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Price Discovery Efficiency of Futures Derivatives Market in India-with Special Reference to Gold

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Abstract: Gradual transformation of commodity markets in India has been of great importance for both the country's overall economic distribution and its linkages with financial sector. Commodity futures, being an extraordinary hedging and risk management instrument provide efficient portfolio management benefits which may enhance investors' returns. So, taking into consideration the significance of Gold in India and its volatility the study is conducted to analyze the efficiency of Gold futures in discovering price in spot market. The study is carried on using different econometric tools like ADF, Johansen's Cointegration and Granger Causality test. Daily closing prices of gold in futures and spot market are taken for the study from the official website of MCX from January 2016 to December 2018. The empirical results revealed that i) the futures and spot prices of Gold are I(1) and cointegrated in the long run, ii) there is a unidirectional flow of information from futures market to spot market for Gold in maximum contracts and iii) Gold futures market is efficient in discovering price in spot market. This present piece of work will be useful to the investors to diversify their positional risk with the proper use of gold futures market as well as to research scholars for conducting further studies in this area.

Keywords: Commodity Futures, Gold Futures, Price Discovery, Efficiency

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Introduction

In the world of online trading one can trade stocks, currencies and commodities. Physical commodities are certainly bought and sold directly in market whereas commodity futures are a bit different and fall into the category of online trading. Futures markets perform the economic role of hedging and price discovery. The prices of these commodity futures are determined by market forces such as demand and supply, inflation, interest rates, import duties, etc. There are two types of commodities such as agricultural (wheat, turmeric) and non-agricultural commodities (gold, lead, crude oil) which are traded on futures market.

Gold, the most sought-after of all exquisite metals, is acquired throughout the world for its beauty, liquidity, investment opportunities, and industrial properties. Gold also known as yellow metal is considered as a symbol of purity and good fortune. As an investment vehicle, gold is typically viewed as a financial asset that maintains its value and purchasing power during the

periods of inflation. As an asset, gold traditionally is considered as a shock absorber asset during times of political, social, and economic torment. In 1965 the price for 10 grams of gold was Rs. 63.25 and in 1974 it was Rs. 506. The price increased by around 700% in 10 years. In 2008 the price was Rs. 12,500 where as it was Rs. 31,438 in the year 2018. The increase in price in last 10 years was by around 150%. It shows that gold is very volatile and unstable. India is the 2nd largest consuming country when gold is concerned with 23% of Global Gold Consumption. As per the report of MCX in 2017-18, India has Rs. 1397.4 billion Gold Reserves. In India the total demand for the Gold is 737 tonnes whereas the supply is 1019 tonnes.India is one of the major importing countries of Gold. The major importing sources for India are Switzerland, UAE, Ghana, USA and Peru. In the FY17-18 Gold bar worth US$ 5854 million was imported to India.Definitely, itcan be said that the demand for the Gold is increasing year after year. Gold futures are a sort of derivatives contract, which involves futures trading with Gold as the underlying asset. In 1974 the first gold futures contract was traded on the COMEX platform in New York. Two countrywide multi-commodity exchanges, namely MCX & NCDEX launched Gold futures contracts in late 2003. Gold futures are considered as modern hedging and market-based risk management technique.

Taking into consideration the demand for Gold in India, the volatility in its price trend and Gold futures as a hedging instrument this paper studies the price discovery mechanism of Gold futures in India.

Review of Literature

Dr. Shree Bhagwat and MaraviA S (2018) in their article named "An Empirical Study on the Price Discovery of Gold and Silver with Special Reference to the Multi Commodity Exchange Limited"investigated the price discovery function of Gold & Silver in Indian commodity exchangeandto discover how prices of selected commodities fluctuate in Indian Commodity Market. The study employed statistical techniques, Pearson co-relation coefficient, simple linear regression model and t-Test to investigate the study. The empirical results show that spot market leads the future market in long run dynamics and acts as a primary market for discovering price.

