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Vivek Kumar
Research Scholar, Indira Gandhi National Open University

Correspondence:
Vivek Kumar
Research Scholar, Indira Gandhi National Open University

Futures Market of Pepper in India: An Empirical Study

Vivek Kumar

Abstract
Persistence of agricultural price instability along with farmer's direct exposure to such fluctuations remains a major concern for policy makers in India. In view of such a feature, the present study attempts to empirically examine the performance and efficiency of pepper futures market for its role of price discovery and risk management functions. The performance assessment methods of extent of liquidity, price volatility and basis risk have been employed as analytical variables. Using the econometrics techniques such as cointegration, VECM, Granger causality, impulse response and variance decomposition, the study seeks to generate empirical results to evaluate the level of development of pepper futures market as an efficient mechanism of risk management and price discovery. Empirical study of the pepper futures market in India indicates that pepper has not done well as performance and efficiency are concern. Looking at the result it can be said that, hedgers find futures market useful to manage price risk and can be very useful in risk management functions. In the presence of an expected increase of price risk, findings of the study would help address the mechanisms of risk management and price discovery of futures market for pepper.

Keywords: Futures Market, Pepper, NCDEX, Price Discovery, Risk Management

1. Introduction
Persistence of agricultural price instability along with farmer's direct exposure to such fluctuations remains major concerns for policy makers in India. The dimension of the problem warrants additional attention in case of agricultural products since unlike others, these carry added risk of witnessing seasonal fluctuations and attracting lower prices during harvest season. Changing economic environment, changing demand and supply position of agricultural commodities and growing international competitions require wider roles for futures markets in an agricultural economy. All this indicates that India can be promoted as a major centre for trading of agricultural commodities derivatives. Under such circumstances, a wider role for futures markets to ensure stability is required as an efficient risk minimizing tool.

A major problem with operationalisation of futures market for agriculture in India is its unorganised character. In addition, risks associated with agricultural commodities market tend to vary from commodity to commodity avoiding tractable solutions. Therefore, demand for commodity wise research on the underlying fundamentals which govern demand, supply and pricing behavior poses a surmountable task in searching for a viable option. Futures market is highly useful to all the segments of the economy. It is useful to the producer because they can get an idea of the prices likely to prevail at a future point of time and therefore, can decide between various commodities and choose the best that suits them. It enables the consumer to get an idea of the prices, at which the commodity would be available at a future point of time. The futures trading are also useful to the exporters, as it provides an advance indication of the prices likely to prevail and helps the exporters in quoting a realistic price.

Keeping in view the above, the present study proposes to analyse the futures market for a single commodity, viz., pepper, in India. It may be useful to point out that the selected commodity has a share of 3.60 percent of total agricultural commodities traded in futures market in 2011-12. India produces around 23% of the total world Pepper production with Kerala alone producing around 90% of total production in India. Kerela pepper is considered

to be the premium grade and rules above all the international grade. India being one of the largest producer and consumer, the price of pepper is determined largely by domestic factors apart from other producing nation. Moreover, its prices in the spot market are often driven by unexpected changes in exchange rate, which poses a problem for their factoring into the futures prices. Pepper has been recently upgraded to international exchanges to deal in international contracts. Along with this, it is the commodity that is only traded in India and internationally. It is felt that a systematic investigation of pepper futures market to assess their effectiveness in transferring risk is likely to shed useful light, since pepper futures market has witness substantial trading interest internationally. This would help in understanding the usefulness of pepper commodity futures markets in protecting the interests of farmers, traders and exporters.

2. Review of literature

Futures markets role is usually assessed by examining the relation between spot and futures prices through the cointegration technique. It may be useful to note that the work on long-run equilibrium relationship in time series through cointegration after being introduced by Granger (1981) [24] and extended by Engle and Granger (1987) [18], Engle and Yoo (1987) [18], and Stock and Watson (1988) among others, other studies came up including the error correction in cointegrating relationships. Consequently, along with long run equilibrium in the cointegrating series, the short run dynamics have been tried to be captured by models using, maximum likelihood approach based on vector error correction model (VECM) (see Johansen (1988 and 1991) and Johansen and Juselius (1990)). Essentially such models help analyse the equilibrium error of the previous periods to indicate the direction of causality and speed at which departure from equilibrium is corrected. In the process such models succeed in establishing the price discovery, performance and efficiency of the commodity markets.

