Market Efficiency and Volatility Spillovers in Futures and Spot Commodity Market: The Agricultural Sector Perspective

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Abstract

Future contracts in commodity market with limited maturities are primarily used for hedging commodity price-fluctuation risks or for taking advantage of price movements, rather than for the buying or selling of the actual cash commodity. This paper is an effort to analyze the market efficiency of the Indian commodity market and volatility spillover effects between the spot and future market with reference to agri commodities guar seed and chana. The result indicates that the commodity futures markets effectively serves the price discovery function in the spot market implying that there is a flow of information from future to spot commodity markets. Although the innovations in one market can predict the volatility in another market, the volatility spillovers from future to the spot market are dominant. However in Agri commodities the volatility in spot market may influences volatility in future market.

Introduction

Ever since the dawn of civilization, commodity trading has remained an integral part of mankind. The first and the foremost reason is that commodity represents the fundamental elements of lifestyles of human beings. In earlier days, people used to exchange goods for goods, which was called as “Barter System”. With the advancement of civilization, trading system has gone through various changes and has now entered into an era of Futures trading. Existence of a vibrant, active and liquid commodity market is considered as a healthy sign for the development of an economy. In the context of an emerging market like India, the growth of capital and commodity future market would depend on the effectiveness of derivatives in managing risk. Future contracts can be used for hedging against unfavourable price fluctuation. The main aim of Futures market is to offer a mechanism wherein the price risk associated with commodities can be successfully managed. All the commodities are not suited for futures trading.

Futures contracts in commodity market with finite maturities are primarily used for hedging commodity price-fluctuation risks or for taking advantage of price movements, rather than for buying or selling of the actual cash commodity. The buyer of the futures contract (the party with a long position) agrees on a fixed purchase price to buy the underlying commodity (wheat, gold or T-bills, for example) from the seller on the expiration of the contract. The seller of the futures contract (the party with a short position) agrees to sell the underlying commodity to the buyer at expiration at the fixed sales price. As time passes, the contract's price changes relative to the fixed price at which the trade was initiated. This results in profits or losses for the trader. An established company that has enjoyed a long history of solid earnings will probably continue to do so. But a commodity that has trended up during one year may turn around in the opposite direction the next year and very quickly, too. The commodity trader should therefore identify and incorporate contingency plans. Hedging programs are used by individuals and companies wanting protection against adverse price moves which would affect the cash commodities in which they deal. In most cases, delivery never takes place. Instead, both the buyer and the seller, acting independently of each other, usually liquidate their long and short positions before the contract expires, the buyer sells futures and the seller buys futures. Arbitrageurs in the futures markets are constantly watching the relationship between cash and futures in order to exploit such mispricing. An arbitrageur would typically buy a particular commodity at a lower price on one exchange and sell it on another where it fetches them a higher price. This creates a natural hedge and therefore the risk is low. If, for example, an arbitrageur realized that gold futures in a certain month were overpriced in relation to the cash gold market and/or interest rates, he would immediately sell those contracts knowing that he could lock in a risk-free profit. Traders on the floor of the exchange would notice the heavy selling activity and react by quickly pushing down the futures price, thus bringing it back into line with the cash market. For this reason, such opportunities are rare and fleeting. Most arbitrage strategies are carried out by traders from large dealer firms. There are two basic categories of futures participants: hedgers and speculators. In general, hedgers use futures for protection against adverse future price movements in the underlying cash commodity. The rationale of hedging is based upon the demonstrated tendency of cash prices and futures values to move in tandem.

Mukherjee (2011) suggests that besides the well-established fact towards the requirement of market based instrument, there has always been a doubt, as expressed by different bodies, on the usefulness and suitability of futures contract in developing the underlying agricultural commodity market, especially in agricultural based economy like India. Therefore, an attempt is required to be made to re-validate the impact of futures trading on commodity market in India.

The effect of the introduction of futures trading on the spot market volatility has been widely documented in the financial literature. In earlier studies the main objective was to investigate the impact of introduction of index futures trading on volatility of selected Metal and Agri commodities in Indian Commodity Market. These studies found that the introduction of commodity futures trading generally reduced or at least did not increase cash price volatility.

The purpose of this paper is to empirically examine lead-lag relationships between the level of futures trading activity and cash price volatility in commodity futures markets.

Review of the Literature

The history of futures trading in commodities in India dates back to the later part of 19th century when the first commodity exchange, viz. The Bombay Cotton Trade Association Ltd. was set up for organizing futures trading. The early 20th century saw the mushrooming of a number of commodity Exchanges. The principal commodity markets functioning in pre-independence era were the cotton markets of Bombay, Karachi, Ahmedabad and Indore, the wheat markets of Bombay, Hapur, Karachi, Lyallpur, Amritsar, Okara and Calcutta, the groundnut markets of Madras and Bombay, the linseed markets of Bombay and Calcutta, Jute and Hessian markets of Calcutta, Bullion markets of Bombay, Calcutta, Delhi and Amritsar and sugar markets of Bombay, Calcutta, Kanpur and Muzaffarnagar.

Further Sen (2008) in his report explains that there were no uniform guidelines or regulations. These were essentially outcomes of needs of particular trade communities and were based on mutual trust and faith. They were regulated by social control of close-knit groups and whenever such control failed; there would be a crisis.

In 1990, liberalization & globalization in India resulted in a need to examine the role of futures trading. The Indian government then set up a Committee headed by Prof. K. N Kabrain (1993). As explained by Ahuja (2006) the Committee recommended futures trading in 17 commodity groups. It also suggested strengthening of the Forward Markets Commission and certain amendments to Forward Contracts (Regulation) Act 1952, particularly allowing options trading in goods and registration of brokers with Forward Markets Commission. The Government accepted most of these recommendations and futures' trading was permitted in all recommended commodities.

