zero, i.e., $E(et) = 0$. This study has used *INDIA's Gold Rate* as a dependent factor, while the *USA's Gold Rate* has been taken as the independent variable. The researchers also discovered that Indian gold price volatility is leveraged and heavily influenced by the changes in US gold prices (Natchimuthu et al., 2017). In addition, the ordinary least squares regression (OLS) analysis can be used to establish whether there is the dependence of the US gold rate on India's gold rate or not.

3.3. Unit root test: Augmented Dickey-Fuller test

Data realization is going to be used in the case of time series to derive conclusions regarding core stochastic procedures. The stationary test is crucial in deriving the conclusion from the investigation of time series. The present study has employed the augmented Dickey-Fuller test (ADF) to estimate the unit root. The ADF test estimates the regression equation given below:

$$\Delta y_t = \beta_0 + \varepsilon y_{t-1} + \sum_{i-2}^{m} \Delta\, y_{t-i} + \varepsilon \qquad (3)$$

where, Δ – a first difference operator; ε – error term.

Thus, the null hypotheses for unit root are:

H_{01}*: India Gold Prices has a unit root.*

H_{02}*: US Gold Prices has a unit root.*

A stochastic trend is usually used to characterize macroeconomic time-series data, which may be detached via differencing. The results can be of three varieties: some variables are stationary on levels, some variables turn into stationary after running one differentiation, while some variables turn into stationary after more than one differentiation. In the study, the ADF equation is performed in two cases: one, when it only includes intercept; and another, when it includes both intercept and time-trend (Sarbapriya, 2011).

3.4. Johansen cointegration test

Cointegration is an econometric instrument for time series variables. It is a precondition to extend long term stability in economic relationship between two, or more than two, variables which have unit roots. Since the data is characterized as time-series, the Johansen technique by Johansen and Juselius (1992) is used to establish the number of cointegrated vectors against every given number of non-stationary variables which are of identical order (Ray, 2011).

Random variables are considered to be co-integrated if each of the time series has been found as non-stationary. The Johansen cointegration approach can be used to determine a long-running association between the two variables. In such studies, cointegration tests are used to establish if a group of non-stationary series is co-integrated.

3.5. Granger causality test

Causality refers to the reaction concept, which is often used during the construction of forecasting models. The application of causality tests in economics has been satisfied by Granger (1969) and Sims (1972). The Granger causality test, devised by Granger (1969), is used to determine whether one-time series has any significance in forecasting or not. Thus, the typical application of the Granger causality test (Granger, 1988) relates to whether the previous values of a variable can lead to reliable forecasting of changes in another variable. A simple Granger causality test has been used to assess the bivariate autoregressive processes for India and the USA. This includes measuring the causality factor of India's gold rate upon the US gold rate; and similarly, of the US gold rate upon India's. To examine the direction of the causal relationship between India's and the US gold rates, the Granger causality test involves the estimation of the regression equations which are provided below.

If causality runs from India to the US gold rate, the equation so formed will be:

$$USA\ Gold\ Rate = \sum_{t=1}^{n} ai\, X_{t-i} + \sum_{j=1}^{n} \beta_j\, India_{t-j} + \varepsilon 1_t \qquad (4)$$

If causality runs from the US to India gold rate, the equation so formed will be:

$$India's\ Gold\ Rate = \sum_{t=1}^{n} \partial i\, X_{t-i} + \sum_{j=1}^{n} \partial_j\, USA_{t-j} + \varepsilon 2_t \qquad (5)$$

where, ε_{it} uncorrelated stationary random process, while subscript *t* denotes the time period.

4. EMPIRICAL RESULTS

To explore the dynamics of the association among gold rate between India and the US with data for the period 2005 to 2018 and this includes the 3157 observations. The two main variables are *India gold rate* and *USA gold rate*. The methodology for data analysis in the research is based on the application of the unit root test, cointegration, and Granger causality model. The movement of India's gold rate and the US gold rate is shown in Figure 1 and Figure 2.

