

Efficiency of Agro-Commodity Futures Market

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INTRODUCTION

India is an agricultural country and one third of its population still depends on the sector directly or indirectly. With a share of about 20% in the national GDP as compared to the level of 50% in 1947, agriculture continues to be the mainstay of the Indian economy. Agriculture sector is an important factor in achieving a GDP growth of 8-10%. All this indicates that India can be promoted as a major centre for trading of commodity derivatives.

Commodity derivatives are contracts which do not have value of their own, but derive their value from the underlying commodity like wheat, rice, sugar, oil, gold, silver etc. Commodity derivatives have a crucial role to play in price risk management process, especially in any agriculture denominated economy. Instability of commodity prices has always been a major concern of the producers as well as the consumers in an agriculture dominated country like India. Farmers' direct exposure to price fluctuations, for instance, makes it too risky for many farmers to invest in otherwise profitable activities. Commodity derivatives market is a place where these farmers and traders can reduce their price risk. These contracts enable them to lock in the prices of the products well in advance. Moreover, futures prices give necessary indicators to producers and consumers about the likely future ready (spot) price and demand and supply conditions traded.

Since the start of commodity futures trading in 2002, the commodities futures market in India has experienced an unprecedented boom in terms of the number of modern exchanges, number of commodities allowed for derivatives trading as well as the value of futures trading in commodities. During 2005-06, the total value of commodity futures trade was Rs 21340 billion as compared to Rs 5710 billion during 2004-05, showing an increase of 274%. The volume of trade has gone upto 668.5 million tonnes during 2005-06 as compared to 194.2 million tones during 2004-05. The trade volume has also gone up by 244% during 2005-06. The skyrocketing trading volume, nascent stage of operations and the importance of commodity derivatives to the economy of India has inspired the researcher to choose this topic for research.

LITERATURE REVIEW

Commodity futures include a large number of commodities that can be divided into four main categories. These are i) Agricultural commodities ii) Precious metals iii) Other metals and iv) Energy. There are a number of studies on commodity derivatives. I have focused on studies on *Agricultural Commodity Futures* only. Some of the important studies and their findings have been mentioned in this section.

Just and Rausser (1981) found that the futures market does just as well as publicly available econometric models, in terms of forecasting commodity prices. **Roll (1984)** found that price movements in the orange juice futures market could predict freezing temperatures in Florida better than the US national weather services could. In other words, the futures market was found to be efficient in terms of incorporating available weather information. However, *Roll* indicates that a 'puzzle' remains in the orange juices futures market because there is a large amount of inexplicable price volatility.

Using a semi-strong form test, **Rausser and Carter (1983)** examined the efficiency of the soybean complex. The relative accuracy of soybean, soybean oil, and soybean meal futures markets was examined via structurally based ARIMA models. In some cases, the models out-performed the futures markets for both long and short-range forecasts. However, Rausser and Carter stressed that unless the forecast information from the models is sufficient to provide profitable trades, then superior forecasting performance in a statistical sense has no economic significance.

A simple linear regression model was used by **Bigman, Goldfarb, and Schechtman (1983)** to test the efficiency of wheat, corn and soybean trading at the CBOT. Based on F tests, they concluded that futures prices generally provide inefficient estimates of the spot price at maturity. **Fama and French (1987)** tested for evidence of whether or not commodity futures prices provided forecast information superior to the information contained in spot prices. They found that futures markets for the seasonal commodities contain superior forecast power relative to spot prices. However, this was not the case for non-seasonal commodities.

Jagannathan (1985), assuming rational expectations, analyzed the determinants of risk premium. He examined whether two-month returns to futures speculation for three commodities (corn, wheat, and soybeans) for the

