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Price Dynamics of Turmeric in Spot and Futures Markets

Shireesha.M[1]*, N.Vani[2] and G. ManasaVeena[3]

[1,2,3]Dept. of Agricultural Economics, S.V. Agricultural College, Tirupati – 517 501, A.P
E-mail: [1]murthy.shireesha55@gmail.com

Abstract—*This paper examined the relationship between turmeric futures price traded in National Commodity and Derivatives Exchange (NCDEX), Mumbai and spot price prevailed in Duggirala market, Andhra Pradesh over a period of three years (2012 -2015) by employing Johansen's co-integration test, examined the causality by Granger Causality test and also captured the speed of adjustment to deviations in long run equilibrium by using Vector Error Correction Model (VECM). The data were made stationary by employing Augumented Dickey Fuller (ADF) test. It was found in the study by co-integration test that futures price of turmeric led the spot market in price discovery. The results of VECM showed that the spot prices attained short run equilibrium as indicated by the level of significance and the rapid speed of adjustment and futures prices were not influenced by lagged spot prices. Unidirectional causality was observed between futures and spot prices implying that futures prices influenced the spot prices of selected market but not vice-versa and also proved the occurrence of price transmission from futures market to spot prices of turmeric. The result of the study showed that commodity futures market with respect to turmeric are efficient, since they played a fair role in price discovery.*

Keywords*: Price discovery, Causality, Co-integration, Futures price, Spot price.*

1. INTRODUCTION

Turmeric known as 'golden spice' in the world is widely cultivated in different countries such as India, China, Myanmar, Nigeria, Bangladesh, Pakistan, Sri Lanka, Taiwan, Burma, Indonesia, etc. India contributes nearly 85-90 per cent of global turmeric production and its annual production ranges between 8.5-9.3 lakh tonnes. Major turmeric growing states are Andhra Pradesh, Tamil Nadu, Karnataka, Odisha, West Bengal and Maharashtra. Indian turmeric is considered as the best in the world because of its high curcumin content. The various varieties of turmeric that are traded in India are Allepey finger (Kerala), Erode turmeric (Tamil Nadu), Salem turmeric (Tamil Nadu), Rajapore turmeric (Maharashtra), Sangli turmeric (Maharashtra), Nizamabad bulb (Andhra Pradesh) etc. India is the largest producer, consumer and as well as exporter of turmeric in the world. This makes turmeric prices very open to price changes in Indian demand and supply.

Agricultural commodity futures market in India can play a significant role in the price discovery and price risk management. A well developed and effective agricultural commodity futures market facilitates price discovery and thereby, helps in minimising the price risk associated with seasonal variations in the demand and supply of agricultural commodities. Thus, futures markets serve as a mechanism to reduce the price risk associated with commodities by revealing the information about future spot market prices and refers to the use of futures price for pricing spot market transactions. This means that futures price functions as market's expectations of subsequent spot price. The extent to which futures market performs the price discovery function well can be measured from the temporal causal relationship between futures and spot prices. If the information is reflected first in futures price and subsequently in spot price, futures price should lead spot price, indicating that the futures market performs the price discovery function and it is usually regarded as the leading indicator of judging the efficiency of the futures market.

The objective of this paper is to investigate the relationship between futures and spot prices of turmeric by employing Johansen's co-integration test.

2. MATERIALS AND METHODS

The daily closing futures prices of turmeric over a period of three years (January 2012 - January 2014) were collected from National Commodities and Derivatives Exchange Ltd. (NCDEX), Mumbai since it had been a leading agri-commodity exchange with a market share over 80 per cent (www.ncdex.com). The daily closing prices of turmeric in Duggirala, major spot market of Andhra Pradesh were also collected from AGMARKNET (www.agmarknet.com) for the same period.