Figure 1. Movement of India gold rate

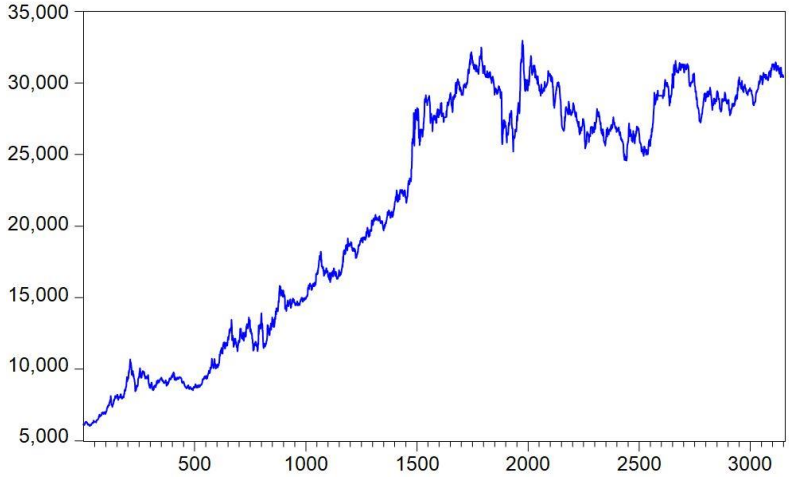
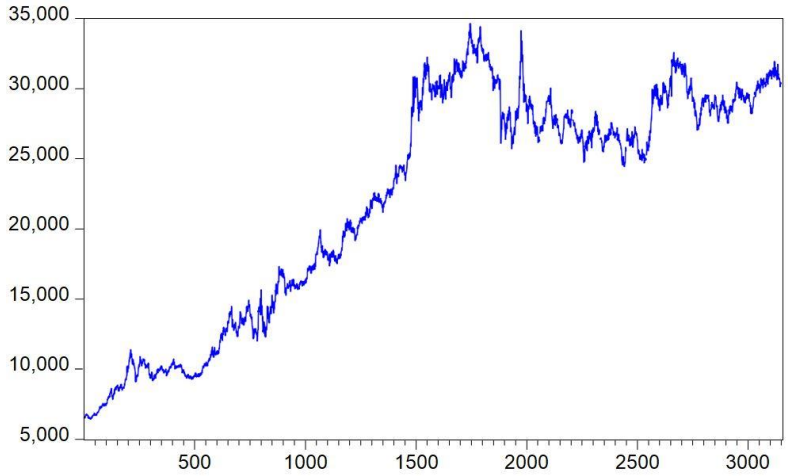


Figure 2. Movement of the US gold rate



Augmented Dickey-Fuller test: A series is considered stationary when ADF < negative critical value; while the series is considered non-stationary when ADF > negative critical value.

The results of the unit root test have been provided by applying the ADF test for India and US gold rate at intercept form, at a trend and intercept.

Table 1a. ADF test statistics at intercept form (level) & at trend and intercept form

		T-statistic	*Prob.**
Augmented Dickey-Fuller test statistic		-1.502261	0.5326
Test critical values	1% level	-3.432233	
	5% level	-2.862257	
	10% level	-2.567196	

Table 1b. ADF test statistics at trend and intercept form

		T-statistic	*Prob.**
Augmented Dickey-Fuller test statistic		-1.464359	0.8416
Test critical values	1% level	-3.960949	
	5% level	-3.411230	
	10% level	-3.127450	

Notes: Null hypothesis: India gold rate has a unit root.
** MacKinnon (1996) one-sided p-values.*

It is clear from Tables 1a and 1b that the series of India's gold rate is non-stationary at level (intercept and trend and intercept form) as the value of P-statistics is greater than 0.05 statistics.

Table 2a. ADF test statistics at intercept (first difference)

		T-statistic	*Prob.**
Augmented Dickey-Fuller test statistic		-55.76519	0.0001
Test critical values	1% level	-3.432234	
	5% level	-2.862258	
	10% level	-2.567196	

Table 2b. ADF test statistics at trend and intercept (first difference)

		T-statistic	*Prob.**
Augmented Dickey-Fuller test statistic		-55.77364	0.0000
Test critical values	1% level	-3.960950	
	5% level	-3.411231	
	10% level	-3.127450	

Notes: Null hypothesis: D(India_gold_rate) has a unit root.
** MacKinnon (1996) one-sided p-values.*

ADF test statistics after differencing the series are shown in Tables 2a and 2b Gold India series attained stationary at first differencing, using the ADF test method. On this basis, the null hypothesis has been rejected. It can be concluded that gold India has a stationary series value.

