Gold Future Market Efficiency Post 2007 Financial Crisis: An Empirical Study

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Key Words:

1. Gold Prices
2. Market Efficiency
3. Financial Crisis
4. Future Prices
5. Cointegration

Abstract

Gold has been an integral part of the avenues for personal investments in India. Gold futures make the gold market complete. But market of gold is efficient or not is a different thing. Cointegration between spot and future market is necessary condition for market being efficient. An efficient market increases the confidence of people in the asset and in the overall financial system. Johansen's Cointegration method has been applied in this study to find out cointegration between spot and future prices of gold on different time series generated at different time-slots during the period of gold future contracts. Both the spot and future markets have been found to be market efficient during the period of study.

INTRODUCTION

The study of any markets attracts academicians and industry alike. They have varied reasons for doing such studies but the importance for studying the market remains the same for studying financial markets as well. In financial markets this becomes more important because of direct involvement of all type of investors. It is obvious that investors want that financial markets should be appropriate place to invest their hard earned money which they have in the form of savings. This expectation of market being an appropriate place needs to be defined. In financial literature an appropriate market can be understood that reflects true price of the assets which are made available for buying and selling in the market. This concept can further be defined as Market Efficiency. In other words it can be said that efficient market is a market where prices of the assets should reflect all the information about the assets.

This is one of the practical realities that most of the investors invest in markets of different assets not because it is efficient but because it is inefficient. The price anomalies due to inefficiency of a market are one of the main incentives for investing into a market and same applies to the financial markets of financial securities, commodities and other financial products (Kumar, 2009). Investors at the time of investing do not look for only normal profits. Rather the charm of abnormal profit is more lucrative which is there not in the efficient market but in the inefficient markets. The market of gold is also not an exception in this context. Gold is one of the most important and historically significant commodities which people buy for various reasons. But despite varied reasons for buying of gold, one of the main reasons is for the purpose of personal investments (Vaidyanathan, 1999). The motive for personal investments in gold may be for normal profit or for abnormal profit. But the question of having the price of gold reflecting all the information about the gold (market efficiency) or not, remains imperative to all which include investors, traders, policy makers and researchers. The idea of market efficiency coupled with right timing can be immensely profitable if executed well by investors. Those who buy gold, before buying would like to know whether the price of gold being bought is correct or not. The correctness of the price of the gold is determined by market efficiency and therefore knowledge of market efficiency becomes so important. It is the inefficient time during which going into the market would be a good decision (when asset is underpriced) and similarly it would be the inefficiency present in the market when assets are overpriced, would be the appropriate time to sell the asset.

Market efficiency as a concept is not new. The use of market efficiency term has been started in the beginning of 20th century. There are some scattered works on this concept and discovery of random walk hypothesis further gave direction to the concept of market efficiency

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(Samuelson, 1965, Dimson and Mussavian, 1988) . In the contemporary time it is Fama (1965, 1970) who presented the concept of market efficiency in structured way and practically has given birth to the concept of market efficiency which has been evolved in the present form. Tobin (1984) explained that the market efficiency can be of four types. These are informational efficiency, allocational efficiency, insurance efficiency and operational efficiency. The concept of Tobin (1984) is a broad idea within this the efficiency of market has been explained. But now the market efficiency is understood only as informational efficiency (Bruiter 2003, Dimson and Mussavian, 1998). In the rest of the paper, market efficiency has the context of informational efficiency only. Dimson and Mussavian (1998) in their landmark work presented the history of market efficiency. Many studies have been done for trying to explain the concept of market efficiency (Samulson, 1965; Fama, 1991, Fama and French 1992) further but with limited success in explaining the concept completely. Some studies found anomalies in the market and some other studies said that it is the behavior of the investors than the rationality of the investors, decide about the efficient or inefficient of the markets (Mehra and Prescott,1985; Debondt and Thaler, 1990). But despite all the work done to explain and formalize the concept of market efficiency, it is still could not be explained fully. Therefore the concept of market efficiency is called efficient market hypothesis (EMH). Fama (1970) further divided EMH into three levels (Dimson and Mussavian 1985). The first is level is the weak-form market efficiency where all the past information about the asset should reflect in the price of the assets. Second level is the semi-strong form of market efficiency where all the published information about the asset should reflect into the price of the asset price. The third level of market efficiency is the strong-form market efficiency. In this form of market efficiency the price of the asset should reflect not only all the published information but private information also (Reilly and Brown, 2011). In this paper also weak-form market efficiency has been studied. Studies comprises of commodities market like for gold market used in this paper, discusses weak-form efficient market efficiency only (Singh and Singh, 2014; Kaur and Rao, 2010; Efe-omojevwe, 2013).

