PRICE DYNAMISM OF PEPPER IN SPOT AND FUTURES MARKET

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Abstract

This paper has examined the price dynamics of pepper in spot and futures market. Futures Trading in pepper has been undertaken without break since 1957 in the India Pepper and Spice Trade Association (IPSTA). IPSTA launched its online trading system from April 2004 and is the only regional exchange to go for full-fledged online trading IPSTA Pepper prices data were used for the sample period from January 2006 to March 2012. The ADF test and PP test are used in testing the stationarity levels. The Johansen Co-integration test used provides empirical evidence that spot and future prices are co-integrated. The Granger Causality test also shows that there exists a bi-directional relationship between the spot and futures prices evidencing that the pepper prices do possess the price discovery function.

Key Words: *ADF test, PP test, Stationarity, Johansen Co-integration, Granger Causality*

JEL Classification: G13, G14

1. INTRODUCTION

The Indian commodity futures market has achieved a surge in values and volumes of commodities traded over the last decade. Having market participants with various objectives and information, the futures market enables the current futures price to act as an accurate indicator of the spot price expected at the maturity of the futures contract thereby performing price discovery and price risk management. The price discovery mechanism is dynamic by providing an idea about the market efficiency, volatility, hedging effectiveness and arbitrage opportunities in futures market. The King of Spices “Pepper” has gained wide marketability after the invocation of futures trading. A future trading on pepper has been undertaken way back to 1957 itself. Since then it could get attractive price. Black Pepper the King of Spices, is one of the oldest and the most popular spice traded internationally. Till 1999 India was the main producer and exporter, from 1999 onwards Vietnam emerged as the top producing and exporting country due to bringing in large number of hectares under pepper cultivation. Pepper was one of the first crops that were cultivated in India. Kerala is the leading pepper-producing state in India contributing to around 96% of the total production. The India Pepper and Spice Trade Association (IPSTA) has been functioning in futures trading in pepper without break since 1957. IPSTA launched its online trading system from April 2004 and is the only regional exchange to go for full-fledged online trading and to diversify into multi-commodity trading. It has signed a pact with the Multi Commodity Exchange to ensure a national reach and the only exchange in the south to facilitate futures trading in multi-commodities. The purpose of the present study is to examine the long-run equilibrium relationship between the commodity spot and futures markets of pepper traded in IPSTA in India. The present study is also significant enough as it enables to find the lead-lag relationship between the prices of pepper, throwing light in determining which market is more efficient in processing and reflecting of new information.

2. REVIEW OF LITERATURE

The purpose of review of past studies in precise is to address the sizeable literature showing the long-run relationship and the casual relationship between the spot and futures prices of commodities traded in futures exchange.

Gardbade and Silber (1983) used daily spot and futures prices to understand the price discovery process in four storable agricultural commodities (wheat, corn, oats and orange juice) and found that the futures markets dominate the spot markets for wheat, corn and orange juice,, but for oats the results were not clear enough.

Mattos& Garcia(2004) analyzed the lead-lag relationship between spot and futures prices in the Brazilian agricultural markets for coffee(Arabica), corn, cotton, live cattle, soybeans and sugar and found mixed results. It was found that the futures and the spot prices were co integrated in the case of live cattle and the coffee markets. Besides, the analysis revealed that there was no co integrating relationship in the thinly trade markets like corn, cotton, soybeans. Roy(2008) examined the price discovery process of 32 wheat futures contracts in India andfound that the Indian wheat futures markets are well co-integrated with their spot markets with bidirectional causality observed in majority of wheat futures contract. Goyari & Jena(2011) examined the commodity futures market from June 2005 to January 2008 using the daily spot and futures prices of gold, crude oil and guar seed stating that the spot price and the futures price are co-integrated suggesting that they have a long-run relationship.WestGaard(2011) considered the relationship between gas oil and Brent crude oil using ICE futures. They found that in normal periods, energy futures prices, both crude oil related and otherwise are strongly correlated, but that during volatile periods corresponding to financial and environmental crises, the spread between gas and crude oil is likely to deviate taking some time to revert to its original equilibrium value. Mihaela Nicolau(2012) analysed the dynamic relationship between spot and futures prices of the crude oil, a very important commodity. The results confirm that the prices of one and two maturity futures predict spot prices, but is not true for longer maturity futures contracts. Nik Muhammad Naziman Ab Rahman, Abdol Samad Nawi &Yusrina Hayati Nik Muhd Naziman(2012) investigated the market efficiency of the Malaysian crude palm oil prices from 1998 to 2010 and confirmed that the spot and futures prices are co-integrated. The Error-Correction Model (ECM) also shows that there is a dynamics relationship between spot and futures prices evidencing that the crude palm oil prices do possess the price discovery function.Takeshi INOUE & Shigeyuki HAMORI(2012) while examining the efficiency of the commodity futures market in India estimated the long-run equilibrium relationship between the multi-commodity futures and spot prices and then test for market efficiency in a weak form sense by applying both the DOLS and the FMOLS methods from 2nd January 2006 to 31st March 2011. The results indicate a co-integrating relationship between these indices and that the commodity futures market seems to be efficient only during the more recent sub-sample period since july 2009. Velmurugan P. Shanmugam & Bill Hu(2012) investigated the interrelationship and direction of information flows between spot and futures prices of 12 agricultural commodities, for a period of 1995 to 2011 and two sub-periods, before 2006 and since 2006 and found that co-integration and long-term relationship exist significantly in spot and futures returns for all the commodities. The causality tests also indicate that futures prices lead changes in spot prices and have stronger ability to predict spot prices in Wheat (CBOT), Corn, Soybean oil, Cotton, Live cattle, Feeder cattle, Cocoa, Sugar, and Coffee. For other commodities, both spot and futures prices are equally responsible for the price discovery process due to information flow from both sides.