Table 3a. ADF test statistics at intercept form (level)

		T-statistic	*Prob.**
Augmented Dickey-Fuller test statistic		-1.703785	0.4293
Test critical values	1% level	-3.432271	
	5% level	-2.862274	
	10% level	-2.567205	

Table 3b. ADF test statistics at trend and intercept form (level)

		T-statistic	*Prob.**
Augmented Dickey-Fuller test statistic		-1.602257	0.7923
Test critical values	1% level	-3.961004	
	5% level	-3.411257	
	10% level	-3.127466	

Notes: Null hypothesis: USA gold rate has a unit root.
** MacKinnon (1996) one-sided p-values.*

It is clear from Tables 3a and 3b that series of US gold rate series is non-stationary at level (intercept and trend and intercept form) as the value of P-statistics are greater than 0.05 statistics.

Table 4a. ADF test statistics at intercept (first difference)

		T-statistic	*Prob.**
Augmented Dickey-Fuller test statistic		-63.82298	0.0001
Test critical values	1% level	-3.432271	
	5% level	-2.862274	
	10% level	-2.567205	

Table 4b. ADF test statistics at trend and intercept (first difference)

		T-statistic	*Prob.**
Augmented Dickey-Fuller test statistic		-63.83356	0.0000
Test critical values	1% level	-3.961004	
	5% level	-3.411257	
	10% level	-3.127466	

Notes: Null hypothesis: D(USA gold rate) has a unit root.
** MacKinnon (1996) one-sided p-values.*

ADF test statistics after differencing the series is shown in Tables 4a and 4b The US gold series attained stationary at first differencing, using the ADF test method. On this basis, the null hypothesis has been rejected. It can be concluded that gold India has a stationary series value.

4.1. Akaike information criterion (AIC)

The Akaike information criterion (AIC) is employed to determine the goodness of fit regarding any econometric model. It provides an assessment of the amount of information that might be lost by applying a specific model, or a set of models, to explain the reality during the Granger causality test.

AIC helps to decide about lags and use of lags is very essential because variables do not impact on one another instaneously but do so within a time span called a lag.

Table 5. Akaike information value

Lag	*1*	*2*	*3*	*4*	*5*
AIC value	27.58	27.15	27.07	27.05	27.04

4.2. Johansen's cointegration

This test will be applied to check whether the prolonged equilibrium symmetry between variables. The cointegration test hypothesis is:

H_{03}: India's gold/USA gold rate do not have a long-run relationship.

H1: India's gold/USA gold have a long-run relationship.

Table 6. Unrestricted cointegration rank test (trace test)

Hypothesized No. of CE(s)	*Eigenvalue*	*Trace statistic*	*0.05 Critical value*	*Prob.***
None	0.003283	13.02896	15.49471	0.1138
At most 1	0.000997	3.031513	3.841466	0.0817

Note: Trace test indicates no co integration at the 0.05 level.

It can be inferred from the above table that the trace test statistic values show a significant value at 0.05, which denotes the acceptance of the null hypothesis. Thus, the alternative hypothesis that there exists cointegration between gold prices in India and the US is rejected. The findings also show that there is no long-term relationship between the two variables. To further analyze the presence of a long-term causal affiliation between the two variables, the Granger causality test has been applied after choosing the required lag length, and the selection of VAR model for this study.

4.3. Granger causality test

The Granger causality model is an econometric, statistical proposition tool employed to find out whether one time series can help to forecast another. The test measures the lag lead relationship between two variables by taking F-test findings at 0.05 value of significance (Bilal et al., 2013). The findings as per the Granger causality model have been tabulated in Table 7 below.

Table 7. Granger causality test between US Gold rate and India Gold rate

Pairwise Granger causality tests Date: 06/28/19 Time: 20:30 Sample: 1 3157 Lags: 5			
Null hypothesis	***Obs.***	***F-statistic***	***Prob.***
USA_GOLD_RATE does not Granger Cause INDIA_GOLD_RATE	3040	289.252	1E-253
INDIA_GOLD_RATE does not Granger Cause USA_GOLD_RATE		9.74617	3.E-09

The above table results that the US gold market does not granger India's gold rate and India's gold rate does not granger India's gold rate as the probability value is less than 5%. Thus, these results lead to refutation of the null hypothesis. Accordingly, the study moves towards accepting the alternative hypothesis, i.e., the US gold market affects the Indian gold market and India gold market also affects the US god market rate.

