COINTEGRATION OF SPOT PRICE AND FUTURE PRICE OF PEPPER- EVIDENCE FROM INDIAN COMMODITY MARKET

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ABSTRACT

The paper examines the causal relationship between the price of Pepper in the spot and future market. The daily closing price of spot and future price of Pepper in National Commodities and derivatives exchange for the period from 2005-06 to 2012-13 are taken as input for the study. The relationships between the two series are analyzed by applying Pairwise Granger Causality test. Descriptive statistical analysis and Jarque Bera Test are applied to study the nature of distribution of the time series data of spot and future price of Pepper. Correlogram analysis is applied to test the presence of auto correlation in the series. The Augmented Dickey Fuller test (ADF) shows the data series of spot and future price of Pepper are stationary at first order level. Granger Causality is applied to examine the relationship between spot and future price of Pepper. The test results indicate bilateral causality between the price of Pepper in the spot and futures market.

Keywords:

Jarque Bera test, Auto Correlation, Augmented Dickey Fuller test, Granger causality

1. Introduction

India has been traditionally known as the "Land of Spices". It is the World's largest producer and consumer of spices and it has been among the leading spice exporting countries. India contributes 70 % of global spice production. India produces as many as 60 spices out of the 109 spices listed by the International Organization for Standardization. Among the spices produced in India, Pepper is known as the "King of Spices" and called as the "Black gold" of India.The domestic price, production as well as profitability of Pepper are highly influenced by the domestic and global factors. As a commodity traded in the spot, futures and export market, global demand and supply plays a crucial role in shaping Pepper prices. For instance, Pepper that was trading at a price of Rs 200 per kg in the year 2000 has dropped to Rs 65 per kg in 2005 and surged to Rs 365 per kg in March 2013. Due to high price volatility of Pepper in the spot market, it is imperative for the farmers and traders to go for hedging in the derivative market. For the hedging to be effective, it is essential to understand the fundamental factors affecting pepper price, study the role of futures market in price discovery and the relationship between the price of Pepper in the spot and futures market.

1.1 History of commodities trading in India

History of trading in commodities in India dates back to several centuries, but organized futures market in India emerged in 1875 when the Bombay Cotton Trade Association was established. The futures trading in oilseeds started in 1900 when Gujarati VyapariMandali was established and this was followed by the commencement of derivatives trading in oilseeds, Jute, wheat and bullion trading. The futures trading in gold began in Mumbai in 1920. During the first half of the 20th century, there were many commodity futures exchanges, including the Calcutta Hessian Exchange Ltd that was established in 1927. Those exchanges traded in jute, pepper, potatoes, sugar, turmeric, etc. However, India's history of commodity futures market has been turbulent. Options were banned in cotton in 1939 by the Government of Bombay to curb widespread speculation. A sense of ambiguity and uncertainty continued to prevail since the Government prohibited options trading in the case of cotton and also simultaneously banned forward trading in many commodities. With this, the historical nature and presence of the commodities market weakened in India. In mid-1940s, trading in forwards and futures became difficult as a result of

price controls by the government. The principal commodity exchanges functioning before Independence were not governed by any regulations or guidelines. The trade was executed based on trust and faith. They were regulated by social control of participating members. Whenever the control failed, it has led to crisis. In order to address the issue, a comprehensive legislation was enacted by the Bombay State in 1947 in the form of the Bombay Forward Contracts Control Act.

1.2 History of Pepper

Pepper has a long history that is 4000 years old and it moves back to even before 410A.D. In the Roman Empire, Pepper was well established as an article of commerce, shipped to Rea Sea ports by Arabs using the Arabian Sea Monsoons, then on to the city of Alexandria in Egypt. Vasco de Gama's discovery of a sea-route to the spice lands of Malabar Coast in 1498 was triggered by his obsession with spices, particularly pepper. Gama's feat had two results. One, it gave Portugal a secure monopoly over the spice trade. Two, it destroyed the economies of Alexandria, Genoa and Venice, which were built on the prosperity which pepper had brought them.