PremShah(2013) investigated the relationship between the spot and future prices of cocoa, coffee, crude oil, gold, natural gas and silver, and found that there exists a long-run relationship for all except crude oil. The reason behind the absence of long-run relationship might be the dramatic price movement in the recent period since crude oil is the worldwide traded energy commodity, and a bi-directional causal relationship also exists between the spot and futures prices of all commodities except natural gas and silver.

The reviews give precise view about the relationship between the spot and futures prices of various commodities. However to make an in-depth study about the relationship between spot and futures prices of pepper traded in IPSTA the following objectives are set.

3. OBJECTIVES OF THE STUDY

1. To identify the long-run equilibrium relationship between the spot and futures prices of IPSTA pepper
2. To ascertain the Lead-Lag relationship between the spot and futures prices of IPSTA pepper

4. HYPOTHESIS

$H0_1$ = There is no significant relationship between the spot and futures prices of pepper in the long-run.
$H0_2$ = There is no lead-lag relationship between the spot and futures prices of pepper.

5. DATA & METHODOLOGY

The study is based on secondary data. The data for establishing price discovery and relationship between spot and futures prices of pepper were collected from IPSTA. The India Spice and Trade Association (IPSTA) the only regional exchange in the south doing futures trading in pepper without break since 1957 started its online trading from 2004. The ready market prices and futures prices of pepper released by IPSTA in Kochi from January 2006 to March 2012 have been retrieved from their website in case of pepper.

Johansen's Co-integration approach and Granger causality have been employed to investigate the price discovery process in spot and futures market of pepper in IPSTA. It is necessary to test the stationary of the series before doing co-integration analysis. The Augmented Dickey-Fuller (1979) test was employed to infer the stationary of the series. If the series are non-stationary in levels and stationary at differences, then there is a chance of co-integration relationship between them which reveals the long-run relationship between the series. Johansen's co-integration test has been employed to investigate the long-run relationship between two variables. The presence of co-integration ensures long term relationship of spot and futures prices of pepper and the absence of co-integration shows that spot and futures prices drift apart without bound or the futures price provides little information about the movement of the spot price. The co-integration statistics is based on comparing the number of co-integrating vectors under the null and alternative hypotheses. Thus the rank of Π defines the number of co-integrating vectors. If the rank is 1, a single co-integrating vector exists between the two variables. On the other hand, if the rank of Π is 0, then co-integration does not exist between St and Ft. Johansen Co-integration uses two tests to determine the number of co-integration vectors, the Maximum Eigen value test and the Trace test. The Maximum Eigen value statistic tests the null hypothesis of r co-integrating relations against the alternative of r+1 co-integrating relations for r = 0,1,2………n-1. Trace statistics investigate the null hypothesis of r co-integrating relations against the alternative of n co-integrating relations, where n is the number of variables in the system for r = 0,1,2…….n-1. The study uses the Johannes multivariate approach. X_1 denotes a vector which includes the **K** time series. If the elements in X_t are co-integrated, X can be expressed by vector autoregressive model(VAR). Once the series are integrated in an identical order, then Johansen Multivariate Maximum likelihood co-integration test can be employed to investigate the long-run relationship between spot and futures prices and it is presented below.