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1960-1978 period are consistent with the consumption-beta model of risk premium. This model required that the relative return to two different assets moved proportionally to the relative conditional covariances of the return to each asset and the rate of change of consumption. Jagannathan modelled the time-varying conditional covariance between the rate of change of consumption and the real return to forward speculation by projecting the observed covariances on a set of variables that included U.S. industrial production growth and the U.S. terms of trade. He found that while the comovements of the estimated ex-ante returns to forward speculation and the estimated conditional covariances are broadly consistent with the predictions of the consumption-beta model, on the whole, the evidence suggested that this model did not provide an adequate description of returns to futures speculation. Later, **Maberly (1985)**, **Elam and Dixon (1988)** and **Shen and Wang (1990)** pointed out the result is invalid based on such conventional F tests when the prices series are non-stationary. **Maberly (1985)** reveals that the inference that the market is inefficient for the more distant futures contracts is a direct result of the bias inherent in using OLS to estimate the parameters in models with censored data. He believes that an inherent restriction on the dependent variable in basic regression equation is responsible for inefficiency. **Elam and Dixon (1988)**, however, demonstrated that the misleading results are due to biases in the estimates of parameters resulting from the regressor in the regression model being the lagged value of the dependent variable. The development of co-integration theory by **Engle and Grange (1987)** provided a new technique for testing market efficiency.

Graciela Kaminsky and Manmohan S. Kumar (1989) made an econometric investigation into the efficiency of commodity futures markets. The methodology adopted in this study took as a measure of efficiency excess returns in seven different commodity markets over the 1976-1988 period. Their results indicated that it is not possible to make any strong generalizations on the efficiency of the commodity futures market for short-term forecast horizons. For longer periods, however, it does appear that several of the markets may not be fully efficient.

Chowdhury (1991) points out the problems of conventional hypothesis testing in the futures market literature and suggests how the co-integration approach can be used to circumvent some of these difficulties. The novelty of alternative approach lies in its potential use as a method of testing efficiency in any market. The empirical results indicate the rejection of the efficient market hypothesis for commodities.

Furstenberg and Zapata (1993) evaluated the relationship of the North Carolina corn and soybean markets with respect to the CBOT. Co-integration existed between any pair of these markets and no strong evidence was found to reject the efficiency hypothesis. **Aulton, Ennew, and Rayner (1997)** re-investigated the efficiency of UK agricultural commodity futures markets using the co-integration methodology. They found that the market is efficient for wheat but not efficient for pigment and potatoes. **Tomek (1997)** stresses that futures prices can provide poor forecasts but still be efficient, as long as their forecasts are better than any alternative such as an econometric model. If the futures market is efficient, then it should be able to out-forecast an econometric model.

Guo Y. Luo (1998) investigated informational efficiency by applying the evolutionary idea of natural selection. The agents were assumed to be rational. He found that in the short run, the futures prices merely aggravate all noise speculators' belief or predictions. In the long run, with the probability of 1, the proportion of time that the futures price equals the spot price converges to one as time goes to infinity.

Kellard, et al. (1999) examined the efficiency of several widely traded commodities in different markets, including soybeans on the CBOT and live hogs and live cattle on the Chicago Mercantile Exchange. The results showed that the long run equilibrium condition holds, but there was evidence of short-run inefficiency for most of the markets studied. The degree of the inefficiency was measured based on the forecast error variances.

Neil Kellard et al. (1999) investigates the claim that the finding of cointegration between commodity spot and lagged futures rates reflects the existence of commodity arbitrage and not, as is generally accepted, long-run market efficiency. The methodology of Kellard et al. (1999) is employed to match spot and lagged futures rates correctly for the UK wheat futures contract traded at LIFFE. Bi-variate analysis shows that spot and lagged futures rates are cointegrated with the vector (1, -1), a necessary condition for market efficiency. However, at variance with asymptotic theory, in a tri-variate VECM estimation, the spot rate, lagged futures rate and lagged domestic interest rate are shown to be cointegrated with the vector (1,-1, 1). The "cointegration" paradox is explained by investigating the relative magnitudes of the forecast error and the domestic interest rate. The small sample results demonstrate that it is impossible to distinguish between the influence of commodity arbitrage and the existence of market efficiency using cointegration-based tests. In summary, this work implies that such tests are not wholly appropriate for evaluating commodity market efficiency.

Mckenzie and Holt (2002) tested market efficiency and unbiasedness is tested in four agricultural commodity

futures markets – live cattle, hogs, corn, and soybean meal – using cointegration and error correction models with GQARCH-in-mean processes. They found that each market is unbiased in the long run, although cattle, hogs and corn futures markets exhibit short-run inefficiencies and pricing biases. Models for cattle and corn outperform futures prices in out-of-sample forecasting. Results also suggested short-run time-varying risk premiums in cattle and hog futures market.