The study of market efficiency of gold also becomes very important because of the role, gold plays for an economy. Economic prowess, strength of a currency and role of gold are very strongly interwoven. Gold in history has been the cynosure for the economic strength for any nation. The Gold has gradually lost its center stage since World War-I (WW-I). Before WW-I the world was totally dependent upon gold for the international trade. Between WW-I and WW-II, during the second phase of international monetary system of gold, it has been found that the importance of gold has gradually come down. After WW-II, further the Bretton Woods accord took the shine away from the gold as bellwether for the international monetary system and some importance shifted to dollar on the cost of both gold and pound sterling. The International monetary system adopted after the WW-II also cannot sustain the vagaries of the international trade and finally the present International monetary system came into being which is based upon the market forces after Bretton woods system collapsed in 1972 (Taylor and Sarno, 1998). But despite all the fluctuation in terms of importance, the gold is still important and relevant. The role and importance of gold as a hedge for domestic currency and an avenue for investment are some of the issues for which debate is still on and no end it is seen in the foreseeable future. Among such uncertain but glorious past about gold, it becomes imperative to explore and understand the market of gold further. This is the motivation for doing the study of market efficiency of markets of gold. The study is confined to India because the expectation with which India is being seen by the world as the economic power in decades to come, justifies the focus of the research on the Indian gold market only (Walt, 1985; Saran and Gua, 2005; Wu and Zhou, 2006). Besides this, India may not reckon high among the gold producing nations but stands second in terms of consumption of gold (Soundararajan et al, 2014; Suresh, 2013; Vaidyanathan, 1999). Therefore studying gold market in India is justified. The Indian gold market (including gold future market) is efficient or not is the main objective of this study.

The study has further been divided into five parts. The second part is review of literature. In the third part data and research methodology has been discussed. In the fourth part results have been explained. In the next part discussion on the similar research findings have been elaborated. In the sixth and last session concluding observations have been discussed.

REVIEW OF LITERATURE

Review of literature for this paper has been divided into five categories. The first category is on importance of market efficiency for equity, commodity, currency and interest rates markets. The second category is on methods for testing market efficiency. The third category for the review of literature for this paper is on evidences on market efficiency. The fourth category is on the use of cointegration for testing market efficiency. The last and fifth category is on the testing of the market efficiency for gold markets and other commodities markets.

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The first category of literature is on importance of market efficiency. The importance of market efficiency concept is evident with this fact that an efficient market does not provide opportunities for abnormal profit rather only a normal profit can be achieved. If we go by risk versus return approach, in an efficient market, it is not very lucrative to invest in the stock market (Chowdhury, 1991; Floros and Vougas, 2008). The historical perspective from the evolution point of view also explains the importance of market efficiency (Dimson and Mussavian, 1988). Though, market efficiency as a concept started quite early and evolved over the years but market efficiency still remains one of the center stage concepts of finance and financial markets (Dimson and Mussavian, 1988).

The second category of literature is on testing of market efficiency. The conventional method for testing of market efficiency has been given by Fama (1965, 1970). Fama (1991) also explained that the learning of market efficiency can be compared with equilibrium pricing models like capital asset pricing model (CAPM) which can be used for testing the market efficiency. The method used for testing of the market efficiency largely depends upon the short-term and long-term return of the asset prices (Fama 1991; French and Roll, 1986; Poterba and Summer, 1988, Fama and French 1989; Campbell and Siller, 1988; Zeitz, 1995). Breuer and Wohar (1996) explained in their work that there is difference between empirical work and theory for market efficiency for future and spot rate. They attributed the difference in findings to the different methods for sampling for the empirical testing. Taking the issue of market efficiency in the cases of assets having both future prices and spot prices, it was MacDonald and Taylor (1998) who proposed the use of time series cointegration in such cases (Floros and Vougas, 2008; Beck, 1994).

