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   REVIEW OF LITERATURE

   NEED/IMPORTANCE OF THE STUDY

   STATEMENT OF THE PROBLEM

   OBJECTIVES

   HYPOTHESES

   RESEARCH METHODOLOGY

   RESULTS & DISCUSSION

   FINDINGS

   RECOMMENDATIONS/SUGGESTIONS

   CONCLUSIONS

   SCOPE FOR FURTHER RESEARCH

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   REFERENCES

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CONTRIBUTIONS TO BOOKS

- Sharma T., Kwatra, G. (2008) Effectiveness of Social Advertising: A Study of Selected Campaigns, Corporate Social Responsibility, Edited by David Crowther & Nicholas Capaldi, Ashgate Research Companion to Corporate Social Responsibility, Chapter 15, pp 287-303.

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- Schemenner, R.W., Huber, J.C. and Cook, R.L. (1987), "Geographic Differences and the Location of New Manufacturing Facilities," Journal of Urban Economics, Vol. 21, No. 1, pp. 83-104.

CONFERENCE PAPERS

- Garg, Sambhav (2011): "Business Ethics" Paper presented at the Annual International Conference for the All India Management Association, New Delhi, India, 19–22 June.

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- Kumar S. (2011): "Customer Value: A Comparative Study of Rural and Urban Customers," Thesis, Kurukshetra University, Kurukshetra.

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- Garg, Bhavet (2011): Towards a New Natural Gas Policy, Political Weekly, Viewed on January 01, 2012 http://epw.in/user/viewabstract.jsp

EFFICIENCY OF COMMODITY FUTURES IN PRICE DISCOVERY: AN EMPIRICAL STUDY OF AGRICULTURAL COMMODITIES

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ABSTRACT

The main aim of the present study is to find out whether commodity futures market is efficient in price discovery for agricultural commodities in India. The daily closing price information of spot and futures markets, for a period of 10 years (2004 – 2013), for three agricultural commodities viz., Chana, Chilli and Turmeric which are traded in National Commodity & Derivatives Exchange Ltd (NCDEX), is taken for the study. The present study examines price discovery function in spot-futures agricultural commodity market in India by using VAR model, Johansen test of Co-integration, VECM, OLS method, and Granger Causality tests. The cointegration results reveal that there is a long-run association between commodity spot and futures prices of Chana, Chilli and Turmeric. The VECM results show that there is a long–run causality running from futures prices to spot prices of near month contracts of Chana, Chilli and Turmeric. The speed of adjustment towards equilibrium is lower in the sample agricultural commodities. The granger causality test results disclose that there is only a unidirectional causality from futures returns to spot returns of Chilli and Turmeric. In case of Chana, bidirectional causality from futures to spot returns is observed. So, it is revealed that the near month futures contracts are suitable for hedging.

JEL CLASSIFICATION
C22, C32, G14, O13, Q13.

KEYWORDS
Commodity Futures, Price Discovery, Price Risk Management, Price Volatility.

1. INTRODUCTION

In the wake of globalization and surge in global uncertainties, the prices in commodity markets have been showing wide fluctuations. Commodity price volatility is the most critical issue faced by the producers of primary commodities. Fluctuating commodity prices pose a continuous financial risk for businesses. Derivatives products serve the vitally important economic functions of price discovery and risk management. The transparency, which emerges from their trading mechanism, ensures the price discovery in the underlying market. Further, they serve as risk management tools by facilitating the trading of risks among the market participants.

Price discovery and risk transfer are considered to be two major contributions of futures market towards the organization of economic activity (Garbade & Silber, 1983). Price discovery hinges on whether new information in the market is reflected first in the changes in futures prices or changes in spot prices (Hoffman, 1932). Through price discovery function, futures market establishes a competitive reference (future) price from which spot price can be derived. This implies that futures price serves as market's expectations of subsequent spot price. In other words, price discovery is the process by which markets incorporate this information to arrive at equilibrium (Working, 1948). In a static sense, price discovery implies the existence of equilibrium price and in a dynamic sense, the price discovery process describes how information is produced and transmitted across the markets. Futures prices serve as the market expectations of subsequent spot prices and can be used by exporters, producers including farmers for optimal decision making and resource allocation.

