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How Efficient are Futures Market Operations in Mitigating Price Risk? An Explorative Analysis

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INTRODUCTION

India being an agrarian economy, instability in commodity prices has always remained a major concern for the producers as well as the consumers. Various other challenges have cropped into Indian agriculture during the post-WTO regime, for instance dragging technological progress, depletion of water resources, stagnant productivity and, more importantly, lagging market reforms. Fragmented rural markets is another challenge in efficient marketing/trading of agricultural commodities in India. Given the exposure of farmers to such risks and challenges, it makes their investment in farming an unprofitable proposition. There are various ways to cope with this problem. Market based risk management tools for commodities have assumed special significance in the liberalisation era (Sahadevan, 2002). 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 futures markets. These markets serve as a risk-shifting function, and can be used to lock-in prices instead of relying on uncertain price developments (Raipuria, 2002). An efficient futures market provides a mechanism for managing risk associated with the uncertainty of future events.

Price risk refers to the probability of adverse movements in prices of commodities, services or assets. Agricultural products, unlike others, have an added risk. Many of these being typically seasonal, tend to attract lower prices during the harvest season. The forward and futures contracts are considered to be an efficient risk minimising tool which insulate buyers and sellers from the unexpected changes in futures prices. These contracts enable them to lock-in the prices of the products well in advance. Moreover, futures prices give necessary indications to producers and consumers about the likely futures ready price and demand and supply conditions of the commodity traded. The cash market or ready delivery market on the other hand is a time-tested market system, which is used in all forms of business to transfer the title of goods. Keeping this in view, the paper tries to explore how close the prices of near month futures contracts moved with the cash markets using co-integration technique,

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thereby ascertaining whether the futures market conform to the basic premise of mitigating risk amongst farmers and consumers. Though the paper is an attempt to investigate the efficiency of futures markets in respect of prices of important cereals, pulses, oilseeds, cash and commercial crops, it also reflects the genuine shortcomings related to specific statistical characteristics of commodities time series price data pertaining to seasonality, overlapping data and unevenly spaced observations.

Data and Source

In order to provide an empirical basis of the mechanism of the futures markets in the country, a detailed analysis relating to stationarity, cointegration and price adjustment mechanism between spot and futures prices (near month contracts of the MCX)[1] of important cereals, pulses, oilseeds and cash crops were undertaken using spot and futures prices data pertaining to the period October, 2004 to May, 2007.

Methodology

The co-integration technique was employed in the present study to analyse the long run relationship between spot price and future price. In the present study, co-integration test[2] suggested by Engle and Granger (1987) was employed (Gujarati, 2004). Augmented Dickey Fuller (ADF) test was applied to test for stationarity.

The test regression for the ADF test is the AR (1) process:

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta Y_{t-i} + \varepsilon_t$$

where;

$\Delta Y_t = Y_t - Y_{t-1}$

Y_t = a vector to be tested for co-integration;

t = time or trend variable,

β_1, β_2, δ and α_i = parameters, and

ε_t = random error term (white noise).

After getting the stationarity in the time series, the next step is the Engle-Granger two step procedures to test for co-integration. The first step involves co-integration of two series, which are of the same order of integration.
The co-integration regression model used is:

$$S_t = \alpha + \beta f_t + u_t$$

where:

S_t = spot prices of crop at time 't',
f_t = futures price at time 't'.
α and β = co-integration parameters and
u_t = residual is the cointegration vector/equilibrium error.

u_t, residual shows the deviation from equilibrium and this equilibrium error in the long run tends to zero. The equilibrium error has to be made stationary for getting co-integration between two integrated variables. The stationarity of the error can be verified through the following equation:

$$\Delta u_t = a_0 u_{t-1}$$

The test implies that errors adjust to the long run equilibrium.

In the second step, error correction model[3] (ECM) developed by Engle and Granger was used for correcting the disequilibrium. The model for ECM is represented as:

$$\Delta S_t = \alpha_0 + \alpha_1 \Delta f_t + \alpha_2 u_{t-1} + \varepsilon_t$$

ECM equation states that ΔS_t depends on Δf_t, and the equilibrium error term. If the error term is non-zero, then the model is in disequilibrium. The speed at which the price approaches equilibrium depends on the magnitude of α_2. Hence, α_2 is expected to be negative. Then $\alpha_2 u_{t-1}$ is also negative and ΔS_t will be negative to restore the equilibrium in the long run.

