A Study of the Efficiency and Unbiasedness in NCDEX : A Case Study of Guar Gum

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Abstract

The paper aims to study the market efficiency and unbiasedness among guar gum futures contracts traded at the 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 the futures market for guar gum is inefficient 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 Classification : C14, C32, G14

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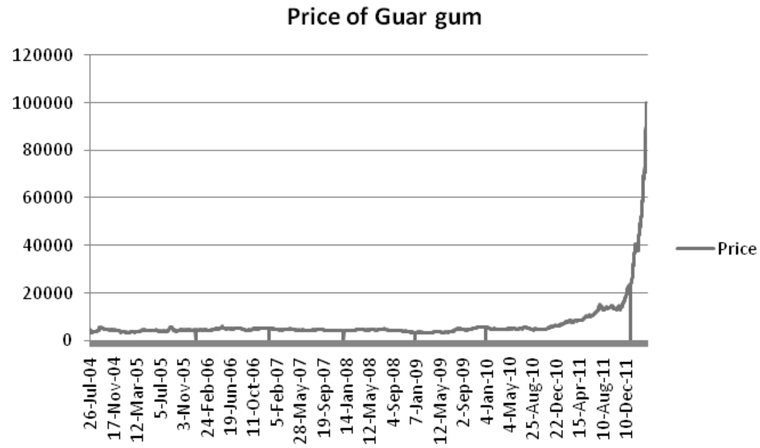
Agricultural commodity futures markets in India have witnessed extraordinary price hikes and volatility in the recent past. During this period, future prices of guar gum contracts have also experienced an unusual movement. Guar gum, extracted from guar seeds, is cultivated largely in Rajasthan, and is used as an additive and thickening agent in a vide range of industries, including food, animal feed, paper, textiles, ore floatation, explosives, shale gas exploration, and so forth. The country commands about 80% of the global production followed by Pakistan. Guar gum also emerged as the biggest agricultural item of export for India in 2011, upstaging the much better known items of basmati and non-basmati. Futures prices of guar gum at the National Commodity & Derivatives Exchange Ltd. (NCDEX) skyrocketed 1000% in the last one year to touch ₹100,000 a tonne. The guar gum prices in

Figure 1 .Spot Price of Guar Gum at NCDEX Exchange



NCDEX (n.d.). Market Data – Futures Prices. Retrieved from http://www.ncdex.com/MarketData/FuturePrices.aspx

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2011-12 soared almost 10 times higher than last year (2010 - 11), which was the steepest rise in any agricultural commodity in the history of Indian futures exchanges (Figure 1). The futures price change volatility (return volatility) in 2011-12 went up by almost 80% as compared to 2010-11 figures (Jha, 2012). Rapidly growing global demand in the oil drilling sector along with rampant speculation activities in derivative markets are considered two probable reasons by experts for this phenomenon. Further, to curb price volatility and speculation in the commodity exchanges, the Forward Markets Commission (FMC) banned traders from taking fresh positions in the running contracts of guar gum and guar seed in March 2012, and constituted a 40 member advisory committee, comprising of various stakeholders groups, including Warehousing Development and Regulatory Authority (WDRA), Securities and Exchange Board of India (SEBI), promoters of commodity bourses, farmers, and co-operatives.

After more than six months of ban on futures trading in guar gum contracts, FMC on the recommendation of the advisory committee is planning to relaunch futures trading in guar seed and gum. On the other hand, 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 is passed to accord adequate powers to Forward Markets Commission (FMC) with a view to regulate the market and penalize any insider trading, cartelization, and price manipulations.

Objectives of the Study

The present paper discusses conflicting viewpoints regarding relisting of guar contracts and the role of guar futures in providing crucial role of price discovery and risk management to its stakeholders, and also tests the efficiency and unbiasedness in the context of guar gum contracts traded at NCDEX. More specifically, we used a quantitative approach to examine:

(i) The long-run efficiency and unbiasedness among the futures and the spot price for different maturities for guar gum 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 gum contracts is justified, otherwise the FMC should reconsider its decision for relisting such contracts on the exchange.