In efficient markets, new information is impounded simultaneously into cash and futures markets (Zhong et al. 2004). In other words, financial market pricing theory states that market efficiency is a function of how fast and how much information is reflected in prices. The rate at which prices exhibits market information is the rate at which this information is disseminated to market participants (Zapata et al. 2005). In reality, institutional factors such as liquidity, transaction costs, and other market restrictions may produce an empirical lead-lag relationship between price changes in the two markets. The market that provides the greater liquidity and low trading cost as advocated by Fleming, Ostdiek and Whaley (1996) is likely to play a more important role in price discovery.

2. REVIEW OF LITERATURE

Pindyck and Robert S (2001) have provided an explanation of short-run commodity price movements that is based on "fundamentals," i.e., rational shifts in supply and demand in each of two markets. It also explained how prices, rates of production, and inventory levels are interrelated, and are determined via equilibrium in two interconnected markets.

Susan Thomas (2003) has shown some evidence on the role played by the nascent futures markets in price discovery. They offered three policy proposals: using reference rates for strengthening transparency, exploring a greater role for cash settlement, and treating warehouse receipts as securities.

YangJianet et al. (2005) have examined the lead-lag relationship between futures trading activity (volume and open interest) and cash price volatility of major agricultural commodities. Granger causality tests and generalized forecast error variance decompositions method have shown that an unexpected increase in futures trading volume unidirectionally causes an increase in cash price volatility for most commodities. Further, they found a weak causal feedback between open interest and cash price volatility.

S.M. Lokare (2007) has examined the efficacy and performance of commodity derivatives in steering the price risk management. He found that almost all the commodities throw an evidence of co-integration in both spot and future prices, presaging that these markets are marching in the right direction of achieving improved operational efficiency, *albeit*, at a slower pace. He also found that hedging proves to be an effective proposition in respect of some commodities, while the others entail moderate or considerably higher risk.

R. Salvadi Easwaran and P. Ramasundaram (2008) have made an investigation into the futures markets in agricultural commodities in India. Bartlett's homogeneity of variance test was used to test the integration between spot and futures markets. The test results of price discovery have indicated that price discovery does not occur in agricultural commodity futures market. The econometric analysis of the relationship between price return, volume, market depth and volatility has shown that the market volume and depth are not significantly influenced by the return and volatility of futures as well as spot markets.

Nath and Lingareddy (2008) the authors have tried to explore the effect of futures trading on spot prices of pulses by using correlations, regression analysis and the Granger causality test. Their study found that volatility in urad as well as pulses prices was higher during the period of futures trading than in the period prior to its introduction as well as after the ban of futures contract.

Mantu Kumar Mahalik et al. (2009) have examined price discovery and volatility spillovers in Indian spot-futures commodity markets by using cointegration (Johansen, 1991), VECM and the bivariate EGARCH (Nelson, 1991) model. This study has used four futures and spot indices of Multi-Commodity Exchange (MCX). VECM shows that commodity futures markets effectively serve the price discovery function in the spot market implying that there is a flow of information from future to spot commodity markets. Besides the bivariate GARCH model indicates that the volatility spillovers from future to the spot market are dominant in the case of ENERGY and COMDEX index while AGRISP acts as a source of volatility towards the agri-futures market.

Mallikarjunappa T and Afsal E M (2010) had made an attempt to determine the lead-lag relationship between spot and futures markets in the Indian context by using high frequency price data of twelve individual stocks, observed at one-minute interval. The study applied the concept of co-integration and establishes the spot-futures relationship using Vector Error Correction Mechanism (VECM) represented by EGARCH framework. They found no significant leading or lagging effects in either spot or futures markets with respect to top twelve individual stocks. There exists a contemporaneous and bi-directional lead-lag relationship between the spot and the futures markets.

Mukherjee Kedar Nath (2011) has made an attempt to re-validate the impact of futures trading on agricultural commodity market in India. The statistical techniques used are multiple regression model, VAR model and GARCH model. The analysis showed that the price volatility for most of the selected agricultural commodities was higher in pre- futures period and gets significantly reduced after getting listed in futures. The empirical findings have significantly shown that comparative advantage of futures market in disseminating information, leading to a significant price discovery and risk management.

Kumar Brajesh and Pandey Ajay (2011) have investigated the effectiveness of the price discovery function of commodity futures markets in India. It can be concluded that in the Indian commodity futures markets, futures markets do not dominate the price discovery process as they do in other developed markets. For the precious metals and energy commodities, the futures markets lead the price discovery role. In the case of agricultural commodities and industrial metals, the price discovery takes place in both spot and futures markets. For the precious metals and energy commodities, which are more tradable in nature, futures markets are not affected by spot markets.