Kumar S, Dr. Gupta M and Dr. Taneja Y P (2018) in their research article titled, "Empirical Evidences on Price Discovery of Gold in Spot and Derivative Market of India"studied the efficiency in Gold and Gold guinea contract traded on MCX and examined the long run dynamic relationship between their spot and futures prices. ADF test, Johansen Cointegration Test, Granger Causality test and VECM are used to analyze the objectives. The result of Causality test shows that there is bi-directional relationship between Gold Spot and futures prices whereas there is no causation from either side for Gold Guinea. Thus, Gold is efficient in modeling efficient strategies for hedging and speculation activities.

Gupta S & Bhardwaj S (2018) conducted a study on "Price Discovery in Indian Spot and Future markets of Gold and Silver"to examine the effect of different factors affecting price in the spot and future commodity markets. They also aimed to study the price discovery process of Gold and Silver future and spot price contracts. ADF test, VAR Lag Order SC criteria, VECM and Granger Causality Test are applied for the study. The tests reveal that spot and future prices of both the commodities have long run integration and show a bi-directional relationship between the two prices. Thus it is concluded that the price discovery function is efficient.

Dr. Swain A K and Dr. Samal G P (2017) conducted a research on"Price Volatility in the Indian Gold Spot Market: An Econometric Analysis"where they examined the gold spot price trend during last 5 decades. They also wanted to analyze the time varying volatility and the presence of volatility clustering in the gold spot price trends. They used the econometric tools like ARCH, GARCH, EGARCH and TARCH to analyze the time varying volatility in the gold spot price. The outcomes indicate that all the ARCH family models are specified correctly in the study and thus concluded that the future conditional variance in gold spot price is based on the past variances.

Adämmer P and Bohl M T (2017), in their research paper titled "Price discovery dynamics in European agricultural markets" conducted a study to examine the influence of European agricultural futures contracts on price discovery during periods of price turmoil and rising trading activity (2007-2013). The authors used a hand-collected data set of German spot prices for canola, wheat, and corn as these commodities reflect a significant share in European global agricultural production as well as are the most liquid agricultural contracts traded in Europe. The sample data taken for the analysis is from January 2000 to December 2016. Unit Root tests, cointegration test and Time varying vector error correction model (VECM) is applied with a Diagonal-VECH-GARCH. The empirical results of the study conclude that the impact of the futures markets was significantly stronger during the first period of price turmoil (2007 to 2009) than during the second one (2010 to 2013). However trading activity in the futures markets was much higher during the second period as compared to the first period. Thus, the paper indicates that more trading activity in futures markets did not lead to a higher influence on spot prices of the commodities.

Dr. Anand R G (2017) in his research article titled "Analysis of the volatility of the Commodity Market with specific reference to Gold as a commodity"triedto study the volatility and the dynamics of the commodity fluctuations for various periods. The study also aims at analyzing the factors responsible for bullish run of gold in long term and understanding Gold as a commodity better. Financial tools such as candle stick chart, simple & exponential moving average and Moving Average Convergence Divergence are used for analyzing the study. The researcher concluded that the commodity

market is good for long term investment rather than short and medium term and has the potentiality to reap more returns for the investors.

Dr. Nirmala S and Deepthy S (2016), in their paper named "Price Discovery in Commodity Markets: A Study of Precious Metals Market in Multi Commodity Exchange" had undertaken the study to analyze the price discovery function of gold & silver futures and spot price contracts. The study uses ADF Test, Cointegration technique, VECM and Granger causality test for analysis. Cointegration test implies that there is long run equilibrium relationship between spot and futures of gold (unidirectional FàS) and silver (bidirectional). VECM test shows that there is bidirectional relationship in case of gold in the short run whereas unidirectional relationship in silver prices, from F to S. Granger Causality Test implies that future price of gold and silver can be used to predict spot prices and vice versa. Hence, it is concluded that futures price helps to a great extent to discover price in the spot market of both the commodities.