J.B. Singh (2004) attempted to understand the price risk of agricultural and derived commodities, with a view to justify the use of futures markets for individual commodities. He investigated the use of futures market to discover prices, manage uncertainty and risk, and improve the performance of agricultural commodities. He collected daily cash and futures prices for 6 agro-commodities viz, pepper, castor seed, potato, gur, turmeric and Hessian for the period 1988-99 from 'Forward Market Bulletin'. He found that among all commodities, castor seed (Ahmedabad And Mumbai) and pepper futures markets are efficient and unbiased and also performs the role of risk management and hedging effectiveness, gur (H&M) and role of risk but turmeric markets are inefficient and biased. In terms of hedging effectiveness, potato fares poorly.

Wang, H. Holly et al. (2005) studied the efficiency of the Chinese wheat and soybean futures markets. Formal statistical tests were conducted based on Johansen's cointegration approach for three different cash markets and six different futures forecasting horizons ranging from 1 week to 4 months. The results suggest a long-term equilibrium relationship between the futures price and cash price for soybeans and weak short-term efficiency in the soybean futures market. The futures market for wheat is inefficient, which may be caused by over-speculation and government intervention.

Qingfeng "Wilson" Liu (2005) examined the relations among hog, corn, and soybean meal futures price series using the Perron (1997) unit root test and autoregressive multivariate cointegration models. Accounting for the significant seasonal factors and time trends, they found that the three series are cointegrated with one single cointegrating vector, whose coefficients are comparable to the ratios used by the United States Department of Agriculture (USDA). They found that inefficiency exists in these three commodity futures markets.

OBJECTIVES

- i) To test analytically, the efficiency of futures market of *Guar Gum and Guar Seed* in India.
- ii) To find the reasons for inefficiency, in case *Guar Gum and Guar Seed* futures market is inefficient, and suggest possible policy and solutions for improving the *Guar Gum and Guar Seed* futures market in India.

RESEARCH METHODOLOGY

Different econometric techniques have been used by different researchers to test the efficiency of commodity futures market from time to time. With time, the research methods have evolved. These are simple linear regression model, the law of one price model, the co-integration methodology and Johansen's Co-integration methodology. The view of market efficiency employed in this study is weak form efficiency as this is the most widely tested hypothesis. If the futures market is weakly efficient, there will be no opportunities to earn abnormal profits using the trading rule based upon the historical sequences of prices. In the past, many studies like Tomek and Grey (1970), Kofi (1973) Cargill and Rausser (1975), Goss (1981), Solt and Swanson (1981, Sheldon (1987), Aulton, Ennew and Rayner (1997) Wang, H. Holly and Bingfan ke (2002), J.B. Singh (2004) have used weak form efficiency. Testing the relationship between spot and futures price series for efficiency of market requires three steps:

a) Regression Analysis: This requires testing the null hypothesis that there is no correlation between spot price and futures price series. If the null hypothesis is rejected, it would establish the long run or equilibrium relationship between the two series.

b) Test for Cointegration: Here, I have used ECM which entails estimating the short-run or equilibrium relationship between the spot and futures prices.

c) Test for Unbiasedness: If the null of no cointegration is rejected, then proceed to test the parameter values consistent with efficiency. This requires testing the joint null hypothesis that the lagged values of futures prices do not contain any useful information which could be used to forecast S_t .

If the efficiency holds for the following cointegration relationships

$$SP_t = \alpha + \beta FP_t + \epsilon_t$$

$$SP_t = \alpha + \beta FP_{t-1} + \epsilon_t$$

$$SP_t = \alpha + \beta FP_{t-2} + \epsilon_t$$

and the residuals are stationary, then there is evidence that the market is unbiased. In other words, if unbiased

hypothesis holds, then the spot and futures price series are cointegrated with a unit parameter. Conversely, if the unbiasedness hypothesis does not hold, the spot and futures price series will diverge without bound.

In this study, I have used tests like **Augmented Dickey-Fuller (ADF) Unit Root test** for testing stationarity of price time series. **Error Correction Mechanism (ECM)**, a test for cointegration, has been used to test the efficiency of futures markets and **Engle Granger (EG)** has been used to test cointegration as well as unbiasedness of *Guar Gum and Guar Seed* market for the select period of study (from June 2004 to May 2007).

