Factors Influencing Commodity Futures Prices in India: A Polynomial Distributed Lag Model

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ABSTRACT

The objective of this paper is to study the factors influencing commodity futures prices of the Indian commodity market. Five factors have been considered in this study, namely: spot price, the U.S. dollar exchange rate against rupees, market wide information, risk free rate of interest, and financial speculation. To test the long-run equilibrium relationships between commodity futures prices and the factors, Johansen's Cointegration test has been used. The short-run relationships have been verified by Vector Error Correction Model. Finally, the lag relationships of these factors with the commodity futures price, is modelled by Almon Polynomial Distributed Lag model. The study shows that spot price, market wide information, financial speculation and exchange rate of the US dollar influence the futures price. However, the degree of impact depends on the commodity and on the period of analysis. Additionally, risk free rate of interest does not show influence on the futures prices.

Introduction

High and volatile futures prices of agricultural commodities have been a common question among researchers and stakeholders involved in the futures markets in recent days. For the investors utilizing futures market in their business operations, the futures price movements in agricultural markets play an important role. Yang et al. (2001) asserted that futures prices are unbiased predictors of spot prices as the storability component does not affect the integration between spot and futures prices. Thus, it plays a significant role in price discovery. Price discovery and hedging efficiency are the primary purposes behind establishing the futures market. So, understanding future price movements is crucial to stakeholders. The excessive variability in futures and spot prices has caused problems for futures market participants and the consumers. Increasing risk has led to inefficient resource allocation for producers, merchandisers, and speculators. It limits the access to food in the developing countries that depend on imports and have lower incomes.

Masters and White (2008) suggested that the integration of energy and agricultural markets, macroeconomic conditions, and financial speculation are key drivers of commodity futures price volatility. Karali and Power (2009) conclude that Macroeconomic conditions are also drivers

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of high commodity futures prices. Tangermann (2011) added that rapid economic growth creates additional demand for commodities. As a result, stocks to use ratios decreases and prices of agricultural commodities increases. Besides, due to export of commodities, the stocks to use ratio decreases significantly. Helbling et al. (2008) finds that the strength or weakness of the U.S. dollar affects commodity prices. A weak U.S. dollar influences commodity prices because they are typically priced in the U.S. dollar. It increases interest in futures contracts as instruments of protection against inflation. Masters and White (2008) have shown that financial speculation also influences commodity futures price. Abhyankar (1995) revealed that the market wide information is another factor influencing futures price. Futures prices depend on the price expectations of the firms for a particular commodity. It is an average of traders' expectation of the spot price that will prevail at the futures contract's maturity. Futures trading can affect a state change in price expectations by altering the quantity of traders' information. Expected price depends on available information on future supply and demand. More informed traders can predict more accurate expected price than less informed traders. Information is dispersed among the traders because; it is costly and changes frequently. Information consists of a knowledge of the random shocks that affects demand. The dispersed information about supply and demand is concentrated in one place and reflected in the futures price. All futures traders receive this information and the information incorporated in futures price can be gained by the traders.

The present study examines the influence of different relevant factors on daily futures prices of four agricultural commodities Barley, Maize, Mustard Seed and Pepper traded in Indian commodity exchange NCDEX. To accomplish this objective, the study analyses if the daily futures price is influenced by the spot price of that commodity, the U.S. dollar exchange rate against rupees, market wide information, risk free rate of interest, and financial speculations. To check whether there is the long-run equilibrium relationship between commodity futures prices and the factors under consideration, the Johansen's Cointegration Test has been used. The short-run relationship or return spillover has been tested by the Vector Error Correction Model (VECM). Moreover, following Siddiqui (2009), to examine the lag relationship, a dynamic methodology of Almon Polynomial Distributed Lag model is used. Since, a regressand may respond to regressors with a certain degree of time lag. In the time-series data, Distributed Lag and autoregressive models pose the issues of serious multicollinearity, inconsistency and simultaneity when estimated by OLS. To tackle these issues, Almon's model is a better substitute for the Koyck and autoregressive models. Polynomial Distributed Lag model make the static economic theory a dynamic one by considering explicitly the role of time. It also helps us to distinguish between short-run and long-run response of the dependent variable to a unit change in the value of the explanatory variables. Also, these models address the topic of causality in economic variables. Though the Granger causality modelling has received noticeable attention in the empirical literature, but it has to be used with great caution because it is very sensitive to the lag length used in the model.

Selection of factors influencing futures prices

Spot and futures prices are expected to be associated in stock or commodity market. Several studies in different markets in the world

have shown that futures prices dominate the spot prices (Asche and Guttormsen, 2002; Zapata et al., 2005). In the Indian market , Iyer and Mehta (2007) have found that for Chana and copper future market dominates the spot market in the pre expiration week. For the commodities chana, gold, copper and rubber the same case happens in the expiration weeks. Spot prices also dominate the futures prices. In the Indian commodity market, during the pre expiration and expiration week the spot market for Nickel dominates the futures market (Iyer and Mehta, 2007). The spot market for the commodities Cotton, Potato and Chana lead the futures market (Author, 2010). Again, for the commodities Mustard Seed and Pepper spot price volatility has weak causal feedback on futures prices for Mustard Seed and Pepper (Author, 2013). So, a lead-lag relationship may exist between spot and futures. This lead-lag relation occurs due to the difference in speed of information in the two markets. In some commodity markets, futures market disseminates information faster than the spot market. In that case futures market influences the spot market. Again, if the spot market disseminates information faster than futures market, then the spot market influences the futures market. Also, there exists a bidirectional information flow between two markets. Therefore, to judge the influence of the spot prices on futures prices, spot prices have been considered as a factor in this study.

The demand and supply of a commodity may depend on the amount of export of the commodity. A significant amount of export may cause a shortage of supply of the commodity in the market. This may affect the futures prices of a commodity. Again, the amount of export of a commodity may depend on the dollar exchange rate. The econometric analysis by Joshi and Little (1994) and Srinivasan and Wallack (2003), show that real exchange rate appreciation negatively affects India's aggregate merchandise exports. Veeramani (2008) have found that the appreciation of the REER (Real Effective Exchange Rate) leads to a fall in the dollar value of India's merchandise exports. He does not find a significant negative effect of real exchange rate appreciation on exports. India's total commodity exports have shown a high growth of about 21.3 percent (in US dollars) during 2011-12. During the financial year 2010-2011 the growth percentage was 40.5. Especially, for cereals, spices and nuts and seeds the growth rate was 98.1, 58.6 and 70 respectively. In the period 2010 to 2012 the US dollar exchange rate has been increased from Rs.45 to Rs.55. So, it will be interesting to check whether the exchange rate contains information about the future movements in the commodity futures market.

Market wide information is another factor which can influence commodity futures prices. Markets assimilate random information from economic agents and incorporate it into the prices. The sources of information are official statistics, commodity reports and knowledge of the private investors. Market wide information can provide the future direction of commodity futures prices, which fluctuate with demand and supply of the commodity and other economic factors. Good market wide information specific to a commodity encourages investors to buy a commodity while bad information motivates them to sell the commodity. Again, good information about overall market motivates the investors to buy all commodities to some extent. Good market wide information on the overall market may have three possible outcomes. If there is no commodity specific information about a particular commodity, overall news on the commodity will be good. If

there is good commodity specific information, then the two information will reinforce the good news. Again, if there is bad commodity specific information, then two contradictory information will make the overall news bad.