Sridhar L S, Dr. Sumathy M, Sudha N and Charles A A (2016), in their research paper titled, "Price Discovery in Commodity Market – An Empirical Study on the Silver Market" set out to investigate the Price Discovery mechanism in Commodity Market with reference to silver and to investigate whether there exists relationship between its spot and futures price or not. The result shows that there exists short run relationship between silver spot and futures prices but do not have any long run relationship. Thus, it is concluded that silver spot price serve as a price discovery mechanism for future market transactions.

Dr. Behera C (2015) conducted a study on "Price Discovery and Market Efficiency in Indian Futures Market" to examine the market efficiency of Indian futures market in discovering price in the spot market with respect to metal and energy commodity. ADF and PP test, Engle-Granger cointegration technique and standard deviations of their futures and spot prices on a monthly basis are taken for analyzing the objective. Granger Causality test indicates that the price discovery takes place in the futures market of the respective commodities. Thus, the study concludes that futures market is more informational efficient in all commodities except in gold market.

Madasu P (2015) conducted a study on" Econometric Analysis of Spot and Futures Indices of MCX" where he outlines the objective as to examine the co-integration between the spot & futures commodity market in India and to test the causality between them. ADF and PP tests, Johansen Co-integration test and Granger causality test are conducted for the study futures and spot indices namely MCXCOMDEX, MCXAGRI, MCXMETAL and MCXENERGY are examined. It is inferred that there is a bi-directional flow of information in Metal and Energy commodity markets whereas in the case of Agricultural products the flow of information is from specific index to the broad based index. Thus, it is concluded that the commodity markets with respect to certain

commodity are efficient and the price discovery mechanism in these specified markets is functioning well.

Adämmer P, Bohl M T and Gross C (2015), conducted a research on "Price Discovery in Thinly Traded Futures Markets: How Thin is Too Thin?" to study the price discovery process of two thinly traded agricultural futures contracts, hog and piglet, traded at the European Exchange in Frankfurt. The methodologies used are cointegration technique of autoregressive distributed lag (ARDL) bounds test and vector error correction models (VECMs). The authors also used time-variation in the parameters by applying the Kalman filter which only provides indications of average price discovery. The common price discovery measures indicates that both futures markets are dominant in the price discovery process, however by estimating time-varying parameters (VECM), it is revealed that price discovery in the less liquid piglet market is denoted by strong fluctuations. Comparing the results of both markets the authors inferred that the trading volume threshold which is necessary to promote efficient price discovery is very low. Thus it is also concluded that neglecting time-variation in the parameters, particularly when analyzing thinly traded futures markets, may lead to misleading results.

Dolatabadi S, Nielsen M O and XU K (2014), conducted a study on "A Fractionally Cointegrated VAR Analysis of Price Discovery in Commodity Futures Markets" to analyze price discovery in the spot and futures markets for five non-ferrous metals (aluminum, copper, lead, nickel, and zinc). The authors have used the fractionally cointegrated vector autoregressive (FCVAR) model to analyze price discovery. The findings of the study are that for all markets except copper, the fractional integration parameter is highly remarkable, showing that the usual, non-fractional CVAR model is inappropriate. Next, when allowed for fractional integration in the long-run price discovery, it shows that fewer lags are needed in the autoregressive formulation, further emphasizing the usefulness of the fractional model. Compared to the results of the non-fractional model, it is found out that the spot market is more dominant is discovering price with respect to non-ferrous metals,while, using standard likelihood ratio tests, the authors did not reject the hypothesis that price discovery takes place exclusively in the spot (futures) market for copper, lead, and zinc (aluminum and nickel).

