Global Financial Crisis and Price Risk Management in Gold Futures Market-Evidences from Indian & US Markets

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Abstract
Over the globe, gold is one of the most traded commodities. Due to its gobal demand, gold is traded in both spot and futures market. Price risk management is a fundamental but vital function of futures market. To effectively discharge this function, futures market has to be efficient. Thus, it is important to analyze efficiency of futures market. None of the studies in literature analyses price risk management role of gold futures in India and US with reference to global financial crisis of 2008-09. Thus, this study aims at investigating the gold futures role in managing price risk related to gold spot market before and after the crisis in Indian and US markets. The results of Johansen's cointegration test indicate that the gold spot and futures markets are cointegrated in both the sub-periods in both India and US. Granger causality test results signifies that gold futures play an important role in price discovery in both Indian and US markets, with some feedback from spot market at Multi Commodity Exchange (MCX), India . However, the price discovery role of gold futures markets has strengthened after the crisis in both the markets. Thus, we conclude that gold futures market performs price risk management function in the pre and the post–crisis periods at Multi Commodity Exchange (MCX), India and New York Merchantile Exchange (NYMEX) Comex, US.

Keywords: *Risk Management, Efficiency, Price Discovery, Gold Futures, Global Financial Crisis, Cointegration*

JEL Classification: *C22, G01, G14, Q02*

1. Introduction

Price risk management is a fundamental but vital function of futures market. To effectively discharge this function, futures market has to be efficient. Since the introduction of commodity futures trading , there have been questions on the very basic functions of commodity futures viz. Are commodity futures markets

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performing price risk management function? Do these markets lead to price discovery? Are these markets informationally efficient? An efficient commodity futures market provides an estimate of future spot price of underlying commodity in the form futures price and hence helps in managing price risk associated with that commodity. There are numerous studies on commodity futures market efficiency in both developed and emerging economies. The findings of these studies are conflicting in nature. Many studies like Arora and Sandhar (2017), Malhotra and Sharma (2016), Singh and Singh (2015), Gupta and Ravi (2013), Ali and Gupta (2011), Singh (2010), Lokare (2007), Bose (2006), Gulen (2000), Oellermann, Brorsen and Farris (1989), Allen and Som (1987), Bigman, Goldfarb, and Schechtman (1983) and many others report evidences of efficient commodity markets. However, inefficiency evidence has been found in work of Inoue and Hamori (2012), Soni and Singla (2012), Easwaran and Ramasundaram (2008), Mananyi and Struthers (1997), Schroeder & Goodwin (1991) and many others while mixed results have been found in the studies of Goss (1981), Aulton, Ennew*, and* Rayner (1997), MacDonald and Taylor (1988a), Wang and Ke (2005), Singh (2007), Mckenzie and Holt (2002) etc. Commodity futures market can perform the function of price risk management provided the commodity futures markets are efficient. Thus it is imperative to analyze commodity market efficiency.

Over the globe, gold is one of most traded commodity and India is second largest gold jewellery market in the world. MCX is the leading commodity exchange for metals futures in India and NYMEX Comex gold futures ranks first in gold futures all over the world in 2014 FIA annual volume survey. Since USA was the epicenter of global turmoil of 2008, it looks interesting to study the gold futures market across the global financial crisis of 2008. However, there are a few studies on gold futures market efficiency. Also, *none of the studies in literature analyses price risk management role of gold futures in India and USA with reference to global financial crisis of 2008-09*. Thus, , this study aims at investigating the gold futures role in managing price risk with reference to global financial crisis of 2008-09. The remaining paper contains four sections. Section 2 presents some literature review, Section 3 defines the data and the research methodology, Section 4 presents the results and discussion, and Section 5 provides a conclusion and research implication.