Sen (2008) pointed out that the futures' trading in agricultural commodities is so far limited to only a few commodities. The volume / production ratio of some of these commodities is too high, indicating prevalence of excessive speculation in futures trading in those commodities. The commodities with a history of high price volatility (e.g. guar seed) are prone to excessive speculative interests which open up futures market to the charge of distorting prices having no linkage to the fundamentals of the demand and supply factors. Antonio and Foster (1992) suggest that the introduction of futures trading enhances both the incentive and means for speculation. The speculative trade associated with futures trading has been accused, however, of destabilizing the underlying spot market inducing price volatility. Explaining speculation further Chassard and Halliwell (1986) comment that speculation can artificially distort price movements so as to exaggerate the normal response to fundamentals. This effect has been noted by a number of other commentators. Further Ollermann and Farris (1985) also suggest that if price discovered in futures market are used to price cash market transactions, futures market may contribute to increased efficiency in commodity markets. Garbade and Silber (1983) explain that the relationship between future prices and corresponding cash commodity prices can reflect the impact of futures market on cash market transactions. Figlewski (1981) points out the problems occurring due to lack of liquidity and the volatility aspects. He points out that the volatility can decrease due to the liquidity provided by the speculators and so the possible adverse future price shift can be compensated.

Further Bhattacharya et al. (1986) used the Figlewski measure to calculate weekly volatility series for spot and futures prices for GNMAs. The authors postulated that the Granger causality test can be used to check the influence of futures volatility on spot volatility. The results suggested that there was no change in spot volatility since futures trading began.

Even though Bhattacharya study was an improved version of studies suggesting use of volatility measure using causality has invited a lot of criticism. Edwards (1988) strongly points out that the inference of futures trading leading to stabilized or unstabilized spot markets cannot be determined by the Causality tests. He argues that the appearance of futures volatility leading spot volatility could be explained by futures markets reacting more quickly to information. This will eventually reach the spot market where it will have a similar effect on volatility.

In a similar vein, Bessembinder Hendrik and Paul J. Seguin (1993) examined greater futures-trading activity (volume and open interest) associated with greater equity volatility. The authors partitioned each trading activity series into expected and unexpected components. The equity volatility co varies positively with unexpected futures-trading volume and is negatively related to forecastable futures-trading activity. The study found no evidence of a relation between the futures life cycle and spot equity volatility. These findings were consistent with theories predicting that active futures markets enhance the liquidity and depth of the equity markets.

A modified Levene statistic and switching GARACH (1,1) – MA (1) model was used by Yu Shang-Wu (2001).The author observes the impact of index futures contracts on the volatility of the spot market. The findings suggest that the volatility of stock returns in the USA, France, Japan and Australia surged significantly while there were no significant changes in the volatility in the UK and Hong Kong. The different results in different markets can be attributed to variation in macroeconomic factors and the structure of the various markets.

Zant Wouter (2001) investigated a hypothetical hedging scheme in a domestic commodity market under which a commodity board offers a forward contract to domestic producers and local traders of natural rubber and covered its commitments on an international futures exchange-Tokyo Commodity Exchange (TOCOM). The study aimed to quantify welfare gains to agents in the market and costs and benefits of the board empirically. The study concluded that the risk aversion of growers is one and a half to two times as high as that of local traders and the negative impact of risk on utility almost completely vanishes if forward contracts are available.

Yang Jianet. al. (2005) examined the lead-lag relationship between futures trading activity (volume and open interest) and cash price volatility for major agricultural commodities and found that an unexpected increase in futures trading volume uni-directionally causes an increase in cash price volatility for most commodities. Also there is a weak causal feedback between open interest and cash price volatility. These findings are generally consistent with the destabilizing effect of futures trading on agricultural commodity markets.

Lien Donald and Yang Li (2007) examined the asymmetric effect of basis on the time varying variance and correlation of spot and future returns and its consequences in dynamic futures hedging strategies in commodity markets. The study has examined the effect of Bivariate GARCH model for estimating the Minimum Variance hedge ratio (MVHR) and found that positive basis has a greater impact than the negative basis on the variance and covariance structure. Results of both in-sample and out of sample revealed that incorporating the asymmetry basis effect into the hedging decision leads to a better risk – reduction. The study concluded that separating the effect of positive and negative basis on the time varying variance – covariance in spot and futures markets not only provides better descriptions of the joint dynamic behaviors of commodity prices, but also plays an important role in determining optimal hedging strategies.

Alizadeh AH et al. (2008)examined constant and dynamic hedge ratios in the New York Mercantile Exchange oil futures markets and also examined their hedging performance. The study introduced a Markov regime switching vector error correction model with GARCH error structure. The study found that the dynamic relationship between spot and futures prices are characterized by regime shifts. With the help of in and out-of-sample tests, the study concluded that state dependent hedge ratios are able to provide significant reduction in portfolio risk and market agents may be able to obtain superior gains, measured in terms of both variance reduction and increase in utility. The study suggested that for the purpose of obtaining more efficient hedge ratios, these should be allowed to be dependent upon the state of the market.

Gallo Giampiero M. and Otranto Edoardo (2008)examined the volatility spillovers, interdependence and co – movements between markets and found that volatility in one market reacts to innovations in other markets as a result of financial integration. The research study employed Multi – Chain Markov Switching Model (MCMS, Otarnto 2005) to study the market characterizations by relying on the definitions of spillover, interdependence and co – movements. The model is estimated on the weekly high – low range of five Asian markets assuming a central (but not necessarily dominant) role for Hong Kong. The results showed plausible market characterizations over the long run with a spillover from Hong Kong to Korea and Thailand, interdependence with Malaysia and co – movement with Singapore.

GemanHelyette and OhanaSteve (2008)examined time – consistency in managing a commodity portfolio. The study determined the problem of managing a storable commodity portfolio which includes physical assets and positions in spot and futures markets. The study revealed that the vast amount of capital involved in the acquisition of a power plant or storage facility implies that the financing period stretches over a period of several quarters or years.

The study assessed that only the recursive dynamic value measures based on a utility-type aggregator and certainty equivalent are time consistent. The study suggested to have important insights through these risk measures on the trade-offs between date specific risks.

Chng Michael T. (2009)examined that non – trivial cross-elasticity and slow information flow are empirically manifested in cross-market volume – volatility interactions among seemingly unrelated commodities. The study investigated cross-market volatility – volume transmission effects in TOCOM's natural rubber, palladium and gasoline futures markets.