Peri M, Baldi L and Vandone D (2013), in their research paper titled, "Price discovery in commodity markets" investigates the long-run relationship between spot and futures prices for corn and soybean. Weekly spot prices of corn US No. 2 yellow Free On Board (FOB) US Gulf and soybeans No. 1 FOB US Gulf are taken for the analysis, while futures prices are collected from DataStream and are from Chicago Board of Trade (CBOT). The null hypothesis of the study is that that the spot price does not Granger cause futures price against the alternative hypothesis. For investigating the order of integration of the variables, Generalized Least Squares (GLS), ADF-GLS test and the Zivot

and Andrews test (ZA) has been used. The authors have also applied cointegration methodology following the Kejriwal and Perron (2010) procedure to investigate the presence of potentially unknown structural breaks. As well as Granger Causality test following the Toda and Yamamoto's approach has been used to study the causality relationships between spot and futures prices within each specific sub period. The study concludes that multiple breaks exist in the cointegrating relationship between prices and sub periods consequently identified express different dynamics in the causal relationship between spot and futures prices and support the idea that fundamentals are important in explaining the price discovery of food commodity markets.

From the past studies, it is observed that there are extensive literatures on the concerned subject considering the agricultural as well as non-agricultural commodity market in India. However, it is comparatively less in case of non-agricultural commodity market. Further, in the area of non-agricultural commodity, very less number of studies has been conducted with respect to gold of bullion market as compared to other commodities which can be considered under metal and energy category. Further there is limited number of studies on gold in recent years. Therefore, considering the price volatility in gold spot market, the present study is conducted to give insights about Indian gold futures market and its price discovery efficiency in recent years. The time period taken for the study is from January 2016 to December 2018. Thus, this study carries a significant role to re-consider the fact of price discovery efficiency of Indian Gold futures market in recent times.

Objectives of the Study

The Indian commodity market is gaining its importance day by day. Previously main focus was the agricultural sector, but with advent of time and increasing globalization, the non-agricultural commodity market is also in the verge of growth. However, regardless of India being one of the leaders in commodity futures market still there exist concern regarding the efficiency of the futures market in discovering price. Efficiency of price discovery is necessary for the investors and traders to diversify and hedge their price risk. The present study seeks to examine the following facets of non-agricultural commodity market with special reference to Gold.

1. To analyze the price discovery efficiency of Gold futures market in India.
2. To analyze the causal relationship between Gold futuresprice and spot price in India.

Scope of the Study

The scope of the study is limited to Gold series of Non- agricultural commodity market of India. There are 21 Commodity Exchanges in India out of which, 16 are Regional Exchanges and 5 are National Exchanges. Out of the five national

exchanges, the major trading platform forGold isMulti Commodity Exchange (MCX); therefore, the study confines only to goldfutures contracts traded in MCX.

Hypothesis of the Study

The main hypothesis set for the study is:

H0: Gold Futures market in India is inefficient in discovering price.

H1: Gold Futures market in India is efficient in discovering price.

Sub Hypothesis:

1. H0: $\alpha = 0$ (non-stationary& has unit root),
   H1: $\alpha \neq 0$ (stationary and has no unit root)
2. H0: Futures and Spot prices are not cointegrated.
   H1: Futures and Spot prices are cointegrated.
3. H0: Futures price/ Spot price do not Granger Cause Spot price/ Futures price
   H1: Futures price/ Spot price Granger Cause Spot price/ Futures price

Limitations of the Study

This study is conducted to gain knowledge about the price discovery efficiency of the gold futures market in India. But the study suffers from certain limitations, they are

1. This study is confined only to one non-agricultural commodity i.e., Gold
2. Gold series of only one commodity exchange i.e., MCX is considered for collecting data.
3. Time period taken for study is limited to three years only from January 2016 to December 2018.

Research Methodology

Research Design

The present study is analytical in nature. It is based on secondary data collected from official website of MultiCommodity Exchange of India (www.mcxindia.com). Different econometric models have been used to carry out this study.

Data Source

The study is based on secondary data. The source of data includes published data of various government and private sector agencies, brochure of the MCX and its official website.

Sample Design

MCX is India's leading commodity derivatives exchange with a market share of 91.6% per cent in terms of the value of commodity futures contracts traded in FY 2019. Therefore official website of MCX is selected as the source of collecting data. Daily closing prices of spot prices of Gold at Ahmedabad Market are taken for the purpose of the study. Similarly daily closing prices of futures is also taken for 18 contracts- 6 contracts each of the year 2016, 2017 and 2018 respectively.

