Testing Efficiency of Guar seed Futures: Empirical Evidence from India

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The paper aims to study the market efficiency, *unbiasedness among Guar seed futures contracts traded at National Commodity & Derivatives Exchange Ltd (NCDEX). The study has tested the* market efficiency and unbiasedness with different maturities using cointegration analysis, and short-term market efficiency, using an error correction model and GARCH-M-ECM. *The results suggest that futures market for guar seed is inefficient and biased in both short run and long run for all maturity periods, which may be caused by over-speculation or market manipulation. The results indicate an urgent need to provide more powers to FMC to regulate the market and penalize any insider trading, cartelization and price manipulations.*

Keywords: Cointegration, Market efficiency, Futures market, Guar gum
JEL Classifications: C14, C32, G14

Introduction

The recent fiasco in futures trading of guar[2] contracts has flagged off concerns over the role of commodity exchanges in fuelling inflation,

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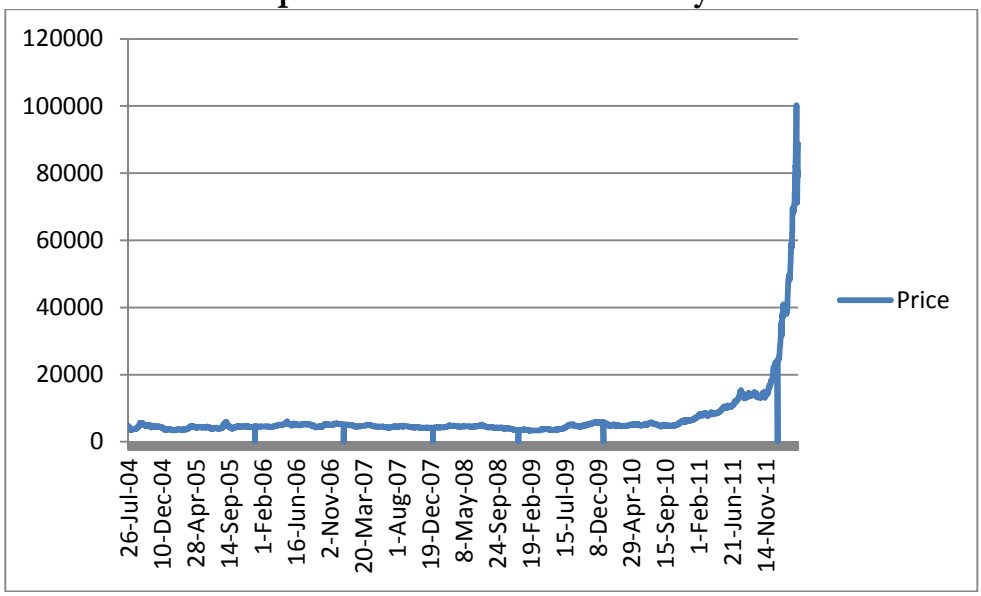
[2]Guar , cultivated largely in Rajasthan(India) and used as an additive and thickening agent in vide range of industries including food, animal feed, paper, textiles, ore

volatility and speculation rather than performing its prime objective of price discovery and risk management to its stakeholders.The future prices of both guar seed and guar gum contracts experienced an unusual movement in 2011-2012. The prices in 2011-12 soared all most 10 times higher than last year and which was the steepest rise in any agricultural commodity in the history of Indian future exchanges (Figure 1). The future price change volatility (return volatility) in 2011-12 has gone up by almost 80% compared to 2010-11 figures (Jha, 2012).

Figure 1

Spot Price of Guar over the years



Source of data: NCDEX website

To curb price volatility and speculation in the commodity exchanges the Forward Markets Commission (FMC) banned traders from taking

floatation, explosives, shale gas exploration etc. The country commands about 80% of the global production followed by Pakistan. Guar also emerged as the biggest agricultural item of export for India in 2011, upstaging the much better known items of basmati and non-basmati.

fresh positions in the running contracts in March 2012 and also constituted a 40 member advisory committee, headed by the FMC chairman Ramesh Abhishek and other stakeholders groups including Warehousing Development and Regulatory Authority (WDRA), Securities and Exchange Board of India (SEBI), promoters of commodity bourses, farmers and co-operatives.