In 1595, Houtman of Holland made a successful voyage to Indonesia. This was the beginning of the end of Portugal's monopoly over spice trade. By 1605, the Dutch drove away the Portuguese from the Moluccas. Holland gradually established a firm grip over the pepper producing centers near Lampong in Sumatra and Banten in Java.

During the 19th century, London emerged as the world's most important spice center. By then, increased production had driven pepper prices down, making it affordable even to the man on the street. Pepper no longer remained the exclusive commodity of the rich and famous. When the fortunes of the Dutch East India Company were down, the US entered the scene. In 1797, Jonathan Carnes of Massachusetts sailed into the New York waters with Sumatran pepper worth US $100,000. The US cities of Salem and Boston soon became main spice centres.

In the recent years, Pepper trade encompasses the whole world with Western Europe, United States, Japan and Korea being the biggest consumers. The main pepper producing countries are Vietnam, India, Indonesia, Brazil, Malaysia, China and Sri Lanka. Of the total world trade in spices, valued by the International Trade Centre in Geneva at $1.5-2.0 billion, pepper holds a commanding 34% share. India

remains the largest producer of pepper, but recently Vietnam has been aggressively expanding its pepper cultivation, and is the world's largest exporter of the spice.

II. Review of literature

Samuelson (1965) found that price volatility of a futures contract should increase as a contract approaches its delivery date. The so-called Samuelson effect had been investigated by a number of authors and had received mixed support. There existed more consistent empirical support for predicting seasonal volatility in grain futures markets. In general, volatility increases in the spring, peaks in the summer, and decline towards the end of a year.Anderson (1985) found that seasonality was a primary factor in explaining futures price volatility in grain markets and that contract maturity was a secondary factor.Kenyon at al. (1987) showed that corn, soybeans, and wheat futures price volatility was affected by seasons, lagged volatility, and loan rates.

Streeter and Tomek (1992) showed that time to delivery had nonlinear effects on price volatility and that volatility decreased in months immediately prior to contract expiration. They also found significant seasonal effects, with volatility increasing in summer months. Furthermore, lagged volatility had a significant positive effect on price volatility.Yang and Brorsen (1993) reported evidence of seasonality in corn, soybeans, and wheat futures price variability. However, they found time-to-delivery effects only for soybeans and oats.

Goodwin and Schnepf (2000) found, corn and wheat price variability was significantly affected by inventories, growing conditions, trading volume, open interest, and seasonality. Their results showed evidence of positive time-to-delivery effects for corn but no effects for wheat. Chatrath et al., (2002) found that daily returns (log price changes) on soybean, corn, wheat, and cotton futures contracts were significantly affected by seasonality and lagged daily returns. They analysed the time-to-delivery effects for soybean and corn and found support for the Samuelson effect.

Sorensen (2002) analysed seasonal price patterns for corn, soybeans, and wheat futures, and concluded that the seasonal components for all three commodities peaked about two to three months before the beginning of harvest.Kalev and Duong (2008) provided evidence of the Samuelson effect in agricultural futures markets using seemingly unrelated regressions (SUR). They constructed time series of the nearest delivery contract, the second-nearest delivery contract and so on to measure the relationship between time to delivery and price volatility.

III. Objectives of the study

(1) To analyze the pattern of price movement of Pepper in the spot market

(2) To study the relationship between Pepper price movement in the spot and futures market.

(3) To examine the causal relationship between spot and future price of Pepper.

IV. Hypotheses

HYPOTHESES OF THE STUDY

For the enhancement of the study, the following hypotheses have been framed

H_0 - The time series data of spot price of Pepper is normally distributed

H_0 - There is no significant autocorrelation in the time series of spot price of Pepper

H_0 - The series of spot price of Pepper is non stationary

H_0 - The Spot price of Pepper does not Granger cause future price

H_0 - The future price of Pepper does not Granger Cause spot price

VI. Research methodology

The study is based on the secondary data. The daily closing price of Pepper in the spot and futures market with respect to National Commodities and Derivatives Exchange (NCDEX) is consideredfor the study. The period of the study ranges from April 2005 to March 2013. The monthly returns are measured by taking the natural logarithm of monthly average closing price. The nature of distribution of the series is determined by applying the Normality test, Auto Correlation test and Augmented Dickey-Fuller (ADF) test. The causal relationship between spot and futures market is analyzed through testing of hypothesis by applying Pairwise Granger Causality test.