Interest rate represents the opportunity cost of holding inventory between the current period and the period of maturity of the future contract. Chang and Fang (1990) have shown that in measuring intertemporal hedging effectiveness, correlation between the changes in interest rate and the changes in cash and futures prices is an essential component. It is also important for describing the relative effectiveness of spot and futures market (Baillie and Myers, 1991). Non stationary interest rate implies non stationarity in carrying charges. So, risk free rate of interest is important for describing dynamic relationship between spot and futures prices.

Another factor influencing commodity futures prices is speculation in the commodity market. Speculation was started in the commodity market to enable the investors to protect them against short-term price volatility. The buyer can insure them against sudden price increases and sellers against sudden price falls. But now a day, speculation is largely dependent on demand and supply and the fundamentals of the respective commodity. When the supply of a commodity is insufficient then the prices may be moved to a high value by big speculation. Speculation contributes extreme volatility in the spot and futures prices. Choudhury (2011) concluded that there exists mixed evidence for the fact that index fund trading has influence over commodity price hike. Though rice and palm oil are not included in the major commodity indices, but price volatility also increased for these commodities. Also, several other studies indicated that the new group of index traders has made the futures market more volatile, and difficult to predict. So the effect of speculative activities by the traders is needed to be checked.

Literature Review

Several studies have investigated the dynamic relationship between commodity futures trading and spot market returns. However, in Indian commodity markets we find only a few references. Asche and Guttormsen (2002) observed that for the International Petroleum Exchange (IPE) in the gas oil contract, future price leads spot price. Giot (2003) used the skewed student GARCH model to compare the incremental information content in the collection of agricultural commodities (cocoa, coffee, and sugar future contract) for lagged implied volatility. They observed that for options on futures contract the conditional variance and VaR forecast of the underlying future forecast has high information content for the implied volatility. Zapata et al. (2005), using Granger causality test, found that information flow is directed from futures prices to cash prices for world sugar on the New York Exchange. Yang et al. (2005), observed that for most commodities, unexpected positive changes in trading volume increase spot price volatility. For unexpected open interest there exists a very weak effect on spot price volatility. Karande (2006) chosen two different markets of the castor seed: export-oriented and production-oriented, and studied dissemination of information between spot and futures markets. The study concluded that futures dominate the spot price. Export-oriented market dominates the production-oriented market, except in the harvest season. Praveen and Sudhakar (2006) compared the price discovery process of the Indian commodity market with the developed commodity markets. Their study highlighted that futures market influenced the spot market and facilitated better price discovery in the spot market. Gupta and Singh (2006) used price discovery as the main characteristic for judging efficiency of the Indian equity futures market. They concluded that

futures market leads the spot market in respect of information flow during the period of high fluctuation. In Indian the commodity market, Iyer and Mehta (2007) have found that for Chana and copper, future market dominates the spot market in the pre-expiration week. For the commodities Chana, gold, copper and rubber, the same case happens in the expiration weeks. Nickel was the only commodity where the spot market plays a dominant role. Pati and Reddy and Sebastin (2008) examined the dynamic relationship between derivatives market and the underlying spot market. The study observed that price innovations appeared first in the derivatives market and were subsequently transmitted to the equity market. Choudhary and Bajaj (2012) tested the price discovery in the Indian stock market. They have evidenced that the futures market is leading the spot market in case of 12 securities and spot market leads for 19 securities. Author (2013) using four agricultural commodities Barley, Maize, Pepper and Mustard Seed from the Indian commodity market examined the relation between commodity futures trading activity and spot price volatility. The study finds that unexpected trading volume causes spot price volatility for most of the commodities. Also a weak causal feedback from spot price volatility to unexpected trading volume and in the direction of spot price volatility to unexpected open interest is observed.

Veeramani (2008) have found that the growth of the REER (Real Effective Exchange Rate) leads to a fall in the amount merchandise exports. He finds that there is little gain in keeping the REER constant. He also concluded that any slowdown in India's GDP growth would also lead to a fall in the growth rate of exports. Helbling et al. (2008) examine the relations of macroeconomic factors, such as the U.S. dollar/Euro exchange rate to the commodity price. They conclude that because most commodities are priced in U.S dollars, and the exchange rate has continuously declined since 2002, the demand for agricultural futures contracts have increased, as instruments of protection, relative to stocks, bonds, or currencies. Charlebois and Hamann (2010) investigated that prices of commodities, including soybeans, could grow by 14 percent, on average, between 2008 and 2011 because of a weak U.S dollar.

Market wide information is another factor which can influence commodity futures prices. Markets assimilate random information from economic agents and incorporate it into the prices. The sources of information are official statistics, commodity reports and knowledge of the private investors. Market wide information can provide the future direction of commodity futures prices, which fluctuate with demand and supply of the commodity and other economic factors. Good market wide information specific to a commodity encourages investors to buy a commodity while bad information motivates them to sell the commodity. Again, good information about overall market motivates the investors to buy all commodities to some extent. Good market wide information on the overall market may have three possible outcomes. If there is no commodity specific information about a particular commodity, overall news on the commodity will be good. If there is good commodity specific information, then the two information will reinforce the good news. Again, if there is bad commodity specific information, then two contradictory information will make the overall news bad.

Zapata and Fortenbery (1995) tested thetemporal relationship between Chicago corn and soybean cash pries, nearby future prices and interest rate. They observed that the three series move together.

Chang and Fang (1990) observed the correlation between the changes of cash and futures prices with the interest rate. They have concluded that interest rate is a necessary component in measuring intertemporal hedging effectiveness. Baillie and Myers (1991) observed the importance of interest in describing the relative effectiveness of spot and futures market.

Studies by Masters and White (2008) examine the open interest composition. They note that the unleveraged futures position index funds (long only) have created an artificial demand for commodities. Their findings emphasize that the net flows invested for several firms, such as the Dow Jones AIG Commodity Index (DJ-USB), the Standard & Poor's Goldman Sachs Commodity Index (S&P-GSCI), and the Power-Shares Dutch Bank Agricultural Index (DB-AGI) have increased considerably. Brooks and Chance (2010) noted that open interest is compounded by hedgers and speculators in general, but each group has a different purpose. Traditional speculators take long and short positions, while non-traditional speculators only hold long positions. The speculators received special attention in recent years due to their increasing participation in futures markets. Irwin et al. (2009) also analysed the volume of speculation in the open interest composition. The findings assert that there is insufficient evidence to conclude a linkage between excessive financial speculation and price volatility in commodity markets. Choudhury (2011) examined the contribution of speculation behind the price hikes of agricultural commodities. He finds evidences both in support of the fact and against the fact. He also added that it is difficult to isolate the effect of index fund from the effect of rising demand from emerging markets and supply shortfalls due to natural disasters in major food producing countries.

After an extensive review of previous literatures, we find that no existing study examined the effect of five factors on the futures returns. The factors considered in this study are movements of spot prices, the U.S dollar exchange rate against rupees, market wide information, risk free rate of interest and financial speculations. Different studies around the world examine the effect of one or two factors. However, none of them have used all the factors together. Especially, in the Indian commodity market, there is no previous work similar to this topic.