The data on futures and spot prices of these commodities was collected from the NCDEX website.

DATA ANALYSIS

TESTING FOR STATIONARITY

1. Graphical Analysis

Looking at the commodity futures and spot prices time series of guar gum and guar seed in figures 1 and 2, we get the feeling that these series are not stationary i.e. their mean, variance and autocovariance seem to be time variant.

2. Augmented Dickey Fuller Test

To formally test the series for stationarity, Augmented Dickey – Fuller test has been employed in the ‘trend and intercept form’. The results have been shown in Tables 1. The results of table 1 support our findings from the graphical analysis that spot price and futures price series of *Guar Gum and Guar Seed* are non-stationary. In all the cases, the computed value of t-statistic is less than the given critical values. So, the null hypothesis of unit root (Non-Stationarity) is accepted at 5% level of significance for both the commodities and hence, we conclude that these series are non-stationary (Table 1).

Table 1: Augmented Dickey Fuller Test for Spot Price and Future Price Series on levels

Price	Commodity	Lag length	Test Statistics	Critical Values	p-value
Spot Price	Guar Seed	5	-1.701	At 5%, -3.567 10%, -3.217	0.103
	Guar Gum	6	0.445	At 5%, -3.594 10%, -3.232	0.662
Futures Price	Guar Seed	5	-0.553	At 5%, -2.963 10%, -2.620	0.586
	Guar Gum	9	-0.320	At 5%, -3.622 10%, -3.247	0.755

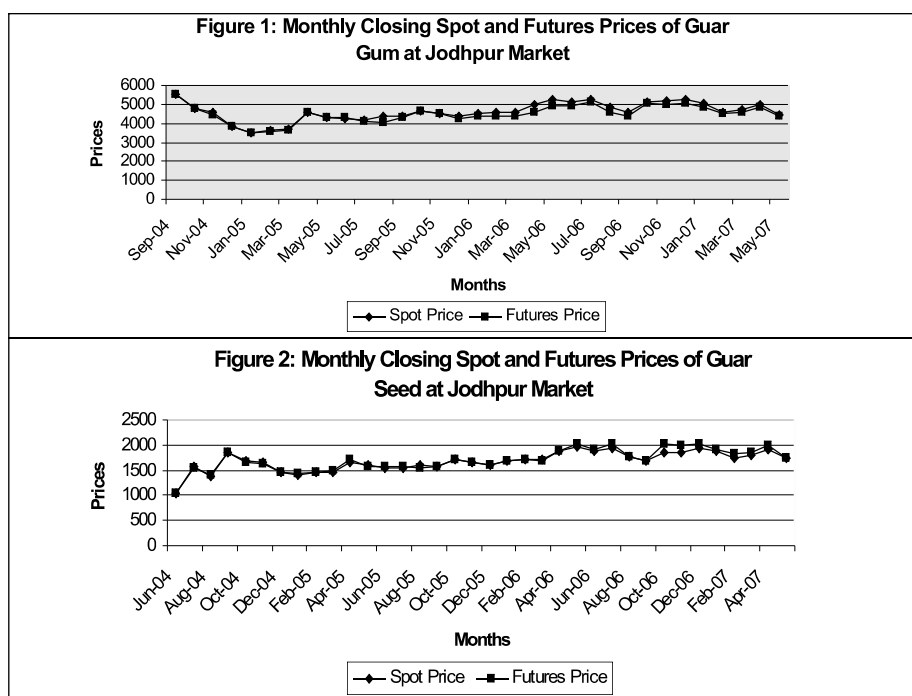


Table 2: Regression of SP_t on FP_t of Guar Seed

Regression Model	B	P	Adjusted R ²	D W Stat
$SP_t = \alpha + \beta FP_t + \epsilon_t$	0.861	0.000	0.966	1.550
$SP_t = \alpha + \beta FP_{t-1} + \epsilon_t$	0.612	0.000	0.543	2.34
$SP_t = \alpha + \beta FP_{t-2} + \epsilon_t$	0.528	0.000	0.468	2.30