6.1 Tools used for the study

6.1.1 Jarque Bera Test

Jarque Bera test is a goodness of fit measure used to determine whether the sample data follows normal distribution. The test determines whether the sample data have the skewness and kurtosis. The t-test tests the significance of null hypothesis that states the data forms normal distribution. A normally distributed data set have skewness and excess kurtosis equal to zero and JB statistic asymptotically has a chi-square distribution with two degrees of freedom. Any deviation from this increases the Jarque Bera Statistic.

$$JB = \frac{n}{6}\left(S^2 + \frac{1}{4}(K-3)^2\right)$$

Where

JB = Jarque Bera Statistic

n = number of observations

S = Skewness

K = Kurtosis

6.1.2 Augmented Dickey-Fuller Test

A unit root test tests whether a time series variable is non stationary using an autoregressive model. It is a descriptive tool performed to classify a series in to stationary and non stationary. Augmented Dickey Fuller (ADF) test is applied for large samples. It is an augmented version of the Dickey – Fuller test for a larger and more complicated set of time series models. The ADF statistic used in the test is a negative number. The more negative it is, the stronger the rejection of the hypothesis that there is a unit at some level of confidence. The Augmented Dickey-Fuller test model taken in this study is as follows.

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \cdots + \delta_{p-1} \Delta y_{t-p+1} + \varepsilon_t,$$

Where α is a constant, β is the coefficient on a time trend, Yt signifies time series to get tested and e_t is the white noise error term.

6.1.3 Granger Causality Test

The Granger Causality test is a statistical hypothesis test for determining whether one time series is useful in forecasting another series. This was proposed by Granger (1969) and popularized by Sims (1972)

Steps involved in Granger Causality Test

Regress the first orders of spot price of Pepper with the future price for the period of observation. Assume a particular autoregressive lag length *p*, and estimate the following unrestricted equation by ordinary least squares (OLS):

$$x_t = c_1 + \sum_{i=1}^{p} \alpha_i x_{t-i} + \sum_{i=1}^{p} \beta_i y_{t-i} + u_t$$

$$H_0 : \beta_1 = \beta_2 = \ldots = \beta_p = 0$$

Conduct an *F*-test of the null hypothesis by estimating the following restricted equation by OLS

$$x_t = c_t + \sum_{i=1}^{p} \gamma_i x_{t-i} + e_t$$

Compare their respective sum of squared residuals.

$$RSS_1 = \sum_{t=1}^{T} \hat{u}_t^2 \qquad RSS_0 = \sum_{t=1}^{T} \hat{e}_t^2$$

$$S_1 = \frac{(RSS_0 - RSS_1)/p}{RSS_1/(T-2p-1)} \sim F_{p,\, T-2p-1}$$

If the test statistic is greater than the specified critical value, then reject the null hypothesis that *Y* does not Granger-cause *X*.