Data

Four commodities traded in the Indian market; Barley, Maize, Mustard Seed and Pepper, have been chosen for this study. The commodities have been selected according to the availability of data, frequency of trading and volume of trading. Though these are not among the most important commodities for the Indian market, but these are important for Indian as well as international market. All of these commodities have been regularly traded in the market. Mustard Seed is the second largest oil producing seed in the world and as a source of edible oil its rank is third after palm and soya oil. India has 11% share in the world's production of Mustard Seed. In India, it is the second important edible oil after groundnut. In the Eastern, Northern and Central part of thiss country Mustard oil is the primary edible oil. During 2011-2012, the production figure was 5.880 million tonnes. By the next year, it has been increased to 7.112 million tonnes. The same trend has been observed in the amount of export. The export of the Mustard Seed and its products have earned Rs. 7209.422 million during 2011-2012 and the amount increased to Rs. 10171.524 million in the next year. Again, Barley is a key ingredient for brewing beer. According to the production of Barley India secure 14th position

in the world. It has shown a production of 1.620 million tonnes in the period 2011-2012. The amount of export was 0.04510127 million tonnes in the same year and the amount has been substantially increased to 266.867 thousand tonnes during 2012-2013. Fulfilling the domestic demand of 1.525 million tonnes, India has earned Rs. 4369.626 million in this period. Maize is the third most important crop in India. The estimated Maize production in 2012-13 was 20 million tonnes, which was slightly lesser than the previous year's production 21.570 million tonnes. The volume of export of Maize in 2011-2012 was 4.470 million tonnes and the estimated value for the same during 2012-2013 was 4.760 million tonnes. Being the 5th largest exporter of maize, during 2012-2013 India has exported maize of Rs.70963.414 million, which is greater than the amount Rs.51575.149 million in the previous year. Pepper is another prominent source of earning foreign currencies for India. Being the second largest producer of pepper, India accounted for 18.7% of the world production. In 2011-2012 India has produced 0.052 million tonnes of Pepper, which is 10% of the total production of spices in this country. A major production of it is exported to USA, UK and Canada. During 2010-2011 and 2011-2012 India has exported 18850 tonnes and 26700 tonnes of Pepper and earned respectively 3830 million and 8780 million rupees. In 2010 India was the 4th largest exporter pepper the world and exported 7% of the global export. So, keeping in mind the economic importance of the selected commodities, they have been selected as representatives of the Indian commodity market.

Data for this study has been taken from the website of National Commodity Exchange (NCDEX) in India. The sample period of the data set is from 1st January 2004 to 31st December 2012. The data consists of daily cash closing prices, daily futures settlement prices, total futures open interest for the agricultural commodities Barley, Maize, Mustard Seed, Pepper, Jeera and Chana traded in NCDEX. The risk free rate of interests and exchange rates of the US dollar against Indian rupee are collected from the website of Reserve Bank of India.

Methodology

Constant maturity futures prices of Barley, Maize, Mustard Seed and Pepper are considered in the model. The futures prices have been selected from the month prior to expiration of a contarct.To explain the movements of futures prices of Barley, Maize, Mustard Seed and Pepper, daily spot prices of these commodities consider as a factor in this study. Furthermore, market-wide information may have an influence on the futures returns. In NCDEX there is an index Dhaanya which represents the scenario of the Indian commodity market. But, unfortunately it cannot be used as a control variable to capture market wide factor since some of the commodities under study are used to construct the index Dhaanya. Jeera is one of the important spices regularly traded in the Indian commodity market. So, the prices of Jeera have been used as a control variable to capture market wide factor. However, Jeera may not be able to fully capture the market wide information. So, another commodity Chana has been selected to supplement the results. The spot prices of Chana have been used as another proxy for market wide factor. Jeera has been used in the model as the first representative for market wide factor (MWF_1) and Chana as the second representative (MWF_2). Again, the U.S. dollar exchange rate has an influence on the commodity prices. To check this factor, the exchange rate of the US dollar against Indian rupee is considered in this study. Risk free rate of interest represents the opportunity cost

associated with holding inventory till the maturity of the future contract. To represent this factor, interest rate of 90 days Indian government treasury bill is used. Masters and White (2008) noted that there is sufficient evidence to conclude a linkage between futures open interest and financial speculation. In this study, open interest is used as the representative variable for financial speculation in the agricultural commodity markets.

Measure of Association

To check the association between the futures prices and the factors under consideration, correlations have been measured. Karl Pearson's measure of correlation coefficient has been used for this purpose.

Bai and Perron Procedure for Structural Break

During the period of this study, the global market has gone through a long recession. There was a marked global economic decline. It has begun in December 2007 and took a particularly sharp downward turn in September 2008. The active phase of the crisis can be dated from August 7, 2007 when BNP Paribas terminated withdrawals from three hedge funds citing liquidity evaporation. It in turn manifested as a liquidity crisis. The global recession affected the entire world economy, economy including India. According to the U.S. National Bureau of Economic Research the recession began in December 2007 and ended in June 2009. During this period, the Indian market also underwent a drastic change. The period of change of behaviour can be identified using a structural break in economic series. To identify the structural breaks Bai and Perron (2003) procedure is used. A given number of breakpoints and a minimum distance between the break points have to be specified for this procedure. The procedure investigates all possible models under these assumptions. The optimal model is chosen according to the minimum sum of squared residuals and according to information criteria. Hence the analysis is done separately for two periods. 4th April 2004 to 3rd October 2008 is the first period of analysis, which is the period before the recession. Between 4th October 2008 and 18th May 2009, the market has gone through several changes due to global meltdown. The 2nd period of analysis considered in this study is during 19th May 2009 to 31st December 2012, which is the post recession period.

Johansen's Test for Long-run Cointegration

Engle and Granger (1987) suggested in their cointegration theory that two non-stationary series having a same stochastic trend, tend to move together over the long-run. In the short-run, deviation from long-run equilibrium may occur. To explore the relationship between commodity futures prices with different factors, cointegration between futures prices and the factors is tested. The Johansen's full information multivariate cointegrating procedure is used to perform the cointegration analysis. The Johansen's Cointegration test is conducted through the k^{th} order vector error correction model (VECM) represented by the equation

$$\Delta X_t = \prod X_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-1} + \gamma + \varepsilon_t \qquad (1)$$

Where, X_t is $(n \times 1)$ vector to be tested for cointegration, $\Delta X_t = X_t - X_{t-1}$, γ, is the vector of deterministic term, Π and Γ are coefficient matrix. The rank of the coefficient matrix Π indicates the existence of cointegration between endogenous variable. If the rank of the matrix Π

is zero, no cointegration exists between the variables. If Π is a full rank matrix, then varied in vector X_t are stationary. If the rank lies between zero and *n*, cointegration exists between the variables under study. The lag length k is selected for a minimum value of Akaike Information Criterion (AIC). To test the long-run relationship likelihood ratio test has been used. The trace statistics test the null hypothesis of at most r cointegrating vectors against a general alternative hypothesis of more than r cointegrating vectors. Trace statistics is given by

$$(\lambda - trace) = -T\sum_{i=r+1}^{n} \ln(1-\tilde{\lambda})_i \quad (2)$$

Where T is the number of observations and λ is the eigenvalues. In this study, to test the cointegration between futures prices and each factor the value of n is 2. The null hypothesis would be rank = 0 and rank = 1. If rank = 0 is rejected and *r* = 1 is not rejected, the conclusion will be that the two series are cointegrated.