Liu Peng (Peter) and Tang Ke (2010)investigated arbitrage – free conditions under the dual cash and storage markets for commodities. The study examined that the convenience yield is non – negative in the absence of the existence of the arbitrage in the cash – storage dual markets. The study employed a three – factor model which captured log – spot price, the convenience yield and the interest rate. The study also considered that the classical models are not arbitrage free because the classical NCY (net convenience yield) models do exhibit a high probability of violating the non – negativity criteria of the convenience yield due to the high degree of volatility of the convenience yield. The study found out that the separation of the convenience yield and the storage cost reduces the volatility of the convenience yield and therefore, yields a smaller probability of violating the non – negative criteria.

Minten Bart et al.(2010)studied the impact of the modern retail on basic foods prices facing urban consumers. The research study indicated that modern retail is emerging quickly and offering more labeled, branded food products and more choice than traditional markets. The study further made an attempt to find out that modern retail at its incipience in India sells basic foods mostly at the same or lower prices than traditional retail and thus become an important contributor to improved urban food security. The study employed hedonic price regression and propensity score matching.

Paschke Raphael and Prokopczuk Marcel (2010)developed a continuous time factor model of commodity prices that allows for higher – order autoregressive and moving average components. The study estimated the parsimonious version of the general model for the crude oil futures market and demonstrated the model's superior performance in pricing nearby futures contracts in – and out – of – sample. The study argued that a simple AR(1) representation of the short – term factor (that is , the convenience yield) is not sufficient to model the futures curve. The study developed a new model that relied on continuous time autoregressive moving average (CARMA) processes and derived closed – form futures and options valuation formulas. The study concluded that the model substantially improves the pricing of long – horizon contracts with information from the short end of the futures curve.

Sakthivel P. and Kamaiah B. (2010)investigated the impact of introduction of index futures trading on volatility of Nifty. The study employed GARCH (1, 1) model to capture the time varying nature of the volatility and volatility clustering phenomena using daily closing price of the Nifty. The results showed that after introduction of the futures trading reduced stock market volatility, due to increase market efficiency. The study also examined futures trading changes structure of spot market volatility using GARCH model. The study observed that there is a changes structure in spot market volatility after introduction futures trading. Specifically, there is evidence that the increased impact on recent news and reduced effect of the uncertainty originating from the old news. The study concluded that the introduction of the derivatives contract improved the market efficiency and reduced the asymmetric information.

Verma Ashutosh and Kumar Vijaya C. V. R. S. (2010) examined the Samuelson's hypothesis which states that the price volatility increases as the contract nears its maturity. The study also examined the BCSS hypothesis which provides that negative covariance between the spot price and net cost of carry explains the maturity effect. The study has examined these hypotheses on the data for wheat and pepper futures contract traded at NCDEX from the date of listing of the contract to 31st March 2007 and the maturity effect has been examined for each contract individually. The study has indicated that maturity effect is present in around 45 per cent of the wheat and pepper contracts. Evidence supporting the BCSS hypothesis is present more strongly in the case of wheat as compared to pepper and 79 per cent of the contracts having maturity effect have depicted negative covariance in the case of wheat. The study concluded that maturity effect is present and it is explained to a large extent by the negative co-variance between spot price and net carry cost.

Debasish S. S. (2011)investigated the effect of futures trading on the volatility and operating efficiency of the underlying Indian stock market by taking a sample of selected individual stocks. The study examined whether the index futures trading in India has caused a significant change in spot price volatility of the underlying stocks and how the index futures trading has affected market/trading efficiency in the Indian futures and stock markets. The study employed event study approach to test whether the introduction of index futures trading has resulted in significant change in volatility and efficiency of the stock returns. The study indicated that the introduction of Nifty index futures trading in India is associated with both reduction in spot price volatility and reduced trading efficiency in the underlying stock market. The study suggested that there is a trade-off between gains and costs associated with the introduction of derivatives trading at least on a short-term perspective.

Fernandez Viviana (2011)analysed annual and monthly series of various commodity categories and considered alternative price deflators. The study tested the existence of downward trends in real commodity prices. The study employed GAUSS routines methodology written by Harvey et al. (2010) . The study tested the significant role of pricede flator and time frequency in identifying a negative and/or broken trend. The study concluded that time frequency and price deflators play a key role when tested for Prebisch – Singer (PS) hypothesis.

Nair Abhilash S. (2011)examined the impact of introduction of derivatives trading on the underlying spot market volatility of seventy two scripts using symmetric and asymmetric GARCH methods. The research study indicated the existence of asymmetric response to new information. Further, the results indicate an increase in the efficiency of processing new information. Overall, the study found that there is a strong evidence of a reduction of volatility after the introduction of derivatives trading.

Back Janis et al. (2012)studied the impact of seasonally fluctuating volatility in commodity markets on the pricing of options. The study incorporated seasonality in volatility as an important aspect to consider for the valuation of futures contracts. The study extended two standard continuous time commodity derivatives valuation models to incorporate seasonality in volatility. The study concluded that incorporating the stylized fact of seasonally fluctuating volatility significantly improves options valuation performance and suggested that seasonality in volatility should be accounted for when dealing with options on seasonal commodities.

Nazlioglu Saban et al. (2012) examined whether volatility in oil prices have any explanatory impact on the volatility in agricultural commodity prices. The study investigated volatility spillover between oil and selected agricultural commodity markets (wheat, corn, soybean and sugar) that are key agricultural products for biofuels and for food in the world. The study focused on determining the impact of the food price crisis by dividing the data into two sub - periods: pre crisis period and post crisis period. The study found out that there is no risk transmission between oil and agricultural commodity markets in the pre-crisis period, but the oil market volatility spills on the agricultural markets (with the exception of sugar) in the post-crisis period. The study suggested that local measures to suppress price uncertainty in agricultural markets may not be effective in the short run. The global factors such as the risk in energy markets seem to drive the short run volatility in agricultural markets. The importance of this effect is higher for countries that are most vulnerable to food price fluctuations. Silverio Renan and Szklo Alexandre (2012)examined the contribution of the futures market to the price discovery process in the spot market for crude oils. The study employed the Kalman filter technique to study the relationship between West Texas Intermediate(WTI) spot and futures prices. The study found that recent evolution of the financial markets has affected the futures oil market so as to increase its contribution to the price discovery process of the spot market. The study concluded that futures markets contribution to price discovery has been increasing throughout time.