Further, the industry body The Associated Chambers of Commerce and Industry of India (ASSOCHAM) has opposed re-listing of guar seed and gum in the futures market till the Forward Contract Regulation Amendment (FCRA) Bill accords adequate powers to Forward Markets Commission (FMC) to regulate and penalize any insider trading, cartelization and price manipulations in the market. On the other the advisory committee has recommended the re-introduction guar contract on exchange platforms, as guar prices have nose dipped after the imposition of ban and the guar farmers, processors are stuck in a vicious cycle of debt, regulatory logjam and market economy as they had anticipated high prices and bought seeds, loans etc. at higher rates.

In the amidst of conflicting viewpoint regarding relisting of guar contracts it becomes imperative to test whether guar futures contracts in the past have been providing crucial role of price discovery and risk management to its stakeholders. More specifically, the paper tests the efficiency and unbiasedness in context of guar seed contracts traded at NCDEX. It employs a quantitative approach to examine: (i) the long-run efficiency and unbiasedness among the futures and the spot price for different maturities for guar seed contracts; (ii) the short-term market efficiency, using an error correction model and GARCH-M-ECM model. If the guar future contracts are found to be efficient and unbiased in terms of providing effective signals to the spot market leading to price discovery and price risk management, relisting of guar seed contract is justified otherwise FMC should reconsider its decision for relisting such contracts on the exchange.

The remainder of the article is organized as follows. Section 2 presents a brief review of literature. Section 3 describes the data source and the methodology adopted in the study. Section 4 presents the empirical results. Finally, Section 5 provides a summary and concludes.

Literature Review

The issue of the lead-lag relationship among future and spot prices using Johansen's cointegration framework has been researched extensively in financial markets across the globe (see Lai and Lai, 1991; Fortenbery and Zapata, 1993; Crowder and Hamed, 1993; Kellard et al., 1999, Antoniou et al., 2001; McKenzie and Holt, 2002; Wang and Ke, 2005; Maslyuk and Smith, 2009; Kawamoto and Hamori, 2011; Bhattacharya and Singh, 2012). Of late, studies in this area gained importance in India too after the commodity market reforms were initiated by government of India through opening up of national level commodity exchanges. Examples of research on price discovery and efficiency of the Indian commodities markets include Sahadevan, 2004; Raizada and Sahi, 2006; Lokare, 2007; Bose, 2008; Kumar and Pandey, 2008; Sahoo and Kumar, 2009; Iyer and Pillai, 2010; Kaur and Rao, 2010; Ali and Gupta, 2011; Sehgal, Rajput and Dua, 2012. The existence of cointegrating relationship using Johansen's cointegration approach has been supported by majority of studies (see Lokare, 2007; Kumar and Pandey, 2008; Sahoo and Kumar, 2009; Ali and Gupta, 2011; Sehgal, Rajput and Dua, 2012.) However, only few studies have studied the future and spot relationship for guar contracts that too for guar seed contracts (see Kaur and Rao, 2010; Ali and Gupta, 2011; Sehgal, Rajput and Dua, 2012.).

Sahadevan (2004) performed tests on futures and spot prices for six agricultural commodities traded at different regional exchanges between January 1999 to August 2001 and obtained results rejecting $\beta_o = 0$, $\beta_1 = 1$. Raizada and Sahi (2006) tested futures and spot prices for wheat contract traded at NCDEX between July 2004 to July 2006 and obtained results rejecting $\beta_o = 0$, $\beta_1 = 1$. Whereas Bose (2008) obtained

results against market efficiency and price discovery of Indian agricultural indices between June 2005 to September 2007. Kaur and Rao (2010) considered four agricultural commodities, namely, Chana, Pepper Malabar, Refined Soya Oil and Guar seed from July 2008 to July 2009 and found future contracts of Pepper and Guar seeds were not fairly priced and had scope for arbitrage opportunity. Iyer and Pillai (2010) found evidence for price discovery in futures market in five out of six commodities using a two-regime threshold vector auto regression (TVAR) and a two-regime threshold autoregression model from October 2005 to March 2008. Ali and Gupta (2011) in their study examined the price discovery of 12 major agricultural commodities including guar seed contract using cointegration and granger causality analysis between July 2004 to January 2007 and found significant cointegration between futures and spot prices for all the selected agricultural commodities excluding wheat and rice. Sehgal, Rajput and Dua (2012) in their study examined the price discovery of 10 major agricultural commodities including guar seed contract using cointegration and granger causality analysis between Nov 2003 to March 2012 and found significant cointegration between futures and spot prices in 9 out of 10 selected agricultural commodities excluding turmeric.