5. CONCLUSION

It is being observed that all over the world, a retail investor can diversify his portfolio through commodity investments into a different asset class apart from shares and bonds and enhance the overall returns of their investments. Commodity returns holds a low or negative co-relation with the returns of other asset. According to Baur and McDermott (2010), gold represents a safe haven against stocks of major emerging and developing countries. Even the financial markets use gold as a store of wealth, investment and a source of prime collateral against financial deals (WGC, 2009). Investors in advanced and emerging markets often switch between oil and gold or combine them to diversify their portfolios (Soytas & Sari, 2009).

The paper seeks to analyze the cointegration and causal link between gold markets in India and the US in the short run and long run. As the spot market for commodities is not explored in any other study, so in this spot market prices are considered for study. The econometrics technique has been employed to test the existence of any causality between the US gold rate and India's gold rate. Augmented Dickey-Fuller test have been utilized to test for the unit roots of the studied variables. To test the cointegration among variables, the Johansen cointegration approach had been used along with the Granger causality test. After carrying out the cointegration analysis of India's gold with the US gold, it can be concluded that India's and the US gold markets do not establish their relationship long period. The results have provided the fact of bidirectional causality between India and US gold prices. The study would hold implications for the portfolio managers or investors who would like to downsize the risk or put up their investments in safe havens or wish to provide a hedge against the fluctuations of these two different markets. One of the major limitation of this paper is that only two variables are involved in the analysis and US gold rate might be weakly exogenous. As data use is daily of nature, so conditional volatility can also be checked to see the results in different angle. We interpret the paper's results as weak evidence of the relationship between India and US gold markets that requires further investigation and much research by applying.

The currency depreciation and other policy measures like change in import duty of gold contract, etc., have to be studied to measure any diversion in the long-term trend. Other potential drivers for live gold price like interest rates, monetary policy, geopolitics and inflation can be considered to test the existence of any anomaly between Indian gold prices and COMEX gold prices. London over the counter spot gold market price can also be considered for finding the correlation between Indian gold and London OTC gold. The investors/arbitrageurs can deploy different spread strategies to attain the better returns because of fair price discovery between Indian gold prices and COMEX gold prices

Future research work in this area can be done by considering the future market of commodities as it will give a new direction to the findings. Perhaps, a future avenue for the authors would be to consider, what factors affect gold prices, e.g., net positions of gold futures contracts in the US and try to relate it to what can cause (lead/lag) relationships between futures and spot prices.