In this study, Augumented Dickey Fuller (ADF) test was used to verify the stationarity of the data developed by Dickey an Fuller (1979). To examine the lead lag relationship between futures and spot prices, Johansen's multiple co-integration test was employed. Further, the necessary lag length of the data series was selected on the basis of Schwarz Information

Criterion (SIC). The co-integration between spot and futures prices is a necessary condition for market efficiency. The absence of co-integration implies that futures price provide little information about movement in cash price indicating that the futures market is not very efficient.

Vector Error Correction Model (VECM) was applied to investigate further on the short-run interaction causality among variables and also to know the speed of adjustment from the short run disequilibrium to the long run equilibrium. If price series are integrated of order one or I(1), then one could run regressions in their first differences.

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

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

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

The coefficient of error-correction term indicates the speed at which the series returns to equilibrium. If it is less than zero, the series converge to long-run equilibrium and if it is positive and zero, the series diverges from equilibrium. When S_t and F_t prices are co-integrated, the ECM will capture dynamic correlations and causalities between their prices.

In the present study, Granger Causality test was used to test the direction of relationship between the spot and futures prices of turmeric. Granger (1969) developed a methodology to examine whether changes in one series cause changes in another. The following two OLS regressions were used.

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

$$X_t = \alpha_0 + \alpha_t X_{t-i} + \beta_j X_{t-i} + U_t$$

Where i = 1to 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 Criterion (AIC) and Schwartz Bayesian Criterion (SBC), number of lags to be included was selected.

3. RESULTS AND DISCUSSION

Augumented Dickey Fuller (ADF) Test

Before determining the interdependence between futures and spot prices, a unit root test was performed to check whether both futures and spot prices of turmeric were stationary or not in selected market.

The ADF test statistics were given for both spot and futures prices (Table 1). Based on Schwarz Information Criterion (SIC), the optimal lag length chosen for ADF test was one. Stationarity of the data for the spot prices was attained at level itself 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 the futures prices of turmeric. The ADF test statistics of the 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 [integrated of order one, I(1)] of non-stationary time series of futures prices of turmeric was then tested and found to be stationary.

Johansen's Multiple Co-integration Test

The co-integration test revealed the Eigen value and the trace statistic for each set of variables. The test rejected the null hypothesis of no co-integration relationship between the futures and spot prices (r=0) at 5 per cent level of probability, indicating the presence of one co-integration equation between them. The purpose of this analysis was to know whether the futures and spot market prices are co-integrated and thereby price transmission (information flow) takes place, helping in the process of price discovery.

Johansen's co-integration test (Table 2) showed the presence of one co-integration relationship between the futures and spot prices of turmeric indicating long run equilibrium relationship between them. The results are corroborated with the findings of Edward and Rao (2013) on turmeric and chillies, Murugananthi *et al.* (2013) on turmeric, Bharadwaj (2014) on cumin and Natarajan and Nirupama (2015) on pepper.

Vector Error Correction Model

From the results of VECM presented in Table 3, it is clearly known that the prices in spot market attained short run equilibrium as shown by negative and significant co-efficient at 5 per cent level of significance indicating the convergence from equilibrium. and the rapid speed of adjustment. Spot prices in the selected market were influenced by their own lags to the extent of 31 percent and 12 per cent at one day and two days for long run equilibrium respectively. Influence of lagged futures prices on spot prices to the extent of 12 percent, 17 percent and 11 percent at one day, two days and three days respectively was also observed. The co-effficients of both lagged spot prices and futures prices were negative and significant at 5 per cent level of significance indicating the

convergence of spot prices and futures prices towards long run equilibrium.

Granger Causality Test

To assess the direction of relationship between the futures and spot prices of turmeric, Granger Causality test was carried out. The results are presented in Table 4.

The causality test showed the unidirectional causality running from futures to spot prices for the selected commodity indicating that futures prices influenced the spot prices in the selected market but not vice-versa. This indicated that the information reflected first in the futures prices and then it was transmitted to spot market prices implying that futures markets had stronger ability to predict subsequent spot prices and played a dominant role in the price discovery process.

