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RESEARCH PAPER

Price discovery of Indian turmeric in futures market

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ABSTRACT

This paper examined the relationship between turmeric futures price traded in National Commodity and Derivatives Exchange (NCDEX), Mumbai and spot price prevailed in Erode market over a period of eight years (2004 -2012). It was found in the study that futures price of turmeric led the spot market in price discovery. The result showed the presence of unidirectional causality from futures price to spot price. In turmeric this implied that futures market discovered prices for turmeric and spot market prices were influenced by the futures market price. The results of Vector Error Correction model indicated that when the co-integration series was in disequilibrium in the short run, it was the spot price that makes greater adjustment in order to reestablish the equilibrium. This study also proved the occurrence of price transmission from futures market to spot prices of turmeric. The result of the study showed commodity futures market with respect to turmeric are efficient, since they played a fair role in price discovery.

KEY WORDS : Turmeric, Co-integration, price discovery

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Turmeric is an ideal spice for life since it has been exhibiting many medicinal properties. Turmeric is a commodity which is inelastic with respect to price and income since it is both an essential commodity and required regularly in meagre quantities in the households (Shinoj and Mathur, 2006). The major spot trading centres for turmeric are Nizamabad, Duggirala and Kadapa in Andhra Pradesh, Sangli in Maharashtra and Salem, Erode, Dharmapuri and Coimbatore in Tamil Nadu.

Futures trading in turmeric was first started in the year 1956, in a regional exchange, the Spices and Oilseeds Exchange Ltd. located in Sangli, Maharashtra. Even though the volume and value of turmeric traded in this exchange was very less, since inception, turmeric is continuously traded in this regional exchange. Futures contracts were commenced for trading on electronic platform after Forward Market Commission had given permission to start national level multi-commodity exchanges. Turmeric futures contract was launched on National Commodity and Derivatives Exchange (NCDEX) platform in April 2004 and since then it witnessed considerable participation from various supply chain participants.

Futures commodity exchanges provides a centralized marketplace where market users can discover the prices of commodities for futures delivery and where risk-averse people can shift commodity price risk to others, who are willing to bear it (Schap and Dan, 2003). The use of market-based price instruments to mitigate price risk provides farmers with new alternatives for availing credit and insurance facilities and

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allows them greater certainty in planning their on-farm activities (Varangis *et al.,* 2003). The forward and futures contracts are efficient risk management 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. Turmeric prices were always subject to high volatility owing to the mismatch at domestic fundamentals. Hence, they have been traded at futures market to mitigate commodity price risk and also to give price signals to the market participants. Movements of price in the futures market can provide an observable signal to the farmers planning under uncertainty. There are very few studies assessed the efficiency of futures market in India. The present study spotlights the relationship that exists between the spot and futures prices of turmeric and examines that if they are integrated or not.

METHODOLOGY

The daily closing futures price over a period of 8 years (December, 2004 – December, 2012) for turmeric was collected from National Commodity and Derivatives Exchange, Mumbai which is a leading agri-commodity exchange with a market share of over 85 per cent. The daily closing prices of these commodities in spot markets were also collected from Agmarknet web site for the same period for Erode market, major turmeric spot market for Tamil Nadu. Time series data were subjected to the following analyses to know the efficiency of futures market in turmeric and also the prevailing relationship between the futures and assess the prevailing relationship between the futures and spot price of turmeric.

Augmented dickey fuller test :

The problem in time series data is that of non-stationarity. Before analysing any time series data, testing for stationarity is a pre-requisite since non-stationary variables will give spurious results. To identify whether series are integrated of order one, the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1979) was employed :

$$\Delta XF_t = \alpha_0 + \alpha X_{ft-1} + \sum_i \beta_i \Delta X_{ft-1} + \varepsilon_t$$

$$\Delta XS_t = \alpha_0 + \alpha X_{st-1} + \sum_i \beta_i \Delta X_{st-1} + \varepsilon_t$$

where, XF_t = the futures price,

XS_t = the spot price

ρ_0 = a constant,

$\rho = (\alpha - 1)$,

Δ = the first difference operator,

εt = white noise error term and

$\Delta xt - 1 = (Xt-1-Xt-2)$, $\Delta Xt-2 = (\Delta Xt-2-\Delta Xt-3)$, etc.,

i = 1 to *n* is number of lagged difference terms

The Null hypothesis was to test that $\rho = 0$. If $\rho = 0$, implying the presence of unit root, meaning the time series under consideration is nonstationary. But for stationarity, ρ must be negative. In the present study, stationarity of the spot and futures price were tested using the Augmented Dickey – Fuller test.

