Impact of Futures Trading on Indian Agricultural Commodity Market

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ABSTRACT

Besides the well-established fact towards the requirement of market based instrument, there is always been a doubt, as expressed by different bodies, on the usefulness and suitability of futures contract in developing the underlying agricultural commodity market, especially in agricultural based economy like India. Therefore, an attempt has been made to re-validate the impact of futures trading on agricultural commodity market in India. The daily price information in spot and futures markets, for a period of 7 years (2004 – 2010), for 9 major agricultural commodities, taken from different categories of Agri-products, are incorporated into various econometric models to test the concerned objective. Like most of the other studies undertaken on world and Indian commodity market, the present study have also exhibited that even though the inflationary pressure on commodity, especially agricultural commodity, prices have gone up sharply after the introduction of commodity futures contracts, the destabilizing effect of the futures contract is casual in nature and tends to vary over a long period of time. The empirical findings significantly shows that comparative advantage of futures market in disseminating information, leading to a significant price discovery and risk management, that can again help to successfully develop the underlying commodity market in India. Therefore instead of curbing the commodity futures market, it can always be suggested to strengthen the market structure to achieve the broader target.

Key Words : Commodity Futures, Lead-Lag Relation, Efficiency, Volatility
JEL Classification : G10, G14, G15

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I. INTRODUCTION

Indian Economy and Role of Agricultural Commodity

It is well-known that commodities are the foundation of the economies of most developing countries by way of providing food, creating income-generating opportunities and export earnings to the people directly involved in agricultural activities. Like others, Indian commodity sector has also been experiencing tremendous surge towards a more sophisticated structure during the last decade. Being a key sector, occupying almost 17% share (at constant price of 2004-05) of India's Gross Domestic Product (GDP) during 2009-10, Agriculture and Allied sectors plays a very important role in the Indian economy. Therefore, unlike of other countries all over the world where the share of that specific sector in their respective GDP is quite marginal (except in some Asian countries like Pakistan, Bangladesh, Sri Lanka, Indonesia, China, Thailand, Malaysia, etc.), the growth of agriculture and allied sector has a significant role in the overall growth of Indian economy, as clearly depicted from *Table T1*. In most of the agriculture driven economy, it has been commonly observed that the agricultural policy (s) made by the Government tends to protect and promote the agriculture sector through different procurement and administered price mechanism. At the same time, in view of reduced direct support to agriculture under the Agreement on Agriculture with the World Trade Organization (WTO), there is a tremendous policy shift towards the market oriented approach.

Historically, the Government intervention is found at every stage of the marketing of major agricultural products. These includes, setting Minimum Support Prices for selected commodities, regulation of every activity of marketing such as transportation, storage, credit supply and international trading of these commodities, etc. But Government intervention has significantly declined after the initiation of liberalisation and economic reforms since 1991. The impact of agricultural commodity is of great importance in the stabilization of Indian economy, as reflected through the share of primary articles, especially the food articles in derivation of the price indices (WPI and CPI) in India. The current weight of primary articles

in 2004-05 series of WPI in India is 20.11815%, out of which the weight of Food and Non-food articles are respectively 14.33709% and 4.25756%. On the other hand the weight of Food and Beverages in CPI in India is currently fixed at 47.13%. These facts clearly indicate the necessity of significant growth and stability of agricultural sector to foster the overall growth of Indian economy.

Derivatives and its Role in Commodity Market

Given the standing International Commodity Agreement, a regular attempts are made world wide to establish the necessity of managing the risk of agricultural market, rather the market itself. It has been clearly observed how the policy of market intervention and stabilization of agricultural commodity market have shifted towards policies that emphasized on the management of the concerned risk through market-based instruments. Prices of agricultural commodities are determined increasingly by market forces of demand and supply. Hence fluctuation in demand and supply of agricultural commodities is expected to result in high price risk for agri-business. Various studies such as *Varangis (2002)***,** *Morgan (2000)* have strongly indicated that due to the radical transformation of commodity market policies in most of the Less Developing Countries (LDCs) from its original interventionist roots to market-based approaches would be able to successfully deal with commodity price risk and will bring the necessary market stability.

Application of several market-based instruments to deal with the commodity price risk basically focuses on the introduction of derivatives viz. futures and options contract on several commodities. In other words, it is widely proposed to setup an efficient derivative market for commodities to strengthen the agricultural market. It is internationally appreciated that if the derivative markets function adequately, some of the important policy goals regarding price volatility of agricultural commodities can be addressed in a market oriented manner. The basic need to trade in commodity derivatives in general and commodity futures in particular arises essentially to get the necessary support from any variation in the commodity prices. This is nothing but what we call *Hedging*. Hedging can be represented as just taking a required amount of counter position (Buy or Sell) in a standardized futures contract against the corresponding position (Sell or Buy) of the related underlying commodity. This counter positions in the futures contract help to offset the loss expected to incur from the adverse price movements of the underlying commodities. Therefore it is very important to develop futures and other forms of derivative trading in all commodities those

are vulnerable to large and erratic price fluctuations. The growth in the production of principal crops in India over the last two decades, as tabulated in *Table T2*, supports the requirement of such futures contract to facilitate the necessary growth in agricultural sector in India. Commodity futures also help to discover the future prices of underlying commodities. This anticipation of commodity prices as on some future dates makes the underlying market more strong and vibrant. Therefore, commodity futures market is expected to have a built-in mechanism for stabilizing commodity prices which are otherwise prone to fluctuate in response to any swing in the demand and supply forces. But at the same time it is also important to ensure that the commodity futures market is free from any manipulations, which otherwise lead to price distortion and resist the market from performing an effective price discovery function. *Table T3* summarizes the simultaneous growth of the whole Economy and also of the Agricultural sector with the growth in commodity futures trading in different countries or regions all over the world over the last decade

Even if it was generally felt that the initiation of derivatives trading on commodities will successfully achieve its primary goal of managing the price volatility observed in the commodity market, especially after the withdrawal of regulators' intervention on agricultural commodities, the role actually played by such market-based instruments in different LDCs has come under a severe doubts among the market players.

History of Commodity Derivatives Market in India

Commodity derivative trading in India has a long but chequered history extending over more than a century. The long experience gained by India in regard to commodity derivatives are of two folds: experience during Pre-Independence era and Post-Independence.

India has experienced its first futures market for cotton at Mumbai in 1875. Subsequently futures trading had started for oilseeds (Mumbai, 1900), jute (Calcutta, 1912), wheat (Hapur, 1913) and bullion (Mumbai, 1920). After a few years of lackluster trading, the markets underwent rapid growth between the two World Wars. As a result, before the outbreak of the Second World War, a large number of commodity exchanges, trading futures contracts in several commodities such as cotton, jute, oilseeds, groundnut, wheat, rice, sugar, silver and gold, flourished at various locations across the country. But the Defence of India Act, 1943 was invoked to prohibit futures trading in some commodities during the Second World War.