Literature Review

Several studies in the past have studied the relationship between spot and futures prices of commodities for exploring the issue of price discovery and market efficiency. Authors who have researched on price discovery and efficiency of the Indian commodities markets include Sahadevan (2002), Sahi and Raizada (2006), Lokare (2007), Bose (2007), Kumar, Singh, 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 Lokare (2007), Kumar et al., (2008), Sahoo and Kumar (2009), Ali and Gupta (2011), and Sehgal et al. (2012). However, only few studies have studied the future and spot relationship for guar contracts, and that too for guar seed contracts (refer to Ali & Gupta, 2011; Kaur & Rao, 2010; Sehgal et al., 2012.).

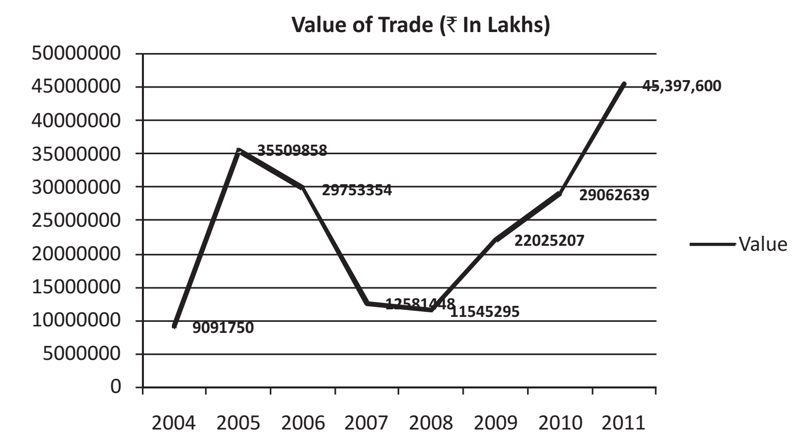
Sahadevan (2002) performed tests on futures and spot prices for six agricultural commodities traded at different regional exchanges between January 1999 to August 2001 and obtained results rejecting $\beta_o= 0, \beta_1=1$. Sahi and Raizada (2006) tested futures and spot prices for wheat contract traded at NCDEX between July 2004 to July 2006 and obtained results rejecting $\beta_o= 0, \beta_1=1$. Whereas Bose (2007) 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 soybean oil, and guar seed from July 2008 to July 2009 and found that 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 the 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 contracts using cointegration and Granger's 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 et al. (2012) in their study examined the price discovery of 10 major agricultural commodities, including guar seed contracts using cointegration and Granger causality analysis between November 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 gum futures contracts are rare. Additionally, none of the existing research studies tested the efficiency and unbiasedness of guar futures with different maturities. Furthermore, most of the studies which tested the existence of cointegrating relationships had not tested the cointegrated vectors (β_o , β_1) (Ali and Gupta, 2011 ; Kaur and Rao, 2007; Sehgal et al., 2012), which might have led to wrong conclusions regarding efficiency and price discovery, though cointegration between the spot price and futures price is only a necessary condition for market efficiency. However, if the restriction β_1=1 is not rejected, then there is strong evidence against the efficiency and unbiasedness of the markets (Kellard, Newbold, Rayner, & Ennew,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 & Hamori, 2011). The present research examines the cointegrating relationships and then tests cointegrating vectors for unbiasedness for guar gum contracts from June 2004 to September 2012 at various maturities. It also tests the short-term market efficiency using Beck's (1994) error correction model and McKenzie and Holt's (2002) GARCH-M-ECM model.

Data and Methods

➬ **Data :** Guar gum futures, traded on the NCDEX, were launched in July 2004. The value of traded contracts grew rapidly after its introduction and reached ₹ 3, 55, 09,858 crores in 2005 and attained a value of ₹ 4,53,97,600 crores in 2011 (Figure 2). The aggregate limits on guar gum contracts set by exchange are 3000 metric tonnes (MT) or 15% of market wide open interest, whichever is higher. The contract for trading in the prompt month expires on the "last trading day," which is defined as the 20th calendar day of the contract month, if 20th happens to be a holiday, a Saturday or a Sunday, then the immediately preceding trading day of the Exchange.