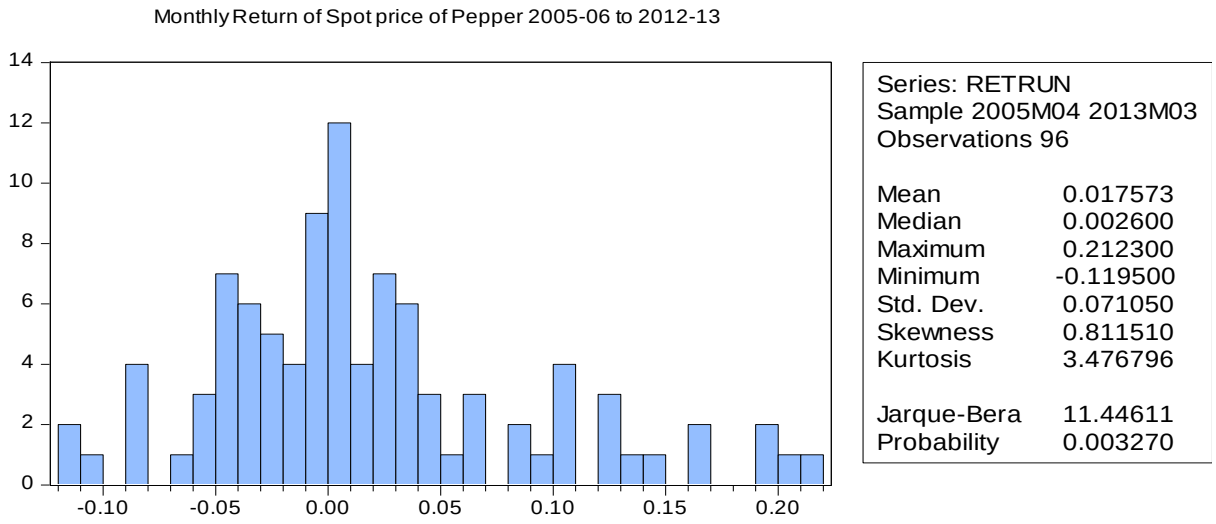
It is worth noting that with lagged dependent variables, as in Granger-causality regressions, the test is valid only asymptotically. An asymptotically equivalent test is given by

$$S_1 = \frac{T(RSS_0 - RSS_1)}{RSS_1} \sim \chi^2(p)$$

VII. Analysis and interpretation

7.1 JarqueBera Test for normality and descriptive statistics

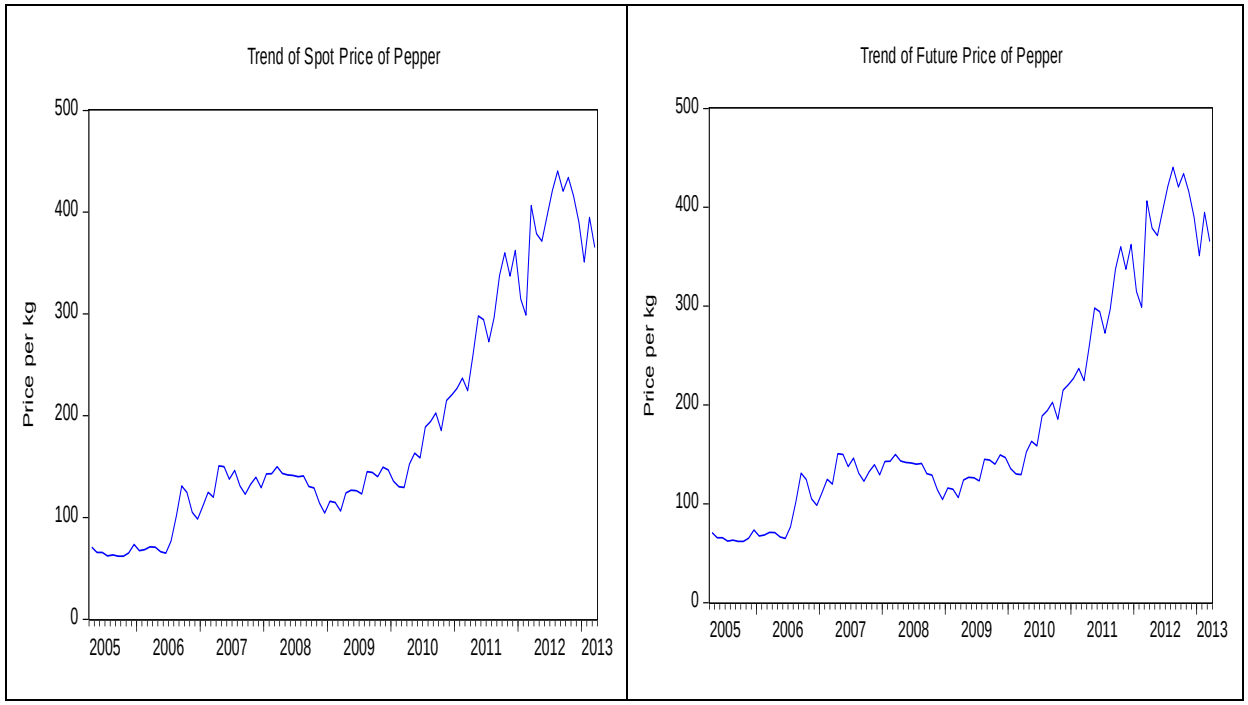
Table 7.1 Normality test of returns of Spot Price of Pepper for the period between 2005-06 and 2012 -13