Sehgal Sanjay et al. (2012) have empirically examined the effect of futures trading activity (trading volume; proxy of futures liquidity) on spot price volatility for seven agricultural commodities (guar seeds, turmeric, soya bean, black pepper, barley, Maize and Castor Seed). They found that unexpected futures trading volume is Granger causing spot price volatility and are significant for five out of seven agricultural commodities (Guar seed, Turmeric, Soybean, Maize and Castor Seed).It has been found reversed effect for one commodity i.e. Pepper the effect of spot volatility on futures trading and for Barley no causality is revealed either from future to spot or Vice-Versa.

Chauhan Ajay Kumar et al. (2013) have made an effort to analyze the market efficiency of the Indian commodity market and volatility spillover effects between the spot and future market with reference to agri-commodities guar seed and chana. The results indicated that the commodity futures markets effectively serves the price discovery function in the spot market implying that there is a flow of information from future to spot commodity markets. The results also indicated that the volatility spillovers from future to the spot market are dominant. However in Agri-commodities the volatility in spot market may influences volatility in future market.

3. NEED FOR AND IMPORTANCE OF THE STUDY

Indian markets have been increasingly integrating with global markets in commodities. This opens a window of opportunity to Indian companies but at the same time exposes them to a whole new world of risks. Among these risks, the most important one is commodity price volatility. Companies need to be able to manage these risks if they are to be globally competitive, and this is where an efficient commodity futures market plays a vital role not only in facilitating price/volatility risk mitigation but also catalyzing near-perfect price discovery. Therefore, the price volatility drives the demand for hedging the risk in the commodity market. The need for commodity derivatives is multifarious in a growing economy like India. Since India is one of the largest producer of agricultural commodities, time is ripe for India to take a dominant role in price leadership at international level. In this backdrop, it is important to empirically examine the price discovery mechanism of select agricultural/primary commodities.

4. RESEARCH GAP

Though commodity markets in emerging economies like India have been growing, not much research has been done on testing the efficiency of commodity derivatives in price discovery of agricultural/primary commodities in India. In this backdrop, an attempt has been made to revisit the debate on price discovery mechanism in agricultural commodities market. It covers fairly longer study period compared to prior research of the subject. The study attempts to address the following question: Are the commodity futures prices useful in price discovery function of spot prices?

5. OBJECTIVE OF THE STUDY

The main aim of the present study is to find out whether commodity futures market is efficient in price discovery for agricultural commodities in India.

6. HYPOTHESES OF THE STUDY

H_{01}: There is no significant long-run association between commodity futures and spot prices.
H_{02}: There is no significant Granger causality from commodity futures prices to spot prices.

7. DATA & RESEARCH METHODOLOGY

This study is based on secondary data which is obtained from the National Commodity & Derivatives Exchange Limited (NCDEX). The daily prices of near-month contracts of spot and futures markets, for a period of 10 years (2004 – 2014), for three agricultural commodities, such as Chana, Chilli and Turmeric are taken from the NCDEX website. Natural Logarithm of daily closing prices is taken to minimize the heteroscedasticity in data. In order to analyze price discovery and risk management functions in both spot and futures prices in agricultural commodity market, Ordinary Least Square (OLS) Method, Vector Autoregression (VAR) model, Johansen test of Co-integration, Vector Error Correction Model (VECM) and Granger Causality model have been used.

8. SCOPE OF THE STUDY

The present study has been carried out with the focus of studying effectiveness of commodity futures in price discovery of agricultural commodities in India with special reference to National Commodity & Derivatives Exchange Limited (NCDEX). Since NCDEX is the largest national commodity exchange for agricultural commodities trading, the primary agricultural commodities which have more domestic consumption viz., Chana, Chilli and Turmeric have been selected for the study. The study has covered a period of 10 years daily near-month contract prices.

9. DATA ANALYSIS

TABLE 1: DESCRIPTIVE STATISTICS OF DAILY SPOT PRICE AND FUTURES PRICES (2004 – 2014)