Figure 2. Value of Trade for Guar Contracts (Guar gum+ guar seed) at NCDEX Exchange



Source : Adapted NCDEX (n.d.). Market Data - Volume Details. Retrieved from http://www.ncdex.com/MarketData/VolumeDetails.aspx

The data for the study comprises of daily closing spot and futures prices from July 2004 till March 2012 collected from the NCDEX website. 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 seven sub - categories, that is, maturity less than 30 days, 31-60 days, 61-90 days, 91-120 days, 121-150 days, 151-180 days, and more than 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

Table 1. Descriptive Statistics for Log of Daily Spot and Futures Prices

Series	Mean	Std. Dev.	Skewness	Kurtosis	J-Bera	Prob.	Obs.
FUT1	3.72	0.18	2.34	8.86	5253.00	0.00	2238.00
FUT2	3.74	0.22	2.53	10.07	6861.92	0.00	2179.00
FUT3	3.75	0.24	2.65	10.74	7859.22	0.00	2145.00
FUT4	3.81	0.28	1.98	6.87	1771.53	0.00	1387.00
FUT5	3.85	0.31	1.54	4.95	582.04	0.00	1053.00
FUT6	3.64	0.07	0.16	1.74	30.82	0.00	435.00
FUT7	3.86	0.30	1.67	5.70	265.85	0.00	347.00
SPOT1	3.74	0.18	2.36	9.09	5544.67	0.00	2238.00
SPOT2	3.75	0.22	2.55	10.18	7045.62	0.00	2179.00
SPOT3	3.75	0.24	2.65	10.68	7770.56	0.00	2145.00
SPOT4	3.81	0.28	1.98	6.88	1770.71	0.00	1387.00
SPOT5	3.86	0.31	1.54	4.94	580.15	0.00	1053.00
SPOT6	3.64	0.07	0.22	1.80	29.81	0.00	435.00
SPOT7	3.85	0.30	1.68	5.76	274.17	0.00	347.00

Source: Compiled by the Authors

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, FUT6 represents maturity between 151-180 days, and FUT7 represents maturity of more than 180 days. SPOT1, SPOT2, SPOT3, SPOT4, SPOT5, SPOT6, SPOT7 represent the corresponding spot prices for the same maturity.

maturity. All series were analyzed in the natural logarithmic form. The descriptive statistics such as mean, standard deviation, skewness, and so forth for spot series and future series for all the commodities are presented in the Table 1.

Econometric Methods : This study empirically analyzes the weak form efficiency for guar gum 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; Kellard et al., 1999 ; Lai, K., & Lai, M. 1991). 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 tested for the presence of cointegration among future and spot series for all seven 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 (Kawamato & Hamori, 2011). Finally, the study uses the model developed by Beck (1994) and McKenzie and Holt (2002) to the test the short term efficiency of guar gum futures contracts.

Johansen Method of Cointegration : The cointegration between the spot price and futures price is a necessary condition for market efficiency. It ensures that there exists a long-run equilibrium relationship between the two series (Wang & Ke, 2005). The maximum likelihood approach of Johansen and Juselius (1990) was used to establish whether there is a long-run relationship between future and spot prices of the selected commodities. Johansen's cointegrating analysis involves estimating the following Vector Error Correction Model in reduced form :

$$\Delta Y_t = \sum_{i=1}^{k-1} \Gamma \Delta Y_{t-1} + \Pi Y_{t-k} + \varepsilon_t \qquad (1)$$

Where, Y_t is a vector of non-stationary variables, and Γ, Π, and λ are matrices of parameters to be estimated. The rank of the matrix Π determines the long-run relationship, and can be decomposed as $\Pi = \alpha\ \beta'$, where α and β contain adjustments and the cointegrating vectors respectively, and Δ and ε_t refer to change and error term respectively.