From the empirical literature cited above, it is clear that studies on Guar seed future contracts are rare. Additionally, none of the existing research has tested the efficiency and unbiasedness of guar futures with different maturities. Further, most of the studies have which have tested the existence of cointegrating relationships have not tested the cointegrated vectors (β_o, β_1) (see Kaur and Rao, 2007; Ali and Gupta, 2011; Sehgal, Rajput and Dua, 2012) which might have lead to wrong conclusions regarding efficiency and price discovery. As though cointegration between the spot price and futures price is only a necessary condition for market efficiency however, if the restriction $\beta_1=1$ is not rejected then there is strong evidence against the efficiency

and unbiasedness of the markets (Kellard et al., 1999). Furthermore, cointegrating relation may not be supported even if the markets are efficient incase the liquidity of spot markets is significantly different from that of futures markets (Kawamoto and Hamori, 2010). The present research examines the cointegrating relationships and then tests cointegrating vectors for unbiasedness for Guar seed contracts from June 2004 to September 2012 at various maturities. It also tests the short-term market efficiency using Beck (1994) error correction model and McKenzie and Holt (2002) GARCH-M-ECM model.

Data and Methods

Data

The data for the study comprises of daily closing spot and futures prices from April 2004 till March 2012 collected from NCDEX website.We initially began with the closing prices from April 2004 to March 2012. However, the futures contracts before August, 2008 were of small duration i.e. for 3 month maturity and study required contracts with longer maturity length. Accordingly we only chose data post August, 2008 which had maturity of 6 months. In this study, maturity length of a futures contract is defined as the remaining time to its expiration and accordingly future price series was classified into six sub categories i.e. maturity less than 30 days, 31-60 days, 61-90 days, 91-120 days, 121-150 days and 151-180 days. Following Kellard et al., 1999 the futures prices of these contracts were matched with the spot price. This procedure allowed for testing efficiency of these contracts for different horizons which can help to see the impact of efficiency on the period left for maturity. All series are analyzed in natural logarithmic form.

The descriptive statistics such as mean, standard deviation, skewness etc. for spot series and future series for all the commodities are presented in Table 1.

Table 1

Descriptive statistics

Series	Mean	Std. Dev.	Skewness	Kurtosis	J-Bera	Prob.	Obs.
FUT1	7.875	0.217	0.173	2.440	18.979	0.000	1051.000
FUT2	7.909	0.239	0.219	2.553	16.417	0.000	1005.000
FUT3	7.936	0.259	0.262	2.828	12.698	0.002	1005.000
FUT4	7.966	0.307	0.532	3.640	65.190	0.000	1016.000
FUT5	8.010	0.371	1.204	5.444	494.054	0.000	1007.000
FUT6	8.056	0.455	1.595	6.949	1085.440	0.000	1011.000
SPOT1	7.803	0.238	0.475	3.057	39.600	0.000	1051.000
SPOT2	7.850	0.262	0.459	2.853	36.249	0.000	1005.000
SPOT3	7.890	0.282	0.399	2.682	30.826	0.000	1005.000
SPOT4	7.933	0.322	0.531	3.147	48.688	0.000	1016.000
SPOT5	7.989	0.384	1.155	5.054	400.814	0.000	1007.000
SPOT6	8.045	0.460	1.579	6.774	1019.866	0.000	1011.000

Data Source: NCDEX Website

Note: FUT1 represents maturity less than 30 days, FUT2 represents maturity between 31-60 days, FUT3 represents maturity between 61-90 days, FUT4 represents maturity between 91-120 days, FUT5 represents maturity between 121-150 days andFUT6 represents maturity between 151-180 days.

Econometric methods

This study empirically analyzes the weak form efficiency for Guar seed futures contracts traded at NCDEX. The conventional process of testing for efficiency requires first testing the presence of cointegration and second testing that futures price at contract purchase is an unbiased predictor of the spot price at the contract termination (Chowdhury, 1991; Lai and Lai, 1991; Kellard et al., 1999).

Before testing for cointegration, each individual price series was examined to determine whether they are I (1). Augmented Dickey-Fuller (ADF) test and non-parametric Phillips-Perron (PP) approaches were employed to examine the stationarity of all the futures and spot price series. In the second step we test for the presence of

cointegration among future and spot series for all six maturity horizons. Subsequently, the dynamic OLS approach proposed by Stock and Watson (1993) was used to estimate the coefficients in the cointegration equation, followed by the Wald test conducted to test the statistical significance of cointegrating vector (see Kawamato and Hamori, 2010). Finally the study uses the model developed by Beck (1994), McKenzie and Holt (2002) to the test the short term efficiency of Guar seed futures contracts.