Since hedging and price discovery are the two most important functions of futures market, studies have attempted to examine the price discovery of futures markets by testing their long run co-movement and lead-lag relation (see, Elumalai *et al.* (2009) [17], Bhardwaj and Vasisht (2009) [8], Singh *et al.* (2009), Amitkar (2004) [2], Mattos and Garcia (2004), Saikat and Nair (1994) [48], Easwaran and Ramasundaram (2008) [16]. Similar findings are given in a study by Raizada and Sahi (2006) [41] on efficiency of wheat futures contracts, the wheat futures market is weak form inefficient and exhibits poor price discovery. Results of the Johansen's cointegration indicated that futures prices two to three months away from maturity are not cointegrated with spot prices. Lokare (2007) [31] found that although Indian commodity market is yet to achieve minimum critical liquidity in some commodities such as sugar, pepper, gur and groundnut, almost all the commodities show an evidence of cointegration between spot and future prices revealing the right direction of achieving the improved operational efficiency, though at a slower rate. Zubaidi and Shah (1994) examined the price efficiency at six regional markets in Sarawak, Malaysia in pepper markets. The results revealed that the regional pepper markets in Sarawak were highly integrated. Price changes are fully and immediately passed on the other markets. The low transportation costs and risk associated with transportation was found to have explained the degree of cointegration observed. For this cointegration tests of spatial price relationships were applied using data for the period 1986 to 1991. Malhotra and Sharma (2013) [33] examined the performance of guar seed futures market. The study indicates that both spot and futures prices observe long run co movement. Short run unidirectional flow of information from the futures to the spot market is observed. Its efficiency and price discovery is tested using Johansen's cointegration, vector error correction method, impulse response and variance decomposition. Saikat and Nair (1994) [48] studied whether the movements in the international prices of Indian pepper had reflected the variations in prices in other exporting countries during the 1980s and also whether the domestic prices of pepper had moved synchronously with International price. The results revealed that due to the open trade status for pepper, the prices have moved synchronously indicating the integration of prices in the world pepper market. Since arrival of crops play very important role in price, several studies have attempted to examine the effect of arrival of many Indian agriculture crops on price discovery and price efficiency (see, Mundinamani *et al.* (1999) [34], Shelke and Kalyankar (2000), Rao *et al.*, (2003) [43] and Chahal *et al*., (2004) [11]. Behura and Pradhan (1998) [6] analysed the relationship between prices of marine fishes for six markets in Odisha. The results indicate that most of these markets are yet to develop fully to facilitate prevalence of efficient mechanisms of risk management and price discovery. Result revealed that out of all the six markets, the price series between Cuttack and Paradip were cointegrated due to good communication facilities and storage facility as in case of Naik and Jain (2002) [37] and Yang *et al.* (2001) [51] has been instrumental in establishing the long run relationship of prices. Baldi *et al.* (2011) [5] identified structural breaks in the prices of CBOT corn and soya bean and found futures markets to be efficient in normal periods, but in times of crisis, when prices rose sharply, cash market also became active in price discovery process. Their observation points out that it is the pattern of the individual commodity that governs the price discovery process and financial trading in futures market not having an impact. In this study Kejriwal and Perron tests is used and data is taken from 2004 to 2010.

Indian studies on commodity futures in India in the presence of hedging have shown mixed results on market efficiency. Sahadevan (2002) [46, 47], in his works on agricultural commodities of pepper, gur, cotton, etc., from 1999 to 2001, has examined the relationship between price returns, trading volume and market depth and found that both markets i.e., spot and futures are not integrated and hence futures market fail to perform its function of hedging price risk. Some empirical studies have analysed hedge ratio and hedging efficiency of futures markets. For example, Park and Switzer (1995) [39], Myers (1999) [35], Choudhry (2004) [13], Floros and Vougas (2006) [19], have examined the hedging effectiveness of financial and commodity derivatives markets. Ripple and Moosa (2005) [45] examined the effect of the maturity on the hedging effectiveness of crude oil. Futures and spot prices were used to calculate the hedge ratio and measure of hedging effectiveness. The empirical results revealed that futures hedging are more effective when the near month contract, rather than distant month contract, is used. Baillie and Myers (1991) [4] estimated minimum variance hedge ratios based on daily data for two futures contracts maturing in 1982 and 1986. They found that the estimated optimal hedge ratios are confined to time variation.

It also reveals that the assumption of constant optimal hedge ratios is inappropriate. In the context of Indian commodity futures markets, Bhaduri and Durai (2008) [7] have estimated optimal hedge ratio and analysed hedging effectiveness of stock index futures of national stock exchange from September 2000 to 2005. The study has used four econometric models i.e., OLS regression, VAR, VECM and MGARCH. The effectiveness of the optimal hedge ratios derived from these models have been examined. The results show that the time varying hedge ratio derived from the MGARCH model provides higher mean return and higher average variance reduction across hedged and unhedged position. Ramakrishna and Jayasheela (2009) [42] have examined hedging effectiveness of nifty futures. They also have examined the price discovery function and the growth and development of futures markets in India. The findings of their study show that hedging is effective for the nifty stock index futures. Study by Yaganti and Kamaiah (2012) investigates the hedging effectiveness of commodities futures contracts for spices and base metals by employing cointegration and error correction methodology with different maturity time horizons i.e., maturity month, nearby month and far month. The optimal hedge ratios are calculated using ordinary least squares (OLS) regression and error correction model (ECM). It is found that the futures market dominates in price discovery in nearby month contracts, in far month contracts, there is no long term relationship between spot and futures prices for turmeric and cardamom. In case of base metals, futures market leads spot market for all the three contracts. Hedging effectiveness is also measured at various maturity periods. Ghosh (1993) [21] found that hedge ratios obtained from traditional methods are underestimated. This study has tested the presence or absence of cointegration relation between spot and futures prices series. The final inference of the study was that hedge ratio from error correction method shows significant improvement over that from OLS regression method. He estimated the hedge ratio by using error correction model (ECM) for S&P 500 index based on daily closing prices from January 1991 to December 1999.