Johansen's methodology requires the estimation of the vector autoregression regression (VAR) equation and the residuals were then used to compute two likelihood ratio (LR) test statistics that can be used in the determination of the unique cointegrating vectors of X_t . The first test, which considered the hypothesis that the rank of Π is less than or equal to *r* cointegrating vectors is given by the following trace test :

$$\text{Trace} = -T\sum_{i=r+1}^{n} \text{In}\,(1-\lambda_i) \qquad (2)$$

The second test statistic is known as the maximal eigen value test, which computed the null hypothesis that there are exactly *r* cointegrating vectors in X_t and is given by:

$$\lambda_{\max} = -T\ln(1-\lambda_r) \qquad (3)$$

The distributions for these tests are not given by the usual chi-squared distributions. The asymptotic critical values for these likelihood ratio tests are calculated via numerical simulations (Johansen & Juselius, 1990 ; Osterwald-Lenum, 1992). To test whether the futures price at the contract purchase date is an unbiased predictor of spot at the contract maturity date, the cointegrating regression is generally specified as:

$$F_{t+1}^{(s-1)} = \alpha + \beta f_t^{(s)} + \Sigma_{i=-k}^{k} \xi \Delta F_{t-1}^{(s)} + u_{t+1} \qquad (4)$$

Where $f_t^{(s)}$ is the logarithm of the lagged futures price (that is, the futures price at contract purchase) and $F_{t+1}^{(s-1)}$ is the logarithm of the spot price that is matched with the settlement date of the futures contract. In the next step, 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 $\alpha = 0$, $\beta = 1$and u_t is white noise. If the restriction $\beta_1=1$ is not rejected, then there is strong evidence against the hypothesis that in long run equilibrium, the spot price is equal to the futures price plus a (possibly zero) constant.

➯ **Beck's (1994) Error Correction Model :** To test the short-term efficiency of these contracts, the study used Beck's (1994) prototypical model developed from an error correction model to test the possibility that past price information could improve forecasts in addition to $(\alpha, \beta) = (0, 1)$. Applying Beck's (1994) model to $f_t^{(s)}$ and $F_{t+1}^{(s-1)}$ yields the following equation:

$$\Delta F_{t+1}^{(s-1)} = c - \rho u_t + b_0 \Delta F_t^{(s)} + \Sigma_{i=1}^{m} a_i \, \Delta F_{t+1-i}^{(s-1)} + \Sigma_{i=1}^{m} b_j \, \Delta F_{t-j}^{(s-1)} + \varepsilon_{t+1} \qquad (5)$$

Here, $u_t = F_t^{(s-1)} - \alpha - \beta F_{t+1}^{(s)}$, $\Delta F_{t+1}^{(s-1)} = F_{t+1}^{(s-1)} - F_t^{(s-1)}$, and $\Delta F_t^{(s)} = F_t^{(s)} - F_{t-1}^{(s)}$

Beck (1994) showed that if $(\rho = 1, \rho\beta = b_0, a_i, b_j = 0)$ is not established in Equation (5), past price information is useful in forecasting prices and the market is not efficient. Testing with Equation (5), in addition to testing cointegrating vectors in Equation (4) results in a more potent test of the efficient market hypothesis.

➯ **Mckenzie and Holt's (2002) Generalized-Quadratic Arch-In-Mean Error Correction Model :** The study also used a generalized-quadratic ARCH-in-mean error correction model proposed by McKenzie and Holt (2002) as a market efficiency test which allows for time-varying risk premiums. The model developed by McKenzie and Holt (2002) has three advantages over the model developed by Beck (1994). First, the model allows for the existence of a time-varying risk premium by parameterizing the time varying conditional variance. Second, it takes into consideration the nonlinear feedback between the conditional mean and conditional variance of spot price changes. Third, if the true data-generating process (DGP) contains GARCH type effects, appropriate model specifications derived from the GARCH class of models will provide more efficient parameter estimates than OLS (Kawamato & Hamori, 2010). Applying the McKenzie and Holt (2002) model to $f_t^{(s)}$ and $F_{t+1}^{(s-1)}$ yields the following equations:

Table 2. Unit Root Test on Spot and Futures Prices of Selected Agricultural Commodities