Granger causality :

Granger (1969) developed a methodology to examine whether changes in one series cause changes in another. If the current value of Y can be predicted by using the past values of X and considering other relevant information including the past values of Y, it may be concluded that X causes Y. Similarly, if the current values of X can be predicted by considering past values of Y and past values of X, it is concluded Y causes X. The following two OLS regressions used in Granger causality test explains the above concept:

$$Y_t = \alpha_0 + \alpha_t Y_{t-1} + \sum_j \beta_j X_{t-j} + U_t$$

$$X_t = \alpha_0 + \alpha_t X_{t-1} + \sum_j \beta_j Y_{t-j} + U_t$$

where "i" = 1 to m and t indicates time t.

Y_t = Spot price at time t,

X_t = futures price at time t,

Y_{t-i} = lagged spot price,

X_{t-i} = lagged futures price,

Granger causality test is very sensitive to the number of lags used in the analysis. Based on Akaike Information Criteria (AIC) and Schwartz Bayesian Criteria (SBC), number of lags to be included was selected. In the present study, Granger causality test was used to test the dynamic relationship between spot and futures price of turmeric.

Johansen multiple co-integration test :

If both the price series are integrated of order one, then those series can be modeled by co-integration analysis. To test the long run equilibrium relationship between the spot and futures price series, Johansen Multiple Co-integration framework was used. The concept of co-integration was first introduced by Granger (1980). Engle and Granger (1987) proposed a procedure for testing the co integration hypothesis. A level regression was performed to generate residuals which may be thought of as equilibrium pricing errors. Residuals were then subjected to tests for co-integration. With two time series-spot price (S_t) and futures prices (F_t) each of which is I(1), the co integration regression equation is :

$$S_t = \eta_0 + \eta_t F_t + \varepsilon_t$$

where, S_t – spot price at time t

η_0 – *constant*

η_t is the regression co-efficient measures the influence of F_t on S_t and ε_t is the residuals or error terms.

The spot price and futures prices will be co-integrated if and only if ε_t is stationary.

Vector error correction mechanism (ECM) :

An Error Correction Model (ECM) is a neat way of

combining the long run, co integrating relationship between the levels variables and the short run relationship between the first differences of the variables. Engle and Granger (1987) demonstrated that once a number of variables are found to be co integrated, then there existed a corresponding error correction representation which implied that the changes in the dependent variable are a function of the level of disequilibrium in the co integrating relationship (captured by the error correction term) as well as changes in other variables.

Even if one demonstrates market integration through co integration, there could be disequilibrium in the short run, *i.e.*, price adjustment across markets may not happen instantaneously. It may take some time for the spatial price adjustments. ECM can incorporate such short run and long run changes in the price movements. The long term casual relationship between spot and futures market was implied through the significance of 't' tests of the lagged error correction term as it contains the long term information because it is derived from the long term relationship. The coefficient of the lagged error correction term is a short-term adjustment coefficient and represented the proportion by which the futures price adjusted in response to the long run disequilibrium :

$$\Delta S_t = \alpha_s Z_{t-1} + \sum_{i=1}^{p} b_{si} \Delta S_{t-i} + \sum_{i=1}^{p} C_{si} \Delta F_{t-i} + \varepsilon_{s,t}$$

$$\Delta F_t = \alpha_F Z_{t-1} + \sum_{i=1}^{p} b_{Fi} \Delta S_{t-i} + \sum_{i=1}^{p} C_{Fi} \Delta F_{t-i} + \varepsilon_{F,t}$$

where, ΔS_t is the differenced price series from spot market

ΔF_t is the differenced price series of futures market,

b_{Si}, c_{Si} , b_{Fi} , and c_{Fi} are the short-run co-efficients,

z_{t-1} is the error correction term (ECT), and $\delta_{S,t}$ and $\delta_{F,t}$ are residuals.

The magnitude of the co-efficients a_S and a_F will determine the speed of adjustment back to the long-run equilibrium following a market shock. When these co-efficients are large, adjustment is quick. When S_t and F_t are co-integrated prices, the ECM will capture dynamic correlations and causalities between their prices. If the coefficient on the lagged F_t price in the S_t equation are found to be significant, then turning points in F_t will lead turning points in S_t, that is, F_t Granger causes S_t. There must be causalities when a spread is mean-reverting and two asset prices are moving in line, but the direction of causality may change over time.

ANALYSIS AND DISCUSSION

The results of the ADF test, Granger causality, Johansen multiple co-integration and Vector error correction model results are presented below :

Augmented dickey fuller test results :

As precondition of co-integration and causality analysis, a unit root test was performed to check whether both spot and futures prices were stationary or not. Unit root tests based on Augmented Dickey-Fuller (ADF) test was used in this study to examine the stationarity of the futures and spot price series. The results are presented Table 1.