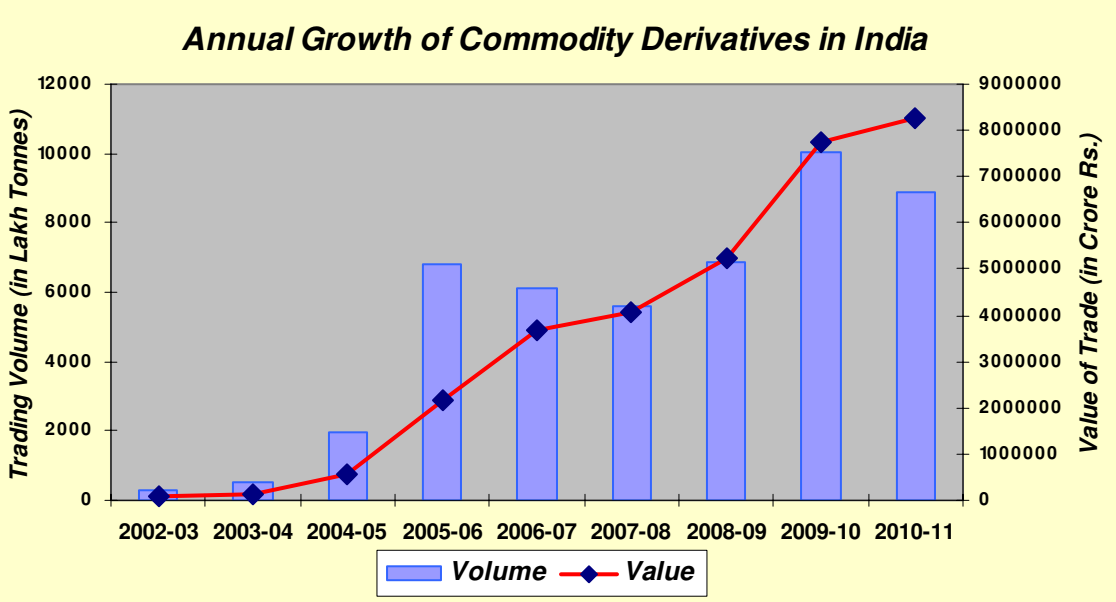
After independence, on the recommendation of the Forward Market Commission (FMC), futures trading were initiated on 16 diverse commodities; and started trading at recognized associations. Consequently, the total number of commodities traded and the number of recognized associations moved respectively to 50 and 30. But this growing status of commodity futures market in India could not last for long. In the wake of recurring agricultural shortages, rising prices, and a growing apprehension that speculating activities on commodities through futures trading may fuel inflation in Indian economy, the then central government banned futures trading in most of the commodities. Even if the *Dantwala Committee (1966)* recognized the benefits of commodity trading even at the time of commodity scarcity, the recommendation are ignored by the concerned authorities. This banning process continued till end 70s, followed by formation of *Khusro Committee* in the year 1980, the recommendation of which supported the revival of futures trading in most of the major commodities including even potatoes and onions. The ban on all other commodities still continued with the misconception that speculative futures trading destabilizes the prices of commodities. But during the new era of liberalization in 1990s, the government appointed another committee in 1993 under the chairmanship of Prof. K.N. Kabra to have a re-look on the necessecity of commodity futures in Indian economy. The *Kabra Committee (1994)* recommended the reintroduction of futures trading in a wide number of commodities and also the upgradation of existing commodity exchanges to facilitate futures trading at the international level. But ultimately the actual reform started after the intervention of international bodies followed by the submission of *World Bank – UNCTAD* report in the year 1997. The international pressure lead the Government of India to accept and implement the majority of the recommendations of Kabra Committee (1994). This eagerness to stimulate commodity futures trading in India not only lead to recognizing and strengthening of various regional commodity exchanges, but also to build up national level muti-commodity exchanges. Accordingly four national level multi-commodity exchanges (MCX, NCDEX, NMCEX, and ICEX) were recognized for online futures trading which started their operations since the year 2003. Therefore, the year 2003 is considered to be a turning point in the history of Indian commodity futures market.

Current Scenario of Commodity Futures Trading in India

With rising prices, the functioning of futures markets came under suspicion during 2006–07 and the government ordered a possible delisting of futures contracts for

commodities like Urad, Tur, Wheat and Rice to avoid the abnormal rise in their domestic spot prices. Followed by this, Sugar, Oil, Rice and Potato were also added to the list in 2007, but were subsequently delisted in 2008. In a similar line of thought, the India Government again banned future trading in Chana, Potato and Soya oil in May 2008. However, a steady process of opening up has been visible in future market for commodities over the last two years.

Figure: F1

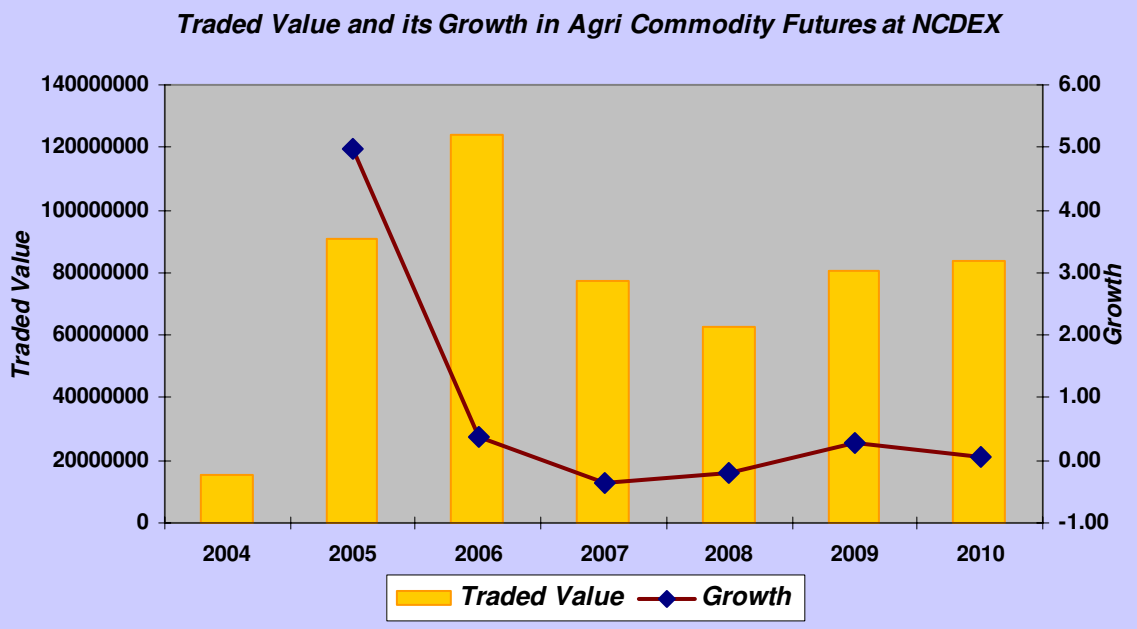


Source: Market Review Report, Forward Market Commission, GoI

As a result of significant policy change, liberalization of world markets and other developments, Indian commodity markets notched up phenomenal growth in terms of number of products on offer, participants, spatial distribution and volume of trade. The cumulative value of commodity trading in India during April to December 2010, as reported by FMC, is 82.71 lakh crore with a growth of 49.66% from the same period in the last year. The overall growth of commodity futures market in India over the last decade can be depicted through *Figure F1*. Even if the growth in all commodities is quite significant, the growth in agriculture commodities in India for the same period is found to be only 7.48%. Futures trading in India is currently permitted in 4 national level multi-commodity exchanges and 18 regional level commodity specific exchanges, and almost 200 different futures contract written on almost 100 commodities. Out of the total, number of agricultural commodities traded in national level exchanges is almost 28 to 30. In fact, there seems to be no limit to the number of commodities eligible to be traded in commodity exchanges, except the fact that the commodity should fulfill the criteria of becoming 'Goods' as defined in the Forward Contract

Regulation Act (FCRA – 1952). In order to widen the scope of commodity futures trading in India, it has also been proposed to widen the definition of commodity through the necessary amendments in the concerned laws, and allows the exchanges to trade even on immovable and intangible assets like real estate, commodity price indices, rainfall, weather indices, carbon credits, etc.

Figure: F2



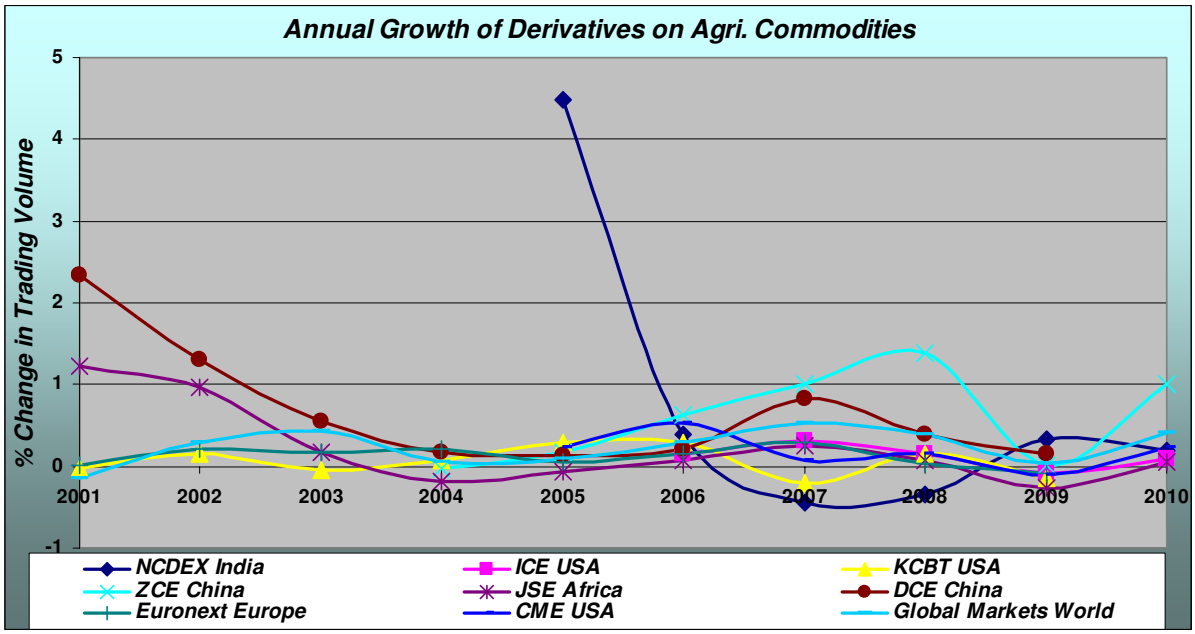
Source: Website of NCDEX

Despite the fact that the national level exchanges, with a modern state-of-the-art technology with electronic online trading system, are eager to provide their facilities to the doorstep of the commodity market functionaries, the potential users, both hedgers and speculators, especially in agricultural commodities and their related products, seems to be reluctant to avail the services and facilities. This unsatisfactory growth of futures contracts in agricultural commodities in India, as depicted in the *Figure F2*, has placed a great question mark on the benefits and feasibility of futures trading and labeled them as the fain factor of rising inflation in Indian economy. But at the same time, if the annual growth of derivatives (futures and options) on agricultural commodities in some of the other developed markets is taken into consideration, as figured in *Figure F3*, then it will be very clear that the concerned growth is quite unstable in almost all the markets.