	Augmented Dickey-Fuller (ADF)		Phillips-Perron (PP)	
	Levels	First Differences	Levels	First Differences
FUT1	4.319 (1.0000)	-43.337 (0.000)*	4.272 (1.000)	-43.569 (0.000)*
FUT2	6.423 (1.0000)	-41.165 (0.000)*	6.518 (1.0000)	-41.611 (0.000)*
FUT3	6.415 (1.000)	-40.900 (0.000)*	6.768 (1.000)	-41.157 (0.000)*
FUT4	5.186 (1.0000)	-39.220 (0.000)*	5.047 (1.000)	-39.151 (0.000)*
FUT5	5.04 (1.00)	-29.713 (0.000)*	5.491 (1.0000)	-29.759 (0.000)*
FUT6	-1.082 (0.722)	-18.599 (0.000)*	-1.143 (0.6976)	-18.812 (0.000)*
FUT7	4.232 (1.000)	-18.013 (0.000)*	4.851 (1.0000)	-18.047 (0.000)*
SPOT1	4.04 (1.00)	-47.460 (0.000)*	3.912 (1.000)	-47.508 (0.000)*
SPOT2	6.184 (1.00)	-46.862 (0.000)*	5.886 (1.000)	-47.050 (0.000)*
SPOT3	6.07 (1.00)	-45.282 (0.000)*	5.802 (1.000)	-45.580 (0.000)*
SPOT4	5.529 (1.00)	-34.966 (0.000)*	5.716 (1.000)	-34.968 (0.000)*
SPOT5	4.711 (1.0000)	-32.597 (0.000)*	4.785 (1.0000)	-32.626 (0.000)*
SPOT6	-1.138 (0.6995)	-24.942 (0.000)*	-1.258 (0.6481)	-24.697 (0.000)*
SPOT7	4.070 (1.0000)	-18.059 (0.000)*	4.543 (1.0000)	-18.105 (0.000)*

Notes: Significant at:* 0.01and ** 0.05 levels; values in parentheses indicate Mackinnon's (1996) *p* -values.

Source: Compiled by the Authors. 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, FUT6 represents maturity between 151-180 days, and FUT7 represents maturity of more than 180 days. SPOT1, SPOT2, SPOT3, SPOT4, SPOT5, SPOT6, SPOT7 represent the corresponding spot prices for the same maturity.

Table 3. Johansen's Cointegration Tests Statistics for Selected Agricultural Commodities

Commodity	Lag(Sic)		Trace statistics		Max-Eigen Statistics		
		H_o: R	λ trace	Prob.	λ max	Prob.	Comment
FUT1/SPOT1	4	0	59.900	0.000*	45.875	0.000*	Rank=1 reject non- cointegration
		1	14.025	0.002*	14.025	0.0002*	
FUT2/SPOT2	5	0	71.381	0.000*	52.005	0.000*	Rank=1 reject non- cointegration
		1	19.376	0.000*	19.376	0.000*	
FUT3/SPOT3	4	0	68.062	0.000*	56.880	0.000*	Rank=1 reject non- cointegration
		1	11.182	0.0008	11.182	0.0008	
FUT4/SPOT4	4	0	66.598	0.000*	56.526	0.000*	Rank=1 reject non- cointegration
		1	10.072	0.0015	10.072	0.0015	
FUT5/SPOT5	4	0	80.513	0.000*	63.812	0.000*	Rank=1 reject non- cointegration
		1	16.701	0.000*	16.701	0.000*	
FUT6/SPOT6	4	0	43.663	0.000*	41.759	0.000*	Rank=1 reject non- cointegration
		1	1.903	0.167	1.903	0.167	
FUT7/SPOT7	2	0	25.592	0.0011	23.636	0.0013	Rank=1 reject non- cointegration
		1	1.956	0.1619	1.956	0.1619	

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

Source: Compiled by the Authors. 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, FUT6 represents maturity between 151-180 days, and FUT7 represents maturity of more than 180 days. SPOT1, SPOT2, SPOT3, SPOT4, SPOT5, SPOT6, SPOT7 represent the corresponding spot prices for the same maturity.