Nair (2002) examined the performance of six commodities futures such as hessian, pepper, castor seed, Gur, Potato and turmeric. In this study, the performance of futures market is assessed based on ratio test such as membership pattern over time, extent of liquidity, price volatility and basis risk. The results indicate that most of these markets are not performing well and yet to develop fully as efficient mechanisms of risk management and price discovery. Other study on the performance of guar seed futures market has been examined by Malhotra and Sharma (2013) [33].

From the above discussion it can be seen that researchers have tried to explore the efficiency of commodities futures market by examining issues like price discovery, hedging effectiveness and performances. However, evidences obtained are mixed as can be seen from above discussion that many issues related to price discovery, hedging effectiveness and performances has not been solved. It is also found that price discovery has failed, hedging is not there and most of the markets and commodities are not integrated and, most of the markets are not performing well and yet to develop fully as efficient mechanisms for risk management and price discovery.

3. Objectives

In light of the above background, the present study is formulated with the following objectives.

(i) To assess the performance of pepper futures market in India.
(ii) To assess the efficiency of pepper futures market in its role of price discovery and risk management functions.

4. Methodology and Data Source

In order to assess the effectiveness of futures market in case of pepper the present study proposes two sets of tools comprising ratio tests and cointegration and related technique for examining the price discovery and market risk management. In the process, performance of pepper futures market is assessed on the basis of extent of liquidity, price volatility and basis risk. On the other hand, the efficiency of the commodity is examined on the basis of the econometrics techniques of cointegration, VECM, Granger causality, impulse response and variance decomposition.

4.1. **Ratio Test:** To assess the performance of pepper futures market, ratio test employed are:

Extent of liquidity, price volatility and basis risk.

4.1.1. Extent of Liquidity =

$$\frac{\text{Total traded volume of Pepper}}{\text{Total production of Pepper}}$$

Total traded volume in transaction and total production of pepper are taken in tonnes. Extent of liquidity is measured in terms of the proportion of the volume of transaction in the futures market to the total production in the country in a year in percent. The volume of transaction is indication of performance. Increasing volumes indicates greater interest in futures trading and therefore generates higher liquidity in market. While volume could vary from year to year depending upon on the volatility in prices, a clear upward or downward trend is an indication of the stakeholder's perceived utility of a futures exchange. Liquidity in a futures market has a direct bearing on the transaction cost and therefore affects participation in futures.

4.1.2. Price Volatility =

$$\frac{\text{Standard deviation of the futures prices of Pepper}}{\text{Standard deviation of the spot prices of Pepper}}$$

Prices of spot and futures of pepper are taken in Rs. /Quintals. Price volatility is calculated as ratio of S.D. of the futures prices to the S.D. of spot prices. The ratio of S.D. of futures and spot prices are considered on a two monthly average basis to assess the futures market performance. If markets are efficient, day to day variations in cash and futures prices are purely a result of new information available. Therefore, for storable commodities, the extent of variation in cash and futures should be similar. Given the competitive structure of the physical markets for agricultural commodities, we assume that these markets are discovering prices efficiently. We also assume that the cost of carrying charges is negligible. The study has compared the extent of volatility in cash and futures prices to examine the extent to which information is incorporated in futures prices.

However, with many restrictions on futures trading such as price and position limit, the price variations are artificially curtailed. Also, due to reasons such as the direction of causality, this measure is treated as only indicative. In such a formulation a ratio close to one indicates that a futures price is able to incorporate information efficiently. A ratio greater than one would indicate speculative activities. A ratio less than one indicate that information is not fully incorporated.

4.1.3. Basis Risk =

$$\frac{\text{Standard deviation of basis prices of Pepper}}{\text{Standard deviation of spot prices of Pepper}}$$

Basis risk is assessed as a ratio of S.D. of basis prices of pepper to S.D. of spot prices of pepper on two months basis. Futures trading aims at reducing price risk by replacing it with a relatively small basis risk. High basis risk reduces the utility of futures trading. The present study has examined the extent of basis risk to assess the utility of the futures market in managing business risk. An unhedged investor faces price risk, while a hedged investor faces basis risk. When basis is predictable, that is the basis risk is low, hedging can be used as an effective instrument of risk management. If the basis risk is as large as the price risk, hedging does not reduce business risk. If the basis is close to zero, that is, the futures price converges to the spot price, a hedger can reduce his business risk by holding until the maturity of the contract. These ratios are divided into three groups, less than 0.5, between 0.5 and 1 and greater than 1. A ratio less than 0.5 would attract the hedgers to use the futures market into an effective instrument of risk management tool.

4.2. Efficiency Test: To assess the efficiency of pepper futures market, cointegration and related techniques employed are: Cointegration, VECM, Granger causality, impulse response and variance decomposition.