One of the underlying assumptions associated with the potential causal relationship between futures and spot prices is that futures prices influence spot prices but not vice-versa. The major argument for the premise that futures prices lead spot prices is that the former respond to new information more quickly than the latter due to lower transaction costs and ease of shorting. In the agricultural market, if new information indicates a rise in prices of commodities, a speculator has the option of either buying futures or spot. However, spot transactions require more initial outlay and possibly time-consuming to implement, while futures transactions could be executed instantly without holding in the physical commodity and with modest up-front cash. Likewise, hedgers who are concerned for the physical commodity and have storage limitations may prefer to buy futures contracts. Hence, both hedgers and speculators would respond to the new information by choosing futures rather than spot transactions. The results are in tune with Murugananthi *et al.* (2013) on turmeric, Mishra (2013) on cumin and Edward and Rao (2013) on turmeric and chillies.

4. CONCLUSIONS

Agricultural commodity futures exchange provides a centralized marketplace where the farmers and other market participants can discover the prices of agricultural commodities for futures delivery and where risk-averse people can shift commodity price risk to others, who are willing to bear it. Ali and Gupta (2011) highlighted that the sustainability of agricultural commodity futures markets depends on the transparency and efficiency of its functioning in terms of price discovery, price risk management, flexible contact specification, controlling unfair speculation, commodity delivery system and coverage, infrastructural support, etc. Empirically the study of this research examined the market which reacts first in agricultural commodity markets in India by assessing the relationship between the spot and futures prices of turmeric traded in NCDEX, using Johansen's co-integration approach. Empirical results suggested the existence of long-run equilibrium relationship between futures and spot prices for turmeric that were taken under this study. The direction of relationship between futures and spot prices was unidirectional for selected agricultural commodity.

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Table 1: ADF test for spot and future prices of turmeric

Market	Level	Lag	First Difference	Lag	Critical value at 1 per cent
Spot	-3.454764 (0.0451)*	2	-	1	**-3.974677**
Futures	-1.666725 (0.7651)	0	-27.2961 (0.0000)*	0	

Table 2: Johansen's Co-integration test for spot and futures prices of turmeric

Hypothesised number of CE (s)	Eigen Value	Trace Statistic	0.05 Critical value	Prob.**
None*	0.041925	38.49491	25.87211	0.0008
At most 1	0.006565	5.130946	12.51798	0.5777

Trace test indicates 1 cointegrating 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: Granger Causality test for spot and futures prices of turmeric

Null Hypothesis	Obs	F-Statistic	Probability
FUTURES does not Granger Cause SPOT	780	28.0931	3.E-17
SPOT does not Granger Cause FUTURES		1.04951	0.3699

Table 3: Vector Error Correction Model for spot and futures prices of turmeric

Error Correction:	D(SPOT)	D(FUTURE)
CointEq1	-0.123185	-0.008224
	(0.02145)	(0.01660)
	[-5.74392]	[-0.49547]
D(SPOT(-1))	-0.315933	-0.011340
	(0.03734)	(0.02890)
	[-8.45999]	[-0.39233]
D(SPOT(-2))	-0.125538	0.032984
	(0.03724)	(0.02883)
	[-3.37068]	[1.14427]
D(SPOT(-3))	-0.051377	-0.010993
	(0.03444)	(0.02666)
	[-1.49171]	[-0.41238]
D(FUTURE(-1))	0.121098	0.015071
	(0.04880)	(0.03777)
	[2.48174]	[0.39906]
D(FUTURE(-2))	0.172335	-0.024045
	(0.04874)	(0.03772)
	[3.53573]	[-0.63739]
D(FUTURE(-3))	0.111988	0.025473
	(0.04906)	(0.03797)
	[2.28252]	[0.67083]
C	-3.074790	-3.686020
	(11.6344)	(9.00455)
	[-0.26428]	[-0.40935]
R-squared	0.2010661	0.001710