Therefore it has found to be very important for all agriculture sector participants, especially the farming community across the country, to understand the process of dissemination of spot and futures prices of agricultural commodities. As a result, after being

identified in the 11th Five Year Plan by the Planning Commission, the Forward Markets Commission (FMC) in collaboration with the exchanges and other related bodies have undertaken a project of disseminating the agricultural commodity prices across the country on real time basis by installing an electronic price ticker boards in all mandis / APMCs which are networked under the AGMARKNET project.

Figure: F3



Source: Websites of respective stock / commodity exchanges
P.N. Growth in 2006 and in 2010 are respectively calculated based on the period Jan.-Oct and Jan.-June from their previous years.

Futures Trading and Price Movement of Agri Commodities in India – Critical Analysis

Giving due importance to the advantages of futures contract, the introduction of commodity futures are now becoming an important issue for the increasing rate of inflation in India and also for the volatile spot market, especially for the agricultural commodities.

As against the argument of Price Discovery, Hedging of Price Risk, Risk Sharing, etc. as the important functions of futures market, several arguments are also offered against the unbridled trade in the commodity future market in India. These are:

i. Possibility of future trading leading to a rise in spot prices and inflation;

ii. Possibility of future trading leading in driving up spot market volatility;

iii. Possibility of future trading not necessarily to be in transparent or costless manner

The critics have widely pointed out that in the presence of any future bad news in the market, the speculators tend to hoard the concerned commodities and hence artificially drive up the prices. As a result of these speculative activities of major market players, the volatility of the underlying spot market for those commodities also increases sharply. Unlike as claimed, the trading opportunities are generally monopolized by large traders/farmers, and give a little space for others to take part in the commodity market.

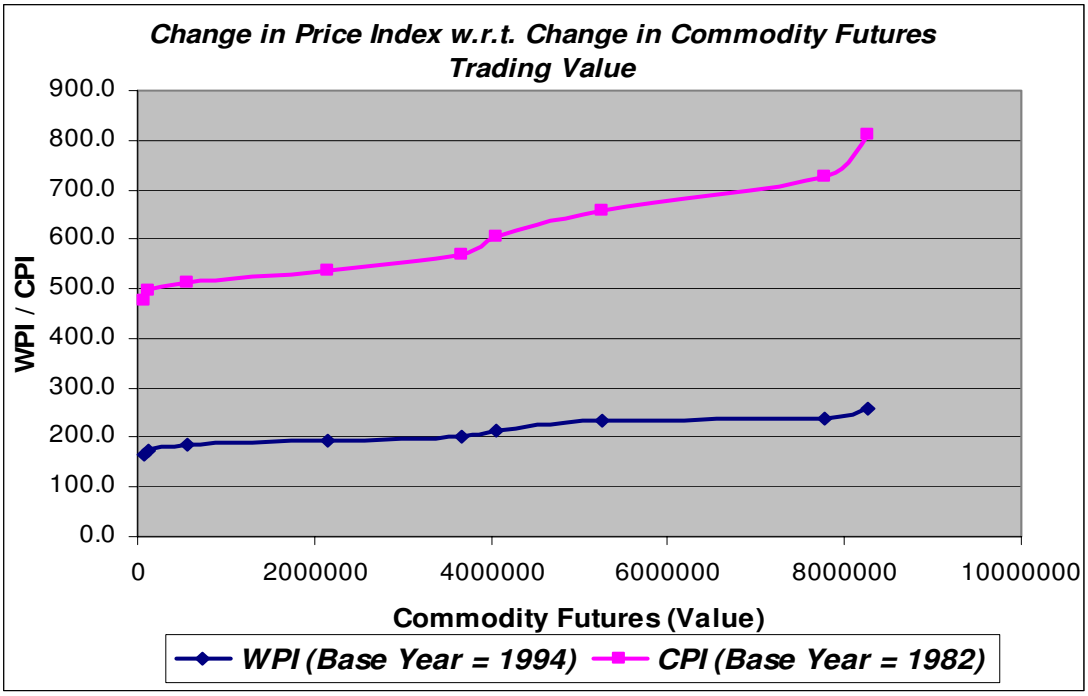
In the wake of consistent rise in rate of inflation started during the first quarter of calendar year 2007 and responding to the concerns expressed at various fora and by various opinions, an Expert Committee was set up under the Chairmanship of Prof. Abhijit Sen, Member, Planning Commission to examine the presence and extent of contribution of futures trading on the unexpected rise in the prices of agricultural commodities. The committee revealed that even if the agricultural price inflation is accelerated during the post futures period, the same can not be attributed only to the trading of futures contract in essential agricultural commodities. A part of the price acceleration of agricultural commodities in the post futures period may be due to rebound/recovery of the past trend of relatively low agricultural prices observed during the pre-futures era. At the same time, they have also stated that the period during which futures trading has been in operation in India is too short to discriminate adequately between the effect of initiating futures trading and a normal cyclical adjustment.

Many of the myths surrounding trading in commodity derivatives in developing markets like in India arise out of widespread volume of speculation in such trading. Perception of common people about speculation is not different from that of gambling. In other words, general people normally fail to differentiate between allowing speculation and allowing the market players to manipulate the market. Therefore it is very important to understand the distinction between speculation, and gambling or manipulation. Even if the nature of any transaction by way of speculation, or gambling, or manipulation looks same, but their purpose can be clearly distinguishable from each other. Even if the motivation for both speculation and gambling are ultimately profit driven, but the very basic difference between these two is that, speculators intend to take the risk which is already there in the market, whereas gamblers create the risk just to satisfy their requirement. The success of a gambler is purely a matter of chance, where the successfulness of any speculative movement depends on the market knowledge, intelligence, and forecasting capability of the speculator. Gambling can not be considered as an economic function and has no role in making a market, whereas speculation plays an important role in market making, especially a new market. A

speculator seeks profit from any expected price change due to anticipated change in the demand and supply of the underlying asset or commodity. On the other hand, a manipulator also attempts to make a profit, but by forcing the price to change in his favorable direction, without justifying the prevailing demand-supply equation in the market.

The prevalent influence of commodity futures trading in intensifying the price inflation in India can be primarily tested through the co-movement of Indian price indices, viz. Wholesale Price Index (WPI) and Consumer Price Index (CPI) with the total traded value of commodity futures trading in India. The comovement of these two price indices with the growing size of commodity futures trading can be reflected through the concerned figure (*Figure: F4*). Given the fact that there is an upward co-movement, reflecting the influence of commodity futures trading on rising inflation, the influence is essentially expected to be temporal in nature and it will be quite extraneous to blame the growth of commodity futures market for such inflationary situation. There are several other which can also be significantly accounted for such rising inflation in Indian economy.

Figure: F4



Source: Various Fortnight Report of FMC, Website of Office of Economic Advisor, Ministry of Commerce and Industry, Govt. of India; and Other Sources

Even if there are considerable amount of arguments for and against the introduction of futures contract especially on essential commodities, the significance of such market-based instruments can not be ignored in an era of liberalization and economic reforms. The only

things that need to be ensured are the presence of an efficient spot market and an effective Risk Management and Regulatory framework. There is no dilemma among the market players that the underlying commodity market in India has large number of infirmities. The presence of these infirmities will lead to various difficulties in the functioning of commodity futures markets. There is no doubt that the futures markets can act as a catalyst of change for spot markets, but whenever futures markets grows faster than the under developed spot market, the gap between the two gets widened thereby exposing the futures market to criticism of being driven by speculators, even if closely regulated by the concerned regulatory bodies (*Abhijit Sen 2008*).