2. Literature Review

Mckenzie and Holt (2002) using modern time series methodology suggest that futures markets of select commodities are efficient and unbiased in long run. Using GQARCH-M-EC, they however find corn and cattle futures markets to be inefficient and biased in short-run. Similar mixed results were reported by Wang and Ke (2005). They conclude that soybean futures market are weakly efficient while the wheat futures market are inefficient due to over-speculation and government intervention. Meanwhile, the results of He and Holt (2004) indicate that the lumber, OSB and NBSK weekly spot and futures prices series are neither cointegrated nor unbiased i.e. markets are inefficient. On the contrary, Xin et al. (2006) report that Chinese copper and aluminium futures markets are efficient. In India, similar findings are indicated in the results of Lokare (2007). He finds that spot and future prices of the sample commodities (except sugar and nickel) are cointegrated. They report that most of the commodities show improved operational efficiency. Singh (2007) explore arbitrage opportunities across MCX, NCDEX and NBOT exchanges and find evidences of cointegration between the soya oil futures prices on these exchanges. His results also suggest that CBOT has relatively high hedging efficiency than these three domestic national exchanges. Sahoo and Kumar (2009) report that the five sample commodity futures markets in India are efficient and there is no evidence of their inflationary effect.

Singh (2010) find that guar gum and guar seed spot and futures markets were cointegrated and unbiased. Similar results are reported by Kaur and Rao (2010) in their study on the weak form efficiency of guar seed, refined soya oil, chana and pepper futures markets. The results of autocorrelation show that all select commodities except refined soya oil futures markets are efficient. The results of run test indicate that futures markets for all the select commodities are efficient. Pavabutr and Chaihetphon (2010) conclude that standard gold futures market performs price discovery function at MCX. They also find that mini gold contracts aid up to 30% in price discovery process probably due to efficient information flow in the market. Also, Ali and Gupta (2011) conclude that futures market is efficient for all select commodities except rice and wheat. They also report that for 6 out of 12 select commodities (Sugar, Castor Seed, Wheat, Soybean, Guar Seed and Chickpea), futures prices granger cause spot prices and for other 3 (Cashew, Rice and Red Lentil) spot prices granger cause futures price. However, the relationship is bi-directional for rest of the select commodities. Similarly, Sehgal et al. (2012) find that markets were efficient for all ten but one commodity (turmeric). However, their results indicate two-way causality for all select commodities except turmeric.

Inoue and Hamori (2012) in their study on MCX-comdex report that the commodity futures market is inefficient for the entire sample period but not for the sub-period July 2009 to March 2011. However, Soni (2013) investigate and conclude that guar gum futures market is inefficient. The possible reason for market inefficiency has been attributed to over-speculation/market manipulation. Arora and Kumar (2013) report that copper and aluminium futures markets perform price discovery function and there exists a bidirectional causality betewen futures and spot markets. Also, futures markets are more efficient than spot markets for both the metals. However, Mahalik et al. (2014) in their study on agri, metals, energy and aggregate commodity indices conclude that these futures markets except metals perform price discovery function. Further they report that there is volatility transmission from futures to spot market in MCX energy and MCX comdex, but reverse spillover in case of MCX agri. Broll et al. (2015) show that the firm's optimal futures position depends on the nature and sign of expectation dependence. Malhotra and Sharma (2016) report long run equilibrium between the spot and futures guar market. They infer that the gaur seed futures market performs price discovery function while spot market causes increased volatility in futures market. Arora and Sandhar (2017) investigate hedging efficiency of crude oil futures traded at MCX, India. Their results indicate that crude oil futures market at MCX efficiently performs hedging function.

From literature, we can see that there a few studies on gold futures market's role to predict future spot price of gold. Also, none of the studies in literature analyses price risk management role of gold futures in India and US with reference to global financial crisis of 2008-09. Knowing the demand, the use and importance of gold in India, and the relevance of global financial crisis in US and Indian markets, there is a great scope for this type of study. Thus, we are motivated to study price risk management in gold futures market at MCX, India and NYMEX Comex, US across the global financial crisis of 2008-09.