The above table shows the descriptive statistics of monthly returns of spot price of Pepper for the period ranging from 2005-06 to 2012-13. The nature of distribution of monthly returns is analyzed on the basis of Skewness, Kurtosis and Jarque – Bera test. For a series to be normally distributed the Skewness should be equal to zero and the Kurtosis should be equal to 3. The observed Skewness value (0.81) is not equal to zero and it is positive. It indicates the series is skewed towards right. The observed kurtosis value (3.14) is more than the critical value (3) which indicates the distribution is peaked and shows the formation of "Leptokurtic" kurtosis. The observed Jarque Bera statistic value is 11.44 and the probability is less than 5 %. Since the test result is not statistically significant at 5 % confidence level the null hypothesis of normal distribution is rejected and alternate hypothesis of non normal distribution is accepted. It shows the monthly returns of Pepper in the spot market are not normally distributed. The reason is attributable to two patterns of price trend observed from 2005 to 2013. The year 2005 to 2008 is marked with normal growth in price, whereas the period from 2009 to 2013 shows continuous uptrend with respect to Pepper price in the spot market. The minimum and maximum monthly return fluctuates between – 11 % and 21 % respectively.

Figure 7.1

Trend of Spot and Future Price of Pepper for the period between 2005-06 and 2012-13



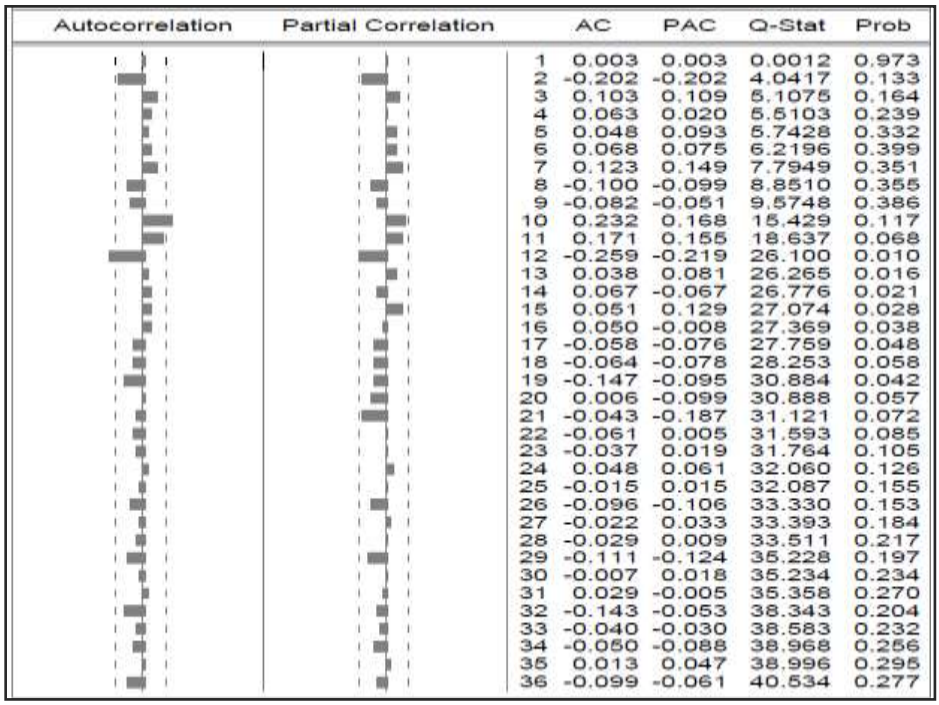
The figure 7.1 shows the price movement of Pepper in the spot and futures market for the year from 2005-06 to 2012-13. Substantial increase in Pepper price is seen after 2009. Uniform price movement is observed between the spot and futures market for the period of analysis. The analysis of price movement shows the existence of volatility in both the markets.