Overview of the Present Study

Given the above perspective of commodity futures, an attempt has been made to validate the market perceptions of different bodies on the usefulness and suitability of futures contract in developing the underlying agricultural commodity market in agricultural based Indian economy. The daily price information in spot and futures markets, for a period of 7 years (2004 – 2010), for 9 major agricultural commodities is extracted from NCDEX data base and incorporated into various econometric models, such as Multiple Regression, Vector Auto Regression, Granger Causality Test, GARCH model, etc., to test the concerned objective. The effect of commodity futures trading in stabilizing the underlying agricultural commodity market for 9 major commodities, taken from different categories (Spices, Pulses, Cereals, Oil and Oil Seeds, and Others) of Agri-products, are examined to throw some light on the rising inflation in Indian agricultural sector. Like other studies undertaken on world and Indian commodity market, the present study have also exhibited that even though the inflationary pressure on commodity, especially agricultural commodity, prices have gone up sharply after the introduction of commodity futures contracts, the destabilizing effect of the futures contract is casual in nature and tends to vary over a long period of time. Therefore, even if the spot prices of major agricultural commodities have been destabilized during the post commodity futures period in Indian economy, it is very difficult to come out with a straight forward statement regarding the usefulness and feasibility of futures contract in commodity, especially on essential agricultural commodities. The empirical findings significantly shows that comparative advantage of futures market in disseminating information, leading to a significant price discovery and risk management, can help to successfully develop the underlying commodity market in India.

The rest of this paper is organized as follows: Section 2 presents a brief review of existing literature relevant to this study and pointed out the possible efforts achieved through this study. The details of data used and a comprehensive description of the methods and the tests applied in this study are presented in Section 3. The analysis of major empirical findings is shown in Section 4, followed by the conclusion in Section 5.

II. REVIEW OF LITERATURE

As far as the temporal relationship among the spot and derivatives viz. futures and options market is concerned, several studies have attempted to examine the lead-lag relationship between the spot and the futures market, pertaining to various underlying asset such as equity, commodity, foreign currency, etc., both in terms of return and / or volatility. An attempt has been made to review the existing literature on the concerned topic based on the nature of asset considered in the study, such as agricultural and non-agricultural commodity, equity products, etc.

By considering various agricultural products, Garbade and Silber (1983), Khoury and Martel (1991), Fortenbery and Zapata (1993), have made an attempt to establish the interrelationship among the spot and futures market in agricultural sector, and have revealed the strength of futures market in successfully discovering the spot prices. Some of these studies have also highlighted on the impact of futures contract on the volatility of the underlying agri-commodity market. Apart from establishing a unidirectional and / or bidirectional flow of information between the spot and futures market, depending on the nature of market and prevailing economic and other conditions, some of the studies have also supported the role of market size and liquidity in discovering prices.

Similarly, several researchers such as Oellermann and Farris (1989), Brorsen, Oellermann and Farris (1989), Oellermann, Brorsen and Farris (1989), Koontz, Garcia and Hudson (1990), Bessler and Covey (1991), etc. have conducted the similar kind of studies but based on Cattle and Livestocks. These studies have investigated the direct impact of futures trading on the spot market and have found the futures market as the centre of price discovery for live cattle. It was generally found that the introduction of futures trading have improved spot market efficiency, but may be with a chance of increased short run spot price volatility. Even if the prices of nearby futures and spot contract showed some evidence of cointegration,

the same may tend to disappear when more distant futures contract was considered. But Koontz, Garcia and Hudson have found a dynamic nature of dominance due to structural change in the spot and futures market.

On the other hand, Quan (1992), Schwarz and Szakmary (1994), Foster (1996), Silvapulle and Moosa (1999) have studied the interrelationship between the spot and futures market in the petroleum sector. Unlike Quan, Schwarz and Szakmary have shown that petroleum futures and spot market are cointegrated and the futures market dominates the spot market. The results derived by Foster (1996), Silvapulle and Moosa (1999) indicated that though the futures market plays the dominent role in the price discovery process, such dominance is strongly temporal and time varying and also largely affected by the market conditions.

Even if there is large number of studies on the interrelationship between spot and derivatives markets, there is a very strong concentration on equity products. Ng. (1987); Kawaller, Koch, and Koch (1987); Herbst, McCormack andWest (1987); Harris (1989); Stoll & Whaley (1990); Cheung and Ng (1990); Chin, Chan and Karolyi (1991); Chan (1992); Wahab and Lashgari (1993); Grunbichler, Longstaff and Schwartz (1994); Harris et al. (1995); Hasbrouck (1995); Abhyankar (1995); Shyy (1996); Iihara (1996); Koutmos (1996); Fleming, Ostdiek and Whaley (1996); Jong and Nijman (1997); Choudhry, T. (1997); Pizzi (1998); De Jong (1998); Chatrath (1998); Abhyankar (1998); Min and Najand (1999); Tse (1999); Frino (2000); Cellier (2003); Thenmozhi (2002); Liena and Yang (2003); Simpson (2004) etc. have investigated the interrelationship between the spot and futures prices in underlying equity market, either for an equity index or for the underlying stocks. Most of the studies have found the fact that even though both the markets are cointegrated with a strong contemporaneous relation, there is a significant lead-lag relationship between the spot and derivatives viz. futures and options markets. By applying various models, starting from multiple regression to VAR, Granger-causality, GARCH, etc., most of the studies have suggested that the leading role of the futures / options market varies from five to forty minutes depending on the nature of markets, but the reverse causality from spot to futures market rarely exist, and not beyond a time lag of 5 minutes.

Given the fact that India have experienced a long-term but turbulent history of commodity derivatives market, few significant research have been conducted during last half decades to bring out the necessity and effectiveness of futures contract, especially on agricultural commodities, to curb the unexpected price movement of the essential

commodities in India. These studies include Karande (2006), Ahuja (2006), Raizada and Sahi (2006), Lokare (2007), Nath and Lingareddy (2007), Bose (2008), Singh ( ), Kumar, Singh and Pandey (2008), Sen and Paul (2010), etc. *Karande (2006)* in his doctoral thesis has examined the three important aspects of commodity futures markets in India, viz basis risk, price discovery and spot price volatility. His study on castorseed futures market, both at Mumbai and Ahmedabad, has found that the castorseed futures market traded both at Mumbai and Ahmedabad exchanges performs the function of price discovery, and the introduction of castorseed futures market has had a beneficial effect on castorseed spot price volatility. In light of the fear that derivatives fuelled unnecessary speculation and were detrimental to the healthy functioning of the underlying commodity market, *Ahuja (2006)* has tried to bring out some facts regarding India's attempt to re-introduce the futures contract on several commodities, and also the issues, such as introduction of new market-based products, standardization of Warehousing, nature of contract settlement, functions of regulator (s), integration of the markets, etc., which need urgent attention for the successful functioning of the market. *Raizada and Sahi (2006)* in their study have shown that the wheat futures market is even weak-form inefficient and fails to play the role of spot price discovery. Spot market has found to capture the market information faster and therefore expected to play the leading role. This inefficiency of the futures market may be attributed to the lack of necessary data to truly capture the actual lead-lag relationship between the spot and futures market. They have also suggested that the trading volume in commodity futures market, along with other factors, have a significant impact on country's inflationary pressure. *Sahi ( )*, in her paper again has empirically proved that in case of few agricultural commodities, the nature of spot price volatility was unchanged even with the onset of futures trading, where as the same was not true for Wheat and Raw Jute. The paper also confirmed that any unexpected rise in futures trading volume or open interest may unidirectionally cause an increase in spot price volatility for some of the agricultural commodities in India. Given due focus on the phase of long and turbulent historical break in Indian commodity derivatives sector, *Lokare (2007)* in his work has tried to shown the efficacy and performance of commodity derivatives, viz. futures contract in steering the price risk management of underlying commodities. He intended to prove that the significant cointegration in spot and futures prices of the selected commodities exhibits the operational efficiency of the concerned markets, may be at a slower pace. At the same time, lower volatility of futures prices for some commodity demonstrates the possibility of inefficient utilization of available information expected to be captured in the prices of futures contract. *Nath and Lingareddy (2007)* in their study have attempted to explore the

effect of introducing futures trading on the spot prices of pulses in India. Favoring the destabilization effect of futures contract, their study found that volatilities of urad, gram and wheat prices were higher during post-futures period than that in the pre-futures period as well as after the ban of futures contracts. However, they believed that the suspicion of futures trading contributing for a rise in inflation appears to have no merit in the present context. *Bose (2008)* has tried to investigate the efficiency, in terms of price dissemination, of Indian commodity indices, both based on metals and energy products and also on agricultural commodities. The results on the former indices clearly exhibit the informational efficiency of the commodity futures market with a significant effect on stabilizing the volatility of the underlying spot market. Unlike of such results, agricultural indices clearly failed to exhibit the feature of market efficiency and price discovery. *Singh ( )* in his paper has tried to investigate the Hessian spot price variability before and after the introduction of futures trading and ascertained that the futures market definitely help in reducing the intra-seasonal and/or inter-seasonal price fluctuations. His results clearly suggested that futures market may be indeed viable policy alternative for policy-makers to reduce uncertainty in agricultural markets. *Kumar, Singh and Pandey (2008)* have examined the hedging effectiveness of futures contract on a financial asset and commodities in Indian markets. By applying different time series models, the authors have found the necessary cointegration between the spot and derivatives markets and have shown that both stock market and commodity derivatives markets in India provide a reasonably high level of hedging effectiveness. But unlike the other studies, Sen and Paul (2010) have clearly suggested that future trading in agricultural goods and especially in food items has neither resulted in price discovery nor less of volatility in food prices. They observed a steep increase in spot prices for major food items along with a granger causal link from future to spot prices for commodities on which futures are traded.