$$\Delta x_t = \sum_{t-1}^{p-1} \Gamma i X_{t-i} + \Pi x_t + o_1 \begin{pmatrix} 1 \\ \overline{1} \end{pmatrix} \approx N(\theta, \Sigma), \qquad \text{---------------} \ 1$$

Where Xt = (St Ft)' is the vector of spot and futures prices, each being I (1) such that the first differenced series are I (0); Δ denotes the first difference operator; *Γ*i and Π are 1×1 coefficient matrices measuring the short-and long-run adjustment of the system to change in Xti and t ε_t is 1×0 vector of white noise error terms. The test results are relatively sensitive to the lag length. The lag length **P** is selected on the basis of multivariate generalizations of Akaike's information criteria (AIC) and Schwarz's criteria (SC). The two chance ratio test is employed to identify the co-integration between the two series. First statistic λtrace tests whether the number of co integrating vectors is zero or one and Second other λmax tests whether single co-integrating equation is sufficient or two are compulsory. In general r co-integrated vector is corrected. The following the test statistics can be constructed formula as:

$$\lambda Trace(\mathrm{r}) = -\mathrm{T}\sum_{i=r+1}^{n} 1n(1-\lambda_t)..\qquad \text{--------------------}\quad 2$$

$$\lambda \max(\mathrm{r},\mathrm{r}+1) = -T1n(1-\lambda, \mathrm{r}=1)..\qquad \text{--------------------}\quad 3$$

Where, **n** is the number of separate series to be examined, **T** is the number of usable observations and (λi) are the estimated Eigen values (also called characteristic roots)obtained from the (i+1) × (i+1) 'cointegrating matrix.' The first test statistic (λtrace) tests whether the number of distinct co-integrating vectors is less than or equal to r. The second test statistic (λmax) tests the null that the number of co-integrating vectors is r against an r +1.

Johansen and Jueselins (1990) provide the critical values of these statistics. The rank of Π may be tested using the λmax and λtrace. If rank(Π) =1, then there is single co-integrating vector and Π can be factored as Π =αβ′, where α and β′ are 2×1 vectors. Using this factorisation β′ represents the vector of co-integrating parameters and α is the vector of error correction coefficients measuring the speed of convergence to the long-run steady state.

Johansen suggests two different likelihood ratio tests, the trace and maximum eigen value tests, to determine the rank of Π and the number of co-integrating vectors. The trace statistic tests the null hypothesis of r co-integrating vectors against the alternative hypothesis of n co-integrating vectors. The maximum eigen value test, on the other hand, tests the null hypothesis of r co-integrating vectors against the alternative hypothesis of r+1 co-integrating vectors.

In some cases Trace and Maximum Eigen value statistics may yield different results and indicates that in this case the results of trace test should be preferred. If spot and futures prices are co-integrated then causality must exist in at least one direction (Granger, 1988). Granger causality can identify whether two variables move one after the other or contemporaneously. When they move contemporaneously, one provides no information for characterising the other. If 'X causes Y', then changes in X should precede changes in Y.

6. EMPIRICAL ANALYSIS & RESULTS

Table 1: Descriptive Statistics for Pepper Price

Particulars	**Pepper**	
	Futures Price	Spot Price
Mean	16971.18	16586.18
Median	14300.00	13900.00
Maximum	115305.0	42400.00
Minimum	6454.000	1390.000
Std.Dev.	8169.142	7790.325
Skewness	1.985155	1.262108
Kurtosis	14.52026	3.790786
Jarque-Bera	11309.21	532.9387
Probability	0.000000	0.000000

Source: Computed Secondary Data

The table1 presents summary statistics of futures and spot prices of pepper. Skewness and Kurtosis are the estimated centralized third and fourth moments of the data. The skewness of a symmetric distribution should be 0 and the kurtosis should be around 3. Jarque-Bera reports that the null hypothesis is that the series follow a normal distribution. As a rule of thumb the 5% critical value is around 6. For values greater than 6 H0 can be rejected. It also confirms this finding, rejecting the null hypothesis of normality at 1% level.

Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests have been used to test the stationary of the data series. The ADF test uses the existence of a unit root. The distribution theory supporting the ADF assumes that the errors are statistically independent and have a constant variance. PP test allows the disturbances to be weekly dependent and heterogeneously distributed.