4.2.1. Cointegration Analysis

The study establishes the number of unit root that the series contains when testing for cointegration. Therefore, the data series is first tried to be made stationarity by taking the first difference of spot and futures price series. The first difference of price series so calculated is tested for stationarity using augmented Dickey-Fuller (ADF) test. Before examining the long run relationship between futures and spot prices, order of integration for futures and spot prices (existence or absence of non- stationarity) in the series examined through augmented Dickey Fuller (ADF) specified by

$$\Delta F_t = \alpha + \beta t + \varphi F_{t-1} + \sum_{i=1}^{p-1} \gamma_i \Delta F_{t-i} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots (1)$$

$$\Delta S_t = \alpha + \beta t + \varphi S_{t-1} + \sum_{i=1}^{p-1} \gamma_i \Delta S_{t-i} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots (2)$$

where:
β = Coefficient on a time trend
ρ = Lag order of the AR process
ε_t = Residual, the equilibrium error

For two non stationarity series to be cointegrated, they must be integrated of the same order. To examine, whether there is any stable long run relationship between futures prices and spot prices of pepper the study postulate that, the futures prices of pepper is related on the spot prices of pepper with the assumption of no trend and the regression equation takes the form

$$F_t = \alpha + \beta S_t + u_t \quad \ldots\ldots\ldots\ldots\ldots (3)$$

where:
F_t = Futures prices of pepper at time t
S_t = Spot prices of pepper at time t.
α and β = Cointegrating parameters and
u_t = Residual, the cointegrated equilibrium error

4.2.2. Vector Error Correction Model (VECM)

VECM model can only be used if variables have cointegration. Before evaluating efficiency and calculating VCEM, lag length selection is important. Lag length is calculated using VECM lag order selection criteria. To capture the deviations in the short run within the framework of cointegration analysis, which implies stable long run co-movement, adjustment to temporary deviation is analysed using VECM. The VECM allows for the short run shocks and estimates the degree of convergence towards the long run relationship. The advantage of VECM is that it allows for the short run dynamics as well as an assessment for the degree towards the long run relation as shown by cointegration. Before estimating the VECM, the numbers of lags of the spot and futures price series that are included in the VECM have been identified on the basis of VECM lag order selection criteria. The equations for the test are specified as

$$\Delta F_t = \alpha + \delta u_{t-1} + \sum_{i=1}^{k} \beta_i \Delta F_{t-i} + \sum_{j-1}^{k} \gamma_i \Delta S_{t-i} + V_t \quad \ldots (4)$$

$$\Delta S_t = \alpha' + \delta' u_{t-1} + \sum_{i=1}^{k} \beta'_i \Delta F_{t-i} + \sum_{j-1}^{k} \gamma'_i \Delta S_{t-i} + V'_t \quad \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

where, F and S refer to futures and spot prices, respectively of pepper. V is white noise.

The lagged values and lag residuals of the long run model and the difference of the spot and future price series are used to estimate the error correction to determine the short run deviation from the equilibrium. The coefficient of the error term is expected to be negative. These coefficients are referred to as the speed of adjustment factors and measure the short run deviation from the long run equilibrium. As coefficient value approaches zero, the paths are slow to adjust back to long run deviation. The farther it is from zero, the more rapid path the price series are likely to take to reach long run equilibrium. This indicates that spot price series adjust to changes in the futures prices series in the same period.

4.2.3. Granger Causality

Eagle Granger suggest that if cointegration exists between two variables in long run, then there must be either unidirectional or bidirectional Granger causality between these variables. The joint significance of all the lag of spot and futures prices included in the VECM is examined using

Granger causality which measures precedence and information contents. Null hypothesis is no causality between futures and spot prices. The rejection of the null hypothesis implies information transmission from spot prices to future prices and vice versa. If the lags of both series are significant, there is a bi-directional flow of information. The equations for the test are specified as

$$F_t = a_0 + a_1F_{t-1} + ... + a_pF_{t-p} + b_1S_{t-1} + ... + b_pS_{t-p} + u_t \quad \ldots\ldots (6)$$
$$S_t = c_0 + c_1S_{t-1} + ... + c_pS_{t-p} + d_1F_{t-1} + ... + d_pF_{t-p} + v_t \quad \ldots\ldots (7)$$

where, F and S refer to futures and spot prices, u, v are white noises.

4.2.4. Impulse Response

In addition to the examination of the coefficients of VECM model for the analysis of short run dynamics in spot and futures market, the techniques of impulse response function and variance decomposition give useful information on the impact of changes in the value of a variable on the other variables, i.e., what is the impact of shock on the variables in the system. How long futures prices can affect spot prices and spot prices can affect future prices. The effect of one S.D. shock today on the current and the future values of spot and futures log price are ascertained with the impulse response graph. It shows how log of spot prices response to shocks in log futures prices before it settles down and vice versa. Effect of response of log of spot prices to its own shock and to shocks in log futures prices and vice versa is measured on Y axis with time lag on X axis.

4.2.5. Variance Decomposition

It indicates how much proportion of variation in spot prices is due to its own shock against the shock in futures prices and likewise for the variation in futures prices. The study reports the percentage variation in pepper futures prices explained by its own lagged values and by the lagged values of spot prices and similarly for spot prices. Percentage variation in pepper futures prices explained by its own lagged values and by the lagged values of spot prices and vice versa is captured over lagged time. Variance decomposition, gives information about the source of information in the forecast error.