The ADF test statistics were given for both spot and futures price (Table 1). Based on Schwarz information criteria, the optimal lag length chosen for ADF test was 2. Both spot and futures price contained a single unit root at 1% level of significance, implying that both the series were non-stationary. Whereas at first difference of both the seires reject the hypothesis of unit root at 1% level of significance, implying that the series became stationary.

Results of granger causality test :

After making the time series stationary, it was imperative to test the causality to assess the direction of relationship among the series (Malliaris and Urrutia, 1998; Silvapulle and Moosa, 1999; Bryant *et al.*, 2006). Granger causality tests were used to analyze the direction of relationship among price series. In the present study, Granger causality test was used to assess the direction of relationship between futures and spot prices (Table 1).

The result of Table 2 showed the presence of unidirectional causality from futures market to spot prices of turmeric. This implied that futures market discovers prices for turmeric and futures markets have enough ability to impact subsequent spot prices, *i.e.* to discover prices in spot market for turmeric. The results of this study are quite useful to various stakeholders of turmeric value chain comprising

Table 1 : Results of augmented dickey fuller test

Sr. No.	Market	Test values		Critical values (at 1 per cent level)
		Level	First difference	
1.	Spot(S_t)	-1.2199	-21.139	-3.475
2.	Futures (F_t)	-1.4922	-19.964	

Table 2 : Results of granger causality test

Sr. No.	Null Hypothesis	F-Statistic	Prob	Direction of relationship
1.	Spot does not Granger cause futures	1.84563	1.00E-11	Unidirectional
2.	Futures does not Granger cause spot	32.5640	0.0931	

producers, processors, traders, commission agents, commodity exchange's participants and also to regulators and policy makers to make their decisions.

Results of Co-integration analysis :

Wang and Ke (2005) elaborated the use of co-integration for exploring the efficiency in futures market as it provided predictive signal on price convergence. The co-integration 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. After testing the precondition of non-stationary time series of price information, co-integration test was carried out to determine the existence of a long-run relationship between the spot and futures prices (Table 3).

The Null hypothesis of no integration was rejected at one per cent level of significance in both the trace test and maximum eigenvalue statistics and indicating the presence of one co- integration equation among spot and futures price and indicated the presence of long run equilibrium relationship among the spot and futures market price of turmeric.

Results of vector error correction model :

The estimates of the speed of adjustment co-efficients obtained by Vector error correction model is presented in the Table 4 and 5. The error correction term that is the speed of adjustment coefficient was significant in both equations. The error correction term in spot equation was greater in absolute term than that of futures equation. The results indicated that when the co-integration series was in disequilibrium in the short run, it was the spot price that makes greater adjustment in order to reestablish the equilibrium. The futures market contributes 75 per cent to the price discovery where as spot price contribute only to 25 per cent. The results also indicated that futures price was not influenced by lagged spot price but spot price was influenced by its own one day lag and futures one day lag.

Summary and conclusion :

Both spot and futures price series of turmeric were integrated of order one. There existed unidirectional causality between the spot and futures price of turmeric from futures to spot. The above study indicated that both the futures and spot prices of turmeric are integrated, as far as NCDEX futures and Erode spot markets are concerned. This study also proved the fact that the futures markets helped in price transmission to spot prices of turmeric. To conclude that the farmers can rely on futures prices for making selling decisions with regard to turmeric in India. The result of the study showed commodity futures market with respect to turmeric are efficient, since they played a fair role in price discovery. Apart from price discovery as given by Ali and Gupta (2011), the sustainability of agricultural commodity futures markets depends on the transparency and efficiency of its functioning in price risk management, flexible contact specification, controlling unfair speculation, commodity delivery system and coverage, infrastructural support.

Table 3 : Results of co-integration analysis

Sr. No.	Hypothesized no of co integration equation	Eigen value	Trace statistics	Critical value	Prob**
1.	None*	0.041411	53.55985	15.49471	0.000
2.	At most 1	0.001357	1.666775	3.841466	0.1967

Trace test and Max-eigenvalue test indicate 1 co integrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 4 : Results of vector error correction model for differenced futures equation equation 1: d_Futures

	Coefficient	Std. Error	t-ratio	p-value	
Const	9.33011	8.97804	1.0392	0.29891	
d_Futures_1	0.0117567	0.0329404	0.3569	0.72122	
d_Spot_1	-0.0321392	0.0310982	-1.0335	0.30159	
EC1	-0.0251699	0.0132016	-1.9066	0.05681	*

Table 5 : Results of vector error correction model for differenced spot equation equation 2: d_Spot

	Coefficient	Std. Error	t-ratio	p-value	
Const	-18.8035	9.06839	-2.0735	0.03833	**
d_Futures_1	0.146492	0.0332719	4.4029	0.00001	***
d_Spot_1	-0.119259	0.0314112	-3.7967	0.00015	***
EC1	0.074042	0.0133345	5.5527	<0.00001	***

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