Table 2: Test of Stationarity of Time Series Variables

Variable	**ADF Test**		**PP Test**	
	At Levels	**1st Difference**	**At Levels**	**1st Difference**
Futures Pepper	-0.098054	-22.80707*	-8.500139	-311.7967*
(p value)	0.9478	0.0000*	0.0000	0.0001*
Spot Pepper	1.303959	-39.66717*	1.010394	-63.28623*
(p value)	0.9987	0.0000*	0.9968	0.0001*

Source: Computed Secondary Data *- denotes the significance at 1% level.

The table2 gives the estimates of the ADF & to double check the robustness of the results, PP test has also been applied for the prices at the levels and difference of the series. The ADF Statistics at level for Pepper (-0.098054), spot(1.303959) and the PP Statistics for futures (-8.500139), spot(1.010394) indicates that the computed value of statistics are all insignificant at the 5% significance level for both ADF and PP tests. The results fail to reject the null hypothesis of unit roots in their level form. Thus, implying that there is no possibility of the series to be stationary around a constant mean or around deterministic linear trend. Therefore the first difference of all series is tested for stationary of the series. The results revealed that the value of statistics for pepper is significant at the 1% level indicating the rejection of null hypothesis of the existence of a unit root for each of the price series in their first difference. Thus all the prices series need to be differenced once in order to achieve stationarity and they are confirmed to be integrated of order one.

All the results of the Dickey & Fuller and Phillips Perron unit root tests of the price series for pepper showed that both the spot and futures price series are not stationary at their initial levels but became stationary at the first difference. Once the series are integrated in an identical order, co-integration test should be employed to investigate the long-run relationship between spot and futures prices.

Table 3: Long Term Relationship between Futures and Spot Price of Pepper

Commodity	**Hypothesis**	**Trace Statistics**		**Max-Eigen Statistics**		**Cointegration/Non-Cointegration**
		ʌTrace	**p-value**	**λmax**	**p-value**	
IPSTA-Pepper	H_0:r = 0	432.2340*	0.0001*	225.8686*	0.0001*	Co-integrated
	H_0:r ≤ 0	206.3654*	0.0001*	204.4087*	0.0001*	

Source: Computed Secondary Data *- denotes significance level at 1%

The table 3 gives the results of co-integration tests. The results of the Johansen trace and max indicate that the null hypothesis of non-co-integration(r=0) is rejected at the one percent significant level for pepper stating that there are co-integrations between the spot and futures prices in case of pepper with the existence of long-term market efficiency and indicates that the futures prices efficiently predict subsequent spot prices or the futures prices provide enough information about the movement of the spot prices. Although co-integration method helps to illustrate the relationship between the futures and spot prices of pepper, they do not imply causation. Granger Causality is used to provide information about causal relations, (i.e.) whether spot influences futures of vice-versa.

Table 4: Lead-Lag Relationship between Futures and Spot Price of Pepper

Commodity	Null Hypothesis	F-statistic	Probability	Direction
IPSTA-Pepper	F→ S	5.845978*	0.0538*	Bi-directional
	S → F	636.3930*	0.0000*	

Source: Computed Secondary Data

The table 4 shows the results of Granger causality test for spot and futures prices of pepper. The upper row of the f-statistic column for each commodity states the null hypothesis that futures price does not Granger-cause spot price, the lower row reports the f-statistic for the null hypothesis that spot price does not Granger-cause futures price. The Granger causality test results show bi-directional flow of information in case of pepper. It implies that future prices Granger cause spot prices. This shows both the spot and futures markets are equally responsible for the price discovery process implying that the futures markets help discover prices in the spot markets and that the markets are efficient. The causality results also suggest that information flow from futures market to spot markets appears to have increased over the years. This apparent increase in information flows could be attributed to the increase in the relative importance of electronic trading of futures contracts in recent years, which results in more transparent and widely accessible prices.

7. CONCLUSION

Commodity derivative markets in India, although really old in origin went through various bans, suspensions and regulations. New procedures and legal changes are continuing to happen charting the possible future developments in these markets. Commodity futures and derivatives have a crucial role to play in the price risk management process, especially in agriculture. Commodity derivatives and futures serve as instruments to achieve price discovery and price risk management. Hence it is felt imperative to study the working of futures markets in agro-commodities particularly in pepper with the specific objectives of knowing the lead-lag and long-run relationship between the spot and futures prices. Moreover futures prices could be predicted effectively because of bi-directional relation between spot and futures price and price volatility is relatively less. Hence, farmers and traders of pepper prefer futures trading.

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