Table 4. Testing Restrictions in Cointegrating Regression

Variables	FUT1/SPOT1	FUT2/SPOT2	FUT3/SPOT3	FUT4/SPOT4	FUT5/SPOT5	FUT6/SPOT6	FUT7/SPOT7
β0	0.0946	0.0701	0.0373	-0.0155	-0.0143	0.0752	0.0258
B1	0.9790	0.983	0.9908	1.0033	1.0043	0.9798	0.9910
Wald Test β1=1	0.0001*	0.000*	0.0001*	0.0001*	0.000*	0.000*	0.0004*
Wald Test β0 = 0 and β1=1	.0000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*
Significant at :* 0.01 and ** 0.05 levels							

Source: Compiled by the Authors. 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, FUT6 represents maturity between 151-180 days, and FUT7 represents maturity of more than 180 days. SPOT1, SPOT2, SPOT3, SPOT4, SPOT5, SPOT6, SPOT7 represent the corresponding spot prices for the same maturity.

Table 5. ECM Model

Dependent Var. Independent Var.	FUT1 /SPOT1	FUT2 /SPOT2	FUT3 /SPOT3	FUT4/SPOT4	FUT5/SPOT5	FUT6/SPOT6	FUT7/SPOT7
ρ	-0.023	0.025	0.036	-0.109	0.022	-0.039	0.424
b_0	-0.971	-0.947	-0.932	-1.05	-1.01	-0.981	-1.006
b_1	-0.081	-0.143	-0.176	-0.127	-0.079	-0.449	0.063
b_2	-0.083	-0.138	-0.118	-0.233	-0.17	-0.303	-0.116
a_1	0.134	0.225	0.289	0.209	0.186	0.512	-0.087
a_2	0.136	0.2	0.135	0.173	0.129	0.335	0.07
c	0	0	0.001	0.001	0.001	0	0.004
Schwarz criterion	-6.64	-6.66	-6.72	-6.62	-6.51	-6.73	-4.9
Wald Test ρ =1	0.0001*	0.000*	0.0001*	0.0001*	0.000*	0.000*	0.0004*
Wald Test a_0 =0 and b_1 =1	.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*
Wald Test b_1 =1							

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

Source: Compiled by the Authors. 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, FUT6 represents maturity between 151-180 days, and FUT7 represents maturity of more than 180 days. SPOT1, SPOT2, SPOT3, SPOT4, SPOT5, SPOT6, SPOT7 represent the corresponding spot prices for the same maturity.

$$\Delta F^{(s\text{-}1)}_{t+1} = c - \rho u_t + b_0 \Delta F^{(s)}_t + \sum_{i=1}^{m} a_i \, \Delta F^{(s\text{-}1)}_{t+1-i} + \sum_{i=1}^{m} b_j \, \Delta F^{(s)}_{t-j} + \varepsilon_{t+1}$$

$$\Delta F^{(s\text{-}1)}_{t+1} = c + \theta \sqrt{h_{t+1}} - \rho u_t + b_0 \Delta F^{(s)}_t + \Sigma^{m}_{i=1} a_i \, \Delta F^{(s\text{-}1)}_{t+1-i} + \Sigma^{m}_{i=1} b_j \, \Delta F^{(s)}_{t-j} + \varepsilon_{t+1} \qquad (6a)$$

$$\varepsilon_{t+1} = \omega_t \sqrt{h_t} \;\; \omega_t \sim N(0,1) \qquad (6b)$$

$$h_t = \gamma + \sum_{i=1}^{r} \eta_i \, h_{t-i} + \sum_{j=1}^{s} \xi_{jj} \varepsilon^2_{t-j} + \sum_{j=1}^{s} \xi_j \varepsilon_{t-j} + \sum_{j \neq k}^{s} \xi_{jk} \varepsilon_{t-j} \varepsilon_{t-k} \qquad (6c)$$

where h_t represents the conditional dispersion of spot price variation at time t. As in Beck's (1994) model, if (ρ = 1, $\rho\beta = b_0$, a_i, b_j = 0) is not established in Equation (6), past price information is useful for forecasting prices, and the market is not efficient. McKenzie and Holt (2002) stated that a test using Equation (4) is a test of long-run market efficiency and that one using Equation (6) is a test of short-run market efficiency. For simplicity, the former model is called the ECM model and the latter, the GARCH-M-ECM model.

