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Is Futures Market Mitigating Price Risk: An Exploration of Wheat and Maize Market

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Abstract

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 in a bid to avert the price risk often tend to go for distress sale and thereby reduce the potential returns. In order to cope up with this problem, futures trading has emerged as a viable option for providing a greater degree of assurance on the price front. Thus, futures markets serve as a risk -shifting function. In the present study, an attempt has been made to look into the mechanism of movement of spot and futures prices for two important food crops in Indian agriculture. The Augmented Dickey Fuller (ADF) test has been used for both the crops to check the stationarity of the time series data. Most of the series have been observed to follow the stationary pattern at the first difference. The co-integration test has been attempted to find out whether there exists a long-run relationship between spot and futures prices of various contract months for maize and wheat crops. However, there exists a short run disequilibrium between these two. It has been observed that the futures contract behave in an expected manner and there exists a mechanism for long-run equilibrium in the maize as well as wheat crops. This phenomenon of price convergence for both maize and wheat crops clearly states that the farmers are mitigating price risk as spot prices and future prices converges.

Introduction

India is traditionally an agrarian economy, therefore, instability of commodity prices has always been a major concern of the producers as well as the consumers. Various challenges have cropped into the Indian agriculture in post-WTO regime; for instance technological changes, innovative irrigation techniques, productivity enhancement and more

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importantly, the market reforms. Fragmented rural market is a huge challenge in the marketing/trading of agricultural commodities in India. Farmers' direct exposure to price fluctuations makes it too risky for many farmers to invest in otherwise profitable activities. There are various ways to cope up with this problem. Market-based risk management tools for commodities have assumed special significance in the liberalization era (Sahadevan, 2002). Apart from increasing the stability of the market, various factors 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).

The 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 them being typically seasonal tend to attract lower prices during the harvest season. The forward and futures contracts are considered to be an efficient risk minimizing tools which insulate buyers and sellers from unexpected changes in future price movements. 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 future 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 title of goods.

In the year 2004, National Commodity & Derivatives Exchange Limited (NCDEX), located at Mumbai having operations in 390 centres started operations in futures trading. NCDEX is one among the three National Commodity Exchanges in the country. It is regulated by Forward Market Commission in respect of futures trading in commodities and currently facilitates trading of thirty-six commodities, mainly cash crops and few cereals crops.

Genesis of Commodity Futures in India

Although India has a long history of trade in commodity derivatives, this segment remained underdeveloped due to government intervention in many commodity markets to control prices. The government controls the prices and distribution of many agricultural commodities and forwards and futures trading are permitted only in certain commodity items. Free trade in many commodity items is restricted under the Essential Commodities Act, 1950, and forward and futures contracts are limited to certain commodity items under the Forward Contracts (Regulation) Act, 1952.

The first commodity exchange was set up in India by Bombay Cotton Trade Association Ltd, and formal organized futures trading started in cotton in 1875. Subsequently, many exchanges came up in different parts of the country for futures trade in various commodities. The Gujrati Vyapari Mandali came into existence in 1900, which had undertaken futures trade in oilseeds first time in the country. The Calcutta Hessian Exchange Ltd and East India Jute Association Ltd were set up in 1919 and 1927, respectively for futures trade in raw jute. In 1921, futures in cotton were organized in Mumbai under the auspices of East India Cotton Association. Many exchanges came up in the agricultural centres in north India before world war broke out and engaged in wheat futures until it was prohibited. The exchanges in Hapur, Muzaffarnagar, Meerut, Bhatinda, etc. were established during this period. The futures trade in spices was first organized by IPSTA in Cochin in 1957. Later, futures trade was altogether banned by the government in 1966 in order to have control on the movement of prices of many agricultural and essential commodities. Options are though permitted now in stock market, they are not allowed in commodities. However, the government withdrew the ban on futures with passage of Forward Contract (Regulation) Act in 1952.