Descriptive Statistics	*NCDEX - Agricultural Commodities - Near Month Contracts*											
	Chana				Chilli				Turmeric			
	SP	FP	SR	FR	SP	FP	SR	FR	SP	FP	SR	FR
Mean	2561.86	2570.97	0.03	0.02	5673.81	5502.37	0.13	0.12	5503.32	5405.33	0.05	0.06
Median	2390.00	2404.50	0.00	0.00	5452.15	5178.00	-0.07	-0.04	4947.50	4719.00	-0.02	-0.06
Maximum	5021.90	4933.00	10.39	10.63	10420.00	10336.00	47.30	42.95	17047.05	15776.00	23.31	31.90
Minimum	1386.45	1398.00	-12.17	-25.76	1695.60	1733.00	-49.78	-58.06	1896.65	1817.00	-44.65	-36.45
Std. Dev.	759.14	742.28	1.48	1.72	1944.90	1917.04	3.13	3.95	3827.61	3592.07	2.66	3.34
Skewness	0.97	0.93	-0.22	-1.61	0.39	0.62	2.38	0.58	1.43	1.37	-4.25	0.21
Kurtosis	3.96	3.86	9.82	31.24	3.08	3.22	124.04	68.10	4.20	4.05	96.48	32.48
No. of Observations	2676	2676	2675	2675	1187	1187	1186	1186	1386	1386	1385	1385

Note: SP = Spot Price; FP = Futures Price; SR = Spot Returns; FR = Futures Returns

Table 1 reports the descriptive statistics of variables for the period of the sample based on the daily prices and returns. It shows that the returns on spot and futures of Chilli are much higher than the returns of Chana and Turmeric during the study period. It also shows that the standard deviation of returns of Chilli and Turmeric is more than the Chana. It implies that the variability in returns is more in case of Chilli and Turmeric than Chana. Positive skewness was observed in the prices of spot and futures for Chana, Chilli and Turmeric near month contracts. Negative skewness was observed in the returns of spot and futures of Chana and spot returns of Turmeric. A large Kurtosis figure (> 3) is also observed in the prices and returns of spot and futures of Chana, Chilli and Turmeric commodities, indicating a relatively Leptokurtic distribution.

EFFECTIVENESS OF COMMODITY FUTURES IN PRICE DISCOVERY OF SPOT PRICES

TESTING STATIONARITY OF COMMODITY FUTURES AND SPOT RETURNS

Augmented Dickey Fuller (ADF) test has been conducted to analyse the stationarity of spot and futures returns of sample commodities for near month contracts. The following equation describes the estimation of stationarity under ADF test.

$$\Delta Y_t = \alpha_0 + \gamma Y_{t-1} + \sum_{j=1}^{p} \beta_j \Delta Y_{t-j} + \varepsilon_t$$

The unit root test is then carried out under the null hypothesis $\gamma = 1$ against the alternative hypothesis of $\gamma < 1$. Once the value for the test statistic is computed, it can be compared to the relevant critical value for the ADF test. If the test statistic is less than the critical value then the null hypothesis of $\gamma = 1$ is rejected and no unit root is present and the series become stationary.

TABLE 2: TESTING OF STATIONARITY OF COMMODITY SPOT AND FUTURES PRICES & RETURNS

Augmented Dickey Fuller test - Log Prices						
Particulars	**Chana - Near Month**		**Chilli - Near Month**		**Turmeric - Near Month**	
	t-Statistic	*Prob.**	*t-Statistic*	*Prob.**	*t-Statistic*	*Prob.**
Log Spot Prices	-1.983179	0.2945	-1.901357	0.3319	-0.967595	0.7664
Log Futures Prices	-2.008064	0.2835	-2.096392	0.2463	-1.083507	0.7243
Augmented Dickey Fuller test - Ln futures and Spot Returns						
Particulars	**Chana - Near Month**		**Chilli - Near Month**		**Turmeric - Near Month**	
	t-Statistic	*Prob.**	*t-Statistic*	*Prob.**	*t-Statistic*	*Prob.**
Spot Returns	-47.11322	0.0001	-31.62426	0.0000	-32.88813	0.0000
Futures Returns	-50.83035	0.0001	-31.63985	0.0000	-36.53932	0.0000

Test critical values:1% level -3.432948; 5% level -2.862574; 10% level -2.567366

*MacKinnon (1996) one-sided p-values.

The table 2 shows the results of stationarity test on the log values of spot and futures prices and log values of spot and futures returns for near month contracts of Chana, Chilli and Turmeric respectively. The results of the ADF test confirm that the data series of spot and futures prices is non- stationary at level form (p > 0.05) and the data series of spot and futures returns is stationary (p < 0.05). Hence, Johansen test of cointegration is used to check long run equilibrium relationship between spot and futures prices of sample commodities.