REFERENCES

1. Afsal, E. M., & Haque, M. I. (2016). Market interactions in gold and stock markets: Evidences from Saudi Arabia. *International Journal of Economics and Financial, 6*(3), 1025-1033. Retrieved from http://www.econjournals.com/index.php/ijefi/article/view/2702
2. Agarwal, R. N. (2000). *Financial integration and capital markets in developing countries: A study of growth, volatility and efficiency in the Indian capital market*.
3. Agmon, T. (1972). The relations among equity markets: A study of share price co-movements in the United States, United Kingdom, Germany and Japan. *The Journal of Finance, 27*(4), 839-855. https://doi.org/10.1111/j.1540-6261.1972.tb01315.x
4. Anuja, R. (2016). A survey on the influence of gold, crude oil & US dollar rates on stock price movement in India. *International Journal of Innovative Research in Science, Engineering and Technology, 5*(11), 19463-19470. Retrieved from http://www.ijirset.com/upload/2016/november/135_A%20Survey.pdf
5. Bampinas, G., & Panagiotidis, T. (2015). On the relationship between oil and gold before and after financial crisis: Linear, nonlinear and time-varying causality testing. *De Gruyter*. https://doi.org/10.1515/snde-2014-0060
6. Baur, D. G., & McDermott, T. (2010). Is gold a safe haven? International evidence. *Journal of Banking & Finance, 34*(8), 1886-1898. https://doi.org/10.1016/j.jbankfin.2009.12.008
7. Belke, A., & Keil, J. (2016). Financial integration, global liquidity and global macroeconomic linkages. *Journal of Economic Studies, 43*(1), 16-26. https://doi.org/10.1108/JES-02-2015-0026
8. Bhunia, A., & Mukhuti, S. (2015). *Relationship between gold price and stock market – An evidence of India: Gold price and stock market*. Scotts Valley, CA: CreateSpace Independent Publishing Platform.
9. Bhuyan, A. K., & Dash, A. K. (2018). A dynamic causality analysis between gold price movements and stock market returns: Evidence from India. *Journal of Management Research and Analysis, 5*(2), 117-124. http://doi.org/10.18231/2394-2770.2018.0019
10. Bilal, A., Talib, A., Haq, I. U., Khan, M. N. A. A., & Naveed, M. (2013). How gold prices correspond to stock index: A comparative analysis of Karachi Stock Exchange and Bombay Stock Exchange. *World Applied Sciences Journal, 21*(4), 485-491. Retrieved from https://www.semanticscholar.org/paper/How-gold-prices-correspond-to-stock-index%3A-a-of-and-Bilal-Talib/4980710092564c6f646fb42b7973cc00034e5f66
11. Borensztein, E., De Gregorio, J., & Lee, J.-W. (1998). How does foreign direct investment affect economic growth? *Journal of International Economics, 45*(1), 115-135. https://doi.org/10.1016/S0022-1996(97)00033-0
12. Bredin, D., Conlon, T., & Potì, V. (2015). Does gold glitter in the long-run? Gold as a hedge and safe haven across time and investment horizon. *International Review of Financial Analysis, 41*. Advance online publication. https://doi.org/10.2139/ssrn.2483728
13. Byers, J. D., & Peel, D. A. (1993). Some evidence on the interdependence of national stock markets and the gains from international portfolio diversification. *Applied Financial Economics, 3*(3), 239-242. https://doi.org/10.1080/758535729
14. Cheung, Y.-L., & Mak, S.-C. (1992). The international transmission of stock market fluctuation between the developed markets and the Asian Pacific markets. *Applied Financial Economics, 2*(1), 43-47. https://doi.org/10.1080/758527545
15. Choudhry, T. (1997). Stochastic trends in stock prices: Evidence from Latin American markets. *Journal of Macroeconomics, 19*(2), 285-304. https://doi.org/10.1016/S0164-0704(97)00016-5
16. Dheeriya, P. (1993). Further evidence on causality and feedback across international stocks. *Journal of Economics and Finance, 17*(3), 161-167. https://doi.org/10.1007/BF02920038
17. Gangopadhyay, K., Jangir, A., & Sensarma, R. (2016). Forecasting the price of gold: An error correction approach. *IIMB Management Review, 28*(1), 6-12. http://doi.org/10.1016/j.iimb.2015.11.001
18. Gaur, A., & Bansal, M. (2010). A comparative study of gold price movements in Indian and global markets. *Indian Journal of Finance, 4*(2), 32-37. Retrieved from http://www.indianjournaloffinance.co.in/index.php/IJF/article/view/72636
19. Granger, C. (1969). Investigating causal relations by econometric models and cross-spectral methods. *Econometrica, 37*(3), 424-438. https://doi.org/10.2307/1912791
20. Granger, C. (1988). Causality, cointegration, and control. *Journal of Economic Dynamics and Control, 12*(2-3), 551-559. https://doi.org/10.1016/0165-1889(88)90055-3
21. Huang, B.-N., Yang, C.-W., & Hu, J. W.-S. (2000). Causality and co integration of stock markets among the United States, Japan and the South China Growth Triangle. *International Review of Financial Analysis, 9*(3), 281-297. https://doi.org/10.1016/S1057-5219(00)00031-4
22. Hung, N. T. (2019). Return and volatility spillover across equity markets between China and Southeast Asian countries. *Journal of Economics, Finance and Administrative Science, 24*(47), 66-81. https://doi.org/10.1108/JEFAS-10-2018-0106
23. Hussain, M. M., Aamir, M., Rasool, N., Fayyaz, M., & Mumtaz, M. (2012). The impact of macroeconomic variables on stock prices: An empirical analysis of Karachi Stock Exchange. *Mediterranean Journal of Social Sciences, 3*(3), 295. Retrieved from http://www.richtmann.org/journal/index.php/mjss/article/view/11089