There is a vast amount of literature on the concerned subject considering the equity segment of the financial market. Even if considerable amount of work has also done on world-wide commodity market, it is comparatively less in case of agricultural commodities, especially in agricultural based economy like India, and also during the pre-mature phase of futures market, especially during a period of severe inflationary pressure. In such circumstances, this study carries a significant importance to re-look on the impact of futures contract on the underlying agricultural commodity market in India. Therefore, the broad objectives of this study are:

i. Revalidate the misperception of various interested group of people regarding the usefulness and relevance of commodity futures in countries like India; and

ii. Examine the theories in such a quantitative modeling framework where the basic and essential properties of the market are duly incorporated to get the valid and unbiased results

III. DATA AND METHODOLOGY

Data for Testing Return and / or Volatility Interdependence between Spot and Futures Market

In order to examine the interdependence, alternatively known as lead-lag relationship, between the underlying spot and futures market of the agricultural commodity sector, the basic data used in this study consist of daily price histories for the near-month futures contract of the selected agricultural commodities, and their respective spot prices. The concerned data is taken for a period of 7 years, starting from 2004 to August 2010, and is collected from the website of National Commodities and Derivatives Exchange (NCDEX). The exact period may vary for different commodities, depending on the availability of trading information. In case there are more than one trading prices, the last price, or the closing price is considered for the study. If there is any missing observation, due to non-trading, in any day and in any of the market, the common practice is to remove that specific interval (s) from the sample and therefore has been applied here also.

The commodities considered here are agricultural commodities from all the major categories (Spices, Pulses, Cereals, OIL and Oil Seeds, and Others), as specified by the commodity exchange. The commodities from all the categories are primarily seleceted based on their market share in the commodity futures market in India. The selected commodities are CHANA (as Pulses), WHEAT (as Cereals), CHILLI, JEERA, and PEPPER (as Spices), MASTARD SEED, CASTOR SEED, SOYA OIL (as Oil and Oil Seeds), and MENTHA OIL (as Others).

Daily Price Return on all the commodities, both in spot and futures market, is defined as usual, i.e., the first difference in the log of commodity price, such that $R_{S/F,t} = \ln(P_{S/F,t}) - \ln(P_{S/F,t-1})$. P represents the daily price information of the respective commodities, in Spot (S) or Futures (F) market.

Methodology for Testing Return and / or Volatility Interdependence

Most of the previous studies revealed the fact that spot and derivatives, viz. futures markets may not react at the same time after the flow of new information. Some lead-lag relationship is commonly observed in most of the cases. The interrelationship among the spot and futures market have been modeled in two different sections. The daily interrelationship among the return and / or volatility of the selected commodities in spot and futures market is modeled in three different frameworks. These are Multiple Regression model, Vector Auto Regression (VAR) model, and Generalised Autoregressive Conditional Hetroscedasticity (GARCH) model.

Before applying the aforesaid models, an attempt has been made to describe some of the primary statistical properties of the price and return series of the selected agricultural commodities traded both in spot and futures market in India. These properties are essentially required before selecting any specific modeling framework. The *Descriptive Statistical Measures*[1], estimated for the price and return series of all the selected commodities both in spot and futures market, can be used to explain the univariate statistical behavior of the concerned variable. Other statistical properties required to be verified are Stationarity, Hetroscedasticity, Autocorrelation and Partial Autocorrelation, Cross Correlation, etc. of the concerned time series variables (univariate or bi-variate). Most of the financial asset price data are found to be *Non-stationary*[2] and typically exhibit a very well-known financial property called *Random Walk*[3]. Therefore the stationarity property of the commodity prices is tested through a well-known method called *Augmented Dickey-Fuller Test*[4] (ADF-test).

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1. Descriptive Statistical Measures, basically consist of Mean, Median, Mode, Range, Standard Deviation, Skewness, Kurtosis, etc., can successfully describe the basic properties of an univariate data and to understand the probability distribution of the concerned series.

2. A financial variable is said to be Non-stationary when there is no tendency for the variable to revert back to a trend value due to the property of random walk.

3. Random Walk means the random movement of the prices of a certain financial asset, where the current price information can not be used to predict the future prices of that asset. This property is best captured by a Financial Theory known as Random Walk Hypothesis

4. In statistics, the Dickey-Fuller test tests whether a unit root is present in an autoregressive model and is named after the statisticians D. A. Dickey and W. A. Fuller, who developed the test in the 1970s. Augmented Dickey Fuller (ADF) test is an augmented version of the Dickey-Fuller test to accommodate some forms of serial correlation. The ADF test is applied to the model

$$\Delta y_t = \alpha_0 + \gamma y_{t-1} + \sum_{i=1}^{n} \beta_i \Delta y_{t-i} + \varepsilon_t$$

The unit root test is then carried out under the null hypothesis $\gamma = 1$ against the alternative hypothesis of $\gamma < 1$. Once the value for the test statistic $DF\tau = (\hat{\gamma} - 1)/S.E.(\hat{\gamma})$ is computed, it can be compared to the relevant critical value for the Dickey-Fuller Test. If the test statistic is less than the critical value then the null hypothesis of $\gamma = 1$ is rejected and no unit root is present and the series become stationary.

Stationarity test is important because regressing one non-stationary series on another may produce some spurious results. Therefore, the variables expected to be used in a regression model should posses stationarity. Even if most of the underlying price series are found to be non-stationary, i.e. I (1), their first difference, i.e. the price returns are found to be stationary, i.e. I (0). Therefore, price returns, not the actual prices, are considered to test the interrelationship among the spot and futures market.

On the other hand, test of Heteroscedasticity is required to understand the nature of the variance or deviations of the concerned return series. A return series is said to be Homoscedastic, when its variance is found to be constant over a specific period of time. But if the variance is time-dependent, and varies from one period to another, then the series is known as Heteroscedastic. This nature of a variable affects the selection of a specific model to capture the concerned interrelationship among the variables. Therefore, two different tests named as *ARCH-LM-test and White Heteroscedasticity-test*[5] are performed to verify the Heteroscedastic nature of the spot and futures price returns of the selected agricultural commodities.

In order to identify the significant number of lags required to be included in any autoregressive model, an effort has been made to apply the test of *Autocorrelation and Partial Autocorrelation*[6]. These functions play an important role in data analyses, aimed at identifying the extent of the lag in an autoregressive model. On the other hand, while capturing the interrelationship between two markets, it is also primarily important to know the significant time lag within which the information contained in one price can affect the price available in other market. Alternatively, it is important to capture the actual number of days within which the information successfully flows between two markets. A *cross-*

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5. ARCH-LM and White test of Heteroscedasticity establishes whether the residual variance of a variable in a regression model is constant or homoscedastic. ARCH-LM test statistic is computed from a regression where the squared residuals are regressed on a constant and lagged squared residuals up to order q. The null hypothesis of no ARCH effect is verified through the Engle's LM test statistic (Obs.$\times R^2$) and the F-statistic. In White's test, to test for constant variance, the squared residuals from a regression model is regressed on the squared regressors and all possible cross product of the regressors. Then the H_0 of Homoscedasticity is accepted or rejected depending on the F-stat and the R^2

6. Autocorrelation is a mathematical representation of the degree of similarity between a given time series and a lagged version of itself over successive time intervals. It is also referred to as "lagged correlation" or "serial correlation". It is a mathematical tool for finding repeating patterns, such as the presence of a periodic signal which has been buried under noise. Similarly, the partial autocorrelation at lag k is the autocorrelation between X_t and X_{t-k} that is not accounted for by lags 1 through k-1. Specifically, partial autocorrelations are useful in identifying the order of an autoregressive model.

correlation[7] test [Stoll and Whaley (1990), Kalok Chan (1992), Abhyankar (1995), Min et al (1999)] can be applied to get the significant length of leads or lags. Besides that, when an attempt is made to examine the interdependence between two variables, it is also important to test whether both the variables are co-integrated in long-run, or the interrelationship is temporary or casual. Therefore, *Engel-Granger test of Cointegration*[8] can be applied to verify the possible cointegration among the variables. Though it is assumed that the price series are non-stationary, i.e. I (1), if their linear combination has been found to be I (0), i.e., stationary, then the price series are said to be co-integrated (Engle and Granger, 1987). If this Engle-Granger test confirms that both the price series are co-integrated in the long run, then the system of equations should be modified by inserting an *Error Correction Term*[9] to account for the short-run divergence of prices from their respective equilibrium values.