TABLE 3: OPTIMAL LAG SELECTION – NEAR MONTH CONTRACTS

VAR Lag Order Selection Criteria – Endogenous variables: **LSP LFP – Chana**						
Lag	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	5000.367	NA	8.13E-05	-3.741293	-3.736884	-3.739697
1	15147.52	20271.52	4.10E-08	-11.33347	-11.32025	-11.32869
2	15442.96	589.7779	3.30E-08	-11.55162	-11.52957*	-11.54364
3	15456.55	27.10598	3.27E-08	-11.5588	-11.52793	-11.54763
4	15471.98	30.75584*	3.25e-08*	-11.56735*	-11.52767	-11.55299*
Endogenous variables: **LSP LFP - Chilli**						
Lag	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	842.2153	NA	0.000828	-1.420482	-1.411901	-1.417248
1	5006.643	8307.735	7.30E-07	-8.454173	-8.428429*	-8.444469
2	5017.61	21.83968*	7.22e-07*	-8.465950*	-8.423044	-8.449776*
3	5021.583	7.899248	7.22E-07	-8.465905	-8.405836	-8.443262
4	5024.191	5.176524	7.23E-07	-8.463552	-8.38632	-8.434439
Endogenous variables: **LSP LFP - Turmeric**						
Lag	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	750.5869	NA	0.00116	-1.083339	-1.075768	-1.080507
1	6276.749	11028.33	3.93E-07	-9.07489	-9.052178	-9.066394
2	6304.389	55.07988	3.79E-07	-9.109101	-9.071248*	-9.094941
3	6317.253	25.59748*	3.74e-07*	-9.121929*	-9.068934	-9.102105*
4	6320.497	6.445701	3.75E-07	-9.120834	-9.052699	-9.095347

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion

As the results of cointegration are sensitive to lag length used in the analysis, selection of optimal lag length is necessary. Table 3 presents the results of lag length selection criteria applied in the present study. As per Akaike Information Criterion (AIC) the optimal lag length of 4 days is selected for near month contracts of Chana, 2 days for Chilli and 3 days for Turmeric respectively.

ESTIMATION OF LONG-RUN ASSOCIATION BETWEEN COMMODITY FUTURES AND SPOT PRICES

The price linkage between futures market and spot market is examined using cointegration (Johansen, 1991) analysis which reveals the extent to which two markets have moved together towards long run equilibrium. There are two test statistics for cointegration under the Johansen approach, which are formulated as

TRACE TEST

$$\lambda_{trace}(r) = -T\sum_{i=r+1}^{k}\ln(1-\hat{\lambda}_i)$$

MAXIMUM EIGENVALUE TEST

$$\lambda_{max}(r, r+1) = -T\ln(1-\hat{\lambda}_{i+1})$$

Where *r* is the number of cointegrating vectors under the null hypothesis and $\hat{\lambda}_i$ is the estimated value for the *i*th ordered Eigenvalue from the Π matrix. It is the *i*th largest Eigenvalue of matrix Π. T is the sample size or number of observations. $\hat{\lambda}_{i+1}$is the (1+*r*)th largest squared Eigenvalue. λ_{trace} is a joint test where the null is that the number of cointegrating vectors is less than or equal to *r* against an unspecified or general alternative that there are more than *r*. λ_{max} conducts separate tests on each Eigenvalue, and has as its null hypothesis that the number of cointegrating vectors is *r* against an alternative of *r* +1.

TABLE 4: ESTIMATION OF LONG-RUN ASSOCIATION BETWEEN COMMODITIES FUTURES AND SPOT PRICES

Johansen Co-integration Test							
LSP LFP - Chana - Near Month Contracts							
Hypothesized No. of CE(s)	Eigenvalue	Trace Test			Max-Eigen Value Test		
		Statistic value	Critical Value	Prob.**	Statistic value	Critical Value	Prob.**
None *	0.022399	64.30359	15.49471	0.0000	60.50876	14.2646	0.0000
At most 1	0.00142	3.794828	3.841466	0.0514	3.794828	3.841466	0.0514
LSP LFP - Chilli - Near Month Contracts							
Hypothesized No. of CE(s)	Eigenvalue	Trace Test			Max-Eigen Value Test		
		Statistic value	Critical Value	Prob.**	Statistic value	Critical Value	Prob.**
None *	0.036177	47.28236	15.49471	0.0000	43.62791	14.2646	0.0000
At most 1	0.003082	3.654446	3.841466	0.0559	3.654446	3.841466	0.0559
LSP LFP - Turmeric - Near Month Contract							
Hypothesized No. of CE(s)	Eigenvalue	Trace Test			Max-Eigen Value Test		
		Statistic value	Critical Value	Prob.**	Statistic value	Critical Value	Prob.**
None *	0.031188	44.94325	15.49471	0.0000	43.7877	14.2646	0.0000
At most 1	0.000836	1.155554	3.841466	0.2824	1.155554	3.841466	0.2824

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level; Max-eigenvalue 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 reveals that there is a presence of one cointegration equation between commodity spot and future prices of near month contracts of Chana, Chilli and Turmeric and this signifies the long-run association. While the trace test results point out less than or one cointegration equations, Maximum Eigen value test results confirm the presence of one cointegration equation.