Results and Discussion

Table 2 presents the result of unit root tests for major agricultural commodities by both ADF and PP unit approaches. For all time series, the ADF and PP test statistics fail to reject the unit root hypothesis indicating each of the price series is I (1).

Table 2

Unit root test on spot and futures prices

Series	Augmented Dickey-Fuller (ADF)		Phillips-Perron (PP)	
	Levels	First Differences	Levels	First Differences
FUT1	-1.44(0.565)	-34.379(0.000)*	4.272 (1.000)	-43.569 (0.000)*
FUT2	-1.518(0.5243)	-31.295(0.000)*	6.518 (1.0000)	-41.611 (0.000)*
FUT3	-0.516(0.885)	-31.073(0.000)*	6.768 (1.000)	-41.157 (0.000)*
FUT4	0.418(0.984)	-31.525(0.000)*	5.047 (1.000)	-39.151 (0.000)*
FUT5	1.290(0.998)	-30.581(0.000)*	5.491 (1.0000)	-29.759 (0.000)*
FUT6	2.281(1.000)	-29.004(0.000)*	-1.143 (0.6976)	-18.812 (0.000)*
SPOT1	-1.038 (0.741)	-32.01857 (0.000)*	-1.065494 (0.7311)	-32.01693 (0.000)*
SPOT2	-1.507 (0.529)	-30.25546 (0.000)*	-1.669420 (0.4466)	-30.33178 (0.000)*
SPOT3	-0.770(0.826)	-30.63742 (0.000)*	-0.806026 (0.8165)	-30.63720 (0.000)*
SPOT4	0.147 (0.970)	-31.52479 (0.000)*	0.139327 (0.9685)	-31.52399 (0.000)*
SPOT5	1.126 (0.998)	-30.58117 (0.000)*	1.071771 (0.9973)	-30.58330 (0.000)*
SPOT6	2.320 (1.0000)	-29.00360 (0.000)*	1.919730 (0.9999)	-29.13569 (0.000)*

Notes: Significant at:* 0.01and ** 0.05 levels; values in parentheses indicate MacKinnon (1996) p-values

Data Source: NCDEX Website

After testing the precondition of non-stationary time series of price information, cointegration test has been carried out to determine the existence of a long-run relationship between the spot and futures prices. Table 3 presents the cointegration results from the application of the Johansen method of reduced rank regression using the vector error correction model. The Johansen λ trace (trace statistics) and λ max (maximal eigen value), analysis indicates that null hypothesis of non-cointegration (R=0) is rejected at 0.05 level of significance for all the maturities, indicating the presence of at least one cointegrating relationship.

Table 3

Johansen's cointegration tests statistics

Series		Trace stats.		Max-Eigen Stats.		
	H_o: R	λ trace	Prob.	λ max	Prob.	Comment
FUT1/SPOT1	0	17.76	0.02	15.96	0.03	Rank=1 reject non-cointegration
	1	1.80	0.18	1.80	0.18	
FUT2/SPOT2	0	30.72	0.00	26.43	0.00	Rank=1 reject non-cointegration
	1	4.29	0.04	4.29	0.04	
FUT3/SPOT3	0	18.24	0.02	17.88	0.01	Rank=1 reject non-cointegration
	1	0.36	0.55	0.36	0.55	
FUT4/SPOT4	0	16.87	0.03	16.74	0.02	Rank=1 reject non-cointegration
	1	0.12	0.72	0.12	0.72	
FUT5/SPOT5	0	36.92	0.00	35.71	0.00	Rank=1 reject non-cointegration
	1	1.20	0.27	1.20	0.27	
FUT6/SPOT6	0	53.18	0.00	49.70	0.00	Rank=1 reject non-cointegration
	1	3.47	0.06	3.47	0.06	

Notes: Significant at:* 0.01and ** 0.05 levels

The existence of cointegration between the spot and futures prices confirms the first necessary condition for long-term market efficiency for all maturity horizons. Subsequently, the dynamic OLS approach proposed by Stock and Watson (1993) was used to estimate the coefficients in Equation (4), followed by the Wald test conducted to test the statistical significance of each coefficient. The Wald statistics of unbiasedness $\alpha = 0$ & $\beta_1 = 1$ and market efficiency $\beta_1 = 1$ are shown in Table 4.