After the ban on futures trade many exchanges went out of business and many traders started resorting to unofficial and informal trade in futures. On recommendation of the Khusro Committee in 1980, the government reintroduced futures trading on some selected commodities, including cotton, jute, potatoes, etc. Further in 1993, the Government of India appointed an expert committee on forward markets under the chairmanship of Prof. K.N. Kabra and the report of the committee was submitted in 1994, which recommended the reintroduction of futures already banned and introduction of futures marketing of many more commodities, including silver. In tune with the ongoing economic liberalization, the National Agricultural Policy 2000 has envisaged external and domestic market reforms, dismantling of all controls and regulations in agricultural commodity markets. It has also proposed to enlarge the coverage of futures markets to minimize the wide fluctuations in commodity prices and for hedging the risk emerging from price fluctuations (Naik and Jain, 2002; Swanson1998; Shen and Wang, 1990). In line with the proposal many more agricultural commodities are being brought under futures trading.

Objectives of the Study

Keeping the underlying price risk scenario in the important cereal (food) crops, it was imperative to study the long-run equilibrium relationship between the futures price and the cash price and also to study how successful these

exchanges are in providing hedge against price risk in the wheat and maize crops, the major cereal crops. The existence of such a mechanism in providing price risk cover in wheat and maize has also been amply demonstrated.

Methodology

Crop Selection

The two crops, namely maize and wheat were selected, as these are the most important cereal crops grown on vast area of the country. Wheat crop was selected as being the important fine cereal crop while the maize crop hails from the coarse grain category, having maximum acreage and production.

Data

Two representative cash markets, Delhi for wheat and Nizamabad for maize were chosen to test the efficiency of NCDEX futures market. The Delhi wheat market is surrounded by the major wheat producing areas of Haryana, Rajasthan and UP, whereas the Nizamabad in Andhra Pradesh, is a major maize-producing area of country and the trading platform here caters to the needs of entire southern states.

Daily futures price and spot price data on maize and wheat over the period January 2005 to January 2006 were taken from the NCDEX futures market. Seven contracts for maize crop, i.e. April 2005, May 2005, June 2005, July 2005, August 2005, September 2005 and October 2005 and four contract months for wheat, i.e. October 2005, November 205, December 2005 and January 2006 have been taken for study.

Analytical Framework

Most empirical work based on time series data assumes that the underline time series is stationary. The time series is stationary if its mean, variance and auto-covariance (at various lags) remain the same, no matter at what point we measure them; that is, they are time invariant. If a time series is not stationary, in all the sense, it is called a non-stationary time series. A non-stationary time series will have a time-varying mean or time-varying variance or both. Consequently, the validity of coefficients on explanatory variables is based on stationary series. If, however, a time series process exhibits non-stationarity (i.e. random walk), standard test statistics are no longer valid and concerns arise over interpreting coefficient that are spurious.

To avoid the spurious or non-sense regression, it is necessary to test the time series data for stationarity . Although there are several test of stationarity, most widely used Augmented Dickey Fuller (ADF) unit root test has been employed for the purpose of study.

The ADF test (1981) was conducted for each spot and futures price series at the level and first difference. The test here consisted of the following regression

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

where, Y_t is a vector to be tested for co-integration; $\Delta Y_t = Y_t - Y_{t-i}$, where, t is time or trend variable and ε_t is a pure white noise error-term. The number of lagged-difference terms included should be enough so that error-term in the equation is serially uncorrelated. The null hypothesis that, $\delta = 0$; signifying unit root, states that the time series is non-stationary while, the alternative hypothesis, $\delta < 0$ signifies that the time series is stationary, thereby rejecting the null hypothesis.

The regression of a non-stationary time series on another non-stationary time series may produce a spurious regression. The two time series of price, i.e. spot and futures are individually subjected to unit root analysis. Both are integrated to one, i.e. I(1) signifying unit root, thereby the original time series taken is non-stationary. On regressing the spot price series on futures price series, the error-term is subjected to unit root analysis. If error-term is stationary, i.e. I(0), the two time series are co-integrated and there exists a long-term relationship. Although both price series are individually I(1), their linear combination could be I(0). Before testing for cointegration, each price series was examined to determine whether they were stationary or not (Wang and Ke, 2005).

The Engle and Granger (1987) two-step procedure was used to test the cointegration between the spot and futures price series. The first step is:

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

where, S_t is the spot prices of crop, f_t is the futures price series. The residual u_t is the cointegration vector.

In the second step, the ADF test was used to test for a unit root in the cointegration vector or residual (for spot price series). For spot price series, where ε_t was stationary, the spot price and futures price series were cointegrated.