ESTIMATION OF LONG-RUN AND SHORT-RUN ADJUSTMENT/CONVERGENCE TOWARDS EQUILIBRIUM (CAUSALITY) BETWEEN COMMODITY SPOT AND FUTURES PRICES

To examine the lead-lag relationship or the long-run and short-run speed adjustment/convergence towards equilibrium or long-run steady state (causality) between spot and futures prices of the select commodities, the study uses the Vector Error Correction Model (VECM) as spot and futures prices are cointegrated. When the coefficient of error correction term (coefficient of CointEq1) is negative in sign and significant, then it can say that there is a long-run causality running from futures prices to dependent spot prices (Gujarati, 2009).

$$R_{St} = \alpha_S + \lambda_S Z_{t-1} + \sum_{i=2}^{k}\beta_{Si}R_{St-i} + \sum_{j=2}^{l}\gamma_{Fj}R_{Ft-j} + \varepsilon_{St}$$

$$R_{Ft} = \alpha_F + \lambda_F Z_{t-1} + \sum_{i=21}^{k}\beta_{Fi}R_{Ft-i} + \sum_{j=2}^{l}\gamma_{Sj}R_{St-j} + \varepsilon_{Ft}$$

Where α_S and α_F are the intercepts and ε_{St} and ε_{Ft} are the error terms. Z_{t-1} is the error correction term, which measures how the dependent variable adjusts to the previous period's deviation from the long-run equilibrium. $Z_{t-1} = S_{t-1} - \alpha F_{t-1}$ where α is the cointegrating vector. The coefficients λ_S and λ_F are interpreted as the speed of adjustment parameters. The larger the λ_S, the greater the response of S_t to the previous period's deviation from the long-run equilibrium.