4.3. Data

The secondary data pertaining to this study for analysis are collected and compiled for the period of 5 years i.e. from September 2008 to August 2013. 1369 observation of daily closing prices of spot and futures are collected and compiled. Other data pertaining to this study is collected from the various official websites such as:

1. Historical Futures Prices and Spot Prices, National Commodity & Derivatives Exchange Limited (NCDEX) **(www.ncdex.com)**
2. Annual Reports, Forward Market Commission, Department of Consumer Affair, Ministry of Consumer Affair, Food and Public Distribution, Government of India. **(www.fmc.gov.in)**
3. Research Report (Pepper), Agriwatch Research Report **(www.agriwatch.com)**
4. APY (District), Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Government of India. **(eands.dacnet.nic.in)**

5. Results and Discussion

5.1. Descriptive Statistics of Spot and Futures Prices of Pepper

Before examining the empirical results to see performance and efficiency, it is better to understand the basic individual characteristics of the futures and spot price series with the help of its descriptive statistics i.e., mean, S.D, skewness, kurtosis and Jarque-Bera (J-B).

Basic individual characteristics of the futures and spot price series can be seen in Table 1.It can be seen from the table that the means of both spot and futures prices for the whole period are respectively 24858.95 and 25027.22. It is evident that futures price mean is marginally above the spot price. The volatility between these prices also shows similar result as the S.D. is found to be 10928.37 and 10948.81. Distribution of spot and futures prices of pepper has been found to be approximately symmetric with a skewness coefficient of 0.24 and 0.25 respectively. Both the series are platykurtic, but futures prices series has higher kurtosis of 1.62 than spot prices with 1.49. Jarque-Bera test statistic used to test the normality has a probability of zero at 5% significance level in both series, indicating that future and spot prices series are not normally distributed. So normality condition for the series has to be taken care of for further analysis.

Table 1: Descriptive Statistics of Spot and Futures Prices of Pepper

Year	Prices	N	Mean	S.D	Skewness	Kurtosis	Jarque-Bera	Prob.
2008	Spot	93	12233.81	1249.54	-0.01	1.61	7.49	0.024*
	Futures	93	12025.45	1422.44	0.20	1.80	6.20	0.045*
2009	Spot	287	13128.09	1343.11	-0.07	1.91	14.48	0.001*
	Futures	287	13222.75	1513.85	0.05	2.12	9.47	0.009*
2010	Spot	294	17608.52	3032.02	-0.07	1.57	25.30	0.000*
	Futures	294	17973.24	3088.91	-0.06	1.76	19.18	0.000*
2011	Spot	295	28951.77	4672.96	-0.01	1.67	21.73	0.000*
	Futures	295	29819.09	4744.98	0.01	1.80	17.69	0.000*
2012	Spot	287	38867.40	3472.45	-1.11	3.21	59.47	0.000*
	Futures	287	39334.34	4524.70	-0.63	2.06	29.60	0.000*
2013	Spot	112	37758.22	1818.32	0.43	1.72	11.12	0.004*
	Futures	112	35305.58	758.51	-0.57	2.42	7.62	0.022*
Total	Spot	1368	24858.95	10928.37	0.24	1.49	143.20	0.000*
	Futures	1368	25027.22	10948.81	0.25	1.62	123.93	0.000*

Source: Computed
Note: * indicates significance at 5% level of significance.

5.2. Ratio Test

As mentioned earlier while discussing the methodology, that performance of pepper futures market is assessed on the basis of extent of liquidity, price volatility and basis risk.

5.2.1. Extent of Liquidity

It is seen from the table that the major portion of the total production of pepper does not come to the futures market except for the year 2010-11, because of the less developed futures market for pepper. A producer doesn't find greater interest in futures trading because of less developed futures market. This upward and downward trend is an indication of the stakeholder's perceived utility of a futures exchange. Low liquidity indicate that a producer doesn't find utility in futures exchange. It can be seen from Table 2 that, in the pepper futures market, liquidity varied considerably, ranging from 0.88 times in 2010-11 to 0.16 times the production in 2012-13. Liquidity increased to 0.88 times in 2010-11 from 0.39 times in 2009-10 and decreased further to 0.57 in 2011-12.

Table 2: Extent of Liquidity of Pepper Commodity Market

Year	Liquidity (Percentage)
2009-10	0.39
2010-11	0.88
2011-12	0.57
2012-13	0.16

Source: Computed

This variation in different years happens mainly because of high volatility in price of pepper and a producer doesn't find usefulness of futures market as it is not profitable for them. Overall, liquidity is a serious problem in pepper market.

5.2.2. Price Volatility

Ratio of the S.D. of the futures prices to spot prices of pepper calculating price volatility ratio is reported in Table 3. The ratios are more than one most of the percentage times with 85.7 percentages indicating speculative activities in pepper futures market. The percentage for ratio less than one is 10.7 times, means that information is not fully incorporated. Ratio equal to one is 3.6 times the percentage ratio shows futures price is able to incorporate information efficiently and fully.

