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Lead Lag Relationship And Price Behavior In Potato

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Abstract

The present study attempts to investigate lead-lag relationship between Potato spot price and future prices of India. The data for study is the daily closing prices of spot and futures of Potato. Prices that were trading around Rs 580 per quintal during December, almost doubled by mid-March and touched a high of Rs 1,211 per quintal. However, thereafter, prices have been declining continuously on the back of arrival pressure of the new crop coupled with the Forward Market Commission's intervention in the form of imposition of stock limit. The period of data is from March 2009 to 30th April2012 . All the required data information for the study has been retrieved from the National Commodity Exchange of India(NCDEX) website. Both the data series of future and spot price of Potato are stationary after first difference. From the Johansen-Juselius test, it can be concluded that there is no cointegration between spot and futures prices. The shape of the impulse response graphs that spot market has a slightly larger response to one standard deviation shocks to the future price than the future responses to spot innovations. The results of variance decomposition indicate that only a small percentage changes in forecast error of spot market is explained by the future market, and over the period of time it remains constant.

Introduction

Futures market is expected to serve as a price discovery vehicle for investors in spot market. As Fleming, Ostdiek and Whaley (1996) suggested, the trading cost advantage of futures market makes it more responsive to new information than other markets. As a result, prices are first updated in the futures market,which thus serves as a price discovery vehicle for investors. There are other explanations also for one market leading the other (Infrequent trading hypothesis of Tan and Lim, 2001; liquidity factor identified by Daigler, 1990, etc.). In short, a lead-lag relationship would be eventually established between spot and derivatives markets. The success of a specific futures contract in providing price risk protection, however, is dependent on the ability of a potential hedger to accurately anticipate the future relationship between cash and futures prices. Attempts to quantify and forecast futures-cash price relationships have received considerable attention in the futures market literature.(T Mallikarjunappa and Afsal E M)

This study is a part of research to investigate long run and short run causality between selected agricultural commodities of NCDEX spot price and future prices of India. The data for study is the daily closing prices of spot and futures of chana,Soyabean,soyarefined,Guargum,Potato and Pepper. We found strong evidence of cointegration between the daily spot and one-month futures commodity prices of chana,soyabean,soya oil and pepper. We have not found any correlation between guargum and potato future and spot price. Since there is no cointegration between Potato spot and future prices. We used unrestricted VAR model to measure linkages between spot and future prices.

The Ministry has received a report on the price movements of eight agriculture commodities. These include pepper, potato, cardamom, menthe oil, soya oil, soya bean and chana. However, it has been found that prices of potato in the futures market have come down.According to Mr Thomas, the Forward Market Commission (FMC) has been asked to ascertain whether there have been attempts to hoard commodities to influence the futures markets and if so, how these activities have been financed.(Business Line, April 13,2012)

Potato prices are showing signs of easing following a bull run during January and February 2012 related to low buying interest amid sufficient stocks. Reports on probable rise in imports from Pakistan also weighed on sentiments. The crop from cold storages, which started arriving in the markets, also limited the uptrend in domestic prices.Prices that were trading around Rs 580 per quintal during December, almost doubled by mid-March and touched a high of Rs 1,211 per quintal. However, thereafter, prices have been declining continuously on the back of arrival pressure of the new crop coupled with the Forward Market Commission’s intervention in the form of imposition of stock limit. At present, NCDEX May contract is ruling around Rs 950 per quintal. (Financial Chronicle, May13,2012)

Kailash Chandra Pradhan, K. Sham Bhat study investigated price discovery, information and forecasting in Nifty futures markets. Johansen's (1988) Vector Error Correction Model (VECM) is employed to investigate the causal relationship between spot and futures prices. This study compares the forecasting ability of futures prices on spot prices with three major forecasting techniques namely ARIMA, VAR and VECM model. The Johansen's VECM results found that the spot market leads the futures market and spot prices tend to discover new information more rapidly than futures prices. The findings from VECM perform well on a post-sample basis against the univariate ARIMA model and a VAR model. The results show clearly the importance of taking into account the long-run relationship between the futures and the spot prices in forecasting future spot prices.

