COINTEGRATION ANALYSIS OF PRICE AND DEMAND OF GOLD IN INDIA

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Introduction

Indian gold market is price sensitive and responds to the price fluctuations; considering the Indian demand, it is worth analyzing the dynamics on the domestic price and demand. Gold has been perceived as safe haven especially during periods of financial and economic stress. It is known for its potential in protecting against financial turmoil. International as well as domestic price have risen unabatedly with a faster pace especially from the third quarter of 2011(1). The inflation in domestic price and the hike in the tax has affected the lust for gold in India, though it remains world's second largest physical markets for gold in the form of jewellery, coins and bars. India plays a crucial role in the physical gold trade, but has also a large electronic gold market. In fact, the Multi Commodity Exchange (MCX) is the third largest gold trading exchange. In 2012, the combined traded volume of gold future contracts was 495M Oz or 15,400t, which is a multitude of the physical gold trade (2). Therefore the factors influencing the price and demand of gold in India is a matter of importance. The present study attempts to explore the co-integration between international price, domestic price and demand of gold in India. Cointegration is a very prevalent tool to extract the common trend providing a model of both long run and short run dynamics.

Review of literature

There are diverse studies articles and research papers related to gold, trying to find the factors influencing the price of gold and the influence of gold on the country's economy.

An investigation on the reaction of Indian Stock market Index (Sensex and Nifty) on gold price was carried out by Mukhuti and Bhunia (3). They used unit root test method, bivariate and multivariate cointegration tests and pairwise Gragner causal method to analyze the data collected from Bombay Stock Exchange database and RBI database. And have found that

there is a co-integration between gold price and the two stock market indices in India. This implies gold price in India is influenced by Indian Stock market indices in the long run.

A novel unit root testing procedure for gold with inflation is employed by Worthington et al (4) after taking the endogenously determined structural breaks into account. This approach provides strong evidence of cointegrating relationship between gold and inflation in both post- war period (1945 – 2006) and early 70's (1973 to 2006). They have used Zivot and Andrews test procedure to endogenously determine the most significant structural breaks impacting upon their relationships. The result lend to support the widely held view that a direct and indirect gold investment can serve as an effective inflatory hedge.

In an attempt to explore the long run trend between the prices of gold and silver future contracts for the Tokyo Commodity exchange, for a period of 6 years (2992 to 1996), C Ciner (5) obtained the results which were contrary to prior literature. They found there is no stable long run relationship between priced of gold and silver and they may drift apart in the long run. This is consistent with the remark in Escribano and Granger (1998) that in the 1990s the stable relationship between the prices of gold and silver has been broken. It is also implied that separate demand and supply forces affect the gold and silver markets, consistent with the separate economic uses of these commodities. A trading strategy based on the gold– silver parity will not produce positive results, on average. The price discovery and analysis of spot and future price of Gold in Indian MCX was carried out by Edward et al(6) in which the cointegration as well as lag- lead relation of spot and future price of gold is analyzed. The study employs Johansen's Cointegration test, Vector Error Correction Model (VECM) and Gragner causality test to explore the long run relationship between the variables and its direction. The study shows that there is only one Cointegration relationship that exits between futures and spot Gold and gold 100 prices and causality is bidirectional for the study period. The empirical result confirms that the spot market of Gold plays a leading role marginally and serves as a price discovery vehicle.

Mukhuti et al (7) in their research paper examines the impact of domestic gold price on stock price indices India for the period of 21 years using unit root test and Granger causality test. Methodology. The paper assesses the impact of domestic gold price on stock price indices of BSE (SENSEX) and NSE (NIFTY). The study is based on secondary data obtained from World

Gold Council database and BSE and NSE database. Unit root test indicates that time series are not stationary at levels and the selected time series are stationary at 1st difference. Granger causality test illustrate that no causality exists between nifty and gold price, gold price and Sensex and nifty and Sensex and bidirectional causality exists between gold price and nifty, Sensex and gold price and Sensex and Nifty.

An attempt to examine the price discovery process and volatility spillovers in the spot and futures market of gold is made by P Srinivasan et al (8). The study uses Johansen's cointegration approach and Vector Error Correction Model (VECM) to investigate the price discovery process in spot and futures market of gold in India. They have proved that the study of volatility interdependence provides useful insights into how information is transmitted and disseminated between futures and spot market. Bivariate ECM-EGARCH(1,1) model confirms that futures market of India is not matured and efficient when information gets disseminated. The study suggests that a better understanding of the interdependence of the markets would be useful for policy makers.

Methodology

Any empirical work based on time series assumes that the underlying time series is stationary which means, its mean, variance and auto-covariance at various lags remains being time invariant. Such time series show properties of mean reversion and fluctuation around the mean with broadly constant amplitude. The significance of stationarity lies in the fact that, if a time series in non-stationary, we can study its behavior only for the time period under consideration, generalization of the behavior to other time periods and prediction becomes impossible. A series which is not stationary, and only stationary after differencing a minimum of n times is called 'integrated of order n' denoted I (n). Stationarity of a time series can be tested by unit root tests like Augmented Dickey Fuller (ADF) test or Philips Pheron (PP) tests and as a confirmatory data analysis, a test of stationarity like KPSS test may also be performed. Rejection by ADF and PP and non- rejection by KPSS tests provides ample evidence of an I(1) process.