Vector Error Correction Model (VECM) for Short-run Cointegration

The short-run integration or return spillover between commodity futures prices and the factors influencing it is investigated through VECM model. Vector error correction model specifications provide a long-run equilibrium error correction in prices in the conditional mean equations. This approach is used to model the short run relationship of cointegrated variables. The VECM specification for commodity futures prices and the factors is represented as

$$\Delta P_{Future,t} = C_{Future} + \alpha_{Future}P_{Future,t-1} + \alpha_{Factor}P_{Factor,t-1} + \sum_{i=2}^{k}\beta_{Future,i}\Delta P_{Future,t-i} + \sum_{j=2}^{k}\beta_{Factor,j}\Delta P_{Factor,t-j} + \epsilon_{Future,t} \quad (3)$$

Where $P_{Future,t}$ is the log of futures price of the Indian commodity market and $P_{Factor,t}$ is the log of factor's value. The error correction term is given by the expression.

$$\alpha_{Future}P_{Future,t-1} + \alpha_{Factor}P_{Factor,t-1}$$

The short-run parameter estimates, $\beta_{Future,i}$ and $\beta_{Factor,j}$ measure the short-run integration or return spillover.

Augmented Dickey-Fuller Test for Stationarity

The returns of every data series have been calculated using the following formula

$$r_t = (\ln S_t - \ln S_{t-1})*100 \quad (4)$$

Where, S_t is the value at time t. To check the stationarity of all data series, we use Augmented Dickey-Fuller (ADF) test. The equation of ADF test is given below

$$\Delta X_t = \mu + bt + \beta X_{t-1} + \epsilon_t \quad (5)$$

Here ϵ_t is a white noise residual. If $\beta = 0$ then there is a unit root. The hypothesis under consideration is

$$H_0: b = \beta = 0. \quad (6)$$

Polynomial Distributed Lag Model for Lag Dependence

The finite distributed lag model can be presented as follows

$$Y_t = \alpha + \beta_0 X_t + \beta_1 X_{t-1} + \beta_2 X_{t-2} + \beta_3 X_{t-3} + \cdots + \beta_k X_{t-k} + u_t \quad (7)$$

This can be rewritten more precisely as follows.

$$Y_t = \alpha + \sum_{i=0}^{k}\beta_i X_{t-i} + u_t \quad (8)$$

Here β_i is approximated by the length of the lag. So, β_i is the polynomial function of lag length i. Also the degree of polynomial is less than the length of the lag k.

$$\beta_i = a_0 + a_1 i + a_2 i^2 + a_3 i^3 + a_4 i^4 + \cdots + a_p i^p \quad (9)$$

Substituting of value of the above expression

$$Y_t = \alpha + \sum_{i=0}^{k}(a_0 + a_1 i + a_2 i^2 + a_3 i^3 + a_4 i^4 + \cdots + a_p i^p)X_{t-i} + u_t \quad (10)$$

The equation can further be reduced to the estimable form as follows.

$$Y_t = \alpha + \sum_{i=0}^{k} a_i Z_{it} + u_t \quad (11)$$

Since in the Almon procedure Y is regressed on the constructed variables Z, not the original X variables, thus OLS assumption is valid. The estimated parameters have all the desirable statistical properties. Assuming the second degree polynomial, values of β_i 's can be obtained from the estimated values of the parameters of the equation (8) as follows:

$$\overline{\beta_0} = \overline{a_0}$$

$$\overline{\beta_1} = \overline{a_0} + \overline{a_1} + \overline{a_2}$$

$$\overline{\beta_2} = \overline{a_0} + 2\overline{a_1} + 4\,\overline{a_2}$$

$$\overline{\beta_1} = \overline{a_0} + 3\overline{a_1} + 9\overline{a_2}$$

.....

$$\overline{\beta_1} = \overline{a_0} + k\,\overline{a_1} + k^2\,\overline{a_2} \quad (12)$$

Maximum length of the lag k should be determined in advance. Following Davidson and MacKinnon the question of lag length has been settled by starting with a very large value of the lag length and then seeing whether the fit of the model deteriorates significantly when it is reduced without imposing any restrictions on the shape of the distributed lag. Additionally, Akaike information criteria have been used in order to choose the appropriate lag length and degree of polynomial. The degree of polynomial p should be at least one more than the number of turning points in the curve relating to i.

End point restrictions can be imposed on if the value of independent variable, with a certain degree of lag, affects the dependent variable. The model involving end point restrictions on the values of becomes Restricted-Least Squares Model. A near end constraint restricts the one period lead effect of the independent variable on the dependent variable to be zero. While, far end constraint restricts the effect of the independent variable on the dependent variable to die off beyond the specified lags. The number of parameters estimated will be reduced by the number of restrictions involved.

Analysis

Five factors are considered in this study to analyse their effect of the futures prices. Firstly, the association between the factors and the futures prices has been investigated by Karl Pearson's measure of correlation coefficient. Significant correlation indicated the relevance of the factors in this study. Using Bai and Perron procedure the structural breaks in the period of analysis has been identified. By the helpof this procedure the period of this study has been divided in two sub periods and analysis has been carried out in each period. Johansen's Test for Long-run Cointegration is applied to check the long-run co-movements of the factors and the futures price. For short-run cointegration, Vector Error Correction Model is used. After observing the extent of cointegration between the factors and the futures prices, the Polynomial Distributed Lag Model (PDL) is used to understand the lag dependence structure. For this model, the data series are required to be stationary. So, returns of all the series have been calculated and the resultant series have been checked by Augmented Dickey-Fuller Test. The stationary data series is used in the PDL model to analyse the impact of the factors over futures prices.

Measure of Association

Using Karl Pearson's measure of correlation coefficient, Table1 represents the association between the futures price and different factors. The results show that spot prices (SPOT) are strongly associated with futures prices of commodities in the Indian market. Also, there is association between the futures price and the factors US Dollar (USD), market wide factor

Table 1: Correlation between futures prices and different factors

	Factors	SPOT	USD	MWF_1	MWF_2	INT	SA
Correlation	**Barley**	0.85377	0.38087	0.46629	0.57123	0.67142	0.59048
	Maize	0.97051	0.60009	0.87898	0.69288	0.78403	0.66741
	Mustard Seed	0.99720	0.67413	0.64759	0.84078	0.77912	0.71294
	Pepper	0.99792	0.63443	0.76063	0.84913	0.74609	0.66382

(MWF_1 and MWF_2), interest rate (INT) and speculative activity (SA). For Barley, there is poor correlation between futures prices and the factors US Dollar exchange rate (USD), and market wide factor (MWF_1).

Bai and Perron Procedure for Structural Break

Structural break is identified by the procedure of Bai and Perron (2003). The data series of Jeera and Chana have separately been used to represent the Indian commodity market for the period 1st January 2004 to 31st December 2012. Two breakpoints are opted for the data range of about nine years. The minimum distance between two breakpoints is set equal to six months. The breakpoints identified are 3 October 08 and 18 May 09. So, 1st January 2004 to 3rd October 2008 is the first period of analysis and 19th May 2009 to 31st December 2012 is the 2nd period of analysis.