If two series are cointergrated there is a long-run relationship between the two. In the short, run, there may be a disequilibrium. The above equation

can be written as:

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

Therefore, one can treat the error-term as the 'equilibrium error'. The error-correction model was used to estimate the acceleration speed of short-run deviation to the long-run equilibrium. The error-correction model is :

$$\Delta S_t = \alpha_0 + \alpha_1 \Delta f_t$$

where, Δ denotes first difference operator, ε_t is the random error-term, and $u_{t-1} = S_{t-1} - \alpha - \beta f_{t-1}$, that is the one period lagged value of the error from the cointegrating regression. Of particular interest is the coefficient of the error correction-term, α_2 which indicates the speed at which the series returns to equilibrium. For value of α_2 that is negative (positive) and less than (equal to) zero, the series converges to (or diverges from) the long-run equilibrium.

The above methodology was employed to study the long-run equilibrium relationship between the futures price and the spot/cash price.

Results and Discussion

In order to have an empirical resonance of the mechanism of the futures market in the country, the detailed analysis relating to stationarity, co-integration and price adjustment mechanism between spot and futures prices of wheat and maize market were undertaken and have been discussed in the following sections.

The descriptive statistics of spot and futures prices of wheat crop have been illustrated in Table 1. The variation in the spot prices was found less during the sowing months of wheat, i.e. October and November than in January. It kept on increasing as we moved towards the harvest time while in contrast, the variation in the futures prices decreased from 2.82 to 1.29 per cent. However, the skewness and kurtosis in the prices converged at the same level as we moved towards the harvest season. This reflects the convergence of the both prices.

The descriptive statistics of spot and futures prices of maize crop have been depicted in Table 2. The spot price variation was found to be more during the crop season, i.e. June-October as compared to the preceding months of the season. However, variation in the futures prices of maize ranged between 1.85 and 4.38 for April, 05 and October, 05 contracts, respectively. Further, during mid of crop season, i.e. August, 05, skewness was minimal, signifying less fluctuations in the prices.

The ADF test statistics was conducted to examine the stationarity of the spot and future prices of wheat and maize crops and results have been presented in Tables 3 and 4.

Table 1. Descriptive statistics of spot and futures prices of wheat crop

Contract month	Variable	N	Mean	Coeff. of variation	Skewness	Kurtosis
October, 05	Spot	105	764.80	1.75	1.99	3.30
	Futures	105	804.01	2.82	0.19	-1.42
November, 05	Spot	81	765.93	1.95	1.68	1.81
	Futures	81	810.18	2.15	0.52	-0.69
December, 05	Spot	57	767.72	2.26	1.25	0.20
	Futures	57	812.44	1.13	-0.09	-0.99
January, 06	Spot	32	776.62	2.41	0.43	-1.27
	Futures	32	817.84	1.29	0.50	-1.26

Table 2. Descriptive statistics of spot and futures prices of maize crop

Contract month	Variable	N	Mean	Coeff. of variation	Skewness	Kurtosis
April, 05	Spot	72	518.05	1.66	0.16	-1.28
	Futures	72	547.49	1.85	1.62	2.10
May, 05	Spot	65	524.45	1.08	-0.83	0.53
	Futures	65	546.24	2.24	-0.58	-1.03
June, 05	Spot	69	526.88	1.03	2.57	13.06
	Futures	69	547.19	2.50	0.63	-1.16
July, 05	Spot	76	539.14	3.75	0.83	-0.90
	Futures	76	554.95	1.90	0.07	-1.22
August, 05	Spot	72	562.05	5.41	0.02	-1.33
	Futures	72	569.29	2.53	0.02	-0.37
September, 05	Spot	69	579.56	2.84	0.35	-0.85
	Futures	69	560.12	3.34	-1.16	0.37
October, 05	Spot	86	577.57	2.89	0.19	-0.48
	Futures	86	531.53	4.38	0.10	-0.75

The ADF test at the series levels [integrated of order 0, I(0)] accepted the null hypothesis of unit root (non-stationary) at 5 per cent level of significance for all the spot and futures price series of wheat crop for all the contract months. The ADF test statistics of all the spot and future 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 wheat crop was then tested. The first difference or integrated of order 1 denoted as I(1) of all these price series was found to be stationary.