Research Methodology

Market efficiency of the commodity market is one of the important issues for the participants of the market. An efficient commodity market reflects the fair pricing of the commodities which is one of the requirements for a developing economy like India as it affects a large number of consumers. In the study, the daily data of closing prices of the agri commodities (guar seed and chana) are collected from NCDEX website for the period from 1 April 2004 up to 31st March 2012. Chana is one of the major consumable commodities in India whereas the guar seed in more like as industrial commodity. The daily returns of the spot as well as future prices of these commodities are calculated using the equation $R_t = \log (P_t/P_{t-1}) * 100$ where, Rtis the daily returns, Pt is the price of the commodity at time t, Pt-1 is the price of the commodity at time t.

This paper examines the existence of long term equilibrium relationships, if any, between the spot and future prices of the two commodities as well as the information efficiency of spot and future markets of the commodities. In addition to this, efforts are made to analyze the lead-lag relationships between the volatility in the spot prices and volatility in commodity futures markets. The ADF unit root test, Phillip Perron and KPSS tests are used to test the presence of unit root in the price series. The Johansan's cointegration test is used to test the presence of long term equilibrium relationship between the spot and future market of the commodities. The Vector Error Correction Model (VECM) is used to analyze the error correction mechanism takes place if some disturbance comes in the equilibrium relationship. The Block Exogeneity test (Wald Test) is applied to analyze the short run causality relationship between spot and future market of the commodities. The GARCH (1,1) test with squared lagged residuals of other series as exogenous variable is used to analyze the volatility spillover effects between the spot and future markets. The analysis is done with the help of software's MS Excel and Eviews.

Data Analysis and Interpretation

The Agri commodities guar seed (industrial commodity) and chana (direct consumable commodity) are considered for the study and the behavior of spot prices of both commodities during the period (April 2004 to March 2012) are shown in figure 1 and figure 2. Figure 1 shows the sudden jump in the prices of guar seed after Dec 2011. The basic reason of this jump was the exponential increase in export demand of guar gum. Guar gum is a derivative from guar seed which is mainly used in petroleum refining, food processing and pharmaceutical industry. During the year 2010-11, India exported 4.03 lakh tonnes of guar gum, which is the jump of 85 percent over 2009-10. India is the key exporter of this commodity. India produces 80 percent of the world's total guar gum output in a year. The other reason for a sharp price rise of guar seed is a drop in the supply in the market due to a below normal rainfall in Rajasthan. The production of guar seed in 2011-12 seasons has been estimated at around 11.4 lakh tonnes against 15.5 lakh tonnes last year, a 25 per cent drop.

With respect to the commodity chana, India is the world's largest producer as well as consumer of this commodity. Indian production of chana contributes to nearly 65-70 percent of the global production. In addition to this, out of the total pulses production in the country chana contributes to nearly 45-48 percent. The major players in the trading of chana includes wholesale traders, mills, Commission agents, broker's stockiest, and retail outlets. At present chana is the only pulse in the world which is being traded at the Indian futures exchanges and the volume of trade and liquidity is high and is at par with the other commodities. The price behaviour of the spot prices of chana as shown in fig below indicates the consistent rise in its prices over time, due to which the chana is considered as one of the good commodity to trade in the commodity market.

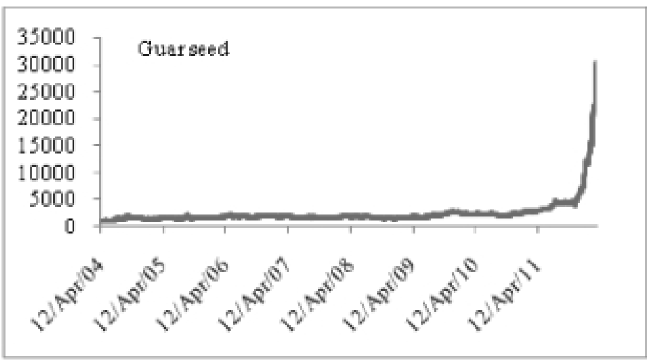

Fig.1Behavior of Gaur Seed Spot Prices with time

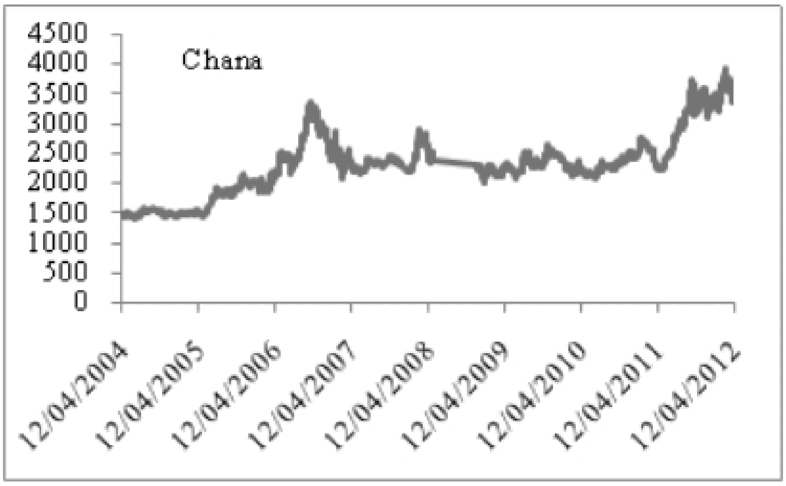

Fig.2 Chana Spot prices with time

The descriptive statistics of the spot and future closing prices of guar seed and chana are shown in table 1. The result indicates the presence of a positive skewness and leptokurtic behavior in the spot and future prices of both the commodities. Due to this the distribution is not normal as indicated by probability values of JarqueBera Test.

