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Causal relationship of gold futures price among selected markets: An investigation

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Abstract
The present paper intends to unfold causal relationship among selected countries gold futures in India, Japan and USA. The data spans from April 2020 to March 2024.For time series diagnostics, ADF test has been used. Further, to explore the causal relationship, Granger causality test has been applied. The results assert that there exists uni-directional causal relationship between US and India gold futures. There is no causality between the gold futures pertaining to India & Japan and Japan & USA. The results are sensitive to traders in gold in selected countries under analysis.

Keywords: Gold futures, causal relationship, granger causality test

Introduction

Globalization creates new investment opportunities by facilitating the integration of the world into a single market. The data pertains to the interdependence of one market with other international markets. As a result, there will be more volatility. If the information is limited to a certain economic sector, academics, portfolio managers, and politicians may not be especially worried. However, if it affects other economic sectors and global economies, it becomes a matter of discussion. At a time when countries are opening up to the global market to satisfy each other's demands, studying price transmission is crucial. The worldwide surplus or shortage of a product is communicated to producers, consumers, and other market participants through the transmission of pricing from international to local markets. Price increases in overseas markets are typically communicated to the domestic food business, which contributes to domestic inflation.

Research from both developed and developing countries demonstrates that any sizable, continuous discrepancy between local and international pricing in either direction significantly slows economic growth and yields far worse than ideal outcomes (FAO, 2003). It is obvious that many stakeholders, including manufacturers, dealers, customers, lawmakers, and others, need to be more conscious of price transfer. When information is more easily accessible, each person may act more sensibly. For instance, farmers may take advantage of high-level price times provided they receive the right price signals. Additionally, traders would be aware of the best times to import and export goods. As a result, examining how prices are transmitted is crucial.

Review of Literature

Liu and An (2011) [18] found evidence of a two-way relationship, however the US market had more sway. Specifically, compared to the NYMEX and CBOT exchanges, the CME Globex had less of an effect on information transfer to China. Interestingly, the Chinese copper market reacted to pricing differences between the two countries faster than the US copper market. For soybeans, this was the situation. Overall, this analysis demonstrates that Chinese futures markets are growing in importance although US markets (NYMEX and CBOT) remain the primary driver of price discovery.

Looked at how the trading of nine commodities in India aluminium, copper, zinc, maize, soybean, natural gas, and petroleum oil was affected by large external futures markets. The impact of price changes in one market on returns and volatility of several commodities a phenomenon known as spillover effects was examined in the study using a variety of statistical tests.

The findings indicate that traded agricultural commodity futures have a high correlation.

Kumar and Babli (2022) [17] focused on the markets in China and India because they recognized the importance of gold futures markets in both developed and developing countries. The study aimed to understand the connections between these two markets by looking at the ripple effects of volatility and returns. The analysis found that there is a substantial data flow between the Indian and Chinese gold futures markets. The study highlights how crucial it is to look at connections between gold futures in these two important emerging economies.

Nath, Dalvi, Pawaskar, Rajaram, S., & Pacheco M (2019) [21] investigate the volatility spillover between soybean futures contracts traded on the US CBOT and the Chinese DCE. It employs a new statistical method to account for any structural changes in the connection. The analysis confirms a volatility spillover effect, although it gradually fades. Surprisingly, the study also identifies seven distinct times when the volatility connection underwent significant shifts, which could be related to significant events like trade wars, pandemics, and international conflicts.

Looked into the connection between gold futures contracts on the NYMEX (US) and MCX (India) markets. They found a long-term equilibrium link between the two markets, indicating that prices may eventually move in unison. Interestingly, short-term MCX price changes can affect NYMEX prices, but short-term NYMEX price changes don't seem to have an immediate effect on MCX pricing. Furthermore, the analysis shows that the volatility and returns of NYMEX gold futures have an impact on the performance of MCX gold futures. Gold futures markets in the US and India.