Pratap Chandra Pati and Purna Chandra Padhanexamined the price discovery process and lead-lag relationship between NSE S&P CNX Nifty stock index futures and its underlying spot index. It investigates the long-term and short-term dynamics of prices between spot and futures market, using Johansen-Juseliuscointegration test, Vector Error Correction Model (VECM), impulse response functions, and variance decomposition. The results support the existence of a long-run relationship between spot and futures prices. Further, VECM indicates short-run unidirectional causality from futures to spot market. In addition, the study finds unidirectional Granger causality from futures market to spot market .

K. Srinivasan, MalabikaDeo employed Johansen's Cointegration test and Vector Error Correction Model (VECM) for analyzing the long run and speed of equilibrium between the between Mini gold spot and futures market by taking daily closing values for both the indices The findings of the study reveal that in the long run, both the markets are cointegrated and causal relationship exists between these two markets. The results shows that unidirectional causality is running from spot to futures market in long-run dynamics and spot market serves as a primary market for price discovery.

AdamopoulosAntonios investigated the causal relationship between stock market developmentand credit market development for Spain using a vector error correction model (VECM). The purpose of this paper is to examine the long run relationship between these variables applying the Johansen cointegration analysis. Granger causality tests discovered a unidirectional causality between credit market development and stock market development with direction from credit market to stock market development and there is a unidirectional causal relationship between stock market development .The direction is from productivity to stock market development for Spain. Therefore, it can be inferred that credit market development and productivity have a positive effect on stock market development.

T Mallikarjunappa and E M Afsal 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. As against the widely accepted hypothesis of futures market, with its cost and hedging advantages, leading the spot market, Indian futures market fails to supply early information to spot market.

MaranMarimuthu, Ng Kean Kok attempted to re-examine the dynamic relationship between the Malaysian, and the Tiger markets (Hong Kong, South Korea, Singapore and Taiwan). The Johansen multivariate cointegrationtest ,VECM using a five-variable and Granger causality test are used to find correlation and lead lag. The results indicate that there is a long run relationship among the five markets and that the Hong Kong and Taiwan markets appear to be the most influential markets in this region.

P. Srinivasan, K. Sham Bhat applied Johansen's Cointegration technique followed by the Vector Error Correction Model (VECM) to examine the lead-lag relationship between NSE spot and futures market for selected twenty-one commercial banking stocks of India. The analysis reveals mixed findings. However, most of the selected commercial bank stocks in India reveal future leads to spot `and equal number of selected banking stocks reveals bi-directional and spot lead to future prices.

Janchung Wang studied empirical evidence related to futures pricing for the SGX FTSE Xinhua China A50 and HKE share index futures markets. He investigated whether the cost of carry model can describe the relationship between index futures prices and underlying stock indexes. The results says that incorporating stock market volatility into pricing models appears beneficial for estimating prices on these two index futures.

Raymond Li evaluates the relationship among the NYMEX futures prices for crude oil, unleaded gasoline, heating oil and the US trade-weighted exchange rate to determine the relationship between the US exchange rate and energy prices. In addition, the causal relationships among the energy futures prices are examined. Cointegration is detected among the variables, but contrary to the existing empirical literature, it is found that the US exchange rate can be excluded from the cointegrating space. The Granger causality tests and impulse response functions also indicate that the US exchange rate is not related to the energy prices.

Tarık Doğru,ÜmitBulut examine the relation between closing prices and trading volume of US Dollar (USD) futures contracts in the Turkish Derivatives Exchange (TURKDEX). The results indicate that while there is not a relation between prices and volume in the short run, there is a relation that is from volume to prices in the long run. Accordingly, it may be said that the futures market in Turkey is not efficient by the efficient market hypothesis.

Kaoru Kawamoto, Shigeyuki Hamori explored market efficiency and unbiasedness among such futures are defined and the concept of "consistently efficient (or consistently efficient and unbiased) market within n-month maturity" is introduced.Market efficiency and unbiasedness among WTI futures with different maturities are tested using cointegration analysis, and short-term market efficiency, using error correction model and GARCH-M-ECM. The results show that WTI futures are consistently efficient within 8-month maturity and consistently efficient and unbiased within 2-month maturity.