Table 3: Regression of SP_t on FP_t of Guar Gum

Regression Model	B	P	Adjusted R ²	D W Stat
$SP_t = \alpha + \beta FP_t + \epsilon_t$	1.032	0.000	0.950	1.192
$SP_t = \alpha + \beta FP_{t-1} + \epsilon_t$	0.519	0.001	0.270	1.320
$SP_t = \alpha + \beta FP_{t-2} + \epsilon_t$	0.435	0.006	0.195	1.114

From the above tables 2 and 3, p-values for β in all cases are zero or less than 0.006. So, our null hypothesis of $\beta=0$ is rejected. It means spot price on maturity date depends on its futures price on the maturity day, the futures price on the last day of a month prior to maturity and the futures price on the 15th of a month prior to maturity. The values of Adjusted R² are also quite high. Thus, we can say that the futures markets for Guar gum and Guar seed are efficient in weak form as there is long run relationship between the spot and futures prices i.e. the futures price F_{t-1} at time t-1 contains all available information for predicting today's spot price S_t .

TESTING COINTEGRATION

The cointegration methodology properly accounts for the non-stationarity behaviour of futures and spot price series. Cointegration between these price series ensures that they do not drift apart. The presence of cointegration between the spot and futures price series is a necessary condition for market efficiency. Here we will try to find out if the spot price and futures price series are cointegrated or not. I have used four methods to gauge the same. The findings of these methods are as follows.

1) GRAPHICAL METHOD

We can see in figure 1, spot prices and futures prices of each commodity are moving in the same fashion. Thus it appears that spot price series of Guar gum and Guar seed are cointegrated with their respective futures price series.

2) CRDW METHOD

According to CRDW test, critical values at 1%, 5% and 10% are 0.511, 0.386 and 0.322 respectively. Since the computed values of d like 0.996, 1.414 and 1.480 are greater than 0.511 (see tables 2 and 3), so for Guar gum and Guar seed, we reject the null hypothesis of no cointegration between the spot and futures prices at the maturity, between the spot prices at the maturity and futures prices on the last day of the month prior to maturity month and between the spot prices at the maturity and futures prices on the 15th of the month prior to maturity month.

3) ENGLE GRANGER TEST

This is the test on the residuals of regression of SP on FP. So, the critical values given by eviews as showed above is not applicable. The critical values to be used here are -3.34 and -3.04 at 5% and 10% resp. The estimated value $t = -3.3452$ is more negative than critical value. So, the null hypothesis of no cointegration can be rejected and thus there is co-integration between SP and FP. The result is significant at 5% as well as 10% level of significance. There is long term, or equilibrium, relationship between them and thus the markets for Guar gum and Guar seed are efficient.

Table 4: Results of EG Test for Guar Gum and Guar Seed

Commodity	Regression	ADF Test Statistic	p-value
Guar Seed	S_t on F_t	-4.895944	0.0000
	S_t on F_{t-1}	-7.724453	0.0000
	S_t on F_{t-2}	-8.216482	0.0000
Guar Gum	S_t on F_t	-3.858897	0.0005
	S_t on F_{t-1}	-4.729789	0.0000
	S_t on F_{t-2}	-4.863881	0.0001

4) ERROR CORRECTION MECHANISM

Here also we will test for cointegration between SP and FP series but under two different models. The model and its results have been shown below.

a) $\Delta SP_t = a + b \Delta FP_t + c\epsilon_{t-1} + \epsilon_t$

Where ΔSP_t represents first difference of SP, ΔFP_t represents first difference of FP and ϵ_{t-1} stands for first lag of residual term. In table 5, the coefficient of res-lag is negative and p -value is zero, the test is significant. So, we can say that there is cointegration between SP and FP series. i.e. there is short term equilibrium between these series. As these results show, 0.50 of the discrepancy in the two price series in the previous month is eliminated this month. Besides, short run changes in the futures price (FP) are quickly reflected in the spot price (SP), as the slope coefficient between the two series is 0.92. Thus, we conclude that there is short term equilibrium between these series.

b) $\Delta SP_t = a + b \Delta FP_t + c\Delta FP_{t-1} + d\epsilon_{t-1} + \epsilon_t$

Where, ΔFP_{t-1} means the first lag of first difference of FP series. In table 5, the coefficient of res-lag is negative and p -value is zero, the test is significant. So, we can conclude that the SP and FP series are cointegrated i.e. there is short term equilibrium between these series.