Table 1: Descriptive Statistics of Spot and Future daily Closing Prices of Commodity Chana and Gaur Seed No. of observations 2274

Descriptive Statistics	Channa				Gaur Seed			
	Spot Close	Future Close	Spot returns	Future returns	Spot Close	Spot returns	Future Close	Future Returns
Mean	2285.36	2313.18	0.0004	0.0004	2506.67	0.0013	2543.35	0.0013
Median	2269.50	2306.00	0.0000	0.0000	1828.78	0.0007	1867.00	0.0006
Maximum	3900.00	3891.00	0.09	0.13	30432	0.12	29900	0.13
Minimum	1386.45	1398.00	-0.08	-0.16	1005.70	-0.19	1024.00	-0.25
Std Dev.	525.29	523.69	0.01	0.02	2716.67	0.02	2731.08	0.02
Skewness	0.48	0.42	-0.21	-0.97	6.03	-0.43	6.06	-0.75
Kurtosis	3.26	3.10	7.29	18.47	44.83	17.10	45.32	17.53
Jarque-Bera	92.29	67.50	1698.74	22175.57	179556.3	18906.66	183662.4	20217.52
Probability	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

It is a recognized fact that many financial time series (commodity prices in this research paper) are random walk or non-stationary time series and contains unit root. Test of unit root in the spot and future commodity prices of guar seed and chanais necessary as the presence of unit root may give invalid inferences in the analysis. Augmented Dickey-Fuller (ADF) test is the popular test for unit root testing of time series. If Yt is the time series to be tested for unit-root, then the test statistic for ADF unit root testing will be given by τ statistics, which is OLS estimate of coefficient of Yt-1 in equation (1), divided by its standard error:

$$\Delta y_t = \rho y_{t-1} + \mu + \lambda_t + \alpha_i \sum_{i=1}^{n} y_{t-i} + u_t \quad \text{... Eq.(1)}$$

Table 2 and table 3 shown below indicate the results of unit root test applied on the spot and future closing prices of chana and guar seed using ADF test along with Philip Perron and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test. The result indicates that both of the commodities are non-stationary at level (prices) but becomes stationary at their first difference. The cointegration test is applied on commodity prices (non-stationary series) however for volatility spillover where stationary series are required, the log returns of the spot and future closing prices are used.

Table 2: Unit Root test Result for Commodity Chana at MCX

Series		ADF Unit Root Test Statistic			Philip Perron Test Statistic			KPSS LM Statistic	
		None	With Intercept	With Trend and Intercept	None	With Intercept	With Trend and Intercept	With Intercept	With Trend and Intercept
Daily Spot closing price of Chana	At Level	0.827 (0.890)	-1.268 (0.647)	-2.350 (0.406)	0.977 (0.914)	-1.059 (0.734)	-2.120 (0.534)	3.272	0.509
	At First Difference	-41.389 (0.000)	-41.408 (0.000)	-41.402 (0.000)	-41.109 (0.000)	-41.126 (0.000)	-41.119 (0.000)	0.079	0.066
Daily Future closing price of Chana	At Level	0.849 (0.894)	-1.166 (0.691)	-2.387 (0.368)	0.855 (0.895)	-1.156 (0.695)	-2.373 (0.394)	3.455	0.458
	At First Difference	-47.156 (0.000)	-47.173 (0.000)	-47.168 (0.000)	-47.155 (0.001)	-47.172 (0.000)	-47.167 (0.000)	0.069	0.053

Table 3: Unit Root test Result for Commodity Gaur Seed

Time Series Variable		ADF Unit Root Test Statistic			Philip Perron Test Statistic			KPSS LM Statistic	
		None	With Intercept	With Trend and Intercept	None	With Intercept	With Trend and Intercept	With Intercept	With Trend and Intercept
Daily Spot closing price of Gaur Seed	At Level	3.597 (0.999)	7.218 (1.000)	7.913 (1.000)	9.077 (1.000)	17.046 (1.000)	17.998 (1.000)	1.707	0.448
	At First Difference	0.6699 (0.860)	0.477 (0.986)	-0.029 (0.995)	-36.457 (0.000)	-36.267 (0.000)	-36.219 (0.000)	1.436	0.617
Daily Future closing price of Gaur Seed	At Level	3.4078 (0.999)	6.803 (1.000)	7.340 (1.000)	8.420 (1.000)	13.117 (1.000)	12.055 (1.000)	1.686	0.452
	At First Difference	1.7182 (0.979)	1.526 (0.999)	1.013 (0.999)	-36.871 (0.000)	-37.095 (0.000)	-37.144 (0.000)	1.295	0.573

In commodity market the future prices of the commodities can be derived from the spot prices, due to which a theoretical relationship is supposed to exist between the spot and future prices of the commodities. The existence of this long term equilibrium relationship between the spot and future prices of the commodities can be tested using cointegration test. The cointegration test is applied on the price series as it requires both of the series integrated at the same order.

The cointegration test was introduced by Granger (1981, 1983) and Engle and Granger (1987) to explain stationary equilibrium relationship among the non-stationary variables. The cointegration test is useful in analyzing the presence of a stationary linear combination among the non-stationary variables of the same order. If such combination is found, an equilibrium relationship is said to exist between the variables. The Johansen cointegration test is applied in the research study between the spot and future closing prices of the commodities guar seed and chana. The result of the Johansen's Co-Integration Test is shown in table 4 and table 5. The result indicates the presence of long term relationship between the spot and future closing prices of both the commodities. Hence the long term equilibrium relationship also exists between the spot and future closing prices of the commodities guar seed and chana.

Table 4: Johansen's Co-Integration Test on spot and future prices of Chana

Cointegration Between	Lag length selected	Cointegration test using	No. of Cointegrating Equations (CEs)	Eigen Value	Statistic	Critical value at 5%	Probability **
Daily Spot Closing and Daily Future Closing of Chana	1 to 4 (in first difference of 2 series)	Trace test	H0: r=0 (None) H1: r ≤ 1 (At most 1)	0.222 0.000	50.328 0.973	15.495 3.841	0.000 0.324
		Max-Eigen Value test	H0: r=0 (None) H1: r ≤ 1 (At most 1)	0.022 0.000	49.354 0.973	14.265 3.841	0.000 0.324

Trace test indicates 1 Cointegrating equation at 5% level of significance
Max-eigen test indicates 1 Cointegrating equation at 5% level of significance

- Denotes rejection of null hypothesis at 5% level of significance
- **Mackinnon et.al.(1999) estimated p values

Table 5: Johansen's Co-Integration Test on spot and future prices of Gaur Seed

Cointegration Between	Lag length selected	Cointegration test using	No. of Cointegrating Equations (CEs)	Eigen Value	Statistic	Critical value at 5%	Probability **
Daily Spot Closing and Daily Future Closing of Chana	1 to 4 (in first difference of 2 series)	Trace test	H0: r=0(None) H1: r ≤ 1(At most 1)	0.096 0.044	329.712 101.752	15.495 3.841	0.000 0.000
		Max-Eigen Value test	H0: r=0(None) H1: r ≤ 1(At most 1)	0.096 0.044	227.960 101.752	14.265 3.841	0.000 0.000

Trace test indicates 1 Cointegrating equation at 5% level of significance
Max-eigen test indicates 1 Cointegrating equation at 5% level of significance

- Denotes rejection of null hypothesis at 5% level of significance
- **Mackinnon et.al.(1999) estimated p values

The equilibrium relationship between the non-stationary variables is used to construct an Error Correction Model (ECM). An error correction model is a statistical specification of economic dynamics through which the pull and push forces restore the equilibrium relationship whenever a disequilibrium takes place. In commodities market the future prices can be estimated using deterministic models. According to these models the future prices of the commodities should be equal to the spot prices plus cost of carry.