Christos Floros examines the price discovery between futures and spot markets in South Africa over the period 2002 to 2006. He employed four empirical methods: (i) a cointegration test, (ii) a Vector Error Correction model, (iii) a Granger causality test, and (iv) an Error Correction model with TGARCH errors. Empirical results show that FTSE/JSE Top 40 stock index futures and spot markets are cointegrated. Furthermore, Granger causality, VECM and ECM-TGARCH(1,1) results suggest a bidirectional causality (feedback) between futures and spot prices.

T. H. Root and D. Lien estimated generalized impulse response functions that result from exogenous shocks to a threshold error correction model of the natural gas futures market. The estimation results of the threshold model indicate that it is an appropriate model of the natural gas futures market. Therefore the calculation of impulse responses should account for both the size of the shock and the history ofthe series. This is accomplished via a generalized impulse response function. Calculation of the generalized impulse response functions indicates that the length of the futures contract is an important determinant of the ability of the system to return to its long run equilibrium following a shock.

Model Specification

The empirical analysis of data reveals that the log of both spot and futures price series isnon-stationary at levels, but stationary at their first differences. We found that there is no correlation between spot and future prices of Potato.So we applied vector autoregression, impulse response function, andvariance decomposition to study the movement of spot and future prices.

Johansen's cointegration test has been applied to test the long-run relationshipbetween spot and futures prices, which is investigated by estimating the following:

$$\Delta Yt = A_0 + \Pi Y_{t-k} \sum_{i=1}^{k-1} \Gamma i \ \Delta Y_{t-i} + \varepsilon_t \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

$$\text{Where } \Pi = \sum_{j=1}^{k} A_j - I \text{ and } \Gamma i = \sum_{j=1}^{i} A_j - I \ldots\ldots\ldots\ldots\ldots(2)$$

Yt = [lnS_t ln F_t ln Ft]' is a (2 x 1) vector of non-stationary log-spot and log-futures prices;ΔY_t = [dln St dln Ft]' is a (2 x 1) column vector first differenced series; ε_t= $[\varepsilon_{s,t}\varepsilon_{ft}]'$ is a (2 x 1) column vector of white noise Gaussian error; A0 is a (2 x 1) column vectorof constants; and Ai is a (2 x 2) matrix of coefficients.

The existence of cointegrating relations among the variables can be examined through the Π matrix. Mathematically, the Π matrix can be rewritten as $\Pi=\alpha\beta'$, where α and β are n x r matrices of rank r. Here, β represents the matrix of cointegrating parameters and αis the matrix of the speed of adjustment parameters. The test for cointegration between the Ys is calculated by looking at the rank of the Πmatrix via eigenvalues.Johansen developed two likelihood ratio tests for testing the number of cointegrating vectors (r)—the trace test and the maximum eigenvalue test. The trace statistic (λ_{max}) tests the null hypothesis of r = 0 (i.e., no cointegration) against the alternative of r > 0,i.e., there is one or more cointegrating vectors. The maximal eigenvalue test statistic (λ_{max}) examines the null hypothesis that the number of cointegrating vectors are less than or equal to r against the alternative of r + 1.

Granger Causality:

For granger causality we will test : Is it spot price that "causes" the future price F (S→ F) or is it the future price that causes spot price (F→S), where the arrow points to the direction of causality. The Granger causality test assumes that the information relevant to the prediction of the respective variables, F and S, is contained solely in the time series data on these variables. The test involves estimating the following pair of regressions:

$$F_t = \sum_1^n \alpha_i S_{t-i} + \sum_{j=1}^n \beta_j F_{t-j} + u_{1t} \ldots\ldots\ldots\ldots\ldots\ldots(3)$$

$$S_t = \sum_1^n \lambda_i S_{t-i} + \sum_{j=1}^n \delta_j F_{t-j} + u_{2t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

where it is assumed that the disturbances u1t and u2t are uncorrelated. since we have two variables, we are dealing with bilateralcausality.Eq(3) postulates that current future price related to past values ofitself as well as that of S, and eq.(4) postulates a similar behavior for spot price.(DamodarN.Gujrati).

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Impulse Response :

We saw that when we introduced ten lags of each variable as regressors, we could not reject thehypothesis that there was bilateral causality between future and spot price. That is, spot affects future and future affects spot. These kinds of situations are ideally suited for the application of VAR.
one can estimate each of the followingequations by OLS.