Johansen's Test for Long-run Cointegration

The existence of cointegration between futures prices and the factors influencing them, is tested by examining the rank of coefficient matrix Ï in equation 1. If the rank of the matrix Ï is one, cointegration exists between the variables under investigation. Table 2 represents the Johansen's Cointegration Rank Test results for Barley. In the 1st period of analysis spot prices (SPOT) and speculative activity (SA) is cointegrated with futures prices. In both the cases null hypothesis for the rank r = 0 is rejected at the 5% level and r =1 is accepted. Same result observed for the 2nd period of analysis. No cointegration is found for the other factors under study. Table 3, Table 4 and Table 5 represents respectively the rank test results for the commodities Maize, Mustard Seed and Pepper. The Results for Maize and Pepper are similar

Table 2: Johansen's Co-integration Rank Test results for Barley using Trace

Period	Name of the Factor	Lag	H_0: r = 0	H_0: r = 1
1st Period	SPOT	2	18.63088*	0.2672
	USD	2	9.6197	0.7339
	MWF_1	2	2.6999	0.2311
	MWF_2	2	5.8228	1.0616
	INT	2	9.6140	0.6710
	SA	2	16.6793*	1.7321
2nd Period	SPOT	2	16.0194*	2.9288
	USD	2	5.7073	0.1161
	MWF_1	2	6.6160	1.1205
	MWF_2	2	7.0621	1.4538
	INT	2	8.8871	1.9469
	SA	2	21.2572*	2.6925

Note: Significance codes: '*' indicates 5% level and '**'indicates 1% level.

Table 3: Johansen's Cointegration Rank Test results for Maize using Trace

Period	Name of the Factor	Lag	H_0: r = 0	H_0: r = 1
1st Period	SPOT	2	31.4980*	6.9175
	USD	2	6.0989	0.2820
	MWF_1	2	6.0184	0.3136
	MWF_2	2	7.4632	1.1316
	INT	2	10.1805	1.7176
	SA	2	57.2823*	0.8082
2nd Period	SPOT	2	49.5986*	1.7599
	USD	2	6.3411	2.3547
	MWF_1	2	8.9892	1.0520
	MWF_2	2	8.8458	1.0487
	INT	2	8.7056	0.1881
	SA	2	61.0822*	2.4576

Note: Significance codes: '*' indicates 5% level and '**'indicates 1% level.

Table 4 : Johansen's Cointegration Rank Test results for Mustard Seed using Trace

Period	Name of the Factor	Lag	H_0: r = 0	H_0: r = 1
1st Period	SPOT	2	19.8858*	3.0593
	USD	2	19.7316*	1.6570
	MWF_1	2	3.2094	0.3913
	MWF_2	2	3.8544	1.0829
	INT	2	9.4812	1.8922
	SA	2	33.8186*	1.8133
2nd Period	SPOT	2	58.9849*	0.7867
	USD	2	5.9043	2.5413
	MWF_1	2	4.5381	0.6903
	MWF_2	2	5.6759	0.7231
	INT	2	11.8829	0.1966
	SA	2	69.6366*	0.8394

Note: Significance codes: '*' indicates 5% level and '**'indicates 1% level.

Table 5: Johansen's Cointegration Rank Test results for Pepper using Trace

Period	Name of the Factor	Lag	H_0: r = 0	H_0: r = 1
1st Period	SPOT	2	97.8043*	0.1576
	USD	2	6.7724	0.6446
	MWF_1	2	4.4091	0.1139
	MWF_2	2	3.7033	0.1344
	INT	2	9.6109	0.4053
	SA	2	70.1954*	0.0434
2nd Period	SPOT	2	55.9737*	0.1990
	USD	2	11.1375	3.2620
	MWF_1	2	3.8528	.0018
	MWF_2		9.4767	0.5843
	INT	2	10.3946	0.0070
	SA	2	45.9093*	0.0100

Note: Significance codes: '*' indicates 5% level and '**'indicates 1% level.

to the results of Barley. For Mustard Seed, four factors Spot Prices (SPOT), exchange rate of the US dollar in rupees (USD), and speculative activities (SA) are cointegrated with futures prices in the 1st period. However, for the second period only spot prices (SPOT) and speculative activities (SA) are coinegrated with the futures prices. So, the long-run equilibrium relationship exists between futures prices and spot prices of all the commodities. Similar long-run co-movements are observed between futures prices and speculative activity.

Vector Error Correction Model (VECM) for Short-run Cointegration

To test the short-run co-movements, the Vector Error Correction Model (VECM) is used. Table 6 represents the results of VECM for the commodity Barley. The short-run coefficients $\hat{a}_{Factor,1}$, which measures the information spillover from different factors to futures prices, are significant for spot prices and speculative activity in the first period. But, in the second period, the short-run coefficients $\hat{a}_{Factor,1}$ are significant for all the factors except interest rate. Here, it is to be noted that MWF_1 and MWF_2 both the variables are

Table 6: Parameter estimation of VECM for different factors influencing the futures price of Barley

Period	Factors	C	α_{Future}	α_{Factor}	$\beta_{Future,1}$	$\beta_{Factor,1}$
1st Period	SPOT	0.04664**	-0.04204	0.03514	0.01929	0.32209**
	USD	0.08613	-0.00382	-0.01626	0.08626	-0.13344
	MWF_1	0.06955	-0.00717	-0.00222	0.18914*	-0.81351*
	MWF_2	8.53307	0.00062	-0.00427	0.10126*	-0.9524*
	INT	16.06111**	-0.02384	1.83722	0.08477*	-5.93449
	SA	0.05177	-0.00294	-0.00392	0.07962*	0.08773*
2nd Period	SPOT	-0.01525**	0.01840	-0.01629	0.11790**	0.22336**
	USD	0.07154	-0.00341	-0.01337	-0.36918**	0.15441
	MWF_1	-0.05296*	-0.00909	0.01227	0.16217*	0.12388*
	MWF_2	9.76181*	-0.01251	0.00169	0.06973	0.12262*
	INT	-15.85867*	-0.00674	2.94184	0.10465*	-7.04198
	SA	-0.00024	-0.00087	0.00070	0.06093*	0.07232*

Note: Significance codes: '*' indicates 5% level and '**'indicates 1% level.

Table 7: Parameter estimation of VECM for different factors influencing futures price of Maize

Period	Factors	C	α_{Future}	α_{Factor}	$\beta_{Future,1}$	$\beta_{Factor,1}$
1st Period	SPOT	0.02679**	-0.04491	0.04095	0.08096*	0.13695*
	USD	0.07261	-0.00360	-0.01323	0.08472*	-0.06609*
	MWF_1	0.00675*	-0.01537	0.01022	0.08860*	0.07754*
	MWF_2	-0.95825	-0.00156	0.00059	-0.40661**	0.08865*
	INT	-4.59761*	-0.01458	2.07607	-0.39766**	-0.39766
	SA	0.00476	0.00013	-0.00068	0.08689*	-0.16011*
2nd Period	SPOT	0.06059**	-0.07263	0.06407	0.01997	0.11477*
	USD	-0.00088	-0.00004	0.00014	0.02940	0.00570
	MWF_1	-0.07284*	-0.01364	0.01759	0.01946	0.15039*
	MWF_2	8.15115*	-0.01418	0.00237	-0.08627*	0.04265**
	INT	10.71048*	-0.01608	0.98850	-0.07683*	7.40824
	SA	0.01037	-0.00256	0.00076	0.00954	0.21146**

Note: Significance codes: '*' indicates 5% level and '**'indicates 1% level.

Table 8: Parameter estimation of VECM for different factors influencing futures price of Mustard Seed

Period	Factors	C	α_{Future}	α_{Factor}	$\beta_{Future,1}$	$\beta_{Factor,1}$
1st Period	SPOT	0.00228**	-0.05596	0.05564	-0.15823**	0.38280**
	USD	0.02271	-0.00129	-0.00416	-0.00822	0.04862
	MWF_1	0.00763	-0.00497	0.00238	-0.00993	0.02172*
	MWF_2	-0.50444	-0.00306	0.00064	-0.06964	0.01419*
	INT	-2.76059*	-0.00695	0.78102	-0.05823	-0.05823
	SA	-0.01139	0.00336	-0.00092	-0.00784	-0.08068*

2nd Period	SPOT	0.10043**	-0.80725	0.79463	0.03420*	-0.78308**
	USD	-0.10666	-0.00054	0.02785	-0.00172	-0.12393*
	MWF_1	-0.14322	-0.00198	0.01628	-0.00475	0.72575**
	MWF_2	-28.37072*	-0.00813	0.01421	-0.00853	0.04253*
	INT	-9.92043	-0.00409	2.12109	-0.00277	20.41179
	SA	-0.02718	-0.00003	0.00218	-0.00214	-0.20144*

Note: Significance codes: '*' indicates 5% level and '**'indicates 1% level.