Data Period

The time period taken for undertaking the study is 3 years i.e., from January 2016 to December 2018.

Tools for Analysis

Different econometric tools are applied to conduct the study such as ADF Test/Unit Root Test, Johansen's Cointegration Test and Granger Causality Test using a software package called 'EViews'- Version 9.

ADF test-It has been carried out on the futures and spot closing prices of Gold to check its stationarity and to know the existence of unit root in it or not.Unit root tests is used to discover if trending data should be first differenced on deterministic functions of time to render the data stationary. The Augmented Dickey-Fuller (ADF) test is specified here as follows:

$$\Delta Yt = b0 + \beta Yt\text{-}1 + \mu 1 Yt\text{-}1 + \mu 2 Yt\text{-}2 + \ldots\ldots\ldots + \mu p Yt\text{-}p + \varepsilon t \qquad (1)$$

where, Yt represents time series to be tested, b0 is the intercept term, β is the coefficient of interest in the unit root test, ìi is the parameter of the augmented lagged first difference of Yt to represent the pth-order autoregressive process, and åtis the white noise error term.

If the null hypothesis is rejected, this means that the time series data is stationary. The decision criteria involve comparing the computed values of ADF 't' statistic with the critical values for the rejection of a hypothesis for a unit root. If the computed Augmented Dickey Fuller 't' statistic is less relative to the critical values, then the null hypothesis of non-stationarity in time series variables cannot be rejected.

Johansen's Cointegration Test- To examine the degree to which the Gold futures and spot prices are sensitive to the same average price over a specific period of time, Cointegration test is used. The basic logic behind this test is that both futures and spot prices can share a long run relationship if they are co-integrated.

The variables are cointegrated if and only if a single cointegrating equation exists between the two prices. The statistic λ_{trace} tests the number of cointegrating vectors is zero or one. A rank of one (1) will indicate a single co-integration and a zero (0) rank will indicate lack of co-integration between St and Ft The following test statistics can be constructed as:

$$\lambda_{trace}(r) = -T\,\Sigma_{i=r+1}^{n}\,1n(1-\lambda_i^1) \quad (2)$$

Where, λ^1 are the Eigen values obtained from the approximation of the Π matrix and T is thenumber of usable observations. The λ_{trace} tests the null hypothesis that there is at most rcointegratingvectors, against the alternative hypothesis that there are greater than rcointegrating vectors.

The decision value involves comparing the computed value or trace statistic for the rejection of hypothesis. If the computed value is more than the critical value at 5% significance level then null hypothesis is said to be rejected. Johanen's cointegration test can also be inferred using p values of the contracts. If p value is less than 0.05, null hypothesis is rejected and alternative hypothesis is accepted.

Granger-causality test- It is applied to examine the direction of causation between futures price and spot price. It helps in knowing whether futures cause spot market or vice versa. The motive of this test is to inquire whether the underlying variables can be used to predict each other or not and to know which market is more informational efficient. The causality test helps to ascertain whether a uni-directional or bi-directional relationship exists between spot price and futures price (Kushankur and Debasish, 2012).

It is analyzed by estimating the following regression models:

$$S_t = a_0 + \Sigma_{k=1}^{p}\,a_{1k}S_{t-k} + \Sigma_{k=1}^{p}a_{2k}\,F_{t-k} + e_t \quad (3)$$

$$F_t = a_0 + \Sigma_{k=1}^{p}\,a_{1k}F_{t-k} + \Sigma_{k=1}^{p}a_{2k}\,F_{t-k} + e_t \quad (4)$$

Where, is the price in the spot market at time (day) t and is the futures price of the nearby contract at time t.F-test is used to test whether Ft does not Grange cause St by examining the null hypothesis that the lagged coefficients of Ft are equal to zero. A similar F-test is used to test the reverse effect, i.e. whether St does not Granger-cause Ft.