Table 5: Results of ECM Test of Selected Commodities

Commodity	ECM Model	Coefficient		p-value		Adj. R ²
		ϵ_{t-1}	ΔFP	ϵ_{t-1}	ΔFP	
Guar Seed	$\Delta SP_t = a + b \Delta FP_t + c\epsilon_{t-1} + \epsilon_t$	-0.808	0.86	0.00	0.00	0.95
	$\Delta SP_t = a + b \Delta FP_t + c\Delta FP_{t-1} + d\epsilon_{t-1} + \epsilon_t$	-0.813	0.85	0.00	0.00	0.95
Guar gum	$\Delta SP_t = a + b \Delta FP_t + c\epsilon_{t-1} + \epsilon_t$	-0.538	0.96	0.00	0.00	0.92
	$\Delta SP_t = a + b \Delta FP_t + c\Delta FP_{t-1} + d\epsilon_{t-1} + \epsilon_t$	-0.537	0.96	0.00	0.00	0.92

ECONOMIC IMPLICATION

Instability of commodity prices has always been a major concern of the producers as well as the consumers in an agriculture -dominated country like India. Farmers' direct exposure to price fluctuations, for instance, makes it too risky for many farmers to invest in otherwise profitable activities. So, taking the results of this study as basis, the online version of commodity trading will ensure that "bonded" Indian farmers can sell their produce online to millions of prospective traders across the world in an internet based commodity exchange for price discovery of their produce. And if they feel that they are still not getting the right price, they can sell it in futures market at an agreed price they feel can be fetched after their produce could go up, increasing the market prices of the commodity.

Farmers can also know the price at which they can sell their produce in the market in future after harvest. They can carry out cost-benefit analysis of a crop before they take decision to sow the crop. If they think that a particular crop can fetch them fair enough money to meet the cost related to their crop (viz. cost of seeds, fertilizers, power, water, or cost of capital), only then they would sow that particular crop. This will again help them to run out the trap of debt and live with a feel of security.

Apart from increasing the stability of the market, various actors in the farm sector can better manage their activities in an environment of unstable prices through commodity derivative markets. These markets serve a risk -shifting function, and can be used to lock -in prices instead of relying on uncertain price developments. The efficient futures markets will help farmers to eradicate the weed of uncertainty about the future spot price of the produce from the field of uncertain price market.

The efficient futures market is very useful to the exporters as it provides an advance indication of the price likely to prevail and thereby help the exporter in quoting a realistic price and thereby secure export contract in a competitive market. Having entered into an export contract, it enables him to hedge his risk by operating in futures market. So, the benefits of efficient futures market are:

- (i) Leads to integrated price structure throughout the country.
- (ii) Helps balance in supply and demand position throughout the year.
- (iii) Encourages competition and acts as a price barometer to farmers and other trade functionaries like

exporters. The efficient futures markets will help farmers to eradicate the weed of uncertainty about the future spot price of the produce from the field of uncertain price market.

CONCLUSION

India has a long history of trade in commodity derivatives. But, the commodity futures markets in India are only four years old. Trading volume and value of futures market in the past two years have increased so much that it pales the stock market. Thus, commodity futures markets have become the area of attraction for traders and researchers. But, there is dearth of research work in this field. Few quantitative studies have been conducted to evaluate the efficiency of these futures markets. This study is a step in the same direction.

This study has focused on the weak form efficiency of commodity futures market of Guar gum and Guar seed. Market efficiency, here, has been measured as the long run or equilibrium relationship between the spot and futures price series and unbiasedness of these markets. We conclude that for Guar gum and Guar seed the spot and futures price series are first difference stationary i.e. $I(1)$. The regression analysis shows that the futures price F_{t-1} at time $t-1$ contains all available information for predicting today's spot price S_t . The results of different cointegration techniques used here indicate that spot price and futures price series are cointegrated. Cointegration between these price series ensures that they do not drift apart. The presence of cointegration between the spot and futures price series is a necessary (but not sufficient) condition for market efficiency. The results should be unbiased also. The Engle Granger test also shows the unbiasedness of the results. Thus, both the conditions for the efficiency of markets are satisfied. So, we can say that future markets are efficient in weak form for all selected commodities.

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