Table 9: Parameter estimation of VECM for different factors influencing futures price of Pepper

Period	Factors	C	α_{Future}	α_{Factor}	$\beta_{Future,1}$	$\beta_{Factor,1}$
1st Period	SPOT	-0.05223**	-0.18892	0.19446	-0.49417**	0.98804**
	USD	0.20207*	-0.00426	-0.04350	- -0.03704	-0.58016*
	MWF_1	-0.03396*	-0.01178	0.01562	-0.06587	0.35862**
	MWF_2	-55.44310	-0.00222	0.03069	-0.03196	0.86205**
	INT	-26.86218	-0.00107	4.14721	-0.02341	-3.01593
	SA	-0.00172	0.00028	-0.00023	-0.02416	0.08013*
2nd Period	SPOT	-0.01702**	-0.16439	0.16621	-0.32357**	0.88881**
	USD	-0.08849**	-0.00201	0.02773	0.04409	-0.07827*
	MWF_1	-0.04692	-0.00118	0.00605	0.03319	0.21287**
	MWF_2	-163.348**	-0.01041	0.14304	0.04814	0.47511*
	INT	-23.17237	-0.00228	8.76501	0.05183	30.24073
	SA	0.00774	-0.00022	-0.00077	0.05000	0.00621*

Note: Significance codes: '*' indicates 5% level and '**'indicates 1% level.

significant in the 2nd period. Table 7, Table 8 and Table 9 respectively represent the results of VECM for the commodity Maize, Mustard Seed and Pepper.

In case of Maize, the $\hat{a}_{Factor,1}$ coefficients are significant for all the factors except interest rate (INT) in the first period of analysis. After the recession, the information spill over is observed for the factors spot price (SPOT), market wide information (MWF_1 and MWF_2) and speculative activities (SA). The factors spot prices (SPOT), market wide factor (MWF_1 and MWF_2) and speculative activities (SA) have a significant effect on futures prices of the Mustard Seed in the first period. In the second period, for Mustard Seed, the $\hat{a}_{Factor,1}$ coefficients are significant for all the factors except interest rate (INT). For Pepper, again, all the factors have a short-run effect on futures prices, except interest rate in the period before the recession. After recession, return spill over has been observed from all the factors to futures prices, except interest rate.

So, the results suggest that there is information spill over from spot to futures prices for all the commodities under study and it is present in both periods. Therefore, spot and futures prices are cointegrated in both long and short run. There is a spill over effect from US dollar

exchange value against rupees to futures price for the commodities Maize and Pepper in the pre recession period. In the post recession period, no such effect is found in case of Maize. But, for Mustard Seed and Pepper, the effect is present in post recession period. For the Barley no such evidence is found. Market wide factor is integrated with futures prices in the short-run for all the commodities except in the first period for Barley. In this case both the variables MWF_1 and MWF_2, representing market wide information, shows similar results. Similar to long-run cointegration results, short-run cointegration is observed between speculative activities and futures prices of all the commodities. Surprisingly, interest rate does not have any effect on the futures prices. The results of cointegration tests show the relevance of these factors in explaining futures prices. To confirm the results of cointegration and information spill over, Almon Polynomial Distributed Lag (PDL) model is used.

Augmented Dickey-Fuller Test for Stationarity

Before using PDL model the stationary of the data series are needed to be checked. Using equation 4 returns have been calculated for all the factors under study and futures prices. After this, for all the return series, stationarity is tested using Augmented Dickey-Fuller Test. For the two periods of analysis, the test results have been represented in Table 10 and Table 11. The test shows that all the series are stationary as the null hypothesis of the existence of unit root has been rejected. The p-values in all the cases are less than 0.01.

Table 10: ADF test results for different data series for two periods of analysis

Commodity	Data Series	1st Period		2nd Period	
		ADF Stat.	Lag Order	ADF Stat.	Lag Order
Barley	FR	-24.98**	12	-28.87**	12
	SPOT	-22.93**	12	-28.04**	12
	SA	-25.35**	12	-29.26**	12
	MWF_1	-23.68**	12	-23.68**	12
	MWF_2	-19.57**	12	-29.01**	12
	USD	-25.07**	12	-28.36**	12
	INT	-22.82**	12	-23.88**	12
Maize	FR	-23.37**	12	-29.14**	12
	SPOT	-21.38**	12	-24.96**	12
	SA	-23.86**	12	-28.66**	12
	MWF_1	-23.49**	12	-28.39**	12
	MWF_2	-23.13**	12	-29.22**	12
	USD	-24.37**	12	-28.85**	12
	INT	-27.06**	12	-27.06**	12

Note: Significance codes: '*' indicates 5% level and '**'indicates 1% level.

Table 11: ADF test results for different data series for two periods of analysis

Commodity	Data Series	1st Period		2nd Period	
		ADF Stat.	Lag Order	ADF Stat.	Lag Order
	FR	-25.77**	12	-27.69**	12
	SPOT	-24.14**	12	-25.57**	12

Mustard Seed	SA	-27.64**	12	-28.59**	12
	MWF_1	-23.50**	12	-28.50**	12
	MWF_2	-25.68**	12	-28.37**	12
	INT	-23.22**	12	-26.88**	12
	USD	-24.40**	12	-27.61**	12
	OIL	-26.39**	12	-27.90**	12
Pepper	FR	-24.29**	12	-28.87**	12
	SPOT	-23.03**	12	-24.96**	12
	SA	-25.09**	12	-29.08**	12
	MWF_1	-23.77**	12	-28.21**	12
	MWF_2	-26.05**	12	-28.71**	12
	INT	-23.72**	12	-27.56**	12
	USD	-24.80**	12	-28.40**	12
	OIL	-26.61**	12	-28.40**	12

Note: Significance codes: '**'indicates 1% level.