$S_{1t} = \alpha + \sum_{j=1}^{k} \beta_j S_{t-j} + \sum_{j=1}^{k} \gamma_j R_{t-j} + u_{1t}$..........(5)

$F_t = \alpha + \sum_{j=1}^{k} \theta_j S_{t-j} + \sum_{j=1}^{k} \gamma_j R_{t-j} + u_{2t}$...........(6)

where the u's are the stochastic error terms, called impulses or innovationsor shocks in the language of VAR.

Data Analysis

The data used in this study consists of daily closing prices of Potato spot price and future prices.The period of data is fromMarch 2009 to 30th April 2012.There are 628 observations.All the required data information for the study has been retrieved from the National Commodity Exchange of India(NCDEX) website.
Since most tradingactivities take place in near monthcontract, only near month contract dataare examined. The dailycontinuous compound return is definedas the first logarithmic difference of closing prices on consecutive tradingdays, i.e., dln St = (ln St – ln St–1) anddln Ft = (ln Ft – ln Ft–1).
Table 1 reports the descriptivestatistics of the spot and future .

Table I: Descriptive Statistics of Future and Spot Price Return of Potato

	$dl_n S_t$	$dl_n F_t$
Mean	0.000770	0.000757
Median	0.00000	0.00000
Std. Deviation	0.050273	0.047688
Skewness	1.669123	1.548389

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Kurtosis	266.5385	104.1720
Jarque-Bera	1814739	267660

The average means of future and spot are almost equal for the sample period.The spot volatility is greater than the future price volatility as revealed by standard deviation.This is to be expected as the futures market is regarded as a source of price stability inthe spot market. The positive skewness coefficients indicate that frequency distribution of futures and spot returns series arepositively skewed or have longer tail to the right. The unconditional distribution of bothspot and futures returns exhibit fat tails and excessive peak at the mean than thecorresponding normal distributions. The non-normality is also confirmed by Jarque-Beratest where the null hypothesis is that the given series is normally distributed. Here the Jarque-Bera statistic is highly statistically significant for both spot and futures returnsseries, and hence we reject the null hypothesis of normality.

As a preliminary investigation, Augmented Dickey Fuller and Phillips-Perron test tests was employed to test the stationary of spot and future price series of potato and its results are presented in Table-II.

Table -II:			Augmented Dickey-Fuller test statistic		Phillips-Perron test statistic	
			t-Statistic	Prob.*	t-Statistic	Prob.*
Potato	Future	With Intercept	-1.532933	0.5164	-1.59764	0.4832
		With Intercept and Trend	-1.344322	0.8757	-1.44532	0.8468
		Without Intercept and Trend	0.273803	0.7651	-0.1979	0.6147
		First Difference	-22.2053	0.00	-21.5039	0.00
	Spot	With Intercept	-1.512864	0.5266	-1.73863	0.4112
		With Intercept and Trend	-1.323741	0.881	-1.65968	0.7679
		Without Intercept and Trend	0.299936	0.7723	-0.21065	0.6102
		First Difference	-24.48486	0.00	-26.1403	0.00

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Notes: * – indicates significance at one per cent level. Optimal lag length is determined by the Schwarz Information Criterion (SIC) .

The above Table II result reveals that both the data series of future and spot price of Potato are stationary after first difference. Johansen's Cointegration test is performed to examine the long-run relationship between spot and future markets of potato and its results are presented in Table-IV.

The estimation procedure of Johansen and Juselius (1990) cointegration test is based onmaximum likelihood estimation with a VAR model. However, prior to the application of VAR model, the selection of lag length is important. The AIC, SIC, HQ, FPE and LR statistics can be applied to determine the VAR order (i.e., lag length, k). The resulting lag structures are reported in Table III. The optimal lag length is one.