Table 6. GARCH-M-ECM Model

Dependent Variable Independent Variable	FUT1/SPOT1	FUT2/SPOT2	FUT3/SPOT3	FUT4/SPOT4	FUT5/SPOT5	FUT6/SPOT6	FUT7/SPOT7
ρ	-0.034	0.006	0.022	-0.092	0.024	-0.031	0.327
b_0	-0.968	-0.942	-0.913	-1.074	-0.988	-0.996	-0.995
η_i	-0.067	-0.125	-0.169	-0.121	-0.294	-0.466	-0.346
θ	0.003	0.000	-0.004	-0.013	0.000	0.000	0.000
γ	0.000	0.000	0.000	0.000	0.000	0.000	0.000
a_{11}	0.391	0.369	0.360	0.342	0.247	0.150	0.182
ξ_1	0.551	0.589	0.609	0.633	0.702	0.600	0.600
c	0.000	0.000	0.001	0.001	0.001	0.000	0.004
Schwarz criterion	-6.619	-6.625	-6.689	-6.579	-6.253	-6.632	-4.731
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)*	(0.0004)*

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

Source: Compiled by the Authors. 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, FUT6 represents maturity between 151-180 days, and FUT7 represents maturity of more than 180 days. SPOT1, SPOT2, SPOT3, SPOT4, SPOT5, SPOT6, SPOT7 represent the corresponding spot prices for the same maturity.

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

$$\varepsilon_{t+1} = \omega_t \sqrt{h_t} \quad \omega_t \sim N(0,1)$$

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

Results and Discussion

The Table 2 presents the results 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). After testing the precondition of non-stationary time series of price information, cointegration test was carried out to determine the existence of a long-run relationship between the spot and futures prices. The 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 the 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.

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 $\alpha = 0$ and $\beta_1 = 1$ and market efficiency $\beta_1 = 1$ are shown in the Table 4. For all price series, the restriction of unbiasedness $\alpha = 0$ and $\beta_1 = 1$ 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 & Ke, 2005). Therefore, it is more important to test the restriction of market efficiency, that is, $\beta_1 = 1$. 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.

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's (1994) error correction model shown in Equation (5) and McKenzie and Holt's (2002) generalized-quadratic ARCH-in-mean error correction model. The results are shown in the Tables 5 and 6. The Wald statistics of the null hypothesis ($\rho = 1$, $\rho\beta = b_0, a_i, b_j = 0$) are also shown in the Tables 5 and 6. For each maturity horizon, the null hypothesis of ($\rho = 1$, $\rho\beta = b_0$, a_i , $b_j = 0$) is not rejected, supporting the fact that past price data does contribute information useful for predicting prices in the future. In summary, the guar gum futures market is not efficient from the perspective of both long-run and short-run market efficiencies.

Summary and Conclusion

In the present paper, we tested for efficiency and unbiasedness in long and short- term guar gum futures contracts for different maturity periods. 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. Furthermore, the short-term market efficiency was tested using Beck's (1994) error correction model and McKenzie and Holt's (2002) GARCH-M-ECM model.

The significant Wald test statistics indicated that futures markets were not efficient in predicting the future ready prices in both long run and short run. The observed market inefficiency can 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 gum. 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 the futures market. Instances of similar nature have been observed in India in the last year, when the FMC alleged that 4,490 entities including many large firms like Ruchi Soya, Betul Oils to be involved in guar gum price manipulation (Jha, 2012; Talukdar, 2012).

The results also testify the fact that the futures contracts for guar gum 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 the 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. These empirical results appear to be in contrast to the results of Kaur and Rao (2010), Ali and Gupta (2011), and Sehgal et al., (2012), who reported guar futures contracts to be efficient and leading to significant price discovery.

Research Implications

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 indicate an urgent need to provide more powers to FMC to regulate the market and penalize any insider trading, cartelization, and price manipulations.

Scope for Future Research

Finally, in terms of future research, the study can be extended to determine the reasons or factors responsible for high speculation in Indian commodity futures markets.

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