Table 3: Ratio of the S.D of the Futures Prices to Spot Prices of Pepper-

Ratio of the S.D of the Futures Price to Spot Price of Pepper							Percentage of time the ratio		
Year/ Month	Jan- Feb	Mar- Apr	May- Jun	Jul- Aug	Sep- Oct	Nov- Dec	<1	=1	>1
2008	_	_	_	_	1.4	1.1	0.0	0.0	100.0
2009	1.1	1.1	1.5	1.2	1.7	1.6	0.0	0.0	100.0
2010	1.5	1.1	1.2	1.2	1.5	1.2	0.0	0.0	100.0
2011	1.3	1.1	1.4	1.3	1.4	1.0	0.0	16.7	83.3
2012	1.4	1.8	1.4	1.2	0.9	2.4	16.7	0.0	66.7
2013	0.8	0.8	_	_	_	_	100.0	0.0	0.0
Total	_	_	_	_	_	_	10.7	3.6	85.7

Source: Computed

These analyses suggest that pepper futures markets are either showing speculative activities or information is not incorporated fully.

5.2.3. Basis Risk

Ratio of the S.D. of the basis prices to spot prices of pepper can be seen in Table 4. The basis variability was lower than the spot price variability in more than 82 per cent of the times during period taken.

Table 4: Ratio of the S.D of the Basis Prices to Spot Price of Pepper

Ratio of the S.D of the Basis Price to Spot Price of Pepper							Percentage of time the ratio		
Year/ Month	Jan- Feb	Mar- Apr	May- Jun	Jul- Aug	Sep- Oct	Nov- Dec	<0.5	0.5-1.0	>1.0
2008	_	_	_	_	0.6	0.4	50.0	50.0	0.0
2009	0.4	0.3	1.1	0.2	0.9	0.8	50.0	33.3	16.7
2010	1.2	0.2	0.8	0.4	0.7	0.9	33.3	50.0	16.7
2011	1.0	0.2	0.8	0.3	0.7	0.6	33.3	66.7	0.0
2012	0.6	0.9	0.6	0.6	1.0	1.5	0.0	66.7	33.3
2013	0.5	1.5	_	_	_	_	50.0	0.0	50.0
Total	_	_	_	_	_	_	32.1	50	17.9

Source: Computed

This suggests that in the case of pepper, hedgers find futures useful to manage price risk. Percentage of times basis risk is between 0.5 and 1 is 50, indicating that futures is not as effective in managing business risk. However, the percentage of times with ratios greater than 1 remained at about 18 per cent cases which means that basis risk is high. Looking at the basis variability it can be clearly seen that basis variability was lower than the spot variability most of the times indicating hedging can be a useful instrument for managing business risk.

5.3 Efficiency Test

As mentioned earlier while discussing the methodology that efficiency of the pepper is examined on the basis of the econometrics techniques of cointegration, VECM, Granger causality, impulse response and variance decomposition.

5.3.1 Cointegration Analysis

Results of unit root test can be seen in Table 5. Here the null hypothesis is that both series have unit roots i.e., non stationarity. At level prices, ADF (t -statistic) value is greater than critical value for both the series and probability value is

also insignificant, indicating the presence of unit root at level. However both the series become stationarity at the first difference as critical value is greater than ADF (t -statistic). The results indicate that both series are not stationarity at levels, but their first differences are stationarity. Thus both are I (1) series. Since it is established through ADF test that both the series have long run relationship. The same order of integration for both spot and future prices reveals that there exists a long run price equilibrium relationship between these two prices. The trace test for cointegration of the two prices with the assumption of no trend in the data was carried out at lag interval of 5, which is selected on the basis of lag selection criterion.

Table 5: Result of Unit root test

	Level Prices			First Difference		
Prices	**ADF (t -Statistic)**	**5% Critical Values (t-Statistic)**	**Prob.**	**ADF (t-Statistic)**	**5% Critical Values (t-Statistic)**	**Prob.**
Spot	1.017064	-1.941056	0.9191	-13.81914	-1.941056	0.0000*
Future	0.870487	-1.941055	0.8971	-34.39298	-1.941055	0.0000*

Source: Computed
Note: * indicates significance at 5% level of significance.

Here the null hypothesis tested is on the number of cointegration equations. The result of trace test is reported in Table 6, which has revealed that trace statistics value at 5 per cent level is greater than critical value, indicating rejection of null hypothesis i.e., number of cointegration equations is none.

Table 6: Cointegration Test (Trace)

Hypothesised No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.
None	0.00909	13.00702	12.3209	0.0383*
At Most 1	0.000419	0.570180	4.129906	0.5121

Source: Computed
Note: * indicates significance at 5% level of significance.

We can also confirm this from probability value, which is 0.0383. The trace statistics value at 5 per cent level is less than critical value for at most 1 cointegration equations.

Table 7: Cointegration Test (Maximum Eigenvalue)

Hypothesised No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.
None	0.00909	12.43684	11.22480	0.0305*
At Most 1	0.000419	0.570180	4.129906	0.5121

Source: Computed
Note: * indicates significance at 5% level of significance.

The Maximum Eigenvalue test result for cointegration also confirms result shown by trace test given in Table 6 as (see Table 7). The result of trace test and Maximum Eigenvalue, rejects the null hypothesis of no cointegration in favour of the alternate hypothesis of one cointegrating equation. This has an important implication for the spot and future prices of pepper as there is a stable long run relationship.