3. Data and Research Methodology

This study uses secondary data on daily closing prices of gold in spot and futures markets. The sample period is from 6th June 2005 to 31 March 2017. The data has been divided into two sub-periods. The pre-crisis period encompasses of 971 (or 850) observations of MCX gold (or NYMEX Comex gold) spread over 6th June 2005 to 13th September 2008, and post-crisis period encompasses of 2354 (or 2226) observations of MCX gold (or NYMEX Comex gold) spread over 15th September 2008 to 31st March, 2017. For Indian market, the data is collected from the website of MCX, India. The spot market of gold is Mumbai. For US market, NYMEX (Comex) gold futures data is extracted from Bloomberg and gold spot prices data from World Gold Council. Natural log (ln) series have been used here. The following methods have been used in this study. Only those data points have been taken for this study for which data is available in both spot and futures markets.

3.1 Unit Root Tests:

Augmented Dickey Fuller (ADF) and Phillip Perron (PP) tests are the most widely used stationarity tests (Chowdhury, 1991; Lai and Lai, 1991; Mckenzie and Holt, 1998; Wang and Ke 2002; Yang et al., 2005; Ali and Gupta, 2011; Bohl and

Stephan, 2013; Arora and Kumar, 2013; Ahmad and Sehgal, 2015; Gupta and Varma, 2016). Here, Akaike Information Criterion (AIC) has been used to determine the number of lags. The null hypothesis assumes that the series is non-stationary. It is important to first test the stationarity of given series before applying cointegration. The two series are expected to be non-stationary on levels and stationary on first differencing.

3.2 Johansen's Cointegration Approach

If a linear combination of two non-stationary variables is I(0) i.e. stationary then the variables are cointegrated. In other words, the variables have long-run relationship. For *Johansen's cointegration* test, a VAR model with k lags containing the given two variables is represented as follows:

$$\Delta Y_t = \mu + \Pi Y_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \, \Delta Y_{t-1} + \varepsilon_t \qquad . \; . \; . \; . \quad (1)$$

Johansen test uses two test statistics to test cointegration. These are λ_{trace} is trace statistics and λ_{max} is max eigen value statistics. We assume that the data has linear deterministic trend. The given series are expected to bear a long-run relationship. This will be analyzed in empirical section of this paper.

3.3. Granger Causality Test

Granger causality test can be represented as a bi-variate of kth order VAR as given below:

$$Y_t = \alpha_0 + \sum_{i=1}^{k} \alpha_i \, Y_{t-i} + \sum_{j=1}^{k} \beta_j \, X_{t-j} + \epsilon_t \qquad (2)$$

$$X_t = \gamma_0 + \sum_{i=1}^{k} \gamma_i \, X_{t-i} + \sum_{j=1}^{k} \delta_j \, Y_{t-j} + \epsilon'_t \qquad (3)$$

Where X_t and Y_t are gold and gold spot price series variables, α_0 and γ_0 are constant drift terms, and ϵ_t and ϵ'_t are error terms. If *y (or x)* Granger causes *x (or y)* then the lags of *y (or x)* should be significant in the equation of *x (or y)*. In this case, it would be said that there is one-way causality running from *y (or x)* to *x (or y)*.

4. Results and Discussion

4.1 Unit Root Test

Here, we have used ADF and PP unit root tests to analyse the stationarity properties of the given series. The results for log series and their log returns for two sub-periods for Indian and US markets have been shown in Table 1. It is evident from the results that the log series of both spot and futures prices are non-stationary in levels at 5% significance level. However, the returns series (i.e. first difference of price series) are found to be stationary. The results are similar for both pre-crisis and post-crisis periods. In other words, we can say that for both Indian and US markets the log spot and futures price series are integrated series of first order in the two sub-periods, i.e. *I(1)* in both pre-crisis and post-crisis periods. Thus, we may proceed to test cointegration relationship between the given log price series.