The "forecasting efficiency of GARCH models for soya futures" in terms of volatility modeling for the USA and India was examined by Sahai (2016). The findings showed that there was a significant degree of volatility persistence in soy oil futures, which gradually decreased. The study's findings demonstrated that GARCH (1, 1) provided a more accurate model of soy oil futures volatility. It was discovered that EGARCH (1, 1) provided a more accurate volatility model for US soy oil futures.

Investigated the effects of leverage and volatility in the futures markets of India, Brazil, Indonesia, and Pakistan. They found that volatility tends to cluster and that good news has a bigger influence on future price than bad news.

After a comprehensive review of a wide range of literature, it can be said that there is little empirical data from the Indian context about the causal relationship among selected markets pertaining to gold futures that explains the futures' directional movement. Consequently, it is essential to carry out empirical research that would improve comprehension and provide a way to assess the gold market's performance.

Objective of the study

To unfold the causal association between gold futures price in India and selected countries.

Hypothesis of the study

H_0: There is no causal relation between India and selected countries gold futures.

Data Collection and period of study

Information has been collected from the commodity exchange of each country. Daily close future prices of gold are considered for analysis. The data considered for analysis includes 4 years starting from 1st April 2020 to 31st March 2024.

Methodology

Before proceeding with the application of the econometric models and measures for the empirical examination of any causal linkage among the gold futures prices of the three markets, it is imperative to diagnose the typical characteristics of time series data. It starts with calculation of descriptive statistics.

Further, testing the presence of unit root in the time series is important as most of the time, the data is not stationary and using a non-stationary data to forecast may lead to erroneous situations like spurious regression. Thus, to confirm the stationarity of the variables, ADF test have been applied. The ADF test examines the null hypothesis of presence of unit root or non-stationarity against an alternative of stationarity.

In order to understand the dynamic relationship among variables, more specifically to know whether one variable is useful in forecasting the other variable or not, Granger Causality test is applied. Granger proposed that if a pair of time series is cointegrated, then one time series must be useful in forecasting the other and thus there must be a causation in either direction. The Granger causality test is a statistical hypothesis test for determining whether one time series is useful in forecasting another. Finally, we formulate the regression equation for each set of variables to test the hypothesis. As the hypothesis are tested bi-directionally, to test each hypothesis two equations are formulated. In total three models are formulated with a pair of equation in each model.

Model 1: Tests the presence of causal linkages between gold futures price of India and Japan.

$$Gold\ Futures\_Ind_t = \alpha_0 + \sum_{i=1}^{n} \alpha_i Gold\ Futures\_Jap_{t-i} + \sum_{i=1}^{n} \beta_i Gold\ Futures\_Ind_{t-i} + \varepsilon_{t1}$$

$$Gold\ Futures\_Jap_t = \alpha_0 + \sum_{i=1}^{n} \alpha_i Gold\ Futures\_Ind_{t-i} + \sum_{i=1}^{n} \beta_i Gold\ Futures\_Jap_{t-i} + \varepsilon_{t1}$$

Model 2: Tests the presence of causal linkages between gold futures price of India and USA

$$Gold\ Futures\_Ind_t = \alpha_0 + \sum_{i=1}^{n} \alpha_i Gold\ Futures\_USA_{t-i} + \sum_{i=1}^{n} \beta_i Gold\ Futures\_Ind_{t-i} + \ \varepsilon_{t1}$$

$$Gold\ Futures\_USA_t = \alpha_0 + \sum_{i=1}^{n} \alpha_i Gold\ Futures\_Ind_{t-i} + \sum_{i=1}^{n} \beta_i Gold\ Futures\_USA_{t-i} + \ \varepsilon_{t1}$$

Model 3: Tests the presence of causal linkages between gold futures price of Japan and USA

$$Gold\ Futures\_Jap_t = \alpha_0 + \sum_{i=1}^{n} \alpha_i Gold\ Futures\_USA_{t-i} + \sum_{i=1}^{n} \beta_i Gold\ Futures\_Jap_{t-i} + \ \varepsilon_{t1}$$

$$Gold\ Futures\_USA_t = \alpha_0 + \sum_{i=1}^{n} \alpha_i Gold\ Futures\_Jap_{t-i} + \sum_{i=1}^{n} \beta_i Gold\ Futures\_USA_{t-i} + \ \varepsilon_{t1}$$

Empirical Findings

The computation of descriptive statistics documented in Table 1, such as skewness, Kurtosis, and Jarque-Bera provides basic albeit elementary evidence about changes in the time series behavior. It explains the fact that futures price distribution of gold is not normally distributed, which is a well-documented fact in financial literature.