TABLE 5: ESTIMATION OF LONG-RUN AND SHORT-RUN ADJUSTMENT /CAUSALITY BETWEEN COMMODITY FUTURES AND SPOT PRICES

VEC - Vector Error Correction Estimates of LSP LFP for Near Month Contracts							
		Chana		Chilli		Turmeric	
Error Correction:		D(LSP)	D(LFP)	D(LSP)	D(LFP)	D(LSP)	D(LFP)
CointEq1	Coefficient	-0.021754	0.044737	-0.02778	0.039219	-0.044087	0.028871
	Standard Error	0.0086	0.01087	0.01179	0.01497	0.01317	0.01708
	t-statistics	[-2.52934]	[4.11402]	[-2.35688]	[2.61933]	[-3.34655]	[1.68986]
	Prob.	0.0115	0.0000	0.0186	0.0089	0.0008	0.0913
D(LSP(-1))	Coefficient	-0.140273	0.048932	0.01054	-0.093393	-0.052826	0.052339
	Standard Error	0.02521	0.03188	0.04125	0.05241	0.03802	0.04931
	t-statistics	[-5.56322]	[1.53491]	[0.25550]	[-1.78214]	[-1.38939]	[1.06145]
	Prob.	0.0000	0.1249	0.7984	0.0750	0.1649	0.2887
D(LSP(-2))	Coefficient	0.019354	0.068243	-0.053819	-0.064645	-0.087443	-0.02068
	Standard Error	0.02536	0.03206	0.04119	0.05233	0.03741	0.04852
	t-statistics	[0.76315]	[2.12833]	[-1.30652]	[-1.23540]	[-2.33715]	[-0.42623]
	Prob.	0.4454	0.0334	0.1916	0.2169	0.0196	0.6700
D(LSP(-3))	Coefficient	-0.087573	0.009288			0.034782	0.017152
	Standard Error	0.02527	0.03196			0.03606	0.04677
	t-statistics	[-3.46491]	[0.29065]			[0.96443]	[0.36672]
	Prob.	0.0005	0.7713			0.3350	0.7139
D(LSP(-4))	Coefficient	-0.064059	0.055019				
	Standard Error	0.02233	0.02823				
	t-statistics	[-2.86897]	[1.94893]				
	Prob.	0.0042	0.0514				
D(LFP(-1))	Coefficient	0.3772	0.007302	0.068277	0.147738	0.158608	0.000229
	Standard Error	0.02035	0.02573	0.03298	0.0419	0.03045	0.03949
	t-statistics	[18.5370]	[0.28384]	[2.07006]	[3.52609]	[5.20862]	[0.00579]
	Prob.	0.0000	0.7766	0.0387	0.0004	0.0000	0.9954
D(LFP(-2))	Coefficient	-0.057483	-0.037123	0.075657	0.046685	0.132713	0.042404
	Standard Error	0.02224	0.02812	0.03311	0.04206	0.03066	0.03976
	t-statistics	[-2.58449]	[-1.32010]	[2.28490]	[1.10991]	[4.32921]	[1.06660]
	Prob.	0.0098	0.1869	0.0225	0.2673	0.0000	0.2863
D(LFP(-3))	Coefficient	-0.004722	-0.01027			0.028648	0.021175
	Standard Error	0.02212	0.02796			0.03003	0.03894
	t-statistics	[-0.21348]	[-0.36727]			[0.95411]	[0.54380]
	Prob.	0.8310	0.7134			0.3402	0.5867
D(LFP(-4))	Coefficient	0.036744	-0.03691				
	Standard Error	0.02128	0.02691				
	t-statistics	[1.72643]	[-1.37164]				
	Prob.	0.0844	0.1703				
C	Coefficient	0.000256	0.000205	0.001179	0.001203	0.000432	0.000522
	Standard Error	0.00026	0.00033	0.0009	0.00114	0.00069	0.0009
	t-statistics	[0.97738]	[0.61949]	[1.30903]	[1.05089]	[0.62308]	[0.58069]
	Prob.	0.3285	0.5356	0.1908	0.2935	0.5333	0.5615
R-squared		0.166567	0.013296	0.024333	0.01566	0.066839	0.005486
Adj. R-squared		0.163748	0.009959	0.020192	0.011482	0.062084	0.00042
F-statistic		59.09103	3.984085	5.875785	3.748278	14.05914	1.082847
Prob(F-statistic)		0.0000	0.000045	0.0000	0.002264	0.0000	0.371762

Table 5 shows the error correction terms of spot and futures prices for different lags and indicate the long-run and short-run speed adjustment/convergence towards equilibrium or long-run steady state. In case of near month contracts of all the select commodities, the coefficient of error correction term of log spot prices is negative in sign and significant ($p<0.05$), which shows long-run causality running from futures prices to spot prices for all the three commodities. The error correction terms of sample commodities viz., Chana, Chilli and Turmeric are -0.021754, -0.02778 and -0.044087 and indicate that there is nearly 2.2%, 2.8% and 4.4% speed of adjustment towards equilibrium.

TABLE 6: ESTIMATION OF PRESENCE OF SHORT-RUN CAUSALITY BETWEEN COMMODITY FUTURES AND SPOT PRICES

Wald Test: - LSP LFP - Near Month Contracts									
Test Statistic	Chana			Chilli			Turmeric		
	Value	df	Prob.	Value	df	Prob.	Value	df	Prob.
F-statistic	107.539	(4, 2661)	0.0000	4.825	(2, 1178)	0.0082	12.497	(3, 1374)	0.0000
Chi-square	430.155	4	0.0000	9.650	2	0.0080	37.490	3	0.0000

Wald test is performed to test the null hypothesis that the joint value of coefficients of future prices at different select lag lengths is zero and the results of the Wald test disproves the hypothesis ($p < 0.05$) for all the coefficients of futures prices of select commodities. This indicates the presence of the short-run causality between the spot and futures markets of Chana, Chilli and Turmeric.

ESTIMATION OF DIRECTION OF CAUSALITY – GRANGER CAUSALITY

Engle and Granger (1987) and Johansen (1991) suggest that if cointegration exists between two variables in the long-run, then there must be either unidirectional or bi-directional causality between these variables. If spot and futures prices are cointegrated, then causality must exist at least in one direction (Granger, 1986). Further, to find out the direction of the causality, Granger Causality test is conducted with the help of the following equations:

CAUSAL RELATIONSHIP FROM FUTURES TO SPOT MARKET

$$R_{St} = \alpha_0 + \sum_{k=1}^{p} \alpha_{1k} R_{S(t-k)} + \sum_{k=1}^{p} \beta_{1k} R_{F(t-k)} + \mu_t \qquad (i)$$