4.2 Johansen Cointegration Test

Johansen's Co-integration test is the most extensively used cointegration technique in the literature (Mckenzie & Holt, 2002; Wang &Ke, 2005, Ali & Gupta, 2011; Arora and Kumar, 2013). To analytically examine cointegration, we run Johansen's cointegration test. We have used AIC criterion to determine optimal lag length (k). Here, k=6 for Indian market in both the pre-crisis and the post-crisis periods while k=6 in the pre-crisis and k=1 in the post-crisis periods for US market. The results shown in Table 2 indicate that LSP (logged spot price) and LFP (logged futures price) series are cointegrated in the pre-crisis period with one cointegrating relation at 5% level of significance in both Indian and US markets. For Indian market in the post-crisis period, the null hypothesis of 'no cointegrating relation ($r=0$)' is rejected The null hypothesis of 'at most one cointegrating relation ($r\leq1$)' is also rejected at 5% but cannot be rejected at 1% level of significance. However for US market, the null hypothesis of $r=0$ is rejected while the null hypothesis of $r\leq1$ is not rejected at 5% level of significance in the post-crisis period. Thus, we can say that the two series are cointegrated in both the sub-periods in both the markets, i.e., spot and futures markets of gold bear long run equilibrium at MCX, India and NYMEX, USA. This is one of the important basic conditions for futures market to perform price discovery and risk management. Similar results are obtained by Lokare (2007), Sahoo and Kumar (2009), and Pavabutr and Chaihetphon (2010).

4.3. Granger Causality Test

Table 3 shows the results of Granger causality test for Indian and US markets. From Table 3, the null hypothesis of 'no causality' from log return of gold spot prices (*RSP*) to log return of gold futures prices (*RFP*) in Indian market is rejected at 5% level of significance. It means RSP Granger causes

Table 1

ADF and PP Test Results on Levels for Pre and Post Crisis Periods

		ADF		PP	
Variable	**Model Form**	**Test Statistics**	***p*-value**	**Test Statistics**	***p*-value**
Pre-Crisis					
$\ln(SP_t)$	Intercept	-1.788411	0.3865	-1.788237	0.3866
	Trend and Intercept	-2.036947	0.5798	-2.096194	0.5468
$\ln(FP_t)$	Intercept	-1.734562	0.4135	-1.734310	0.4136
	Trend and Intercept	-1.932137	0.6367	-2.019167	0.5896
Return on $\ln(SP_t)$	Intercept	-30.69714	0.0000	-30.69706	0.0000
	Trend and Intercept	-30.70988	0.0000	-30.70988	0.0000
Return on $\ln(FP_t)$	Intercept	-31.25086	0.0000	-31.27545	0.0000
	Trend and Intercept	-31.26614	0.0000	-31.28283	0.0000
Post-Crisis					
$\ln(SP_t)$	Intercept	-2.710493	0.0723	-2.674897	0.0786
	Trend and Intercept	-1.929694	0.6385	-1.971086	0.6162
$\ln(FP_t)$	Intercept	-2.616662	0.0897	-2.634754	0.0861
	Trend and Intercept	-2.059869	0.5674	-2.035622	0.5809
Return on $\ln(SP_t)$	Intercept	-48.98858	0.0001	-49.01328	0.0001
	Trend and Intercept	-49.05469	0.0000	-49.07045	0.0000
Return on $\ln(FP_t)$	Intercept	-51.16039	0.0001	-51.10335	0.0001
	Trend and Intercept	-51.21841	0.0000	-51.16765	0.0000

Critical values for Intercept and Trend & Intercept forms are -2.863 and -3.412 respectively.
Source: Authors' Computation

Table 2

Johansen Test Results for Pre-crisis and Post-crisis periods

Period	**Hypothesised No of CE(s)**	**Indian Market**		**US Market**	
		λ_{trace} Stats (Prob.)	**λ_{max} Stats (Prob.)**	**λ_{trace} Stats (Prob.)**	**λ_{max} Stats (Prob.)**
Pre-Crisis	r=0 (None)	43.5841 (0.0000)	0.0410 (0.0000)	161.0231 (0.0001)	158.2413 (0.0001)
	r≤1 (at most 1)	3.2708 (0.0705*)	0.00338 (0.0705*)	2.7818 (0.0953*)	2.7818 (0.0953*)