Price Discovery Efficiency of Gold Market in India

Table 1: ADF Test for Stationarity of Gold Series

Year	*Contract (No. of Months)*	*No. of Observa-tions*	*Spot 'T' Statistic*	*Spot 'P' Value*	*Futures 'T' Statistic*	*Futures 'P' Value*	*Critical 'T' At 5%*
2016	05 Feb 2016 (12)	239	-15.7620	0.0000	-14.9579	0.0000	-2.8735
	05 Apr 2016 (12)	239	-15.3942	0.0000	-7.8567	0.0000	-2.8736
	03 June 2016 (12)	238	-14.5433	0.0000	-16.1933	0.0000	-2.8736
	05 Aug 2016 (12)	238	-15.3094	0.0000	-15.7863	0.0000	-2.8736
	05 Oct 2016 (12)	237	-15.0408	0.0000	-19.6480	0.0000	-2.8736
	05 Dec 2016 (12)	237	-15.0000	0.0000	-18.4449	0.0000	-2.8736
2017	03 Feb 2017 (12)	238	-14.9383	0.0000	-16.3331	0.0000	-2.8736
	05 Apr 2017 (12)	239	-14.9660	0.0000	-15.6282	0.0000	2.8735
	05 June 2017 (12)	238	-14.6896	0.0000	-13.9613	0.0000	-2.8736

contd. table 1

Year	*Contract (No. of Months)*	*No. of Observations*	*Spot 'T' Statistic*	*Spot 'P' Value*	*Futures 'T' Statistic*	*Futures 'P' Value*	*Critical 'T' At 5%*
	04 Aug 2017 (12)	240	-13.6619	0.0000	-13.6985	0.0000	-2.8735
	05 Oct 2017 (12)	241	-14.1350	0.0000	-15.3158	0.0000	-2.8734
	05 Dec 2017 (12)	243	-14.5838	0.0000	-14.8613	0.0000	-2.8733
2018	05 Feb 2018 (12)	242	-14.3964	0.0000	-14.5123	0.0000	-2.8734
	05 Apr 2018 (12)	244	-14.2206	0.0000	-15.4695	0.0000	-2.8733
	05 June 2018 (12)	243	-14.5988	0.0000	-14.2671	0.0000	-2.8733
	03 Aug 2018 (12)	245	-16.3607	0.0000	-16.7634	0.0000	-2.8732
	05 Oct 2018 (12)	243	-16.1906	0.0000	-16.9327	0.0000	-2.8733
	05 Dec 2018 (12)	238	-15.3082	0.0000	-18.1782	0.0000	-2.8736

Source: Author's Estimations

Table 1 shows the computed values of all 18 contracts of Gold at 5% level of significance. It may be seen in the table that the futures and spot prices of all the 18 contracts of Gold are stationary at their first difference and does not contain unit root. The results of the underlying variables may be denoted as I(1) i.e., the series is integrated at the order 1. The computed ADF statistic is more than the respective critical value, which signifies that the null hypothesis is rejected and hence alternative hypothesis is accepted meaning that the Gold futures and spot series are stationary and has no unit root. The evaluation on the basis of p value also put forward the same interpretation.

Table 2: Johansen's Cointegration Test Results for Gold

Year	*Contract (No. of Months)*	*No. of Observations*	*Trace Statistic*	*Critical Value*	*P Value*	*Cointegration (C/NC)*
2016	05 Feb 2016 (12)	239	16.7817	15.4947	0.0318	C
	05 Apr 2016 (12)	239	09.9442	15.4947	0.2850	NC
	03 June 2016 (12)	238	10.1867	15.4947	0.2667	NC
	05 Aug 2016 (12)	238	15.9615	15.4947	0.0425	C
	05 Oct 2016 (12)	237	17.6666	15.4947	0.0232	C
	05 Dec 2016 (12)	237	19.2143	15.4947	0.0131	C
2017	03 Feb 2017 (12)	238	11.9663	15.4947	0.1586	NC
	05 Apr 2017 (12)	239	10.5588	15.4947	0.2402	NC
	05 June 2017 (12)	238	11.9204	15.4947	0.1608	NC
	04 Aug 2017 (12)	240	23.9022	15.4947	0.0022	C
	05 Oct 2017 (12)	241	21.6978	15.4947	0.0051	C
	05 Dec 2017 (12)	243	19.7233	15.4947	0.0108	C
2018	05 Feb 2018 (12)	242	16.4653	15.4947	0.0356	C
	05 Apr 2018 (12)	244	12.1348	15.4947	0.1506	NC
	05 June 2018 (12)	243	14.8116	15.4947	0.0632	NC
	03 Aug 2018 (12)	245	15.9250	15.4947	0.0431	C
	05 Oct 2018 (12)	243	12.9278	15.4947	0.1175	NC
	05 Dec 2018 (12)	238	15.8920	15.4947	0.0436	C