The third category of literature is on evidences of market efficiency. There have been many research papers having the evidences of market efficiency. Floors and Vougas (2008) have evinced the market efficiency in spot and future market of stocks. The same results have been given by Antoniou and Holmes (1996), Buckle et al (1991) and Miffre (2001) for the evidences of market efficiency of equity (spot and future) markets. Arshamapalli and Doukas (1993), Byers and Peel (1993) and Kasa (1992) proposed in their work that the cointegration between US and European markets exists and markets are efficient but it was later rejected by Kanas (1998). The cointegration has been found to have the evidence of market efficiency in the stock exchange of Taiwan (Lin,Chen and Hwang, 2003). Brenner and Kroner (1995) have found evidences of market efficiency as they explored the spot and future market for commodities and currency. Cointegration relationship has been evident in both the cases and further it was discussed that the market for currency is more efficient than the market for commodities. Sohel Azad (2009) has evinced the evidences on market efficiency in the stock markets of China, Korea and Japan.

The fourth category of literature is on the use of cointegration for testing market efficiency. The statistical procedures applied on time series data ensures that the time series concerned should be stationary which is not the usual situation. The processing of non-stationary time series may lead to spurious relationships and therefore cointegration is used for processing non-stationary time-series. Financial series are usually non-stationary therefore cointegration is often applied for statistical testing on financial time series (Gujrati, 2012). Using cointegration for testing market efficiency is also a standard procedure for many such situations (Chowdhary, 1991). Floros and Vougas (2008) and Chawdhary (1991) have applied cointegration for testing the market efficiency on different markets and at different time periods. Brooks, Rew and Ritson (2001) and MacDonald and Taylor (1988) have also explained the utility for using cointegration in establishing the market efficiency in the market. It is a necessary condition that both spot prices and future prices for the same asset are having cointegration for market efficiency (Lai and Lai, 1991; Hakkio and Rush, 1989; Efe-omojevwe, 2013; Inoue and Hamori, 2014). The application of the same concept has been done in this paper to find out the market efficiency in the spot and future markets using cointegration method applied on spot prices and future prices of gold. The cointegration has also been used for testing of price discovery in the spot market by future market using cointegration method (Corbae, Lim and Ouliaris, 1992; Pizzi, Economopoulos and O'neill, 1998; Garbade and Silber, 1983; Figuerola-ferreti and Gonzalo, 2010; Kumar and Sunil, 2004; Kellard, 2002; Ramasamy and Shanmugam , 2004). Ryoo and Smith (2004) have established the use of cointegration for spot and future market using cointegration for Korean stock market and tested for market efficiency. Brenner and Kroner (1995) have compared commodity and currency markets by using cointegration for testing the market efficiency.

The fifth category of literature is on testing market efficiency on gold or other commodities markets. Kritoufek and Vosvrda (2014) studied 25 commodities and discovered different levels for market efficiency among them. Chakraborty and Sarkar (2010) found market

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efficiency using cointegration in Indian commodities market. Geoffrey, Brockman and Tse (1998) have found cointegration in wheat future market and found evidences of market efficiency. Wang and Ke (2005) have studies the Chinese commodity market using cointegration and have found the markets for Soybean is efficient but for wheat inefficient. Inoue and Hamori (2014) discussed about the Indian commodities market and found evidences of market efficiency. Jaksiene and Zvirblis (2010) explained a new European member Lithuania's commodity market and shared the finding for market efficiency and explained that in Lithuania's market, the market efficiency is below than the average level as compared to the other European nations. Luo (1998) explains that market efficiency is found in the commodities future markets if instead of speculations, the normal selective process is followed. This may be an issue of debate that whether this normal selection process is better or speculative selection is better. Rausser and Carter (1983) studied Soybean in US and used ARIMA models to establish the market efficiency and found the mixed results. They tried to address the issue of lack of strong theoretical foundation for studying the cointegration in commodities. The lack of market efficiency in the spot and future markets for commodities, have been attributed to the interest rates (Jumah, Karbuz and Runtler, 1999). There are many studies which have been done on commodities market and studied market efficiency in spot and future markets successfully (Beck, 1994; Spyrou, 2006; Chow, 2001; Koutsoyiannis, 1983; Pavabutr and Chaihetphon, 2010; Arnold, crack and Schwartz, 2007; Kocagil, 1997).

DATA AND METHODOLOGY

Data

The data for the study has been procured from official website of Multi Commodity Exchange of India. The time period for data has been June 2007 to Feb 2014. The Gold future contracts starting from having the expiry of June 2007 to February 2014 have been considered for the study. The data for five points of time have been collected for the Gold future contracts. The five-time data points are after one week of contract floatation, two week, one month, two months and three months. The closing price of the future contracts has been taken. The spot prices of Gold have also been collected for the same corresponding dates at five-time data points as are done for future price collection. The following variables have been used in the study.