Table 4

Testing Restrictions in Cointegrating Regression

Variables	FUT1/ SPOT1	FUT2/ SPOT2	FUT3/ SPOT3	FUT4/ SPOT4	FUT5/ SPOT5	FUT6/ SPOT6
β0	-0.764	-0.775	-0.680	-0.373	-0.264	-0.104
B1	1.088	1.091	1.080	1.043	1.030	1.012
Wald Test β1=1	0.0001*	0.000*	0.0001*	0.0001*	0.000*	0.000*
Wald Test β0=0 and β1=1	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*

Significant at:* 0.01and ** 0.05 levels

For all price series, the restriction of unbiasedness $\alpha = 0$ & $\beta_1 = 1$ on the cointegrating vector was rejected providing evidence that future prices were not a very good predictor of spot prices. However, the unbiasedness hypothesis may be rejected with the existence of a risk premium or a transportation cost even when the market is efficient (Wang and Ke, 2005). Therefore, it is more important to test the restriction of market efficiency i.e. $\beta_1 = 1$. The results of the restriction of market efficiency were also consistent with the previous restriction where the null hypothesis was rejected for all maturity horizons indicating future prices were not consistently efficient and unbiased for our study. The results testify the fact that the futures contracts for guar seed are not perfect hedge against the variations in spot prices. A perfect hedge ensures that the profit or loss on the futures contracts fully offsets the loss or profit on the physical transactions in the spot market. Any disparity between the futures price for a specific maturity contract and the ready prices in physical market on the day of the maturity of futures contract exposes the participants to basis risk. The users of futures markets face this risk because the specific physical commodity they wish to hedge does not have the same price development as that of the standardized futures contract.

Further, the dependency of F_t on past price data (F_t and $F_{t+1}^{(s-1)}$) is investigated in Equation (4), a phenomenon that violates market efficiency using Beck (1994) error correction model shown in Equation (5) and McKenzie and Holt (2002) generalized-quadratic ARCH-in-mean error correction model. The results are shown in Table V & VI. The Wald statistics of the null hypothesis (ρ=1, $\rho\beta$=b_0 ,a_i ,b_j =0) are also shown in Table 5&6.

Table 5

ECM Model

Dependent Variable Independent Variable	FUT1/ SPOT1	FUT2/ SPOT2	FUT3/ SPOT3	FUT4/ SPOT4	FUT5/ SPOT5	FUT6/ SPOT6
$\boldsymbol{\rho}$	-0.024	-0.121	-0.079	-0.074	-0.145	-0.173
$\boldsymbol{b_0}$	-1.149	-1.096	-1.078	-1.054	-1.043	-1.016
$\boldsymbol{b_1}$	-0.108	-0.004	-0.064	-0.471	-0.276	-0.277
$\boldsymbol{b_2}$	-0.037	-0.097	0.171	-0.159	-0.156	-0.160
$\boldsymbol{a_1}$	0.124	0.047	0.118	0.540	0.354	0.378
$\boldsymbol{a_2}$	0.047	0.154	-0.198	0.194	0.162	0.197
$\boldsymbol{c}$	0.001	0.001	0.001	0.001	0.002	0.002
Schwarz criterion	-6.64	-6.66	-6.72	-6.62	-6.51	-6.73
Wald Test $\boldsymbol{\rho}$ =1	.000*	0.000*	0.000*	0.000*	0.000*	0.000*
Wald Test $\boldsymbol{a_0}$ =0 and $\boldsymbol{b_1}$ =1	0.0001*	0.000*	0.0001*	0.0001*	0.000*	0.000*
Wald Test $\boldsymbol{b_1}$ =1	.000*	0.000*	0.000*	0.000*	0.000*	0.000*

Notes: Significant at:* 0.01and ** 0.05 levels

$$\Delta F_{t+1}^{(s-1)} = c - \rho u_t + b_0 \Delta F_t^{(s)} + \sum_{i=1}^{m} a_i \Delta F_{t+1-i}^{(s-1)} + \sum_{i=1}^{m} b_j \Delta F_{t-j}^{(s)} + \varepsilon_{t+1}$$