In commodities the carrying cost includes capital cost, storage cost minus the convenience yield if any. Any difference between the theoretical and actual prices of the commodities may lead to arbitrage opportunities in the market. These arbitrage opportunities help in correcting the disequilibrium between the spot and future prices of the commodities in the market.

The results of the Error Correction model is shown in table 6 for both the commodities. The result indicates that the in case of chana the equilibrium is maintained by both the spot and future series as indicated by t statistics of Equilibrium error for both spot (3.825) and future (-3.546). However, the correction of the equilibrium error is higher in case of the spot prices. In case of guar seed the results indicates that spot price corrects the disequilibrium between the spot and future prices.

Table 6: Error Correction Model Result for Future and Spot price the Commodities

Exchanges	Variables	Δ(Spot)		Δ(Future)	
		Coefficient	t value	Coefficient	t value
Chana	Equilibrium Error	0.031	3.825	-0.037	-3.546
	ΔSpot(-1)	-0.084	-3.821	0.014	0.508
	ΔFuture(-1)	0.392	19.942	0.001	0.042
	Constant	0.662	0.994	0.942	1.124
Gaur Seed	Equilibrium Error	0.364	7.584	-0.097	-2.958
	ΔSpot(-1)	0.537	13.130	0.800	28.518
	ΔFuture(-1)	-0.263	-7.381	-0.399	-16.309
	Constant	8.234	2.130	6.091	2.297

Table 7 represents the results of the Block Exogeneity Wald Test in vector error correction model for chana and guar seed. The results indicate that there exists the bidirectional causality in case of guar seed and unidirectional causality (from future to spot) in case of chana. In guar seed, the Chi square statistic in case of change in future as dependent variable is higher as compared to change in spot as dependent variable. This indicates that although there exists bi-directional causality in spot and future price behavior of guar seed, yet the impact of spot on future is higher. In case of chana the changes in future prices leads to the changes in spot prices.

Table 7: VEC Grangers Causality/ Block Exogeneity Wald Test for Chana

Dependent Variable	Excluded	Chana		Gaur Seed	
		Chi Square Statistic	P Value	Chi Square Statistic	P Value
Δ(Spot)	Δ(Future)	397.679	0.000	54.486	0.000
Δ(Future)	Δ(Spot)	0.259	0.611	813.298	0.000

Variance decomposition explains the percentage of forecasting error that can be explained with the help of variances in its previous behavior as well as the behavior of other series. The results of variance decomposition of spot and future prices of guar seed and chana for ten lags are shown in table 8.

The results indicate that in case of chana the forecasting error in spot prices is mainly explained by the variations in the lagged values of future series whereas the forecasting error in future prices is mainly explained by the variations in its own lagged values. The results also indicates that in case of commodity guar seed the forecasting error in spot prices is also mainly explained by the variations in the lagged values of future series whereas the forecasting error in future prices is explained by the variations in its own lagged values. Hence it can be concluded that the future prices of both the commodities are exogenous in nature whereas the spot prices are influenced by the lagged behavior of future prices.

Table 8 : Forecast Error Variance Decomposition for Chana

	Chana				Gaur Seed			
Period	Variance Decomposition of SC		Variance Decomposition of FC		Variance Decomposition of SC		Variance Decomposition of FC	
	SC	FC	SC	FC	SC	FC	SC	FC
1	72.08	27.92	0.00	100	36.43	63.57	0.000	100
2	50.05	49.95	0.06	99.94	34.48	65.52	15.54	84.46
3	45.63	54.37	0.14	99.86	30.25	69.75	14.74	85.26

	Chana				Gaur Seed			
Period	Variance Decomposition of SC		Variance Decomposition of FC		Variance Decomposition of SC		Variance Decomposition of FC	
	SC	FC	SC	FC	SC	FC	SC	FC
4	43.23	56.77	0.24	99.76	26.57	73.43	13.40	86.60
5	41.71	58.29	0.37	99.63	23.53	76.47	12.15	87.85
6	40.58	59.42	0.52	99.48	21.06	78.94	11.08	88.92
7	39.69	60.31	0.69	99.31	19.04	80.96	10.18	89.82
8	38.94	61.06	0.88	99.12	17.37	82.63	9.44	90.56
9	38.29	61.71	1.08	98.92	15.99	84	8.82	91.18
10	37.72	62.28	1.29	98.71	14.83	85.17	8.29	91.71

The impulse response explains the responsiveness of the endogenous variable in the system to shocks to each of the other endogenous variables. So, for each endogenous variable in the system, a unit shock is applied to the error, and the effects over time are noted. Figure 2 and figure 3 represents the pair wise impulse response relations between the spot and future prices of guar seed and chana respectively. The results indicate the significant and higher response of the spot prices to the shocks in future prices in case of both the commodities guar seed and chana.