Table III-

Lag	LogL	LR	FPE	AIC	SC	HQ
0	2008.839	NA	5.24E-06	-6.484134	-6.469827	-6.47857
1	2060.563	102.9461*	4.49e-06*	-6.638330*	-6.595408*	-6.621645*
2	2061.766	2.38539	4.53E-06	-6.629291	-6.557755	-6.60148
3	2062.853	2.14979	4.57E-06	-6.61988	-6.519729	-6.58095
4	2063.552	1.378375	4.62E-06	-6.609215	-6.48045	-6.55916
5	2064.179	1.231872	4.67E-06	-6.598317	-6.440937	-6.53714
6	2064.899	1.408747	4.72E-06	-6.587718	-6.401723	-6.51542
7	2065.026	0.247938	4.78E-06	-6.575204	-6.360595	-6.49178
8	2066.508	2.882287	4.82E-06	-6.567068	-6.323844	-6.47252

* 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.

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Table-IV: Johansen's Co integration Test Results

Commodity	Hypothesized No. of CE(s)	Eigen Value	Trace Statistic	Critical Value	Prob.**
Potato	None *	0.019789	16.81579	15.49471	0.0315
	At most 1 *	0.00698	4.363562	3.841466	0.0367

Note : * denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

The Table-IV result reveals that there is no co integration vector between Future and spot prices of Potato. Since there is no cointegration between Potato spot and future prices.We will use unrestricted VAR model to measure linkages between spot and future prices.

Table V-

Null Hypothesis:	Obs	F-Statistic	Probability
DSPOT does not Granger Cause DFUTURE	625	0.03274	0.96779
DFUTURE does not Granger Cause DSPOT		57.0215	1.9E-23

Table V measures granger causality between spot and future price of Potato.Hence we reject our null hypothesis which states that future doesn't granger cause spot price at 5% significance level. Hence there is unidirectional causality from future to spot price of Potato.

To find more detailed study of VAR model , impulse response function and variance decomposition are estimated. Figure 1 illustrates the estimated impulse response functions for ten days ahead time horizons.The graphs of impulse response functions depicted in Figure 2 have been plotted forten periods ahead forecasting horizon

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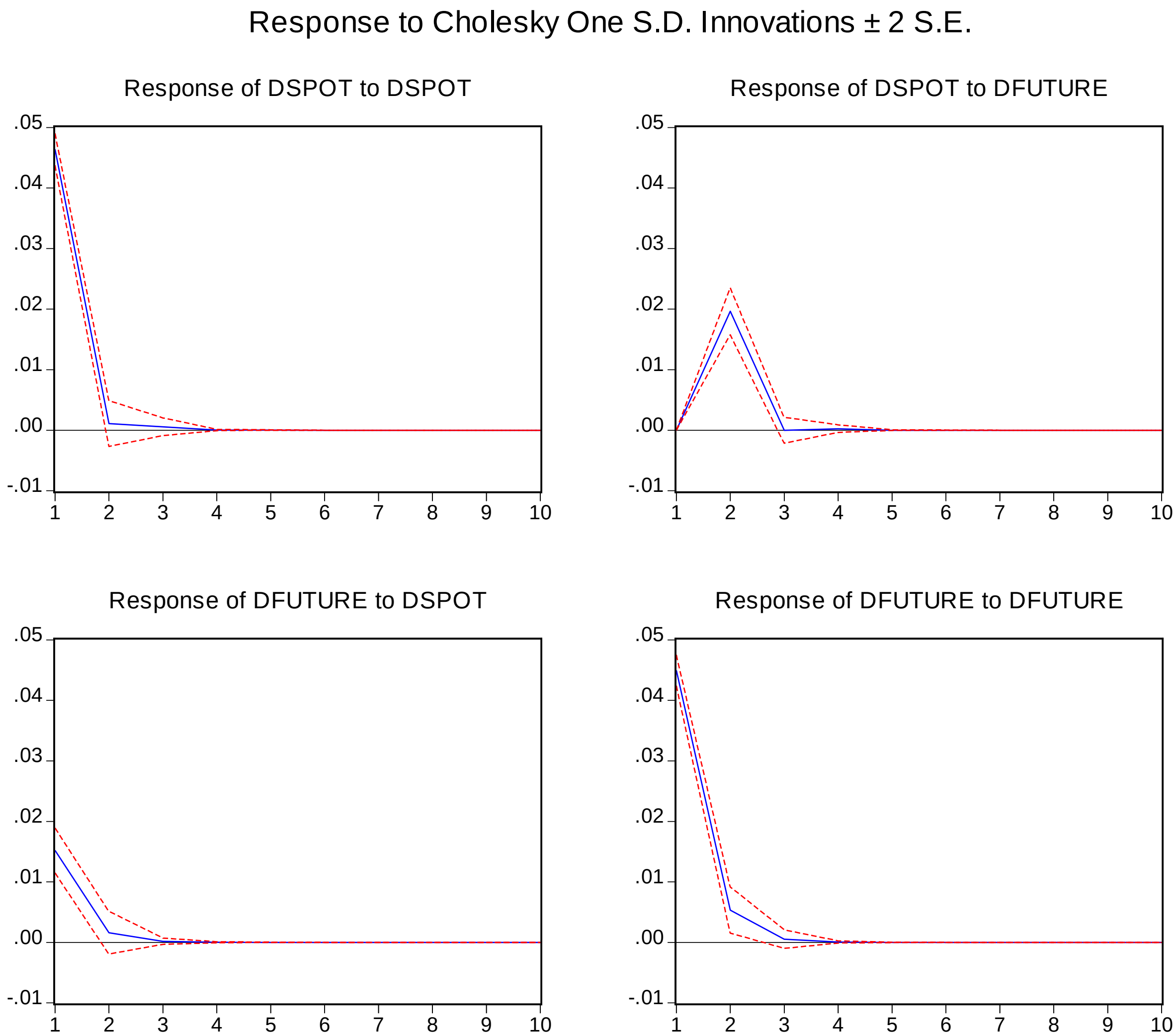
Figure1 :