After attempting all the primary tests, as described in the above section, the next step is to capture the interrelationship between the spot and futures market, for the selected agricultural commodities, through different modeling framework.

Multiple Regression Analysis:

Two multiple regression equations can be framed in line with the above requirement to test the return and / or volatility interdependence between the spot and futures market in Indian commodity sector. The equations used here are such that:

$$R_{s,t} = \alpha + \sum_{k=-n}^{n} \beta_k R_{f,t+k} + \delta Z_{t-1} + \varepsilon_t \qquad (3.1)$$

$$R_{s,t} = \alpha + \sum_{k=-n}^{n} \beta_k R_{f,t+k} + \sum_{i=-m}^{m} \gamma_l \sigma_{f,t+l} + \delta Z_{t-1} + \varepsilon_t \qquad (3.2)$$

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7. In order to get the length of lags (i.e.,β_{-k}) and the length of lead (i.e., β_{+k}), cross correlation coefficient, between the current cash returns ($R_{s,t}$) and lagged futures return ($R_{F,t-k}$), and between the lagged cash return ($R_{s,t-k}$) and current futures return ($R_{F,t}$), can be examined. Significant number of lead or lag can be decided through the t-test, where the asymptotic standard errors for the cross-correlation coefficients is approximated as the square root of the reciprocal of number of observations included in the sample [Chan Kolak (1992)].

8. Engle-Granger test of co-integration deals with testing whether the residuals derived from the equilibrium equation ($\varepsilon_t = Y_t - \alpha_0 - \alpha_1 X_t$) is I (0). If DF and ADF tests confirm that the residual series is stationary, then X and Y series are said to be co-integrated.

9. The residuals from the equilibrium equation of spot and futures prices, lagged by one period, is considered to be the Error Correction Term, such that $ECT_{t-1} = Y_{t-1} - \alpha_0 - \alpha_1 X_{t-1}$.

The first equation is used to test the return interdependence, whereas the second equation is used to test both the return and volatility interdependence among the spot and futures market in Indian commodity sector. $R_{s,t}$ and $R_{f,t}$ respective represent daily price return in cash and futures market, for the selected nine commodities, at time t. $\sigma_{f,t}$ represents the return volatility in the commodity futures market at time t. The coefficients with negative subscripts (i.e., $\beta_{-1}, \beta_{-2}, \ldots, \beta_{-n}$; or $\gamma_{-1}, \gamma_{-2}, \ldots, \gamma_{-m}$) are lag coefficients and those with positive subscripts (i.e., $\beta_{+1}, \beta_{+2}, \ldots, \beta_{+n}$; or $\gamma_{+1}, \gamma_{+2}, \ldots, \gamma_{+m}$) are lead coefficients. Hare the residual derived from a simple GARCH (1, 1) framework on futures return is used as the proxy variable to capture the past and future volatility in the commodity futures market. The significance of the lag coefficients (β_{-n} and / or γ_{-m}) in the above equations reveals that return and / or volatility in futures market leads that of the spot market. On the other hand, if the lead coefficients (β_{+n} and / or γ_{+m}) become significant, then it can be inferred that the spot market plays the leading role in disseminating market information. If the contemporaneous coefficient (i.e., β_0 and / or γ_0) shows the highest value among all other lead-lag coefficients, then it can be inferred that the two markets react simultaneously to most of the information. Along with the highest value of the contemporaneous coefficient (s), if both the lead and lag coefficients are found to be significant, then neither market can said to significantly lead the other and therefore both the markets are proved to be informationally efficient. Z_{t-1} is the error correction term to account for the necessary cointegration among the variables.

Though there is mounting evidence for the time varying nature of stock return volatility, this model will not account for the variability of the disturbances while estimating the daily interrelation between the spot and futures price returns and / or return volatilities of the selected agricultural commodities in India. However, since heteroscedasticity generally leads to inconsistent estimates of standard errors and invalidates inference, the t-statistics for all the coefficients can be adjusted using the procedure outlined in White (1980) [Chan (1992), Abhyankar (1995), Frino (2000) etc.]. This method is well-known as *White's Correction for Hetroscedasticity*[10]

Vector Auto Regression Analysis:

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10. White's (1980) procedure allows estimating the regression using least squares, but then computes a consistent estimate of the covariance matrix allowing for hetroscedasticity that will lead to change the standard errors and therefore the t-statistics, not the coefficients or the joint test statistic like F-stat.

The second framework, adopted to test the interrelationship among the spot and futures market, is the Vector Auto Regression[11] (VAR) model that can successfully capture the simultaneous relation between two time series variables by using their own lagged values. The model to capture the return interdependence is such that

$$R_{S,t} = \alpha_0 + \sum_{i=1}^{p} \alpha_i R_{S,t-i} + \sum_{j=1}^{q} \beta_j R_{F,t-j} + \delta Z_{t-1} + \varepsilon_{S,t} \quad (3.3)$$

$$R_{F,t} = \alpha_0 + \sum_{i=1}^{p} \alpha_i R_{F,t-i} + \sum_{j=1}^{q} \beta_j R_{S,t-j} + \delta Z_{t-1} + \varepsilon_{F,t} \quad (3.4)$$

$R_{S,t}$ and $R_{F,t}$ respectively represent daily return in spot and futures market. The value of time lags (i.e. p and q) considered here are only 2, because of daily frequency for which two days are essentially sufficient to transmit any information from one market to another. The error correction term is used in both the simultaneous equations as an exogenous variable to account for the possible cointegration among the spot and futures returns.

The above VAR model, with the similar specifications, is also applied to test the volatility interdependence between the spot and futures market for the selected agricultural commodities. The only difference is the nature of the variables used in the model. The variables represent the volatilities in spot and futures market. This volatility interdependence or volatility spillover between two markets is captured in the following framework:

$$\sigma_{S,t} = c_1 + \sum_{k=1}^{p} \alpha_{S,k} \sigma_{S,t-k} + \sum_{l=1}^{q} \beta_{S,l} \sigma_{F,t-l} + \upsilon_{S,t} \quad (3.5)$$

$$\sigma_{F,t} = c_2 + \sum_{k=1}^{p} \alpha_{F,k} \sigma_{F,t-k} + \sum_{l=1}^{q} \beta_{F,l} \sigma_{S,t-l} + \upsilon_{F,t} \quad (3.6)$$

Where σ represent the volatility measure. The suffix S and F respectively represent the spot and Futures market. The residual series derived from a simple OLS model and the GARCH variance series derived from a GARCH (1, 1) model are used as the proxies to capture the volatility in spot and futures market. In the both the cases, an AR (2) framework is adopted to generate the volatility series separately in spot and futures market. Like in the previous

11. Vector autoregression (VAR) is an econometric model used to capture the evolution and the interdependencies between multiple time series, generalizing the univariate AR models. All the variables in a VAR are treated symmetrically by including for each variable an equation explaining its evolution based on its own lags and the lags of all the other variables in the model. Based on this feature, Christopher Sims advocates the use of VAR models as a theory-free method to estimate economic relationships among variables.

framework, a lag-length of 2 (both for p and q) is considered to test the volatility interdependence.

In support of the above simultaneous relation among the spot and futures market return and volatility, *Granger Causality Test*[12] in VAR (p, q) framework is also performed to understand the cause and effect relation among both the endogenous variables (spot and futures).

GARCH (1, 1) Analysis:

In addition to the above analysis, another attempt has been made to test the return and volatility interdependence, or in other words, return and volatility spillover among the spot and futures commodity market through a simple *GARCH (1, 1)*[13] model. The GARCH model, considering both return and volatility spillover, is such that

$$R_{S,t} = \alpha_0 + \sum_{i=1}^{2} \alpha_i R_{S,t-i} + \sum_{j=-2}^{2} \beta_j R_{F,t+j} + \sum_{k=-1}^{1} \delta_k h_{F,t+k} + \varepsilon_t \qquad (3.7)$$

$$h_{S,t} = \gamma_0 + \gamma_1 \varepsilon_{S,t-1}^2 + \gamma_2 h_{S,t-1} + \sum_{k=-1}^{1} \varphi_k h_{F,t+k} \qquad (3.8)$$

$R_{S,t}$ and $R_{F,t}$ represent the daily commodity return in spot and futures market. $\varepsilon_{S,t}$ and $h_{S,t}$ represent the current and past volatility in the spot market. Spot return at day t is regressed on its own lagged returns, contemporaneous return and volatility in futures market, lead and lagged futures return with a common length of 2 days, and lead and lagged futures return volatility with a common length of 1 day. $h_{F,t+k}$ represents the futures return volatility (the variance series of a GARCH (1, 1) equation on the futures return) with a lag length of k, and is used as an exogenous variable both in the conditional mean and variance equation to verify the impact of futures market volatility both on the return and volatility in spot market of Indian agricultural commodity sector. The statistical significance of various coefficients (β, δ, φ) with different lead and lag orders reveals the return and / or volatility interdependence between the spot and futures market.