Similarly, ADF test statistics of all the spot and future price series of maize, except futures price series of April month contract and spot price

Table 3. Results of ADF test of unit roots for spot and futures price of wheat crop

Contract month	Prices	Level		First difference	
		Intercept	Intercept & trend	Intercept	Intercept & trend
October, 05	Spot	0.08	-0.62	-7.19*	-7.45*
	Future	-1.39	-0.26	-7.20*	-7.50*
November, 05	Spot	0.45	-0.73	-6.00*	-6.67*
	Future	-1.70	-0.24	-5.85*	-6.33*
December, 05	Spot	0.34	-1.30	-4.72*	-5.06*
	Future	-0.93	-0.89	-4.94*	-5.16*
January, 06	Spot	-0.38	-2.69	-3.73*	-3.67**
	Future	-0.17	-2.37	-3.64*	-3.78**

* and ** denote significance at 1 and 5 % levels, respectively.

Table 4. ADF test result for unit roots for spot and futures price of maize crop

Contract month	Prices	Level		First difference	
		Intercept	Intercept & trend	Intercept	Intercept & trend
April, 05	Spot	-0.32	-2.48	-6.70*	-7.12*
	Future	-3.07**	-3.55**	-8.70*	-8.37*
May, 05	Spot	-3.17**	-2.21	-6.03*	-7.11*
	Future	0.40	-2.21	-6.85*	-7.55*
June, 05	Spot	1.50	2.36	-5.07*	-5.44*
	Future	-1.11	-0.74	-6.08*	-6.08*
July, 05	Spot	0.95	-1.52	-5.61*	-5.97*
	Future	-1.51	-2.84	-5.69*	-5.99*
August, 05	Spot	-0.73	-2.23	-5.19*	-5.15*
	Future	-1.62	-3.33	-5.62*	-5.60*
September, 05	Spot	-1.58	-1.07	-4.72*	-4.88*
	Future	-1.73	-1.76	-6.00*	-5.95*
October, 05	Spot	-1.03	-0.87	-5.59*	-5.94*
	Future	-1.89	-1.09	-8.33*	-8.75*

* and ** denote significance at 1 and 5 % levels, respectively.

series for May contract month fell within the confidence interval, indicating all the price series exhibited random walk or levels of series were non-stationary. Further, the first difference of these non-stationary series of spot and futures prices of maize crop was tested and the first difference or integrated of order 1 denoted as I(1) of these price series was found to be stationary.

Table 5 and 6 depict the results of AEG test for co-integration of spot and futures prices of wheat and maize crop of various contract months,

Table 5. AEG cointegration test for wheat crop

Contract month	Intercept	Coefficient	τ-statistics
October, 05	0.016	-1.068	-10.65*
November, 05	0.049	-1.076	-9.45*
December, 05	0.430	0.219	1.87
January, 06	1.197	0.587	3.68*

*Significant at 1 % level.

respectively. The spot price series was regressed on the futures price of each contract month to obtain residuals on which ADF test was performed. Last column of Table 5 shows the ADF test statistics to study the stationary of residuals from each regression equation.

The results of AEG test for cointegration for spot and futures prices of wheat crop for four contract months, i.e. October 2005, November 2005, December 2005 and January 20006 are presented in Table 5. Three cointegration equations (October 2005, November 2005 and January 2006) had white noise residuals when ADF test was used. This indicates that there was a cointegrating relationship between pairs of spot and futures price series of wheat crop. This further indicates that one of the prices in the pair could be predicted from the other price series. Hence, it is suggested that there is long-run equilibrium/ co-movement among these spot and futures price series of wheat crop.

The τ statistics of the maize crop indicated that six cointegration equations out of seven had white noise residuals when ADF test was used in Table 6. This means there was cointegrating relationship between pairs of spot and futures price series of maize crop. The co-movement between price series of maize crop indicated that one of the prices in the pair could be predicted from the other price series. Therefore, these results are same as in wheat, that is there is long-run equilibrium/ co-movement among these spot and futures price series of maize crop.