Source: Author's Estimations

The results of Johansen'sCointegration test depicted in table-2 indicates that out of 18 contracts of Gold 10 contracts are cointegrated while other 8 contracts are found to be non-cointegrated. It exemplifies that the 10 cointegrated contracts share a long run relationship. Thus for 10 contracts it is

Table 3: Granger Causality Test Results for Gold

Year	*Contract (No. of Months)*	*No. of Observa-tions*	*Hypo-Thesis*	*'F' Statistic*	*P Value*	*Direction*	*Relation-ship*
2016	05 Feb 2016 (12)	239	S/→ F	1.8044	0.1669	Unidirectional	F→S
			F/→ S	12.5401	7.E-06		
	05 Apr 2016 (12)	239	S/→ F	3.3340	0.0374	Bidirectional	F↔S
			F/→ S	14.5588	1.E-06		
	03 June 2016 (12)	238	S/→ F	3.5904	0.0291	Bidirectional	F↔S
			F/→ S	16.1369	3.E-07		
	05 Aug 2016 (12)	238	S/→ F	4.9325	0.0080	Bidirectional	F↔S
			F/→ S	10.4622	4.E-05		
	05 Oct 2016 (12)	237	S/→ F	4.5506	0.0115	Bidirectional	F↔S
			F/→ S	8.4931	0.0003		
	05 Dec 2016 (12)	237	S/→ F	1.29191	0.2767	Unidirectional	F→S
			F/→ S	0.7336	3.E-05		
2017	03 Feb 2017 (12)	238	S/→ F	2.54521	0.0807	Unidirectional	F→S
			F/→ S	9.9254	1.E-08		
	05 Apr 2017 (12)	239	S/→ F	2.45642	0.0880	Unidirectional	F→S
			F/→ S	2.2659	1.E-09		
	05 June 2017 (12)	238	S/→ F	1.27752	0.2807	Unidirectional	F→S
			F/→ S	8.0025	1.E-11		
	04 Aug 2017 (12)	240	S/→ F	0.22173	0.8013	Unidirectional	F→S
			F/→ S	2.8287	3.E-13		
	05 Oct 2017 (12)	241	S/→ F	0.49122	0.6125	Unidirectional	F→S
			F/→ S	2.1714	2.E-09		
	05 Dec 2017 (12)	243	S/→ F	0.39013	0.6774	Unidirectional	F→S
			F/→ S	0.5599	2.E-12		
2018	05 Feb 2018 (12)	242	S/→ F	0.61362	0.5423	Unidirectional	F→S
			F/→ S	3.4954	5.E-10		
	05 Apr 2018 (12)	244	S/→ F	3.14742	0.0448	Bidirectional	F↔S
			F/→ S	0.6822	5.E-09		
	05 June 2018 (12)	243	S/→ F	2.29523	0.1030	Unidirectional	F→S
			F/→ S	5.3315	4.E-14		
	03 Aug 2018 (12)	245	S/→ F	1.11552	0.3295	Unidirectional	F→S
			F/→ S	0.6356	5.E-09		
	05 Oct 2018 (12)	243	S/→ F	3.32752	0.0376	Bidirectional	F↔S
			F/→ S	8.5461	8.E-12		
	05 Dec 2018 (12)	238	S/→ F	1.49911	0.2255	Unidirectional	F→S
			F/→ S	6.1602	3.E-07		

Source: Author's Estimations
Note: F statistic is reported at 5% level of significance

found that calculated value/trace statistic is more than the critical value at 5% significance level and supporting the null hypothesis to be rejected and alternative hypothesis to be accepted i.e., futures and spot prices of Gold are cointegrated. The analysis on the basis of 'p' value also suggests the same interpretation.