Polynomial Distributed Lag Model for Lag Dependence

The results of the Almon PDL model for the commodities Barley, Maize, Mustard Seed and Pepper respectively, are represented in Table 12 to Table 15. For a commodity, in each period, the PDL model has been fitted twice. The 1st model is estimated using Jeera as a representative of market wide factor (MWF_1) and the 2nd model is estimated considereing Chana as a proxy for market wide factor (MWF_2). From PDL model it has been found that for all the commodities, returns of spot prices have significant effect on futures prices but the lag dependence varies from lag 0 to lag 3 depending on the commodities as well as the periods. So, the spot prices have an impact on futures prices in all the cases. Similar results

Table 12: Results of Almon Polynomial Distributed Lag model for Barley

1st Period			2nd Period		
Variable	**Estimate**		**Variable**	**Estimate**	
	Using MWF_1	**Using MWF_2**		**Using MWF_1**	**Using MWF_2**
Intercept	0.1588	0.0688	**Intercept**	0.2546	0.4350
SPOT(0)	0.726193**	0.703313**	**SPOT(0)**	0.217301**	0.206787**
SPOT(1)	0.275344**	0.272808**	**SPOT(1)**	0.090191**	0.089745**
SPOT(2)	0.004029	0.012087	**SPOT(2)**	0.027383	0.031811*
SPOT(3)	-0.087753	-0.07885	**SPOT(3)**	0.005208	0.009668
USD(0)	0.012687	-0.00752	**USD(0)**	-0.181835	-0.115653
USD(1)	-0.03642	-0.04394	**USD(1)**	0.038652	0.048219
USD(2)	-0.054903	-0.05483	**USD(2)**	0.142453	0.122119
MWF(0)	0.16749*	0.162919*	**MWF(0)**	24.03511**	0.214127**
MWF (1)	0.059797	0.05929	**MWF (1)**	9.251903**	0.038618*
MWF (2)	0.108104*	-0.00241	**MWF (2)**	0.318319	-0.055572*
MWF (3)	0.088172*	-0.02217	**MWF(3)**	-2.765649	-0.068445**
INT(0)	0.005921	0.004075	**INT(0)**	-0.621738	0.491398
INT(1)	0.013108	0.013308	**INT(1)**	1.894009	2.363912
INT(2)	0.014517	0.015707	**INT(2)**	2.836214	2.906184
INT(3)	0.010147	0.011271	**INT(3)**	2.204878	2.118214
SA (0)	-0.11986300*	-0.1191960*	**SA (0)**	-0.271226*	-0.30697**
SA (1)	-0.00366200	-0.00302900	**SA (1)**	-0.016388	-0.011828
SA (2)	0.00004892	0.00056000	**SA (2)**	0.113763*	0.137714*
SA (3)	0.00127000	0.00157000	**SA (3)**	0.119225*	0.141657*
R^2	0.7961	0.7062	**R^2**	0.7144	0.7659

Note 1: SPOT = Spot Returns, USD = US dollar Returns, MWF_1 = 1st Market Wide Factor, MWF_2 = 2nd Market Wide Factor,WME=World Market Effect, SA=Speculative Activity, OIL = Diesel Price.

Note 2: Significance codes: '*' indicates 5% level and '**'indicates 1% level.

Table 13: Results of Almon Polynomial Distributed Lag model for Maize

1st Period			2nd Period		
Variable	**Estimate**		**Variable**	**Estimate**	
	Using MWF_1	**Using MWF_2**		**Using MWF_1**	**Using MWF_2**
Intercept	0.0389	0.0673	**Intercept**	0.2555	0.2724
SPOT(0)	0.282618*	0.262225*	**SPOT(0)**	0.294284**	0.295098**
SPOT(1)	0.188208**	0.183185**	**SPOT(1)**	0.180706**	0.188925**
SPOT(2)	0.109635	0.113134	**SPOT(2)**	0.093799*	0.10435**
SPOT(3)	0.046899	0.052073	**SPOT(3)**	0.033564	0.041375
USD(0)	0.451755*	0.435613*	**USD(0)**	-0.021963	-0.030711
USD(1)	-0.018269	-0.075324	**USD(1)**	-0.014053	-0.02574
USD(2)	-0.250237	-0.218238	**USD(2)**	-0.007755	-0.018964
MWF(0)	0.288282**	0.104719*	**MWF(0)**	0.161414**	0.082698**
MWF (1)	0.073826	0.052519	**MWF (1)**	0.085928**	0.056969**
MWF (2)	-0.045706	0.017666	**MWF (2)**	0.033864	0.034609
INT(0)	0.010822	0.007502	**INT(0)**	-0.022771	-0.024388
INT(1)	-0.009586	-0.008059	**INT(1)**	0.047529	0.044793
INT(2)	-0.018192	-0.014497	**INT(2)**	0.074757	0.071919
INT(3)	-0.014997	-0.011811	**INT(3)**	0.058914	0.056987
SA (0)	0.01243100*	0.0128160**	**SA (0)**	0.0088690**	0.009151**
SA (1)	0.0256300*	0.0026770*	**SA (1)**	0.00273900	0.002758
SA (2)	-0.00346400	-0.0028390*	**SA (2)**	0.00188300	0.001768
SA (3)	-0.00415200	-0.0037310**	**SA (3)**	0.000304	0.000182
R^2	0.7587	0.7563	**R^2**	0.7096	0.7008

Note 1: SPOT = Spot Returns, USD = US dollar Returns, MWF_1 = 1st Market Wide Factor, MWF_2 = 2nd Market Wide Factor,WME=World Market Effect, SA=Speculative Activity, OIL = Diesel Price.

Note 2: Significance codes: '*' indicates 5% level and '**'indicates 1% level.

Table 14: Results of Almon Polynomial Distributed Lag model for Mustard Seed

1st Period			2nd Period		
Variable	**Estimate**		**Variable**	**Estimate**	
	Using MWF_1	**Using MWF_2**		**Using MWF_1**	**Using MWF_2**
Intercept	0.0959	0.0728	**Intercept**	0.0863	0.0973
SPOT(0)	0.610827**	0.60779**	**SPOT(0)**	0.902108**	0.898567**
SPOT(1)	0.251566**	0.247172**	**SPOT(1)**	0.27752**	0.276758**
SPOT(2)	0.030008	0.025668	**SPOT(2)**	-0.081028**	-0.080273**
SPOT(3)	-0.053847*	-0.056723**	**SPOT(3)**	-0.173534**	-0.172525**
USD(0)	-0.105793	-0.116215	**USD(0)**	-0.661055*	-0.65547*
USD(1)	0.011423	0.003263	**USD(1)**	-0.408012*	-0.406666*
USD(2)	0.068127	0.062458	**USD(2)**	0.019845	0.018847
MWF(0)	0.219287*	0.217584*	**MWF(0)**	0.189961*	0.177318*
MWF (1)	0.015093	0.019931	**MWF (1)**	0.14587*	0.128033*
MWF (2)	0.01048	0.017782	**MWF (2)**	0.00614	0.023719
INT(0)	-0.021431	-0.022647	**INT(0)**	0.050479	0.038207
INT(1)	-0.000986	-0.001548	**INT(1)**	-0.01359	-0.017982
INT(2)	0.009401	0.00926	**INT(2)**	-0.043359	-0.043079
INT(3)	0.009729	0.009776	**INT(3)**	-0.038829	-0.037085
SA (0)	0.008401**	0.0084080**	**SA (0)**	0.00975300**	0.00851600**
SA (1)	0.0028660*	0.00303800 *	**SA (1)**	0.00120100	0.00120500
SA (2)	-0.00037	-0.00015300	**SA (2)**	0.00022500	0.00034900
SA (3)	-0.0013340	-0.00116600	**SA (3)**	-0.00017500	-0.00005282
R^2	0.7543	0.754	**R^2**	0.8449	0.7582

Note 1: SPOT = Spot Returns, USD = US dollar Returns, MWF_1 = 1st Market Wide Factor, MWF_2 = 2nd Market Wide Factor,WME=World Market Effect, SA=Speculative Activity, OIL = Diesel Price.

Note 2: Significance codes: '*' indicates 5% level and '**'indicates 1% level.