Table 6

GARCH-M-ECM Model

Dependent Variable Independent Variable	FUT1/ SPOT1	FUT2/ SPOT2	FUT3/ SPOT3	FUT4/ SPOT4	FUT5/ SPOT5	FUT6/ SPOT6
ρ	0.061	0.033	0.017	-0.065	-0.129	-0.16
b_0	-1.619	-1.45	-1.382	-1.065	-1.07	-1.029
η_i	1.049	1.034	1.022	0.997	1.01	1.002
b_1	0.16	0.109	0.236	0.491	0.316	0.309
θ	0.108	0.043	0.019	-0.012	-0.026	-0.013
γ	-0.467	-0.339	-0.237	-0.017	-0.104	-0.031
a_{11}	-0.123	-0.042	-0.163	-0.408	-0.228	-0.198
ξ_{jj}	0.686	0.671	0.665	0.47	0.343	0.35
ξ_j	0.248	0.267	0.298	0.502	0.613	0.552
c	-0.467	-0.339	-0.237	-0.017	-0.104	-0.031
Schwarz criterion	-4.475	-4.333	-4.505	-4.462	-4.342	-4.058
Wald Test ρ=1, $\rho\beta=b_0$,a_i ,b_j =0	(0.000)*	(0.0003)*	(0.0001)*	(0.0001)*	(0.0003)*	(0.000)*

Note. Numbers in parentheses indicate P-value. Significant at:* 0.01and ** 0.05 levels

$$\Delta F_{t+1}^{(s-1)} = c + \theta\sqrt{h_{t+1}} - \rho u_t + b_0 \Delta F_t^{(s)} + \sum_{i=1}^{m} a_i \Delta F_{t+1-i}^{(s-1)} + \sum_{i=1}^{m} b_j \Delta F_{t-j}^{(s)} + \varepsilon_{t+1}$$

$$\varepsilon_t = \omega_t \sqrt{h_t}\,\omega_t \sim N(0,1)$$

$$h_t = \gamma + \sum_{i=1}^{r} \eta_i h_{t-i} + \sum_{j=1}^{s} \xi_{jj}\varepsilon_{t-j}^2 + \sum_{j=1}^{s} \xi_j \varepsilon_{t-j} + \sum_{j\neq k}^{s} \xi_{jk}\varepsilon_{t-j\varepsilon_{t-k}}$$

For each maturity horizon, the null hypothesis of (ρ=1, $\rho\beta=b_0$,a_i ,b_j =0) is rejected, supporting the fact that past price data does contribute

information useful for predicting prices in the future. The observed market inefficiency may be attributed to over-speculation or market manipulation. It is very likely that few big traders are trying to actively influence the prices of guar seed. The big firms are followed by many smaller traders thereby leading to herding behavior, which may be one of the reasons for high volatility and price rise in futures market. The instances of similar nature have been observed in India in the last year when The FMC alleged 4,490 entities including many large firms like Ruchi Soya, Betul Oils to be involved in guar gum price manipulation (Jha, 2012; Talukdar, 2012).

Summary and Conclusion

In the present paper, we tested for efficiency, unbiasedness in long and short term guar seed futures contracts for different maturity period. In the first step long term efficiency was tested through Johansen's cointegration approach. Subsequently, the dynamic OLS approach proposed by Stock and Watson (1993) was used to estimate the coefficients in the cointegration equation, followed by the Wald test conducted to test the statistical significance of each coefficient. Further, the short-term market efficiency is tested using Beck (1994) error correction model and McKenzie and Holt (2002) GARCH-M-ECM model.

The significant Wald test statistics indicate that futures markets are not efficient in predicting the future ready prices in both long run and short run. The results imply that guar seed futures contracts have not been able to perform their pivotal role of price discovery and risk management for which they were introduced in India.

These empirical results appears to be in contrast to the results of Kaur and Rao (2010), Ali and Gupta (2011) and Sehgal, Rajput and Dua (2012) which have reported guar future contract as efficient and leading to significant price discovery.

Further, if we compare the results with existing studies on other agriculture commodities contracts traded on the same exchange,the results are similar in case of existence of long term relationship between future and spot prices (see Sahoo and Kumar, 2009; Ali and Gupta, 2011; Sehgal, Rajput and Dua, 2012). However, the results lead to a different conclusion when we tested the restriction of unbiasedness and market efficiency on the cointegrating vectors which indicated long-run and short-run market inefficiencies.

These results have important implications on the previous research on the same issue which concluded efficiency of the futures market on the basis of cointegration results, ignoring the restrictions on cointegrating vectors may lead to incorrect assessment of efficiency and unbiasedness of commodity exchanges.

The results also imply that the decision of reintroduction of guar futures should be taken with care. Cases of price rigging and manipulation should be checked frequently in case of extraordinary price hikes and the operators found guilty of price rigging and cartelization should be punished so that such instances do not occur frequently. Further, the results indicate an urgent need to provide more powers to FMC to regulate the market and penalize any insider trading, cartelization and price manipulations.

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