Even if out of 18 contracts, the futures and spot prices of only 10 contracts are cointegrated, we can proceed for Causality test. The theory says that if the underlying variables are not cointegrated then Pairwise Granger Causality Test can be applied on these contracts to examine the causation on each other.

Table 3 clearly depicts that out of 18 contracts, futures price granger causes spot price in 12 contracts. Further, it is noticed that in balance 6 contracts, there is a bi-directional relationship between Gold futures and spot price. There is no instance of unidirectional relationship between the two from spot to futures. Considering the hypothesis of Futures price does not Granger Cause Spot price, the 'p' value is alsoless than 0.05 for 12 contracts. Thusbasing on the results the null hypothesis can be rejected and concluded that Futures PriceGranger Cause Spot price. Finally it can be inferred that futures market plays an efficient role in discovering price in Spot market and is informational efficient.

Conclusion

The present study endeavors to examine the efficiency of price discovery mechanism in Indian Gold Futures market. Based on the theoretical and empirical literature that is reviewed in this study, the hypothesis is examined in context of an emerging commodity market known as Multi Commodity Exchange. The study investigated the price discovery dynamics using daily closing prices of Gold Futures and Spot collected from the official website of MCX for a period of 3 years i.e., January 2016 - December 2018. It has examined the hypothesis by using different econometric tools such as Augmented Dickey Fuller (ADF) Test, Johansen's Cointegration Test and Granger Causality Test.

Firstly, the ADF test reveals that futures as well as spot prices of Gold are stationary and don't contain unit root. The outcome of Johansen'sCointegration test is that out of 18 contracts 10 contracts are cointegratedin the long run and there existat least one co-integrating equation. Pairwise Granger Causality test infers that in 12 contracts out of 18 contracts, there exists a unidirectional flow of information between futures and spot market of Gold, moving from futures to spot whereas it shows bi-directional causation between them for the rest of the contracts. Thus, in all the three tests of price discoveryi.e., ADF test, Johansen's cointegration test and Pair-wise Granger Causality test the null hypothesis is rejected. Therefore, the prime hypothesis of the paper that Gold Futures market in India is inefficient in discovering price is rejected, proving thatthe information from futures market can be used to predict price in spot market on a future date. Price discovery helps in hedging the risk for

the hedgers. It is quite well known that the trend of gold prices is always very volatile, so efficient price discovery in gold futures market will be help in identifying the hedging opportunities in the volatile market for the importers, exporters and processors. Thus, the present piece of work will be helpful to investors in diversifying and hedging their positional risk with the proper use of gold futures market as well as to research scholars for conducting further studies in this area.

The present study subjects to certain inherent limitations. There are many other factors which may influence the price discovery system such as inflation, demand and supply for gold, etc. So, further studies can be conducted in this area considering such factors and using different other techniques as well in other commodities.

Policy Implications

- Policy measures should be adopted to increase market depth, regular and efficient participation of trading members such as speculators, hedgers, arbitrageurs, etc.
- Necessary and appropriate steps should be taken to shift focus from the present system of 'Production-Oriented Extension' to 'Market-Oriented Extension' in Gold to generate awareness on derivatives market among the processors of gold.
- Suitable programmes should be arranged on capacity building of Processors. Importers, Exporters, etc through financial institutions, regulated market committees, NGOs, etc. for their active participation in futures market.
- Physical markets at various places are largely distorted. So, gold futures market will provide an opportunity for the marginal processors to safeguard against the price volatility of gold.
- Futures market should be strengthened so that real benefits of this technological innovation in the form of electronic markets can percolate to the most deserved beneficiaries.

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