RESULTS AND DISCUSSION

Nearly 81 per cent farmers in the country belong to the small and marginal category. For them, better prices are the best incentive to remain in the farming. The recent NSSO study (Government of India, 2003) on situational assessment survey of farmers reveals that almost 60 per cent farmers are willing to relinquish their profession owing to non-remunerative returns and instability in prices due to market upheavals. Keeping this in mind, the government decision to open up the futures market operation in select commodities is thoroughly investigated in this paper to see the efficiency of futures markets in relation to spot and futures prices in respect of important cereals, pulses, oilseed, cash and commercial crops.

The descriptive statistics of spot and futures prices of these crops have been illustrated in Table 1. The table depicts that futures in Masoor, Potato, Jeera, and Kapas were relatively more unstable than their counterpart spot prices but in Wheat, Chana, Urad, and Refined soya oil spot prices were more unstable than futures. The

mean spot and futures prices of Wheat (816.6 and 814.25), Chana (1741.91 and 1755.67), Urad (2117.69 and 2102.76), Masoor (1876.86 and 1905.21), Potato (612.36 and 669.14) during the period October 2004 to May 2007 are given in Rs./quintal, while that of Refined soya oil is given in Rs./10 kg, Jeera in Rs./kg and Kapas in Rs./50 kg.

TABLE 1. DESCRIPTIVE STATISTICS OF SPOT AND FUTURES PRICES

Commodity (1)	Prices (2)	N (3)	Mean* (Rs./qtl) (4)	Coeff. of variation (5)	Skewness (6)	Kurtosis (7)
Wheat	Spot	339	816.60	10.86	0.88	-0.42
	Futures	339	814.25	9.54	0.76	-0.10
Chana (Chickpea)	Spot	474	1741.91	13.54	0.12	-1.41
	Futures	474	1755.67	13.33	0.49	-0.60
Urad (Black gram)	Spot	474	2117.69	30.24	0.66	-1.07
	Futures	474	2102.76	27.90	0.75	-0.76
Masoor (Lentil)	Spot	272	1876.86	7.78	-0.48	-0.97
	Futures	272	1905.21	8.31	-0.48	-0.75
Refined Soya Oil	Spot	476	374.62	6.02	0.52	-0.33
	Futures	476	376.76	5.35	0.20	-0.73
Potato	Spot	46	612.36	6.67	0.13	-1.62
	Futures	46	669.14	7.66	-0.13	-1.79
Jeera (Cumin)	Spot	388	6802.49	10.47	-0.15	-1.32
	Futures	388	6826.60	11.59	0.20	-1.21
Kapas (Cotton)	Spot	351	333.26	6.46	0.25	-0.81
	Futures	351	337.36	6.82	0.47	-0.72

* The prices of refined soya oil are in Rs./10 kg, Jeera is in Rs./kg, and Kapas is in Rs./50kg.

The variation in the spot and future prices as measured by the coefficient of variation was found to be high in the case of Urad, Chana, Jeera and Wheat. The recent decision of the government for dis-continuance of futures trading in pulses and wheat could be largely attributed to the higher degree of instability in the prices of these commodities. But in the case of Refined soya oil, Potato, Kapas and Masoor, the variability was low with the coefficient of variation ranging from 5.35 to 8.31.

Also, the distribution of spot and future prices of wheat has been found to be positively skewed with a skewness coefficient of 0.88 and 0.76 respectively. However, the distribution of spot and futures prices of Chana, Masoor, Refined soya oil, Potato, Jeera and Kapas were found to be fairly symmetrical. The distribution of spot and future prices of all the crops were found to be platykurtic with negative kurtosis values ranging from -0.10 to -1.79. Low liquidity for these crops could be a potential reason for the higher instability of the futures prices especially in Masoor, Potato, Jeera, and Kapas during the reference period.

The interdependence among prices (spot and futures prices) were probed through multivariate co-integration technique. The integration tests are pre-requisite for co-integration. The order of integration (existence or absence of non-stationarity) in the series was examined through the ADF test. The statistics examined the stationarity of the spot and futures prices and removal thereof of non-stationarity of spot and futures price series, if any of different commodities of wheat, chana, urad, masoor, refined soya oil, potato, jeera and kapas and the results have been presented in Table 2.