24. Ivanov, S. I. (2013). The influence of ETFs on the price discovery of gold, silver and oil. *Journal of Economics and Finance, 37*(3), 453-462. https://doi.org/10.1007/s12197-011-9205-8
25. Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control, 12*(2-3), 231-254. https://doi.org/10.1016/0165-1889(88)90041-3
26. Johansen, S. (1991). Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models. *Econometrica, 59*(6), 1551-1580. https://doi.org/10.2307/2938278
27. Johansen, S., & Juselius, K. (1992). Testing structural hypotheses in a multivariate cointegration analysis of the PPP and the UIP for UK. *Journal of Econometrics, 53*(1-3), 211-244. https://doi.org/10.1016/0304-4076(92)90086-7
28. Kaur, S., & Kaur, D. (2017). Dynamic relationship between gold prices and Indian stock market – An empirical analysis. Paper presented at the *International Conference on Recent Innovations in Science, Agriculture, Engineering and Management, 3*(2), 454-460. Retrieved from http://data.conferenceworld.in/GKU/63.pdf
29. Kearney, C., & Patton, A. J. (2000). Multivariate GARCH modeling of exchange rate volatility transmission in European monetary system. *The Financial Review, 35*(1), 29-48. https://doi.org/10.1111/j.1540-6288.2000.tb01405.x
30. Kumar, B., & Kumar, D. (2018). A dynamic causality analysis between gold price movements and stock market returns: Evidence from India. *Journal of Management Research and Analysis, 5*(2), 117-124. https://doi.org/10.18231/2394-2770.2018.0019
31. Kumar, S. (2017). What determines the gold inflation relation in the long-run? *Studies in Economics and Finance, 34*(4), 430-446. https://doi.org/10.1108/SEF-04-2016-0084
32. Laulajainen, R. (1990). Gold price round the clock. *Resources Policy, 16*(2), 143-152. https://doi.org/10.1016/0301-4207(90)90029-B
33. Lucey, B. M., & Li, S. (2015). What precious metals act as safe havens, and when? Some US evidence. *Applied Economics Letters, 22*(1), 35-45. https://doi.org/10.1080/13504851.2014.920471
34. Lucey, B. M., & Tully, E. (2006). The evolving relationship between gold and silver 1978-2002: Evidence from a dynamic co integration analysis. *Applied Financial Economics Letters, 2*(1), 47-53. https://doi.org/10.1080/17446540500426789
35. MacKinnon, J. G. (1996). Numerical distribution functions for unit root and cointegration tests. *Journal of Applied Economics, 11*(6), 601-618. https://doi.org/10.1002/(SICI)1099-1255(199611)11:6<601::AID-JAE417>3.0.CO;2-T
36. Mukhuti, S., & Bhunia, A. (2013). Is it true that Indian gold price influenced by Indian stock market reaction? *E3 Journal of Business Management and Economics, 4*(8), 181-186. Retrieved from https://econpapers.repec.org/article/etrseries/v_3a4_3ay_3a2013_3ai_3a8_3ap_3a181-186.htm
37. Narang, S. P., & Singh, R. P. (2015). Causal relationship between Gold Price and Sensex: A study in Indian context. *Vivekananda Journal of Research, 1,* 33-37. Retrieved from https://www.researchgate.net/publication/287196336_Causal_Relationship_between_Gold_Price_and_Sensex_A_Study_in_Indian_Context
38. Narayan, P., Narayan, S., & Zheng, X. (2010). Gold and oil markets: Are markets efficient? *Applied Energy, 87*(10), 3299-3303. https://doi.org/10.1016/j.apenergy.2010.03.020
39. Natchimuthu, N., Ram Raj, G., & Hemanth, S. (2017). Is gold price volatility in India leveraged? *Academy of Accounting and Financial Studies, 21*(3), 1-10. Retrieved from https://www.abacademies.org/articles/is-gold-price-volatility-in-india-leveraged-6733.html
40. Ogbonna, B., Iheanacho, E., & Okere, K. (2018). Co integration, dynamic linkage and portfolio diversification from selected stock market in Africa. *IOSR Journal of Economics and Finance (IOSR-JEF), 9*(4), 21-37. Retrieved from https://www.researchgate.net/publication/328831558_Co_integration_Dynamic_Linkage_and_Portfolio_Diversification_from_Selected_Stock_Market_in_Africa
41. Panda, P. K. (2015). Stock market integration: Evidence from India and other major world stock markets. *Indian Journal of Economics and Business, 10*(4), 605-628. http://doi.org/10.2139/ssrn.2699504
42. Pavabutr, P., & Chaihetphon, P. (2010). Price discovery in the Indian gold futures market. *Journal of Economics and Finance, 34,* 455-467. https://doi.org/10.1007/s12197-008-9068-9
43. Pullen, T., Benson, K., & Faff, R. (2014). A comparative analysis of the investment characteristics of alternative gold assets. *Abacus, 50*(1), 76-92. http://doi.org/10.2139/ssrn.1928591
44. Rathod, T. (2014, August 21). *Correlation between Indian and global comexes.* Retrieved from https://www.thehindubusinessline.com/markets/commodities/Correlation-between-Indian-and-global-comexes/article20848913.ece
45. Rehman, M. Z., & Hazazi, M. A. (2014). Examining linkages between Saudi stock market (TASI) and selected stock markets indices. *International Journal of Financial Research, 5*(4), 196-209. https://doi.org/10.5430/ijfr.v5n4p196
46. Richards, A. J. (1995). Comovements in national stock market returns: Evidence of predictability, but not co integration. *Journal of Monetary Economics, 36*(3), 631-654. https://doi.org/10.1016/0304-3932(95)01225-7
47. Samanta, S., & Zadeh, A. (2012). Co-movements of oil, gold, the U.S. dollar, and stocks. *Modern Economy, 3*(1), 111-117. https://doi.org/10.4236/me.2012.31015
48. Sarbapriya, R. (2011). Exploring co integration and causality between foreign trade and economic growth: Econometric evidence from India. *International Journal of Contemporary Business Studies, 2*(10). Advance online publication.
49. Sims, C. (1972). Money, income, and causality. *The American Economic Review, 62*(4), 540-552. Retrieved from http://www.jstor.org/stable/1806097
50. Sindhu. (2013). A study on impact of select factors on the price of Gold. *IOSR Journal of Business and Management, 8*(4), 84-93. https://doi.org/10.9790/487X-0848493
51. Sjastaad, L., & Scacciavillani, F. (1996). The price of gold and the exchange rate. *Journal of International Money and Finance, 15*(6), 879-897. https://doi.org/10.1016/S0261-5606(96)00045-9
52. Soytas, U., & Sari, R. (2009). Energy consumption, economic growth, and carbon emissions: Challenges faced by an EU candidate member. *Ecological Economics, 68*(6), 1667-1675. https://doi.org/10.1016/j.ecolecon.2007.06.014
53. Tabak, B. M., & Lima, E. J. A. (2003). Causality and co integration in stock markets: The case of Latin America. *Brazilian Journal of Business Economics, 3*(2), 27-45. Retrieved from https://portalrevistas.ucb.br/index.php/rbee/article/view/4330
54. Tchereni, B. H. M., & Mpini, S. (2020). Monetary policy shocks and stock market volatility in emerging markets. *Risk Governance and Control: Financial Markets & Institutions, 10*(3), 50-61. http://doi.org/10.22495/rgcv10i3p4