When two series possess stochastic trend, their linear combination usually cancels out the stochastic trend. This property is termed as cointegration. More precisely, cointegration refers to a long- run equilibrium relationship. Though the short term disequilibrium is ignored,

presence of cointegration reveals the efficient of price discovery of one variable over the other. Johansen's test is one among the best tests available for co- integration.

In Johansen's procedure, the Eigen values are arranged in descending order and then the rank of co-integration of matrix H is evaluated using the following two alternative maximum-likelihood ratio based statistics; the test statistics are

$$\lambda \text{ trace } (r) = -T\sum_{i=1}^{k} \text{Ln } (1 - \hat{\lambda} i) \qquad (1)$$

$$\lambda \text{ max } (r, r+1) = - T \text{ Ln}(1 - \hat{\lambda}_{r+1}) \qquad (2)$$

where$\hat{\lambda}$ is the estimate of i^{th} order Eigen value from Π matrix while r denotes the number of cointegrating vectors. A significantly non- zero Eigen value indicates that the corresponding vectors are significant cointegrating vectors.

As a precondition of co-integration and causality analysis, a unit root test is performed using an autoregressive model to check whether a time series variable is non- stationary or not. If there exists a significant co-integration between two series which are stationary at the same level, it is suggested to check for presence of short term disequilibrium and speed of adjustment of disequilibrium toward the long run equilibrium. This is performed by Vector Error Correction Model (VECM) which is a Vector Autoregressive (VAR) model. The model is as follows a_i

$$\Delta y_t = Z_{t-1} + \sum_{i=1}^{k} ai \ \Delta y_{t-I} + \sum_{i=1}^{k} bi \ \Delta x_{t-1} + \epsilon_t \qquad (3)$$

Where Z_{t-1} is the intercept, a and b are long – run coefficient parameters to be estimated, y_{t-1} indicates the error correction term and ϵ is the random error term. After confirming co-integration it is imperative to test for causality to assess the direction of relationship between spot and futures prices.

Results and Discussion

The present study is based on the international and domestic price of gold and the traded quantity of Gold between 2004 and 2014. Daily data of domestic factors were obtained from MCX and the international price was obtained from finance@ yahoo and the data consists of 2505 observations. The descriptive statistics of the three series is given is table (1)

	International Price ($)	Demand (000_S)	Domestic Price (Rs 'Lakhs)
Mean	16154.62	35426.85	760442.2
Median	16944.63	35420.00	654746.2
Maximum	22386.27	157361.0	5408946.
Minimum	8160.400	521.0000	5276.030
Std. Dev.	3305.697	22383.59	646204.1
Skewness	-0.618525	0.621106	1.797765
Kurtosis	2.456979	4.472292	9.081058
Jarque-Bera	190.5014	387.3079	5209.053
Observations	2505	2505	2505

Table 1: Descriptive Statistics of the variables under study

The average international price of gold is 16154 $ with standard deviation 3305.697$ while the average Indian price of gold is Rs 760442.2 with a higher standard deviation of 646204.1 which indicates domestic price is more volatile. Also the presence of skewness or heavy tails is an indicated by the skewness values -0.618525 and 1.797765. this is a reason for non-normality of the data. Domestic price shows a huge peak in the data with a kurtosis value 9.081 (>3). Hence further analysis is carried out in that direction.

Stationarity is tested for all the three series separately to find if we can adopt cointegration analysis and causality study. The null hypothesis for ADF and PP is that the series has unit root, i.e. the series is not stationary. But for KPS, the null hypothesis is that the series is stationary.The results of the unit root and stationarity test are reported in Table 2.

	Augmented Dickey Fuller Test		Philip Perrons Test		KPSS test LM Statistic value
	t statistic	p value	t statistic	p value	
International Price -At level	-1.7465	0.4076	-1.6450	0.3955	3.7060
International Price -At First Difference	-48.7781	0.0001*	-48.679	0.0000*	0.5871*
Domestic Price- At Level	-3.3643	0.4194	-3.004	0.5150	3.3998

Domestic Price- At First Difference	-27.9021	0.0000*	-28.1493	0.0000*	0.2144*
Traded Quantity - At Level	-2.4569	0.3955	-3.6145	0.2986	2.9812
Traded Quantity -At First Difference	-36.3756	0.0001*	-59.2478	0.0001*	0.3926

Table2: Test for Stationarity

* For ADF and PP test indicates the rejection of null hypothesis of the presence of unit root

* For KPSS indicates the acceptance of null hypothesis that the series is stationary as the critical value at 1% is 0.739

All the three tests agree in their inference that there is presence of unit root at level and stationarity at first difference. Since the series are I(1), the study proceeds to test for cointegration between (i)international and domestic price of gold, (ii) domestic price and traded quantity in India, (iii) International price and traded quantity in India.