Post-Crisis	r=0 (None)	74.5360 (0.0000)	70.0527 (0.0000)	216.9532 (0.0000)	115.1778 (0.0000)
	r≤1 (at most 1)	4.4833 (0.0342#)	4.4833 (0.0342#)	7.7537 (0.2725*)	7.7537 (0.2725*)

Note: The critical values are 15.4947 & 3.8414 for trace statistics and 14.26460 & 3.8414 for Max statistics at 5% level of significance. The probablity values have been shown in parentheses. # and * represents insignificant results at 1% and 5% level of significance respectively.
Source: Authors' Computation

RFP. Also, the null hypothesis of 'no causality' from log return of gold futures prices (*RFP*) to log return of gold spot prices (*RSP*) is rejected at 5% level of significance. It means there is bidirectional causality between spot and futures gold market in Indian market. Similar results are reported by Lakshmi et al. (2015). It signifies that gold futures play an important role in price discovery with some feedback from spot market in both the sub-periods. However, the price discovery role of gold futures markets has strengthened after the crisis.
Similarly in US market, a two way causality is observed between spot and futures gold market in the pre-crisis period. However, the results strongly indicate one-way causality from RFP to RSP in the post-crisis period. This leads to conclusion that the NYMEX comex gold futures market dominates the gold spot market in price discovery function in the post–crisis period. Thus, we infer that NYMEX comex gold futures market act as the centre of price discovery in gold in US.

Table 3

Granger Causality Test Results for Pre-crisis and Post-crisis periods

Null Hypothesis	**Indian Market**		**US Market**	
	F-Statistic & Probability			
	Pre-Crisis	**Post-Crisis**	**Pre-Crisis**	**Post-Crisis**
RSP does not Granger Cause RFP	192.187 (0.0000*)	4.04555 (0.0005*)	2.7936 (0.0164)	1.19398 (0.2746)
RFP does not Granger Cause RSP	2.32004 (0.0314*)	196.399 (0.0000*)	82.8274 (0.0000)	794.282 (0.0000*)

*Note: * represents significant results at 5% level of significance.*
Source: Authors' Computation

5. Conclusion and Research Implication

India is among the top two largest importers of gold and MCX is the leading commodity exchange for metals futures in India. NYMEX Comex gold futures ranks first in gold futures all over the world. Since USA was the epicenter of global turmoil of 2008, it looks interesting to study the gold futures market across the global financial crisis of 2008. Thus, this study investigates the gold futures role in managing price risk in India and USA with reference to global financial crisis of 2008-09. The results of Johansen's Cointegration test are the same for Indian and US gold markets. The results indicate that the gold spot and futures markets are cointegrated in both the pre-crisis and the post-crisis periods. However, the results of Granger causality test differ for the two markets across the crisis. In the pre-crisis period, both Indian and US markets a bidirectional causality between spot and futures gold markets. In the post-crisis period, Indian market continues to show bi-directional causality while US market exhibit one-way causality from gold futures to gold spot market. It signifies that gold futures play an important role in price discovery in both Indian and US markets, with some feedback from spot market at Multi Commodity Exchange (MCX), India. However, the price discovery role of gold futures markets has strengthened after the crisis in both the markets but to a greater extend in US market. Thus, we infer that gold futures perform price risk management function in pre-crisis as well as post-crisis period at MCX, India and NYMEX Comex, US. The market participants like companies in gold industry, importers/exporters and jewelers can take position in gold futures market (long or short gold futures) to hedge their spot market position and hence manage price risk associated with trading in gold. In future, research can be extended to other commodities and high frequency data can be used to have more robust results.

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