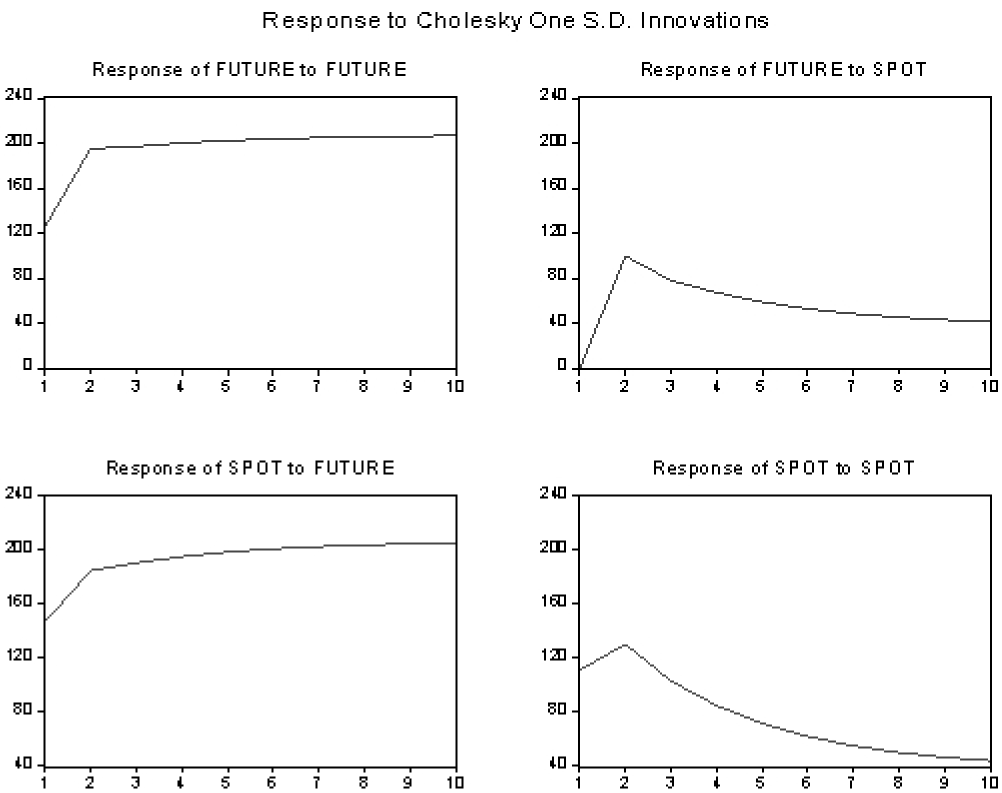

Fig3: Impulse Response Function of Gaur Seed

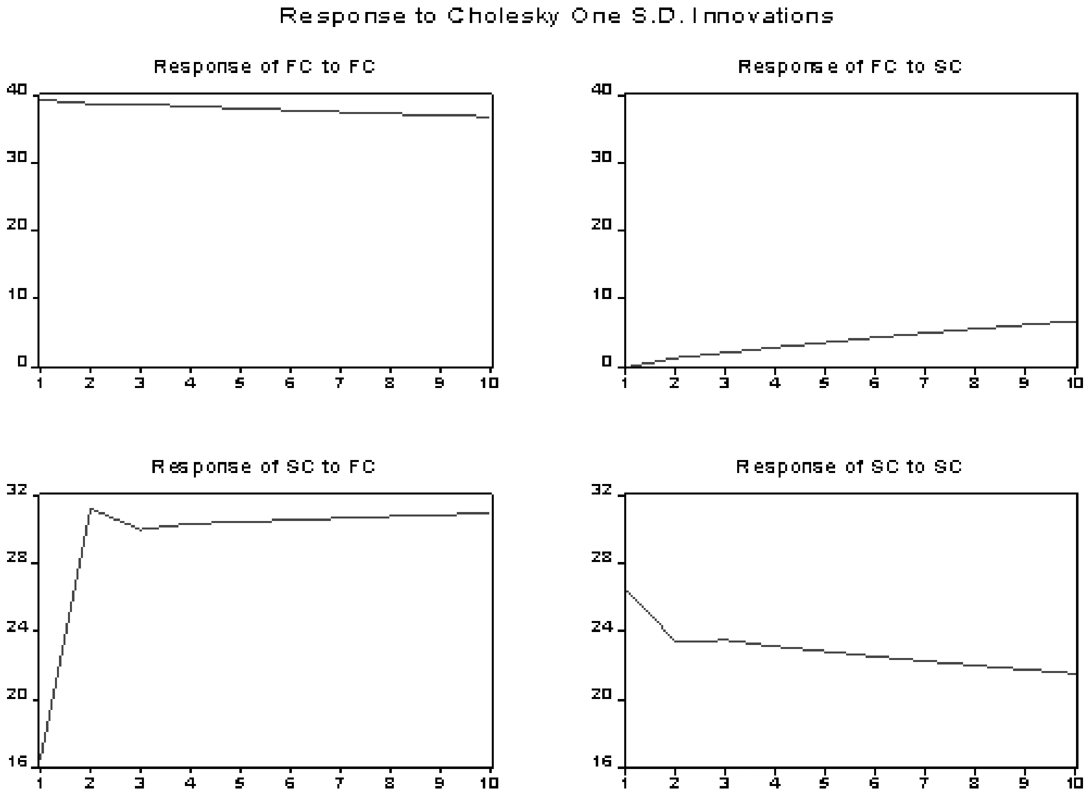

Fig 4: Impulse Response Function of Chana

Volatility Spillover

The future market of the commodities is featured with high volume of trade with better liquidity due to low margin requirements and the presence of large number of participants including traders, speculators and arbitrageurs. Due to this reason the future markets of the commodities are supposed to be more efficient as compared to spot market. Hence when new information about the commodity comes into the market, the participants responds to the information and involves in rebalancing their positions in the portfolios according to their perception about the future implications of the news. In such a case the future market is very fast to respond to the news as compared to the spot market. In this system the volatility lying in the commodity prices is also a major concern for the participants. The objective of this paper is also to analyze the impact of volatility in one series on the future volatility in other series.