Johansen's (1991) trace and maximal Eigen value test statistics are reported in Table 3. Both the test statistics suggest that the null hypothesis of no cointegration is to be rejected and the hypothesis of one cointegration is to be accepted.

Cointegration analysis

Johansen's Cointegration test (1991, 1995) is adopted in the present study to test the presence of cointegration between international and domestic price and demand of gold. It provides evidence for long- run link between the variables. The lag length in the VAR is determined using Akaike minimum final Prediction Error criterion.The result is provided in the Table 3:

Data	Ho	H1	Eigen value	Trace statistic		Max Eigen statistics	
				λ trace	p value	λ max	p value
International price to Domestic Price	r = 0	r ≥ 1	0.03815	100.211	0.0001	97.2414	0.0000*
	r≤ 1	r ≥ 2	0.001187	2.9697	0.0848	2.9697	0.0848
Domestic price to Traded quantity	r = 0	r ≥ 1	0.2206	738.767	0.0001	623.877	0.0001*
	r≤ 1	r ≥ 2	0.04486	114.891	0.0000	114.891	0.000*
International price to Traded Quantity	r = 0	r ≥ 1	0.07748	204.675	0.0001	301.620	0.0001*
	r≤ 1	r ≥ 2	0.01221	3.05529	0.0805	3.0559	0.0805

Table 3. Johansen's Cointegration Test Results

For all the three sets of data, it is observed that a single cointegration vector exists between each pairs.

Causality test

Along with the presence of cointegration always exists a corresponding error correction model which explores causality. Once co-integration is established it is impetus to find the causality to assess the direction of relation between the variables. The short- run relationships between variables is obtained by this test. The results of implementing Grangers' causality test is provided in Table 8

	Direction of causality	F statistic	p value	Conclusion	Causality
I	International Price does not lead Domestic price	14.9513	4.E-07*	Rejected	Unidirectional
	Domestic Price does not lead International price	0.5601	0.5712	Accepted	
II	International price does not lead Domestic Trade quantity	7.8464	0.001*	Rejected	Unidirectional
	Domestic Trade quantity does not lead International price	1.8889	0.1514	Accepted	
III	Domestic price does not lead Traded Quantity	0.9058	0.4044	Accepted	Unidirectional
	Traded Quantity does not lead Domestic price	94.1327	4E -40*	Rejected	

Table 4. Causality Test Results

The Granger's causality test suggests unidirectional causality where International price plays a decisive role in leading the domestic price as well as trade quantity. It is surprising to observe that domestic price does not have a lead in predicting the trade quantity. The results highlights the importance of price at international level alone to decide on future trades on gold for India. But the traded quantity leads the domestic price in India, which is in agreement to the literature available.

Conclusion

The present research work is carried out to analyze the impact of international price of gold in the domestic price and traded quantity. Cointegration and Causality analysis of the time series is carried out on 2505 observation on daily data from March 2006 to March 2014. The result shows the stochastic stationarity for all the series. Cointegration analysis suggest the presence of single cointegration relationship between he pairs. This is very vital to analyze the long term relationship between the series. The study on causality is also carried out which reveals the international price taking a lead in the price discovery as well as in predicting the traded quantity. Hence investors and hedgers can rely on international price for their investments on gold in India. Along with other domestic macroeconomic factors, international price plays a pivotal role.

References

1. Misra and Mohan, 2012, Gold prices and financial stability in India, RBI working paper series, WPS (DEPR): 21/2012.
2. www.goldresearcher.com/supply- demand/ indias-gold-market/
3. Mukti and Bhunia, Is it true that Indian gold price influenced by Indian stock market reaction?, (2013) E3 Journal of Business Management and economics, Vol(48). Pp.181-186, ISSN 2141-7482; http://www.e3journals.org.
4. A C Worthington and M Pahlavani, 2006. Gold investment as an inflationary hedge: Cointegration evidence with allowance for endogenous structural breaks, Working paper, Research online, Accounting & Finance Working Paper 06/04, School ofAccounting& Finance, University of Wollongong,
5. C Ciner, On the long run relationship between gold and silver prices: A note, Global Finance Journal, 12 (2001), 1044-0283/01/$. PII: S1044-0283(01)00034-5
6. Edward &Manoj (2012), Price Discovery and volatility of Gold Spot- Futures Market: Evidence from Multi Commodity Exchange,
7. Mukti and Bhunia, The impact of domestic gold price on stock price indices-An empirical study of Indian stock exchangesUniversal Journal of Marketing and

Business Research (ISSN: 2315-5000) Vol. 2(2) pp. 035-043, May, 2013, online http://www.universalresearchjournals.org/ujmbr

8. P Srinivasan and P Ibrahim, Price discovery and asymmetric volatility spillovers in Indian Spot- Future Gold markets; International Journal of Economic Sciences and Applied Research 5(3): 65 - 80
9. Chris Brooks, Introductory Econometrics for Finance, Cambridge University Press, 2nd Edn, 2008
10. Christopher Dougherty, Introduction to Econometrics; Oxford Publication (2007)