CAUSAL RELATIONSHIP FROM SPOT TO FUTURES MARKET

$$R_{Ft} = \alpha_0 + \sum_{k=1}^{p} \alpha_{1k} R_{S(t-k)} + \sum_{k=1}^{p} \beta_{1k} R_{F(t-k)} + \mu_t \qquad (ii)$$

In the above two equations, R_{St} and R_{Ft} are returns of spot and futures price in period *t* and $R_{S(t-k)}$ and $R_{F(t-k)}$ are the spot and futures price returns in *k* previous periods, i.e. period *(t- k)*. α_k, and β_k are the coefficients and μ_t are the error terms. For the first equation the null hypothesis $\beta_k = 0$ implies that previous periods futures returns do not Granger- cause present periods spot price returns. However, if the null is rejected using a standard joint test like the F-test then it would imply that previous period futures price returns help in predicting today's spot price returns. Similarly, for the second equation rejection of the null $\beta_k = 0$ (which means previous periods spot prices do not cause today's futures price) would signify the power of the previous values of spot price returns in predicting today's futures price returns.

TABLE 7: ESTIMATION OF DIRECTION OF CAUSALITY – GRANGER CAUSALITY

Pairwise Granger Causality Tests										
SR FR - Near Month Contracts		**Chana**			**Chilli**			**Turmeric**		
Null Hypothesis:	*Lag Length*	*Observns*	*F-Statistic*	*Prob.*	*Observns*	*F-Statistic*	*Prob.*	*Observns*	*F-Statistic*	*Prob.*
FR does not Granger Cause SR	1	2674	451.889	0.0000	1185	7.08975	0.0079	1384	29.488	0.0000
SR does not Granger Cause FR			3.32821	0.0682		2.58746	0.108		2.90959	0.0883
FR does not Granger Cause SR	2	2673	228.938	0.0000	1184	7.5234	0.0006	1383	27.2572	0.0000
SR does not Granger Cause FR			5.5052	0.0041		1.76861	0.171		1.08408	0.3385
FR does not Granger Cause SR	3	2672	157.65	0.0000	1183	6.51013	0.0002	1382	19.6185	0.0000
SR does not Granger Cause FR			3.8435	0.0093		1.65155	0.1758		0.70631	0.5483
FR does not Granger Cause SR	4	2671	120.024	0.0000	1182	4.84565	0.0007	1381	14.8807	0.0000
SR does not Granger Cause FR			4.05751	0.0028		1.0378	0.3864		1.67486	0.1533
FR does not Granger Cause SR	5	2670	95.6639	0.0000	1181	3.93751	0.0015	1380	12.0153	0.0000
SR does not Granger Cause FR			3.93567	0.0015		0.99848	0.4173		1.21754	0.2984

Table 7 presents the results of granger causality. The granger causality test has been done from lag one to lag five, to assess the direction of causality on all the week days prices in futures and spot market. The results disclose that there is only a unidirectional causality from futures returns to spot returns of commodities Chilli and Turmeric ($P < 0.05$). However, in the case of Chana, there is a unidirectional causality from futures to spot returns ($P < 0.05$) for lag one and bidirectional causality from futures to spot returns of Chana ($P < 0.05$) for remaining lags.

10. FINDINGS & CONCLUSIONS OF THE STUDY

The cointegration results reveal that there is a presence of one cointegration equation between commodity spot and future prices of near month contracts of Chana, Chilli and Turmeric. It also reveals that there is a long-run association between commodity spot and futures prices of Chana, Chilli and Turmeric. The VECM results show that there is a long –run causality running from futures prices to spot prices of near month contracts of Chana, Chilli and Turmeric. The results of the Wald test reveals that the joint value of all the coefficients of futures prices at select lag lengths of Chana, Chilli and Turmeric contracts indicates the presence of the short-run causality between the spot and futures markets. The granger causality test results disclose that there is only a unidirectional causality from futures returns to spot returns of Chilli and Turmeric. In case of Chana, a unidirectional causality from futures to spot returns for lag one and bidirectional causality from futures to spot returns for remaining lags is observed. So, it is revealed that the near month futures contracts are efficient in price discovery of agricultural commodities in India.

11. IMPLICATIONS OF THE STUDY

As Derivatives market resembles the price expectations of the farmers, the commodity futures will be helpful in efficient price discovery in the agricultural spot market in India. Despite gaps, the futures price and spot prices are related in long-run. The farmer can use futures to hedge price risk. The futures indicate future spot price and so in two commodities futures decide the price of spot but in one commodity there is bidirectional flow showing spot gives the direction to futures.

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