Table 1: Descriptive Statistics of Gold Futures

Statistics	India	Japan	USA
Mean	0.000165	0.000154	0.000116
Median	0.000012	0.000158	7.30E-04
Std. Dev.	0.0029	0.00201	0.0026
Skewness	-0.313564	-0.114528	0.058642
Kurtosis	7.896542	24.35241	7.000125
Jarque-Bera	2396.029	2658.92	1652.632
Prob.	0.000	0.000	0.000

Source: Computed

Further, given the fact that the presence of a stochastic trend or deterministic trend in a financial time series or its stationary or non-stationary in levels is a prerequisite for conducting any analysis, the study begins with testing of price series for a unit root using Augmented Dickey Fuller (ADF). A stationary time series is one for which the mean and variance are constant over time; they depend only on the distance or lag between the two time periods and not on the actual time at which they are computed. The presence of a unit root indicates that the given series has become unstable or non-stationary; showing an uneven movement. The coefficients along with their probabilities have been presented in Table 2.

Table 2: Augmented dickey fuller test of gold futures (ADF Test)

Country	ADF at Level & Intercept at 5%	
	F-Statistic	P-Value
India	-33.32851	0.0011
Japan	-38.54633	0.0001
USA	-24.15436	0.0002

Source: Computed

Finally, Granger Causality Test has been applied on the available data from the three sample markets to investigate about the presence of any causal linkages among the gold futures price of sample markets and the results are documented in Table 3.

Table 3: Outputs of granger causality test of gold futures

Null Hypothesis	F-Statistic	Prob.
Gold_Japan does not Granger Cause Gold_India	2.52461	0.0963
Gold_India does not Granger Cause Gold_Japan	1.36521	0.1369
Gold_USA does not Granger Cause Gold_India	6.89657	0.0023
Gold_India does not Granger Cause Gold_USA	0.96542	0.1521
Gold_Japan does not Granger Cause Gold_USA	1.79852	0.1012
Gold_USA does not Granger Cause Gold_Japan	1.65421	0.1658

Source: Computed

The results of Granger Causality test suggest that gold futures prices are not equally influential on each other i.e. not every market is significant in predicting the future of other market. Some of them are influential whereas the others are not. Results also suggest that one market may have a causal linkage with one particular market but may not have any effect on any other market. The results of the pair-wise Granger causality test indicate that there exist a unidirectional linkage between 'gold futures price of USA and India with F-statistics of 6.89657 and the p-value is also significant. The outputs suggest that the gold futures price of USA influence the gold futures price of India. However, the gold futures price of India does not influence the gold futures price of USA.

The outputs also assert that there is no causality between the gold futures price of India and Japan as the F-statistics is not statistically significant. There is no linkage between the gold futures price of India and Japan. Similar results are also found pertaining to gold futures price of Japan and USA. There is no linkage between the gold futures price of Japan and USA.

Conclusion

The present paper explores the extent of causality among gold futures price of three markets. It aims at finding the causal linkages between the gold futures prices of India, Japan and the USA. The data set span for a period of four years from April 2020 to March 2024. Using daily data for the sample, time series properties have been diagnosed using ADF Unit Root test. Moving forward with the analysis, the presence of any causal linkages among gold futures price of the sample markets have been investigated using the Granger Causality Test. The outputs suggest that the gold futures price of USA influence the gold futures price of India. However, the gold futures price of India does not influence the gold futures price of USA. Further, there is no causal relationship between the gold futures price of India and Japan as well as between Japan and the USA.

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