5.3.2 Vector Error Correction Model

Having examined the existence of a long run relationship between spot and futures prices above, the short run adjustment of such prices is being assessed through the VECM in the following. Lag with lowest value of LR, FPE, AIC, SC and HQ is selected for lag order selection criteria.

Table 8: VECM Lag Order Selection Criteria

Lag	LR	FPE	AIC	SC	HQ
0	NA	2.45e+14	38.80850	38.81616	38.81137
1	14049.59	7.98e+09	28.47619	28.49917	28.48479
2	586.2684	5.21e+09	28.05003	28.08833	28.06437
3	29.61199	5.13e+09	28.03405	28.08767	28.05412
4	32.11040	5.04e+09	28.01619	28.08513*	28.04200
5	22.87599*	4.98e+09*	28.00513*	28.08940	28.03668*
6	2.541323	5.00e+09	28.00912	28.10871	28.04640

Source: Computed
* Indicates lag order selected by the criterion

Value of lag order selection criteria is lowest at lag 5 in four out of five tests. According to VECM lag order selection criteria 5 lags of spot and futures prices are significantly different from zero as reported Table 8. With these lags, the post estimation diagnostics revealed no evidence of autocorrelation.

The result of the estimated VECM is presented in Table 9. It can be seen from the table that the coefficient of at least one error correction term was significant for pepper confirming the presence of cointegaration. The coefficient of the error correction term in the case of spot price equation for pepper is found to be positive and significant at 5% level. Such a result implies that spot prices are stable in the long run and any deviation in their prices due to external shocks that

occurred in the short run is adjusted by the market forces over time. The coefficient of error equilibrium was 0.0089 in spot market equation for pepper. This indicates that when average spot price of pepper is too low, it immediately increases toward futures price by 0.89%.

Table 9: Error Correction Model for Futures and Spot Price

		ΔFuture			Δ spot	
Variables	**Coefficient**	**t-Statistic**	**Prob.**	**Coefficient**	**t-Statistic**	**Prob.**
Equilibrium error	-0.007582	-0.92755	0.3538	0.0089	2.371341	0.0179*
Δ Future(-1)	0.071308	2.181306	0.0293*	0.33455	22.28994	0.0000*
Δ Future(-2)	-0.031699	-0.80092	0.4233	0.073608	4.050832	0.0001*
Δ Future(-3)	-0.0981	-2.46517	0.0138*	-0.007651	-0.418747	0.6755
Δ Future(-4)	-0.025929	-0.65674	0.5115	-0.020009	-1.103819	0.2699
Δ Future(-5)	0.039188	1.048416	0.2946	0.006678	0.389115	0.6973
Δ spot(-1)	-0.019841	-0.28389	0.7765	-0.111489	-3.474539	0.0005*
Δ spot(-2)	0.093414	1.337217	0.1814	0.005008	0.156153	0.8759
Δ spot(-3)	0.160362	2.31468	0.0208*	0.10619	3.338417	0.0009*
Δ spot(-4)	0.106244	1.547202	0.122	0.108425	3.439093	0.0006*
Δ spot(-5)	0.037488	0.680081	0.4966	0.008822	0.348582	0.7275

Note: * indicates significance at 5% level of significance.

As the value of coefficients is low in spot market at 0.89% only, the correction process is very slow. This gives an indication of slow informational efficiency of pepper market. Therefore the results broadly indicate that there exists long run relationship between futures and spot prices and the adjustment towards equilibrium is made by spot price. Further, the table records the short run coefficients depicted by Δ futures (-i, where i indicates the lag period in days) which measure the return spillover from spot to futures market are significant at 5% level at lag 1 and 2. Such a result indicates that spot market is leading the futures market and there is unidirectional causality from spot to futures market in case of pepper. From the above discussion it can broadly be said that the information flows from spot price to futures price. Adjustment towards equilibrium is made by spot price. As the value of coefficients is low in spot market, the correction process is very slow.

5.3.3 Granger Causality

The results of VECM on unidirectional causality from spot to futures price of pepper market are confirmed by Granger causality test. With the null hypothesis of spot price does not Granger cause futures price and futures price does not Granger cause spot price. The Granger causality tests result can be seen in Table 10.

Table 10: Pairwise Granger Causality Tests

Null Hypothesis:	Obs.	F-Statistic	Prob.
Spot price does not Granger cause future price	1363	3.69566	0.0025*
Future price does not Granger cause spot price		111.155	2.0000

Source: Computed
Note: * indicates significance at 5% level of significance.

The F statistics test reject the null hypothesis of no Granger causality from spot to future prices, indicates that there is unidirectional causality from spot prices to futures. Future price is said to be granger caused by spot prices, means spot price helps in the prediction of future price.

5.3.4 Impulse Response

It shows how log of spot prices respond to shocks in log futures prices before it settles down and vice versa.