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12. The Granger Causality test has been applied through a near-VAR approach. Here a pairwise Granger causality test is carried out to verify whether an endogenous variable can be treated as exogenous. This test produces, for each equation in the VAR, the Chi-square (Wald) statistics for the joint significance of each of the other lagged endogenous variables in that framework

13. Even if there is a family of ARCH models with various order specifications, GARCH (1, 1) is considered to be the most parsimonious to successfully capture the GARCH effect in the variance series of the concerned financial asset return.

Apart from the exhibiting the significance of the individual coefficients in all the aforesaid models, it is also tried to test the joint statistical significance of the related variables involved in any equational setup to ensure the effectiveness of all the related forces together. In this context, *F-statistic and Log Likelihood Ratio statistic*[14] are calculated to test the joint significance of the lead and / or lagged variables (return and / or volatility) in commodity futures market in establishing the interrelationship with the underlying spot market.

IV. EMPIRICAL FINDINGS

In order to establish the impact of futures trading on agricultural commodity sector in India, an attempt has been made to present the empirical analysis in two different sub-sections called Primary Analysis and Core Analysis. The results of preliminary analysis is discussed first, followed by the Therefore the first part of this section deals with the findings of some preliminary analysis, subsequently followed by the core analysis.

Preliminary Analysis

The descriptive statistics of daily price as well as of daily return series of the selected agricultural commodities traded both in spot and futures segment at NCDEX, reported in *Table T4*, can be primarily used to understand the basic statistical properties of the concerned price and return variables. The table clearly shows that even if the average daily return of all the commodities in both spot and futures market are positive and almost close to zero, the range between maximum and minimum return lies within the range of 0.16 – 1.66 in spot market and of 0.11 – 1.76 in futures market. But the range of two extreme returns for almost all the commodities is comparatively narrow in the futures market, reflecting a lower variation in the commodity futures market in India. The similar conclusion can also be drawn from the standard deviation values which also support the fact that the volatility is comparatively lower, or at least equal, in the commodity futures market. In regards to the return distribution, most of the return series are not highly skewed but possess excess kurtosis

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14. The redundancy of the lead or lagged return and volatility in commodity futures market in explaining the spot market return and / or volatility movement is jointly examined by the F test Log Likelihood Ratio test under the null hypothesis that all the values of respective coefficients are jointly equal to zero.

up to a large extent, reflecting a possibility of again a large variation and the results are mixed among the commodities and also between the spot and futures market.

The results of Augmented Dickey-Fuller Test to examine the stationarity property of the spot and futures price and return series of the selected commodities are summarized in the table *Table T5*. The significance of the ADF statistics clearly shows that the price series, i.e. the price levels, of none of the selected commodities are found to be stationery. But the first difference of the price series, i.e. the price returns, in both the markets and for all the nine commodities are found to be stationary at maximum level (1%) of significance. Therefore, given the fact that differencing of the levels may lead to loose certain information, the whole exercise of establishing the interrelationship between the spot and futures markets would be based on the price returns, rather the price itself. At the same time, the last column of the same table contains the ADF statistics and their significance of the residuals between the spot and futures returns of the selected commodities. The significance (at 1% level) of all the Engel-Granger test-statistic confirms that the spot and futures returns in Indian agricultural commodity market are highly co-integrated in the long run. Accordingly, the effect of such cointegration between the two markets has been incorporated in the core analysis.

The result of testing time-dependent variance, i.e. test of heteroscedasticity, of the return series of all the selected commodities, both in spot and futures markets, is tabulated in the table *Table T6*. The results are quite mixed within the commodities, markets (spot or futures), and also among two different tests. But at least 50 percent of the selected commodities, in either of the markets, posses the heteroscedasticity feature as per either of the two tests. Therefore, keeping in mind that most of the financial asset returns, in general, are heteroscedastic, an effort has been made to do the final analysis both in consideration with and in absence of this statistical property.

The autocorrelation and partial autocorrelation test is carried out to identify the appropriate lags of say p in an AR (p) model, by considering a maximum of 10 lags selected arbitrarily. The results, not presented in the study, clearly shows that most of the commodity return series, both in spot and futures market, fails to possess a significant autocorrelation or partial auto correlation beyond two lags. But the results are not consistent for all commodities. Therefore, in the subsequent analysis an autoregressive lag of 2 is considered for all the return series, irrespective of the actual as depicted by the concerned test. On the other hand, the result of cross-correlation test considering an arbitrary lead and lag of ten, not presented in the study, also depict some mixed result in regard to the significant number of

leads or lags for the selected nine commodities. But at the same time, there is a consistent fact that, other than the contemporaneous relation, at least one lead and lag are found to be significant for all the commodities, whereas two lead and or lag have also shown the necessary significance for some of the commodities. Irrespective of the significance of the cross correlation coefficients both at the necessary leads and lags, the cross correlation values between the current spot returns and lagged futures return shows comparatively higher significance for most of the selected commodities. These results also primarily exhibit the efficiency of commodity futures market in India in disseminating the information faster than the spot market, which may ultimately expected to transform the spot market in more stable and efficient manner.

Core Analysis:

The impact of financial futures on agricultural commodity market in India is basically analyzed through capturing the interrelationship between the spot and futures market. The impact can be estimated both on the returns and volatility of returns. Comparison of daily standard deviation of prices, as a proxy for the volatility, of a list of commodities on which futures contracts are traded is exhibited in *Table T7*. The daily volatility figures, both before and after the introduction of futures contract, clearly depicts the fact that the price volatility for most of the selected agricultural commodities were higher during the pre-futures period and have been significantly reduced after being listed in the commodity futures market. In other words, the underlying market has been found to be stabilized, for most of the commodities, after the initiation of futures trading. The core findings of the study are discussed in the following three sub sections as captured through three different modeling frameworks.

Results of Multiple Regression Analysis:

The results of co-movement or alternatively called lead-lag relationship among the spot and futures markets, as captured in the multiple regression framework, are tabulated in *Table T8* and *Table T9*. Given due importance to the changing nature of residuals or variance, the regression analysis is done both with and without the necessary correction for hetroscedasticity. The regression results derived through the framework with White's correction are only depicted here. The first table (*Table T8*) deals with the spot and futures

returns, where the daily spot return is regressed on its own lagged (2 days) returns, and the past and future futures returns. On the other hand *Table T9* exhibits the results where an attempt has been made to capture the impact of both futures return and volatility on the movement of spot market return in agricultural commodity sector. A lagged error correction term is also included in both the cases to incorporate the impact of cointegration among the spot and futures returns, as proved by the ADF Unit Root test on the residuals depicted in *Table T5*. Regression results, as supported by the cross-correlation figures, reveals that, other than the contemporaneous return, both the lag and lead coefficients of the commodity futures returns are also found to be significant at least for majority of the selected commodities. It is clear from the table that the contemporaneous β coefficient (i.e., β_0) exhibits the highest value almost in all the nine commodities. This suggests that both spot and futures markets would react simultaneously to much of the information. The table reveals that the lagged futures return coefficients are found to be significant up to the first lag for all the commodities and up to both the lags for Wheat, Chilli, Pepper, Soya Oil and Mentha Oil. This suggests a very strong impact of lagged futures return on the current return of spot market. Similarly, the lead coefficients are also found to be significant but mostly up to the first lag, except for Chana, Mastard Seed and Jeera where the lead futures return are at least equivalently stronger to influence the spot market. Therefore, there are some cases, where the information also flows from spot to futures market. Irrespective of the statistical significance of individual lead and lag coefficients, the joint significance test, as revealed by the F-statistic and Log-Likelihood Ratio statistic in the last two columns of *Table T8*, clearly supports the strong relevance of lagged futures return in explaining the movement of spot market return in Indian agricultural commodity sector. The impact of futures market volatility on the spot market return, as exhibited in *Table T9*, is not found to be very significant in most of the selected commodities. Futures return volatility is found to have a contemporaneous impact on the spot return only in case of Chilli, Jeera, and Soya Oil. Whereas the lagged futures return volatility shows some significant impact in case of Jeera and Soya Oil. Therefore, there is a significant volatility spillover from futures to spot market in case of these two commodities. On the other hand, the volatility spillover from spot to futures market, as supported by the significance of the lead futures volatility coefficient, has been seen only in case of Castor Seed and Soya Oil. Therefore the futures return volatility affecting the spot return is found to be strongest in case of Soya Oil. It is surprisingly being seen that there is no significant lead-lag relationship between the spot and futures market in case of Castor Seed. Both the market

for this commodity reacts simultaneously. In regards to the joint significance of both return and volatility in futures market, after the contemporaneous figures, the lagged futures coefficients are found to be stronger for almost all the commodities except in case of Soya Oil.