Table 6. AEG cointegration test for maize crop

Contract month	Intercept	Coefficient	τ-statistics
April, 05	-0.030	-1.270	-10.92*
May, 05	-0.000	-1.197	-9.52*
June, 05	0.026	-0.996	-5.19*
July, 05	0.075	-1.100	-9.57*
August, 05	0.034	-1.367	-12.08*
September, 05	-0.034	-1.154	-9.38*
October, 05	-0.122	-0.044	-1.20

*denotes significance at 1% level

It has been found that the spot and future price series of various contract months of wheat and maize crops were cointegrated; i.e. there existed a long-term equilibrium relationship between the two. Of course, in the short-run there could be disequilibrium. Therefore, we can treat the error-term as the equilibrium error and this can be used as a short-run behavior of the spot price series to its long-run behaviour. The error-correction model was used to estimate the acceleration speed of the short-run deviation to the long-run equilibrium. The residual of the long-run model and the first difference of the spot and futures price series were used to estimate the error-correction model to determine the short-run deviation from equilibrium. The coefficient of error correction-term which indicates the speed at which the series returns to equilibrium is of particular interest. As a matter of notion, the values of coefficient of the error correction-term that are negative (positive) and less than (equal to) zero, the series converges to the long-run equilibrium. Residuals estimated from the "long-run relationship "Yt=a+bXt" are used in the new regression.

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 equilibrium. As they near or exceed one, short-run deviation will follow rapid path to long-run equilibrium. This indicates that spot price series adjust to changes in the futures prices series in the same period. The error correction-term for maize and wheat crops are presented in Tables 7 and 8, respectively. As evident from Table 7, the error correction term for wheat crop exhibited the desired negative signs with varied degree from -0.08 in October and December contract to – 0.24 in January, 06 contract. It also exhibited the convergence in spot and futures prices.

Similarly, on perusing Table 8 for prices of maize crop, it was aptly clear that the futures contract behaved in the expected manner and there existed a mechanism for long-run equilibrium. The negative sign and the extent of

Table 7. Error correction mechanism (speed-of-adjustment) for prices of wheat crop

Contract month	Intercept	First difference of futures price	τ-statistics	Error correction term	τ-statistics
October, 05	0.63	0.46	4.87	-0.08	-0.78
November, 05	0.65	0.46	4.43	-0.11	-0.88
December, 05	0.83	0.58	4.23	-0.08	-0.60
January, 06	1.24	0.79	4.16	-0.24	-1.28

Table 8. Error correction mechanism (speed-of-adjustment) for prices of maize crop

Contract month	Intercept	First difference of futures price	τ-statistics	Error correction term	τ-statistics
April, 05	0.07	-0.06	-1.09	-0.27	-2.29
May, 05	0.21	-0.02	-0.27	-0.21	-1.61
June, 05	0.49	0.13	0.95	-0.05	-0.25
July, 05	0.67	0.50	4.14	-0.12	-1.09
August, 05	0.85	0.38	2.82	-0.38	-3.29
September, 05	0.32	0.11	1.41	-0.16	-1.26
October, 05	-0.02	0.18	1.90	-0.07	-0.67

error correction-terms of the contract months, April to October, 2005 exhibited the tendency of convergence in the spot and futures prices. However, the degree was maximum in the August contract and minimum in the June contract.

Thus, short-run changes in futures prices series have a positive impact on the short-run changes in the spot price for both maize and wheat crops. This phenomenon of price convergence for both maize and wheat crops clearly depicts that the farmers are mitigating price risk as spot prices and future prices converge. This is a good option for hedging in the Indian futures market for the farmers growing maize and wheat crops.

Conclusions

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 in a bid to avert the price risk often tend to go for distress sale and thereby reduce the potential returns. In order to cope up with this problem, futures trading has emerged as a viable option. Apart from increasing the stability of the market, this mechanism also 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 the present study, an attempt has been made to look into the mechanism of movement of spot and futures prices for two important food crops in the Indian agriculture. The ADF test has been used for both the crops to check the stationarity of the time series data. Most of the series have been found to be stationary at first difference. The co-integration test has been attempted to find out whether there exists a long-run relationship

between spot and futures prices of various contract months for maize and wheat crops. However, in the short-run there may be disequilibrium between these two. It has been observed that the futures contract behaves in an expected manner and there exists a mechanism for long-run equilibrium in the maize as well as wheat crops. This phenomenon of price convergence for both maize and wheat crops clearly depicts that the farmers are mitigating price risk as spot prices and future prices converge.

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