Table -1 Details of the Variables used in the study

SN	Variables	Description
1	Spot 1 W	Spot price time series on dates one week after the start of Gold future
2	Spot 2 W	Spot price time series on dates two weeks after the start of Gold future
3	Spot 1 M	Spot price time series on dates after one month after the start of Gold future
4	Spot 2 M	Spot price time series on dates after two months after the start of Gold future
5	Spot 3 M	Spot price time series on dates after three months after the start of Gold future
6	Future 1 W	Gold future price time series after one week after the start of Gold future

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7	Future 2 W	Gold future price time series after two weeks after the start of Gold future
8	Future 1 M	Gold future price time series after one month after the start of Gold futu re
9	Future 2 M	Gold future price time series after two months after the start of Gold future
10	Future 3 M	Gold future price time series after three months after the start of Gold future

METHODOLOGY

Four set of methodologies have been used in this study for testing the data. The first set of the methodology is on preparation and elementary testing of the data for further analysis. The second set of methodology is of Johansen's Cointegration tests. The third set of methodology is for Error Correction Models. The fourth and last set of methodology is of the impulse response functions for knowing the impact of one time series on the other. In present situation impulse response function is used to know the impact of spot price on future price of gold and vice versa.

Stationarity

In time series data analysis it is one of the important considerations that the time series should be stationary. Non-stationary data sets may produce spurious results which may lead to misleading conclusion. Therefore it is imperative to test for stationarity for the data sets before further analysis is done. Stationarity explains that in time-series there is no trend and variance also do not change with respect to time (Gujrati, 2012). There are several ways by which stationarity in time series can be tested. Dickey and Fuller (1979, 1981) and Fuller (1976) have proposed unit root test for finding the stationarity of the time series. There were several other tests which have also been proposed to test the stationarity in the time series like Phillips-Perron type tests (Phillips and Perron, 1988). Both unit root test and Phillips –Perron type tests have been used in the analysis for stationarity.

Testing market efficiency and Johansen's Cointegration Tests

As discussed under review of literature in this paper that cointegration between spot and future prices is a necessary condition for market efficiency. There are three methods for testing the cointegration (Brooks, 2008; Engel and Granger, 1987; Engel-Yoo, 1987; Johansen, 1988). One of the methods is Johansen's cointegration which has been considered to be better than the other two methods (Brooks, 2008). The cointegration testing method is originally based upon the logic that all the I (1) time series, having linear association should also be I (1). But If the linear association of the I(1) time series comes out to be I(0), all the series are said to have long-term association amongst themselves and this phenomenon is called cointegration (Brooks, 2008). Johansen's cointegration method has been used in this paper for testing cointegration. In Johansen's method following two test statistics (Trace Statistics and Maximum Eigen Value Statistics) have been calculated (equation 1a and 1b). Null hypothesis for no cointegration equation with the alternate hypothesis of starting with 1 cointegration equation, 2 cointegration equations and so on are formulated and tested by both the test statistics separately (Johansen and Juselius, 1990; Johansen, 1991).

Trace Statistics and Maximum Eigen value statistics are as follows.

$$\lambda_{trace}(r) = -T \sum_{j=r+1}^{p} \ln(1 - \hat{\lambda}_j) \quad (1a)$$

$$\lambda_{max}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1}) \quad (1b)$$

In this study the cointegration has been tested between spot price and future prices of Gold at 5 different points of time in reference to the starting of future contracts. The theory says that any two time series having any relationship imply that both the series do not have market efficiency in their respective markets. Because in such cases, one time series variable can be predicted with the help of another time series variable. This, having the cointegration between two series, is in the straight violation of the premise of efficient market hypothesis or informational market efficiency. But this premise is applicable to the extend both the series are of the same nature (like two spot prices time-series, two future prices time-series etc.). Whereas as a special situation if future price time series of one asset and spot price time series of the same asset have cointegration, this ensures that the both the spot and future markets are having market efficiency. This unique situation of cointegration lead to market efficiency is specific to cointegration between future and spot prices of same assets. This may be further

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added that the future spot prices are being decided by current future prices (Floros and Vougas, 2008; Beck, 1994; MacDonals and Taylor, 1998; Chowdhury, 1991).