It is evident from the shape of the impulseresponse graphs that spot market has a larger response to one standard deviation shocksto the future price than the future responses to spot innovations. Initially, the response of spot priceto shocks to futures prices is fluctuating for the 3 days .It is flat from 3rd day till 10th day. On the other hand, response of futures price to shocks to spot prices is strong initially, it is decaying till 3rd day and it remained flat. The response of spot price is higher than the response of future price comparatively.

The forecast error variance decomposition provides an alternative way to look at the finding of the impulse response analysis. It enables in innovating the extent to which a variable helps in explaining the other variables.

Table VI:

Panel A: Variance Decomposition of DSPOT:			Panel B:Variance Decomposition of DFUTURE:		
Period	DSPOT	DFUTURE	Period	DSPOT	DFUTURE
1	100	0	1	10.26623	89.73377
2	84.79864	15.20136	2	10.23657	89.76343
3	84.80053	15.19947	3	10.23658	89.76342
4	84.79863	15.20137	4	10.23657	89.76343
5	84.79863	15.20137	5	10.23657	89.76343
6	84.79863	15.20137	6	10.23657	89.76343
7	84.79863	15.20137	7	10.23657	89.76343
8	84.79863	15.20137	8	10.23657	89.76343
9	84.79863	15.20137	9	10.23657	89.76343
10	84.79863	15.20137	10	10.23657	89.76343

The estimates of the variancedecomposition are reported in Table VI for ten-day time horizons. The reported figures in Panel Ashows the forecast error variance decomposition of spot return.It explains a high level of forecast error variance of itself. At the initial period, it explains 100% variation in its forecast error, but after that it decreased and remain constant. 98.511% variation in the forecast error of spot market is explained by future(15.20136%) in 2nd day.However, only a small percentage changes in forecast error of future market is explained by the spot market(10.26623 %)and over the period of time it remains constant.

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Conclusion

This paper explores the price discovery role and lead-lag relationship between spot and future price of Potato.Both the data series of future and spot price of Potato are stationary after first difference. From the Johansen-Juseliustest, it can be concluded that there is no cointegrationbetween spot and futures prices of potato. However, the study finds unidirectionalGranger causality from futures market to spot.The shape of the impulse response graphs showthat spot market has a slightly larger response to one standard deviation shocksto the future price than the future responses to spotinnovations .The results of variance decomposition indicate that ,a small percentage changes in forecast error of spot market is explained by the future market(15.20136%) and over the period of time it remains constant.

The results of the study is useful for the important implications for the traders, regulatory bodies and practitioners. The arbitragers can take into account the lead-lag relationship between cash and futures market. It provides direction to the traders regarding the spot market. Arbitrageurs can make riskless profit from mispricing of futures .

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