55. Tripathi, L. K., Parashar, A., & Singh, R. (2014). Global factors & gold price in India – A causal study. *International Journal of Advanced Research in Management and Social Sciences, 3*(7), 161-180. Retrieved from http://www.indianjournals.com/ijor.aspx?target=ijor:ijarmss&volume=3&issue=7&article=015
56. Twite, G. (2002). Gold prices, exchange rates, gold stocks and the gold premium. *Australian Journal of Management, 27*(24), 123-140. https://doi.org/10.1177/031289620202700202
57. Voronkova, S. (2004). Equity market integration in Central European emerging markets: A cointegration analysis with shifting regimes. *International Review of Financial Analysis, 13*(5), 633-647. https://doi.org/10.1016/j.irfa.2004.02.017
58. Wong, W.-K., Agarwal, A., & Du, J. (2005). *Financial integration for India stock market, a fractional co integration approach* (Department of Economics Working Paper No. 0501). Retrieved from http://citeseerx.ist.psu.edu /viewdoc/download?doi=10.1.1.115.3616&rep=rep1&type=pdf
59. World Gold Council (WGC). (2009). *Gold investment digest*. Retrieved from https://www.moro.si/wp-content/uploads/2009/10/GID_Oct_2009.pdf
60. Xu, X. E., & Fung, H.-G. (2005). Cross-market linkages between U.S. and Japanese precious metals futures trading. *Journal of International Financial Markets, Institutions and Money, 15*(2), 107-124. https://doi.org/10.1016/j.intfin.2004.03.002
61. Yue, Y.-D., Liu, D.-C., & Xu, S. (2018). Price linkage between Chinese and international nonferrous metals commodity markets based on VAR-DCC-GARCH models. *Transactions of Nonferrous Metals Society of China, 25*(3), 1020-1026. https://doi.org/10.1016/S1003-6326(15)63693-7