Error Correction Model (ECM)

Engel and Granger (1987) have proposed the concept of error correction. The long-term association which may be tested with the help of cointegration proposed by Engel and Granger (1987) establishes the long-term association between or among the time series. The long-term association does undergo its own highs and lows. It is the forces which bring back the long-term association and establish the equilibrium, is studied with the help of error correction model. The equation of error correction model has an error correction term (ECT). The significance of the error correction term would ensure short-term corrective mechanism between the spot and future prices for the series of each time-data point. Moreover, the higher the ECT, the sooner the equilibrium would be restored back. There are many studies where such features of error correction models have been used (Floros and Vougas, 2008; Mukherjee and Naka, 1995; Ghosh (1993).

The equations (2a and 2b) and its interpretation have been supported by the literature. Suppose there are two time series ys and yl. Their error correction model of two equations has been represented by the equations (2a and 2b). The term is also called error correction term (ECT). The significance of the coefficient of ECT (in this example these are αs and αl) testify the long-term association and short-term corrective mechanism among time series. The value of the coefficient of error correction term conveys the speed of adjustment at the time of disequilibrium so that equilibrium is restored (Brooks, 2008; Enders, 2008).

$$\Delta y_{st} = \alpha_s(y_{lt-1} - y_{st-1}) + \epsilon_{st} \quad (2a)$$

$$\Delta y_{lt} = \alpha_l(y_{lt-1} - y_{st-1}) + \epsilon_{lt} \quad (2b)$$

Impulse Response Function

Johansen's cointegration tests are performed in the environment of systems of equation format and the format of systems of equations used in this procedure is known as VAR (Vector Auto Regressive) model. In VAR model the relationship is estimated among time series but how one variable (time series) in the system is going to impact the other variable (time series) in the system is not established directly. For this purpose Impulse Response Function has been studied in this paper (Brooks, 2008; Floros and Vougas, 2008). In this study impulse response function has been studied that how spot prices are impacting the future prices and vice versa.

RESULTS

In this study the first analysis has been done for testing all the 10 time series for stationarity at level as well as at first difference. The results have been reported in the Table 2: Testing of Stationarity

S.N.	Time Series	ADF Test	Phillips-Perron Test	ADF Test	Phillips-Perron Test
		At level		At first difference@	
1	Spot 1 W	-.8182	-.8342	-5.6634*	-5.7850*
2	Spot 2 W	-.8395	-.8335	-6.4144	-6.4140
3	Spot 1 M	-.7151	.7021	-6.3469	-5.6420
4	Spot 2 M	-..5622	-.4699	-5.3735	-5.5353
5	Spot 3 M	.0935	-.4179	-3.2378	-4.3649
6	Future 1 W	-.8063	-.8384	-4.4776	-4.6887
7	Future 2 W	-.8254	-5.0888	-5.0885	-5.1081
8	Future 1 M	-.8604	-.8694	-5.2038	-5.2038
9	Future 2 M	-.6318	-.6011	-5.5543	-5.5212
10	Future 3 M	-.8723	-.8776	-3.4406	-5.2552

The results of ADF tests and Phillips-Perrron type tests have been estimated and it is found that both the set of series of spot and future prices for all the five-time data points are non-stationary in level but stationary on first difference. In other words it can be said that all the series are I(1). This is an appropriate condition for further analysis for cointegration

Further analysis has been done for Johansen's cointegration to explore the cointegration between spot and future price for gold. The results have been reported in

Table 3: Result of Johansen's Cointegration test

SN	Time Series@	Hypnotized No. of CE	Trace Statistics	Max Eigen Value Statistics
	After 1 Week	r =0	23.2395*	15.9988*
		r =1	07.2406	7.2406
	After 2 Weeks	r =0	20.3933*	15.8726
		r =1	04.5212	4.5212
	After 1 Month	r =0	30.1229*	22.1005*
		r =1	8.0224	8.0224
	After 2 Months	r =0	28.9683*	23.9109*
		r =1	05.0504	5.0574
	After 3 Months	r =0	25.6024*	19.3387*
		r =1	06.2637	6.2637

using AIC &SC Criteria (The lag of 6 has been taken for estimating Johansen's Cointegration test). Deterministic trend assumption in the estimation of Johansen's has been considered in this study as no intercept in cointegration equation (CE) and no-intercept in VAR.

Cointegrating equation has been significant for all the five set of time series for 1w, 2w, 1M, 2M, and 3M for spot and future prices of gold. Presence of cointegration between spot and future price of gold ensures the market efficiency. It means evidence for market efficiency has been found for both set of time series which means gold market for spot price and future price are market efficient for 1W, 2W, 1M, 2M, and 3M time periods from the commencement of a gold future contracts.