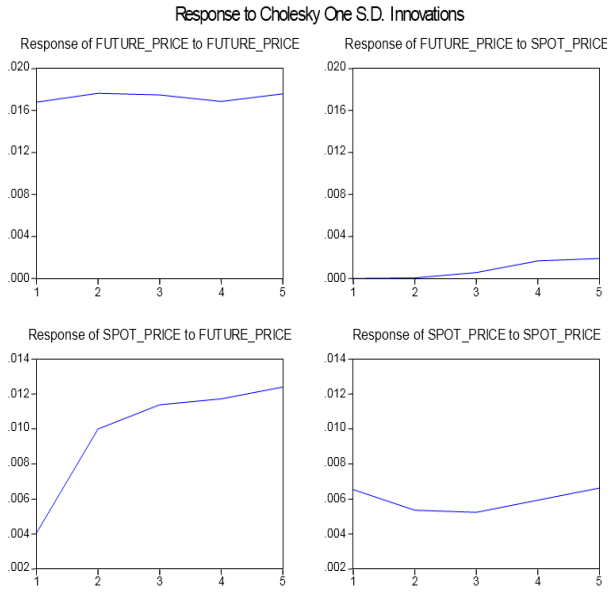

Fig 1: Impulse Response Graph
Source: Computed

The effect of one S.D. shock today on the current and the future values of spot and futures prices are ascertained with the impulse response graphs as shown in Figure 1. Such a result is consistent with those from the VECM analysis above. Therefore, it can be inferred from the graph of impulse response function that in the pepper market, spot returns show greater response to shocks in futures prices, which stays for two days before settling down. Response to shocks in futures prices and spot prices by its own shock is almost constant.

5.3.5 Variance Decomposition

It indicates how much proportion of variation in spot prices is due to its own shock against the shock in futures prices and likewise for the variation in futures prices. The first panel of Table 11 reports the percentage variation in pepper futures prices explained by its own lagged values and by the lagged values of spot prices. As per the second panel of Table 11 spot prices variations explained by futures prices are much larger suggesting greater efficiency of futures market.

Table 11: Variance Decomposition of Pepper spot and Future Price Series

	Futures Prices Explained by	
Period	**Spot Prices (%)**	**Futures Prices (%)**
1	0.000	100
2	0.001	99.998
3	0.037	99.962
4	0.251	99.748
5	0.545	99.454
	Spot Prices Explained by	
Period	**Spot Prices (%)**	**Futures Prices (%)**
1	71.357	28.642
2	41.699	58.3
3	33.578	66.421
4	31.608	68.391
5	31.466	68.533

Source: Computed

The results indicate that around 28.642% to 68.53% of the variations in spot prices are explained by the futures prices, though in spot markets substantial variance is also explained by its own lagged value. On the other hand, spot return appears to be explaining only 0.037% to 0.545% variation in the pepper futures prices.

6. Summary, Conclusions and Limitation

As futures contract fulfills the hedging needs of the farmers, traders and exporters, and also to assist the spot market participants in making informed pricing decisions, the present work assessed the performance and efficiency of pepper futures market. In view of such a feature, the present study attempts to empirically examine the performance and efficiency of pepper futures market for its role of price discovery and risk management functions. For that purpose the performance assessment methods of extent of liquidity, price volatility and basis risk have been employed as analytical variables. Using the econometrics techniques such as Cointegration, VECM, Granger causality, impulse response and variance decomposition, the study has generated empirical results to evaluate the level of development of pepper futures market as an efficient mechanism of risk management and price discovery.

Futures price mean is marginally above the spot price. The volatility between these prices also shows similar result. Distribution of spot and futures prices of pepper has been found to be approximately symmetric. Both the series are platykurtic, but futures prices series has higher kurtosis. Jarque-Bera test statistic used to test the normality is found to be not normally distributed. Performances of pepper futures market is assessed on the basis of extent of liquidity, price volatility and basis risk. Liquidity is a serious problem in pepper futures market. Major portion of the total production of pepper does not come to the futures market. In pepper futures market, liquidity varied considerably, this variation in different years happens mainly because of high volatility in price of pepper. Price volatility ratio suggests that pepper futures markets are either showing speculative activities or information is not incorporated fully. Looking at the basis variability it can be clearly seen that basis variability was lower than the spot variability most of the times indicating hedging can be a useful instrument for managing business risk. Pepper futures market has not done well as performance is concern. Efficiency of the pepper is examined on the basis of the econometrics techniques of cointegration, VECM, Granger causality, impulse response and variance decomposition. Since the results indicate that pepper futures and spot prices are cointegrated, short run adjustment has been taken care by VECM. Error correction is taking place in spot markets, although correction process is very slow i.e., process of adjustment to disequilibrium is slow in both the markets. When the cointegrating relationship was disturbed, it was the spot price which tends to make adjustment towards long run equilibrium. Granger causality test confirm the results of VECM on unidirectional causality from spot to futures price of pepper and therefore spot prices can be used for pricing futures market transactions. From impulse response graph it can be inferred from the graphs that in the pepper market, spot returns show greater response to shocks in futures prices, which stays for two days before it settles down. Variance decomposition shows spot prices variations explained by futures prices are much larger. Empirical study of the pepper futures market in India indicates that pepper has not done well as performance is concern. Looking at the result it can be said that, hedgers find futures market useful to manage price risk and can be very useful in risk management functions.

Due to shortcoming related to time series price data, pertaining to seasonality and unevenly observations, results can be influenced and may not be robust. The use of other analytical techniques such as GARCH and EGARCH may have lead to better depth analysis of study.

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