Table 15: Results of Almon Polynomial Distributed Lag model for Pepper

1st Period			2nd Period		
Variable	**Estimate**		**Variable**	**Estimate**	
	Using MWF_1	**Using MWF_2**		**Using MWF_1**	**Using MWF_2**
Intercept	-0.0991	-0.092	**Intercept**	0.0476	-0.0482
SPOT(0)	1.048356**	1.052007**	**SPOT(0)**	0.954142**	0.954934**
SPOT(1)	0.419368**	0.417098**	**SPOT(1)**	0.38614**	0.384895**
SPOT(2)	0.034979	0.030127	**SPOT(2)**	0.037782	0.035727
SPOT(3)	-0.10481*	-0.108906**	**SPOT(3)**	-0.090932**	-0.09257**
USD(0)	0.076397*	0.080965*	**USD(0)**	0.074926*	0.061007*
USD(1)	0.056609*	0.057626*	**USD(1)**	0.050232*	0.06191*
USD(2)	-0.01605	-0.016981	**USD(2)**	-0.022154	-0.03305
MWF(0)	-0.43823*	-0.409702*	**MWF(0)**	-0.456455*	-0.426*
MWF (1)	-0.00589	-0.001743	**MWF (1)**	-0.169325*	0.116869*
MWF (2)	0.111269	-0.007175	**MWF (2)**	-0.064206	0.022159
INT(0)	-0.00947	-0.011099	**INT(0)**	0.003541	0.004457
INT(1)	0.007818	0.005868	**INT(1)**	0.00661	0.004845
INT(2)	0.015158	0.013374	**INT(2)**	0.007043	0.004231
INT(3)	0.012552	0.011418	**INT(3)**	0.00484	0.002616
SA (0)	0.01349300**	0.0134500**	**SA (0)**	0.02049200*	0.02021000*
SA (1)	0.00505800**	0.00506900**	**SA (1)**	0.00134100	0.00099800
SA (2)	-0.00000322	0.00003403	**SA (2)**	0.00154200	0.00122500
SA (3)	-0.00168900	-0.00165600	**SA (3)**	0.00109500	0.00089300
R^2	0.8563	0.8557	**R^2**	0.8223	0.8214

Note 1: SPOT = Spot Returns, USD = US dollar Returns, MWF_1 = 1st Market Wide Factor, MWF_2 = 2nd Market Wide Factor,WME=World Market Effect, SA=Speculative Activity, OIL = Diesel Price.

Note 2: Significance codes: '*' indicates 5% level and '**'indicates 1% level.

have been observed in cointegration tests. The exchange rate of the US dollar to Indian rupees has a significant effect at lag 0 on the futures price before the period of recession for the commodities Maize and Pepper. Furthermore, the impact of US dollar on futures returns is found for the commodity Pepper throughout the period of study. For Mustard Seed, the same effect is significant for in the 2nd period for lag 1 and lag 2. The market wide information factor has a significant impact on the futures price of Barley, Maize, Mustard Seed and Pepper in both the periods. Furthermore, in post recession period the effect last longer than the pre recession period for most of the commodities. These results are similar to the results of short-run cointegration tests. It is observed that significance of MWF_1 and MWF_2 occurs together.

The risk free rate of interest is supposed to have a impact on the futures prices of of the commodities. However, no such effect is found of the commodities under consideration. Speculative activities have an impact on futures returns in all the periods of analysis for every commodity. For Maize, Mustard Seed and Pepper the effect lasted longer in pre recession period. But, for Barley the effect lasted longer in post recession period.

The cost of carry model states that the futures prices depend on the current spot price and the cost of storing the underlying commodity from current period until the delivery. This is the way usually a future contarct is valued. For this reason the spot prices have an effect on the futures prices in the whole priod of study for all the commodities under consideration. But, the effect of the rate of interest is unobservable in this study. So, interest rate is not a major determinant of commodity futures prices in the Indian market. This is because of the fact that the factors market wide information, speculative activity and demenad and supply exerts strong influence on the futures prices.

The domestic consumption of Barley has shown 50% growth in 2009. This trend has been prevailed during the 2nd period of the study. The domestic and global demand together has influenced the Indian commodity market for Barley. As a result, the market wide factor has shown a significant effect on the futures prices. Also, this demand attracted the speculators in the market and significant speculative activity has been observed in this period. For Maize a significant amount of growth in the quantity of export has been observed in the 1st period. In 2006 and 2007 the percentage of growth in export was 131.86 % and 270.28 % respectively. So, the exchange of US Dollar has shown a significant effect on the futures prices of Maize in the 1st period. The domestic demand of Maize has increased from 13900 thousand metric tonnes to 18900 thousand metric tonnes between 2004 and 2012. A steady growth of domestic demand is observed during this period. The market wide factor is found significant in both the periods of study. Due to the demand of Maize the speculative activity also has been triggered in the whole period of study. In the 2nd period, the broken Mustard Seeds and oil cakes have been exported in a large amount from India. In 2011 and 2012 the total export was of Rs. 2444.2 million and Rs.2668.359 million. The factor USD has been found significant in the 2nd period. The global production did not change significantly between 2009 and 2012 except in the year 2012. But the global consumption of Mustard seed has a steady growth in this period. The consumption was greater than production throughout the whole period of study. The demand in the domestic market made the market wide factor significant. Because of the domestic and

global demand the speculative activity was significant in both the periods. Pepper is one most important commodity in India in terms of export. In both the period of study a significant amount of Pepper has been exported from India. In 2004 India has gained around Rs. 1500 million from the export of pepper which has increased to approximately Rs. 9000 million in 2011. The exchange rate of the US Dollar is a major determinant of the amount of export. So, USD is an important factor for pricing of Pepper futures. Also, global market movements drive the futures prices of Pepper to some extent because of the global demand and supply. As a spice Pepper has large domestic demand in India. In 2010 the domestic consumption of Pepper in India was 0.0413 million tonnes. And it is increasing day by day. So, the demand of local market influences the futures prices of Pepper. The market wide factor was significant in both the periods and only current information affects the market. The speculators also help in price discovery of Pepper by participating in the market.

The results of the present study reveal that there is statistical evidence that spot prices have ability to explain movements in futures prices because of the cost of carry model, which is similar to the results of Iyer and Mehta (2007) and Author (2010). Furthermore, the results of this study indicate that the exchange rate of US dollar against Indian rupees has the power to explain futures price for most of the commodities but it is not uniform over the period of study. The hypothesis that futures price volatility is driven by the U.S dollar strength or weakness is true for some commodities. This result supports the findings of Helbling et al. (2008) and Charlebois and Hamann (2010). For all commodities, market wide information plays a major role in determining futures price in the Indian commodity market. The effect of risk free rate of interest on the futures price is unobservable in the Indian commodity market. Futures open interest expresses the amount of financial speculations involved. This research examined the open interest as a possible driver of commodity futures price. The results reveal that there is significant evidence that the futures open interest can explain futures prices of commodities. The effect is prominent in the two periods, before and after the period of recession. There is evidence that amount of speculation influences the future price of all the commodities.

Conclusion

The present study intends to identify the factors influencing the futures price of commodities in the Indian commodity market. The empirical studies revealed that the fundamental principles of demand and supply are influenced by several other factors. In the context of Indian market, five such factors have been chosen for this study. The factors included in this study are: spot price, the U.S. dollar exchange rate against rupees, market wide information, risk free rate of rate, and financial speculation. It has been found that in Indian market spot prices of commodities have influence over futures price. The exchange rate of the US dollar has significant impact on the futures price movements for most of the commodities. The effect is more prominent on export oriented commodities. Market wide information played a significant role in determining futures price. But, the effect of information does not last for a long period, which is an indication of efficient commodity market. Moreover, the significant influence of financial speculations on the futures price of the commodities is observed.

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