7.2 Auto Correlation test

Application of econometric tools and hypothesis testing requires the data to be stationary or there should not be any autocorrelation in the time series data. Existence of autocorrelation provides biased estimate in ordinary least square equation. The output of linear equation may not be the best linear unbiased estimate. Since there is autocorrelation in the series of spot price of Pepper, it has been converted into its first difference for the period of observation. The first difference

values are verified through correlogram analysis test of autocorrelation. The results of correlogram analysis are tabulated below

Table 7.2 Auto Correlation test of first difference of spot price of Pepper for the period between 2005-06 and 2012-13



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.003	0.003	0.0012	0.973
		2	-0.202	-0.202	4.0417	0.133
		3	0.103	0.109	5.1075	0.164
		4	0.063	0.020	5.5103	0.239
		5	0.048	0.093	5.7428	0.332
		6	0.068	0.075	6.2196	0.399
		7	0.123	0.149	7.7949	0.351
		8	-0.100	-0.099	8.8510	0.355
		9	-0.082	-0.051	9.5748	0.386
		10	0.232	0.168	15.429	0.117
		11	0.171	0.155	18.637	0.068
		12	-0.259	-0.219	26.100	0.010
		13	0.038	0.081	26.265	0.016
		14	0.067	-0.067	26.776	0.021
		15	0.051	0.129	27.074	0.028
		16	0.050	-0.008	27.369	0.038
		17	-0.058	-0.076	27.759	0.048
		18	-0.064	-0.078	28.253	0.058
		19	-0.147	-0.095	30.884	0.042
		20	0.006	-0.099	30.888	0.057
		21	-0.043	-0.187	31.121	0.072
		22	-0.061	0.005	31.593	0.085
		23	-0.037	0.019	31.764	0.105
		24	0.048	0.061	32.060	0.126
		25	-0.015	0.015	32.087	0.155
		26	-0.096	-0.106	33.330	0.153
		27	-0.022	0.033	33.393	0.184
		28	-0.029	0.009	33.511	0.217
		29	-0.111	-0.124	35.228	0.197
		30	-0.007	0.018	35.234	0.234
		31	0.029	-0.005	35.358	0.270
		32	-0.143	-0.053	38.343	0.204
		33	-0.040	-0.030	38.583	0.232
		34	-0.050	-0.088	38.968	0.256
		35	0.013	0.047	38.996	0.295
		36	-0.099	-0.061	40.534	0.277

The above table indicates the correlogram analysis of the series of first difference of spot price of Pepper for the period ranging from 2005-06 to 2012-13. The analysis indicates, spikes are observed only at lag 10 and lag 12. The observed probability value is more than 5 % for most of the lag orders. Therefore the null hypothesis of no serial correlation is accepted. Hence the correlogram analysis concludes there is no serial correlation in the series of first difference of spot price of Pepper for the period ranging from 2005 – 06 to 2012 -13. The test results show the current price is not influenced by the previous price if first order difference is considered in the series. Therefore the farmers and traders can reasonably be able to forecast the future price of Pepper in the spot market by applying appropriate forecasting models.

7.3 Augmented Dickey Fuller (ADF) Test

Table 7.3 ADF test of first difference of spot price of Pepper for the period between

2005-06 and 2012-13

Variable	Coefficient	Standard Error	t-Statistic	Probability
Spot price	-1.2539	0.156231	-8.0259	0.0000
C	1.4987	2.990021	0.50123	0.6174
Trend	0.0539	0.54655	0.9878	0.3259
R-squared	0.49719	Mean dependent variable		-0.4601
Adjusted R-squared	0.48024	S.D dependent variable		19.2167
S.E. of regression	13.8540	Akaike Information Criterion		8.1370
Sum squared residual	17082.26	Schwarz criterion		8.2460
Log likelihood	-374.3749	Hannan-Quinn criterion		8.1810
F-statistic	29.33581	Durbin-Watson statistic		1.8167
Prob(F-statistic)	0.0000			

Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic- based on SIC, Maxlag =11)

The above table shows the results of ADF test of first difference of spot price of Pepper between 2005-06 and 2012-13. The results of the test are analyzed through probability values and t statistic. As per the guidelines the null hypothesis is rejected if the observed p value is less than 5 %. Since the observed p value (0.0000) is less than 5 %, the null hypothesis is rejected. It indicates the time series data of the first difference of spot price of Pepper for the period of observation is stationary.