TABLE 2. ADF TEST FOR VARIOUS FOOD, NON-FOOD AND CASH CROPS IN INDIA (UNIT ROOT TEST)

		Level		First difference	
Commodity	Prices	Intercept	Intercept and trend	Intercept	Intercept and trend
(1)	(2)	(3)	(4)	(5)	(6)
Wheat	Spot	-1.75	-2.07	-11.15*	-11.14*
	Futures	-1.86	-2.55	-12.23*	-12.21*
Chana (Chickpea)	Spot	-0.23	-3.08	-15.14*	-15.18*
	Futures	-0.03	-2.32	-14.40*	-14.46*
Urad (Black gram)	Spot	-0.10	-2.28	-14.36*	-14.40*
	Futures	0.07	-2.20	-13.49*	-13.54*
Masoor (Lentil)	Spot	-1.11	-0.88	-12.50*	-12.52*
	Futures	-1.23	-0.97	-10.81*	-10.83*
Refined Soya Oil	Spot	-1.74	-0.20	-15.15*	-15.48*
	Futures	-1.24	-0.26	-15.85*	-16.04*
Potato	Spot	-1.23	-1.55	-4.09*	-4.14*
	Futures	-0.88	-2.18	-6.83*	-6.66*
Jeera (Cumin)	Spot	-0.07	-3.10	-13.16*	-13.24*
	Futures	-0.72	-3.96	-14.36*	-14.36*
Kapas (Cotton)	Spot	-2.27	-2.41	-12.32*	-12.36*
	Futures	-2.19	-2.46	-12.55*	-12.57*

*reveal significance at 1 per cent of probability level.

The ADF test at the series levels [integrated of order 0, I(0)] supported the null hypothesis of unit root (non-stationary) at 95 per cent level of significance for the spot and futures price series of all the crops. The ADF test statistics of spot and futures price series have fallen within the confidence interval, indicating all price series exhibited random walk or levels of series were non-stationary. The first difference of all these non-stationary time series of spot and futures price of each crop was then tested using τ-test. The first difference or integrated of order 1 denoted as I(1) of all these price series was found to be stationary.

After having established the requirements of unit root, the AEG co-integration analysis was carried out (Table 3). The spot price series was regressed with the futures price for each crop and the residual was obtained, i.e., white noise residual. This indicates that there was a co-integrating relationship between pairs of spot and

futures price series of the crops. This further indicates that one of the prices in the pair could be predicted from the other price series. Since τ-statistics is higher than the observed value, it can be concluded that the residuals from the regression are stationary. Hence, it is concluded that there is long-run equilibrium/co-movement among the spot and futures price series of each crops.

TABLE 3. AEG CO-INTEGRATION TEST FOR VARIOUS FOOD, NON-FOOD AND CASH CROPS IN INDIA

Commodity (1)	Intercept (2)	Coefficient (3)	τ-statistics (4)
Wheat	-0.003	-0.74*	-14.04
Chana (Chickpea)	0.022	-1.06*	-22.90
Urad (Black gram)	0.026	-1.07*	-23.30
Masoor (Lentil)	0.002	-1.14*	-18.96
Refined Soya Oil	-0.002	-1.08*	-23.62
Potato	0.092	-0.63*	-4.29
Jeera (Cumin)	0.180	-1.06*	-20.92
Kapas (Cotton)	0.011	-1.11*	-21.00

*indicates significance at 1 per cent of probability level; value of 't' statistics is 3.06 at 1 per cent of probability level.

Price Transmission Mechanism

Long run equilibrium relationships between spot and future prices were also observed, even though there can be disequilibrium in the short run. For this, the error term can be treated as equilibrium error and also the intertwined relationship in the short run giving way to a long run association. The error correction mechanism (ECM) was used to estimate the acceleration speed of the short run deviation to the long run equilibrium (Table 4). The advantage of ECM is that it allows for the short run dynamics as well as an assessment for the degree towards the long run relation as shown by co-integration.

TABLE 4. ERROR CORRECTION TERMS (SPEED-OF-ADJUSTMENT) FOR PRICES

Commodity (1)	Intercept (2)	First Diff. of future price (3)	τ-statistics (4)	Error correction term (5)	τ-statistics (6)
Wheat	0.20	0.18	5.09	0.26	4.95
Chana (Chickpea)	0.91	0.39	10.42	-0.06	-1.23
Urad (Blackgram)	1.53	0.56	16.18	-0.07	-1.59
Masoor (Lentil)	0.01	0.55	12.71	-0.14	-2.42
Refined Soya Oil	-0.03	0.34	10.32	-0.08	-1.85
Potato	-2.00	0.10	2.21	0.38	2.45
Jeera (Cumin)	-2.35	0.26	9.16	-0.06	-1.24
Kapas (Cotton)	-0.05	0.67	22.56	-0.11	-2.15

The lagged values and lag residual of the long run model and the difference of the spot and future price series were used to estimate the error correction to determine the short run deviation from the equilibrium. The coefficients of the error correction estimate indicated the speed of adjustment at which the price series returns to the equilibrium. The coefficients of the error-term are expected to be negative. These coefficients are referred to as the speed-of-adjustment factors and measure the short-run deviation from the long-run equilibrium. As coefficient values approach zero, the paths are slow to adjust back to the long-run deviation. The farther it is from zero, the more rapid path the price series are likely take to reach a long-run equilibrium. This indicates that spot price series adjust to changes in the futures prices series in the same period.