The volatility spillover between the spot and prices of the commodities guar seed and chana is analyzed using GARCH (1,1) method. GARCH (1,1) technique were developed independently by Bollerslev (1986) & Taylor (1986). GARCH model allows the conditional variance to be dependent upon previous own lags, so that the conditional variance equation in simplest case is now

$$\sigma_t^2 = \alpha_o + \alpha_1 u_{t-1}^2 + \beta \sigma_{t-1}^2 \quad \text{......eq (2)}$$

This is a GARCH(1,1) model. "σ^2_t is" known as conditional variance since it is a one-period ahead estimate for the variance calculated based on any past info thought relevant. In the above mentioned eq 2, one more exogenous variable is included, the square of the lagged error terms of other variable, estimated with the help of ARMA forecasting models. The new equation can be represented as

$$\sigma_t^2 = \alpha_0 + \alpha_1 \mu_{t-1}^2 + \beta_1 \sigma_{t-1}^2 + \beta_2 \epsilon_{t-1}^2 \quad \text{......eq (3)}$$

Where, the last term represents the square of the lagged error terms of other variable. The results of equation 3 for spot and prices of the commodities guar seed and chana are shown in table 9 to table 12. The result indicates the existence of volatility spillover in case of guar seed from future returns to spot returns as indicated by the z statistics (11.84) in table 9. This indicates that in case of guar seed the volatility in future prices influences the volatility in the future movement of the spot prices of the guar seed. Although the significant impact of past volatility in spot prices on the future volatility in future prices can be spotted in the results but in our point of view it can be termed as cascading effects because of co movement of the series.

Table 9: Volatility spillover effects from future market to spot market in case of guar seed

Dependent Variable: Spot returns in Gaur Seed Method: ML - ARCH (Marquardt) - Normal distribution				
Mean Equation				
	Coefficient	Std. Error	z-Statistic	Prob.
C	0.000544	0.000305	1.782563	0.0747
AR(1)	0.314239	0.379283	0.828507	0.4074
MA(1)	-0.260009	0.389669	-0.667255	0.5046
Variance Equation				
C	7.28E-06	1.24E-06	5.861468	0.0000
Residual Term	0.089704	0.011388	7.876931	0.0000
GARCH Term	0.798158	0.012942	61.67117	0.0000
Squared lagged residual in future returns of guar seed	0.076422	0.006450	11.84838	0.0000

Table 10: Volatility spillover effects from future market to spot market in case of guar seed

Dependent Variable: Future returns in Gaur Seed				
Mean Equation				
	Coefficient	Std. Error	z-Statistic	Prob.
C	0.000984	0.000375	2.622048	0.0087
AR(1)	-0.304832	0.245673	-1.240803	0.2147
MA(1)	0.358093	0.241290	1.484075	0.1378
	Variance Equation			
C	1.45E-05	1.86E-06	7.798638	0.0000
Residual Term	0.011118	0.004660	2.385877	0.0170
GARCH Term	0.905461	0.010090	89.73554	0.0000
Squared lagged residual in Spot returns of guar seed	0.057049	0.006959	8.198224	0.0000

For the commodity chana, the result indicates the volatility spillover effects from spot returns to future returns as indicated by the z statistics (10.62) in table 11. This indicates that in case of chana the volatility in spot market influences the volatility in the future movement of the future prices of the chana.

Table 11: Volatility spillover effects from spot market to future market in case of chana

Dependent Variable: Future returns in Chana				
Mean Equation				
	Coefficient	Std. Error	z-Statistic	Prob.
C	0.000559	0.000312	1.795916	0.0725
AR(1)	-0.752064	0.286100	-2.628676	0.0086
MA(1)	0.762860	0.282524	2.700163	0.0069
Variance Equation				
C	1.26E-06	1.77E-07	7.138355	0.0000
Residual Term	0.008996	0.001286	6.996596	0.0000
GARCH Term	0.967436	0.002562	377.5893	0.0000
Squared lagged residual in spot returns of chana	0.027581	0.002596	10.62274	0.0000

Table 12: Volatility spillover effects from future market to spot market in case of chana

Dependent Variable: Spot Returns in Chana				
Mean Equation				
	Coefficient	Std. Error	z-Statistic	Prob.
C	0.000407	0.000290	1.403651	0.1604
AR(1)	-0.149385	0.143461	-1.041292	0.2977
MA(1)	0.308248	0.137117	2.248074	0.0246
Variance Equation				
C	7.00E-06	9.14E-07	7.655934	0.0000
Residual Term	0.097296	0.013866	7.016628	0.0000
GARCH Term	0.779511	0.016654	46.80556	0.0000
Squared lagged residual in future returns of chana	0.074985	0.008784	8.537002	0.0000

Conclusions

The spot and future prices of both the commodities (guar seed and chana) are found to have long term relationship, which is supported by the existence of an error correction mechanism called arbitrage. This error correction mechanism restores the equilibrium relationship whenever some disequilibrium takes place between the two commodity markets. The arbitrage opportunities can be theoretically explained as the difference between the estimated prices using deterministic models and the actual prices in the market. These arbitrage opportunities help in correcting the disequilibrium between the spot and future prices of the commodities in the market. It is found that the correction of the disequilibrium is higher due to the response from the spot prices in case of guar seed.

The bidirectional causality is found to exist between the spot and future market for guar seed and unidirectional causality (from future to spot) exists in case of chana. In guar seed, the impact of spot on future is higher. In case of chana the changes in future prices leads to the changes in spot prices.

The forecasting error in spot prices of chana is found to be explained by the variations in the lagged values of future series whereas the forecasting error in future prices is mainly explained by the variations in its own lagged values. For guar seed the forecasting error in spot prices is also mainly explained by the variations in the lagged values of future series whereas the forecasting error in future prices is explained by the variations in its own lagged values. The future prices of both the commodities are exogenous in nature whereas the spot prices are influenced by the lagged behavior of future prices. The significant and higher response of the spot prices to the shocks in future prices in case of both the commodities guar seed and chana is found in the study.

The future market of the commodities is featured with high volume of trade with better liquidity due to low margin requirements and the presence of large number of participants including traders, speculators and arbitrageurs. Due to this reason the future markets of the commodities are supposed to be more efficient as compared to spot market. Hence when new information about the commodity comes into the market, the participants responds to the information and involves in rebalancing their positions in the portfolios according to their perception about the future implications of the news. In such a case the future market is very fast to respond to the news as compared to the spot market. In this system the volatility lying in the commodity prices is also a major concern for the participants. In case of guar seed the volatility in future prices influences the volatility in the spot prices. Although the significant impact of past volatility in spot prices on the future volatility in future prices can be spotted in the results but in our point of view it can be termed as cascading effects because of co movement of the series. For the commodity chana, the volatility spillover effects is found from spot returns to future returns which means that the volatility in spot market of chana influences the volatility in the future movement of the future prices.

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