The observed t statistic value is -8.02. As per the guidelines the null hypothesis is rejected if the absolute value of the observed t statistic is more than the absolute critical value of t statistic. Since the observed absolute t statistic value is 8.02 which is more than the absolute critical value (3.45) of t statistic at 5 % significance level, the null hypothesis is rejected. Hence the analysis of ADF test indicates the first difference of the time series data of spot price of Pepper for the period of observation is stationary. Hence the data series can be applied in estimating volatility of Pepper by applying GARCH and EGARCH models.

7.4 Pairwise Granger Causality Test

Table7.4 Pairwise Granger Causality Tests

Lag order	Null hypothesis	Observations	F Statistic	Probability	Status
2	Spot price does not Granger Cause Future price	93	24.8956	3.E-09	Reject
	Future price does not Granger Cause		16.6388	7.E-07	Reject

	Spot price				
3	Spot price does not Granger Cause Future price	92	15.8063	3.E-08	Reject
	Future price does not Granger Cause Spot price		10.2401	8.E-06	Reject
4	Spot price does not Granger Cause Future price	91	11.4748	2.E-07	Reject
	Future price does not Granger Cause Spot price		7.83596	2.E-05	Reject
5	Spot price does not Granger Cause Future price	90	10.8844	5.E-08	Reject
	Future price does not Granger Cause Spot price		6.22133	6.E-05	Reject
6	Spot price does not Granger Cause Future price	89	9.17015	2.E-07	Reject
	Future price does not Granger Cause Spot price		5.21491	0.0002	Reject
7	Spot price does not Granger Cause Future price	88	7.80316	5.E-07	Reject
	Future price does not Granger Cause Spot price		3.84426	0.0013	Reject
8	Spot price does not Granger Cause Future price	87	10.5312	1.E-09	Reject
	Future price does not Granger Cause Spot price		5.47232	2.E-05	Reject
9	Spot price does not Granger Cause Future price	86	9.59389	3.E-09	Reject
	Future price does not Granger Cause Spot price		5.13366	3.E-05	Reject
10	Spot price does not Granger Cause Future price	86	9.59389	3.E-09	Reject
	Future price does not Granger Cause Spot price		5.13366	3.E-05	Reject

The above table shows the results of bilateral causality between spot and future price of Pepper under Granger Causality test. The observed values of F tests are more than the critical values and the observed probability values are also less than 5 % for all lag orders from 1 to 10. Therefore the null hypothesis of "Spot price does not Granger Cause Future price and Future price does not Granger Cause Spot Price" are rejected. Hence the Granger Causality test indicates, there is bilateral causality between spot price and future price of Pepper. The causality ran in both directionsi.e the spot price granger cause future price and vice versa. The test result indicates the existence of significant relationship the price movement of Pepper in the spot and futures market. Therefore it is concluded that the futures market of Pepperprovides price discovery mechanism

to the farmers and traders.The price discovery mechanism will facilitate the farmers and traders to effectively hedge the price risk by dealing in the Futures market.

VIII. Conclusion

The farmers and traders are exposed to price risk with respect to commodities.The price risk can be minimized through effective hedging. The futures market operates as a platform for both hedging and speculation. Hence understanding the relationship between spot and futures market is essential for the farmers and traders of commodities. The study examined the co-integration of spot and futures market of Pepper for the period from 2005-06 to 2012-13. The absolute closing prices are converted in to monthly returns. The nature of distribution of the series of monthly return is analyzed through descriptive statistics and Jarque Bera test. The Augmented Dickey Fuller Test is applied to determine whether the series is stationary.Granger Causality test is applied to study the relationship between spot and futures market. The test result shows futures market Granger Cause spot market and vice versa. Therefore the farmers and traders can use the price information in futures market to hedge the risk in spot market.

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