The error correction terms for all crops are presented in Table 4 above. As evident from the table, the error correction term for chana, urad, masoor, refined soya oil, jeera and kapas exhibited the desired negative signs with values ranging from -0.06 to -0.14. They also exhibited the convergence in spot and futures prices. However, the error correction terms were positive in the case of wheat and potato signifying the divergence between spot and futures prices due to spurt in speculative activity.

Thus, short-run changes in the future price series had a positive impact on the short-run changes in the spot prices for chana, urad, masoor, refined soya oil, jeera and kapas except wheat and potato. This phenomenon of price convergence for the above crops clearly depicts that the farmers would be able to mitigate the price risk by taking opposite positions in the markets as the spot prices and future prices effectively converge. It is a good option for hedging in the Indian futures market for the farmers growing these crops.

CONCLUSION

Instability of commodity prices has always been a major concern of the producers as well as the consumers in a predominantly agrarian country such as India. The farmers in a bid to avert the price risk or to get the cash immediately after harvest often tend to go for distress sale thereby reducing the potential for higher returns in future. To cope up with this problem, futures trading has emerged as a viable option, whereby looking at the futures prices for the respective commodities the farmers shall take a decision either to sell or hold. Apart from making the spot markets stable, futures market mechanism provides a greater degree of assurance on the price front. Hence, the futures markets serve as a risk-shifting function, and can be used to lock-in prices instead of relying on uncertain price developments.

In this study, an attempt has been made to look into the mechanism of movement of spot and futures prices for various cereals, pulses, oilseeds and major cash crops in India. The variation in the spot and future prices (CV) was found to be high in the case of urad, chana, wheat and jeera. The recent decision of the government for dis-

continuance of futures trading in pulses and wheat could be largely attributed to the higher degree of instability in the prices of these commodities and justifies the move. However, the imperfections in the market paraphernalia and associated regulations could also be the reason of market upheavals leading to spiralling prices of essential commodities in the past months. The ADF test used to check the stationarity of the time series data has shown that most of the series have been found to be stationary at first difference. The cointegration test has been applied to find out whether there exists a long-run relationship between spot and futures prices of various contract months for these crops assuming that in the short-run there may be disequilibrium between these two. Short-run changes in the future price series have a positive impact on the short-run changes in the spot price for chana, urad, masoor, refined soya oil, jeera and kapas, except wheat and potato. This phenomenon of price convergence for the crops clearly depicts that the farmers would be able to effectively mitigate the price risk in most of the crops. Hence it is concluded that the futures contracts behave in an expected manner and there exists a mechanism for long-run equilibrium between the futures and spot prices in these purposively selected crops. The paper realises the genuine shortcomings accruing due to lack of detailed investigation of seasonality, over lapping data and unspaced observations. The study advocates the need to broaden the coverage by effectively popularising the futures trading among traders, farmers and various stakeholders in the commodity trading domain and convincing the policy makers about the effectiveness and rationality of the futures trading in India.

NOTES

1. MCX: MCX is an independent and de-mutulised multi commodity exchange, headquartered at Mumbai, having permanent recognition from the Government of India for facilitating online trading, clearing and settlement operations for commodities futures market across the country. Presently, the average daily turnover of MCX is around USD1.55 bn (Rs.7,000 crore - April 2006) and it holds more than 55 per cent market share of the total trading volume of all the domestic commodity exchanges.

2. The necessary condition for co-integration is the stationarity of time series data. For the stationary time series data, mean value and variance/ co-variance does not vary systematically. To test stationarity, unit root test is employed.

3. Engle and Granger theorem states that if a set of variables are co-integrated of order (1, 1), then there exits a valid error correction representation of the data. Converse of this theorem also holds good, that is, if an error correction model (ECM) provides an adequate representation of the variables, then they must be co-integrated. Two integrated variables can be co-integrated, when they converge in the long run despite short run divergences. ECM is also known as Granger representation theorem which states that if two variables X and Y are co-integrated, then the relationship between the two can be expressed as ECM.

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