Further the results of Error Correction Models have been reported in

Table 4: Error Correction Model (Coefficient of ECT)

SN	Time Series@	D (spot Series)	D (future series)
1	After 1 Week	-1.5537	-1.3383
2	After 2 Weeks	1.1911*	1.203*
3	After 1 Month	1.2693*	1.59.1*
4	After 2 Months	-.9208	-.0372
5	After 3 Months	.4673	1.219

* Significant at 5%; @ Lag is 4 with the help of AIC &SC Criteria

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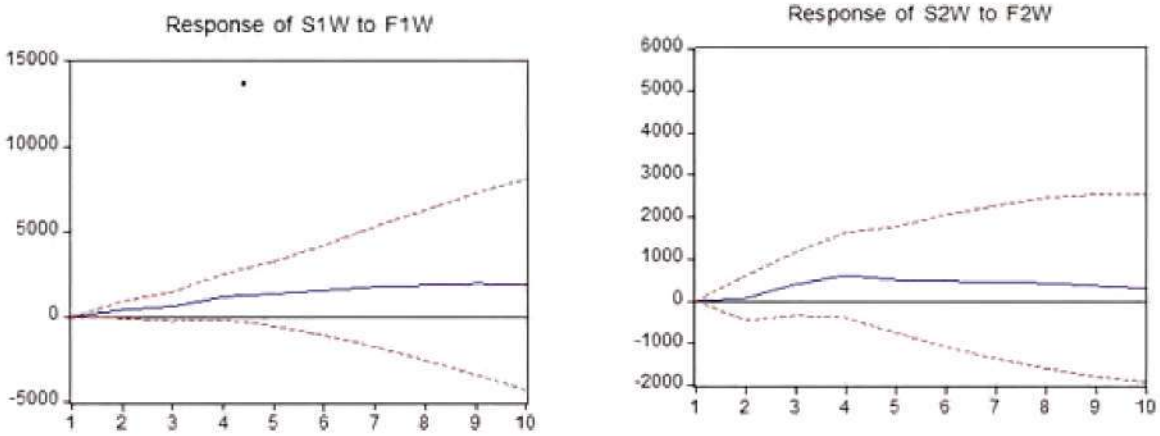
The coefficient of ECT for spot rates for 2-week, and 1-month are significant and same for future price series as well have been reported in this study. Other coefficients for ECT are not significant at 5% level of confidence.

Besides this the speed of adjustment is large for 1-month series as compared to the 2-week series in case of both spot and future markets.

Fig1: Result of Impulse Response Functions



According to the impulse response results it is found that no big response has been found in any of five VAR (Vector Auto Regression) Model estimated in this study neither by spot price on future nor by future price on spot. Two such graphs have been reported (Fig-1). Response of spot prices on future prices for 1-week data series and same for 2-week data series have been shown in the figure-1.

DISCUSSION

The market data for gold has reflected mixed results in the literature. Though, the derivatives market in commodities is relatively new in India. This has been found in the literature that the studies done earlier, have reflected the inefficient gold market but studies done in relatively recent time have found that both future and spot market of the gold are market efficient. Aggarwal and Soenen (1988) have reported inefficient gold market but said that it is difficult to generate abnormal profit from the gold market. Solt and Swanson (1981) in their study on market efficiency have found partial market efficiency for Gold. Gallais-Hamonno, Hoang and Oostertinck (2015) have found gold market is market efficient in Paris. Kumar and Pandey (2013) have also done the study on spot and future market of gold and concluded that for near months when trading is high market efficiency is found but not for far months. In another study for Indian gold market by Pavabuts and Chaihetphon (2010) cointegration has been found between spot and future prices of gold. In USA based study by Kristoufek and Vosvrda (2013) it has been found that the gold market is efficient for both spot and future markets. The results of this paper are also in accordance with the earlier work on this topic.

CONCLUDING OBSERVATIONS

Both the spot and future markets of gold in India during the period starting from 2007 to 2014 are having cointegration. In other words it can be said that both the markets for gold during aforesaid period are market efficient. Moreover, the market efficiency has been found not only for the near months (3- Month and 2-month time periods) but also for far moths (1-month, 2-week and 1-week). In this study, the data for the gold market has been collected only from one commodity exchange. The longer data period might have been taken for the study of the gold markets and its analysis. The same analysis may also be done for the gold markets of other nations for better and diversified understanding of market efficiency of the gold market. These limitations of the study are the scope for further study on the topic.

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