Results of Vector Auto Regression Analysis:

The above results of a multiple regression equation on the lead-lag relationship among the spot and futures returns and volatility of returns are also supported by a bi-variate VAR (p, q) model where the number of lags selected for both the variable are two, as supported by the correlation tests. The VAR results among the spot and futures returns, and among the volatility of such returns are respectively reported in *Table T10*, and in *Table T11* and *T12*. While capturing the volatility interdependence between the spot and futures markets under the VAR framework, an effort has been made to use two proxy measure of volatility viz. the residuals derived from the simple OLS method on return series, and the residuals derived from the GARCH (1, 1) method on the respective return series. Two proxy volatility measures are used to verify the consistency in the results derived with and without the assumption of constant return variance. As in case of the previous regression model, here also lags of two daily intervals are considered for both the return and volatility series. This model also includes the error correction term as an exogenous variable and therefore have considered in both the equations of the model checking the only the return interdependence.

The individual significance of the lagged futures (spot) returns on the return of spot (futures) market are almost consistent with the results of multiple regression as discussed in the above section. The lagged futures return, both at first and second order, in explaining the spot return movement are found to be significant in case of five (Chana, Wheat, Chilli, Pepper and Soya Oil) out of nine selected commodities. On the other hand, the impact of lagged (both the orders) spot return on the current futures return shows greater significance in case of Chana, Jeera and Mastard Seed. Except for Castor Seed and Soya Oil, there is a bi-directional flow of information at least with one day lag. The VAR result for Castor Seed also confirms no interdependence between the spot and futures market. Irrespective of the individual significance of different lagged returns both in spot and futures market, the result of VAR Granger Causality / Block Exogeneity Wald test are used to verify the direction of causation between the spot and futures returns. The results shows that even if there is a significant bi-directional flow of information for almost all the commodities (except for

Wheat, Chilli, and Castor Seed), the causality from futures to spot market is stronger in all the other six commodities.

Similarly, the results of volatility interdependence between the spot and futures markets, in the VAR framework, are tabulated in *Table T11* and *T12*. These results are little different from that of the multiple regression analysis. Here, the variables both in spot and futures market are the volatility of returns represented by two different proxy measures as defined in the above section. Unlike in case of return interdependence, the interdependence between the return volatility in spot and futures market are found to be mixed in nature depending on the proxy volatility measure used in the VAR framework. The results depicted in *Table T11* shows bi-directional volatility spillover for more than 50 percent of the selected commodities, viz. Chana, Jeera, Pepper, Mastard Seed and Mentha Oil, in either of the first or second lag, or the both. But the significance of only the lagged coefficients of futures return volatility in case of Wheat, Chilli, and Soya Oil strongly suggests a unidirectional volatility spillover from futures to spot market for those commodities. At the same time, like in case of return spillover, there is again no interdependence between the spot and futures markets for Castor Seed in terms of volatility. On the other hand, there is absolutely no volatility inter-linkages between both the markets in case of Chana, Wheat, Mastard Seed, Castor Seed and Soya Oil, as depicted in *Table T12* where the GARCH residuals are considered as the proxy volatility measure. This significant divergence in the results of similar analysis may be attributed to the use of GARCH residuals as the proxy measure of volatility. Since the assumption of time variant volatility is more valid in financial time series, the result depicted in *Table T12* may considered to be more robust and practical. As per this table, the bi-directional volatility spillover has been observed strongly in case of Pepper, and weakly in case of Mentha Oil. At the same time, the unidirectional volatility spillover from futures to the spot market has been found to be significant only in case of Chilli and Jeera. Apart from the individual significance of these lag coefficients both the markets in explaining the movement of the other markets, the Granger Causality test reveals a bi-directional causation for one-third of the selected commodities, viz. Chana, Pepper, and Mentha Oil. Similarly, the futures market volatility found to have a significant causation on the volatility of the spot market for Chilli and Jeera. But in case of Mastard Seed, the spot market has found to be stronger in affecting the volatility of the futures market. In support with the individual test of significance, the Granger Causality test also rejects any causation between the spot and futures markets for one-third of the commodities, viz. Wheat, Castor Seed, and Soya Oil.

Above all, the results of these two tables clearly indicate that the selection of proxy measure of volatility plays a very important role in capturing the volatility interdependence between two segments of the financial markets.

Results of GARCH Analysis:

Apart from examining separately the return and volatility interdependence between the spot and futures markets for the selected agricultural commodities in India, an effort has also been made to capture the complete linkages, both in returns and volatility of returns, in a well known GARCH (1, 1) framework with the necessary exogenous variables. The concerned GARCH (1, 1) model through its two equations has tried to capture the impact of futures return and volatility on the spot return in the first equation, and the impact of conditional volatility of futures return on the same of spot return in the following equation. The results are tabulated in *Table T13*. Apart from testing the individual significance of all the coefficients of both the equations, a joint significance test, only for futures return and volatility, is also carried out to verify the joint significance of the concerned variables taken together. The first panel of the table deals with the result of the conditional mean equation in a GARCH (1, 1) framework, whereas the results of the conditional variance equation are presented in the second panel, followed by the joint significance test in the third panel. The results are quite consistent with the same derived through other frameworks as discussed above. The tables clearly reveal that the contemporaneous futures return coefficients in the first panel are found to be significant with a maximum degree for all the nine commodities. There are also some commodities where futures market leads the spot market with greater degree, and vice versa. The joint significance tests on the futures return series confirm significant bi-directional interdependence, with stronger causation from futures to spot. On the other hand, even if the futures return volatility failed to show some significant impact on the spot return, the same has found to have a significant impact on the spot return volatility. But other than the contemporaneous series, the lead coefficients of the futures return volatility, in the conditional variance equation, are found to be significant for all the selected commodities. This ensures the fact that, unlike as claimed by common market participants; the volatility tends to flow from the spot to futures market, not the other way. The joint significant of the futures return volatility shows comparatively poor interdependence between the markets, as indicated by the other models. The reason may be the inclusion of the futures return volatility series also in the conditional mean equation where the same series hardly

shows any significant impact. But overall it is quite clear from the results that other than being having a contemporaneous movement, the futures market volatility hardly play any role to increase the volatility of the spot market for most of the selected agricultural commodities.

Therefore, even if there is strong bi-directional interdependence between the spot and futures market in terms of returns, the volatility interdependence, irrespective of the significant contemporaneous relation, is almost unidirectional from spot to futures market.

V. CONCLUSION

In its long history of trading in commodities and related derivatives, Indian commodity, especially agricultural commodity market has seen several developments between two extreme scenarios: protection of the essential commodity market through government intervention and the opening up of the sector and getting the necessary protection through market based instruments like commodity futures contract. But there is always been a doubt, as expressed by different bodies, on the usefulness and suitability of futures contract in developing the underlying agricultural commodity market, especially in agricultural based economy like India.

Therefore, besides the availability of several committee reports and research studies favoring the utility of futures contract on commodities, a further attempt has been made to re-validate the positive impact of futures trading on agricultural commodity market in India. The daily price information in spot and futures markets, for a period of 7 years (2004 – 2010), for 9 major agricultural commodities, taken from different categories of Agri-products, are incorporated into various econometric models to test the concerned objective. Like other studies undertaken on world and Indian commodity market, the present study have also exhibited that even though the inflationary pressure on commodity, especially agricultural commodity, prices have gone up sharply after the introduction of commodity futures contracts, the destabilizing effect of the futures contract is casual in nature and tends to vary over a long period of time. Therefore, even if the spot prices of few agricultural commodities in India are destabilized during the post commodity futures period, it is very difficult to come out with a straight forward statement regarding the un-usefulness and irrelevance of futures contract in commodity, especially on essential agricultural commodities. The empirical findings significantly shows that comparative advantage of futures market in disseminating

information, leading to a significant price discovery and risk management, can help to successfully develop the underlying commodity market in India. Not only the primary analysis, but also the core analysis of interdependence between the spot and futures market in agricultural commodity sector supports the relevance of futures trading in Indian commodity market, even if at the cost of temporary imbalances. The presence of bidirectional causation between the spot and futures market, even with stronger flow of information from futures to spot market, not only prove the efficiency of both the markets, but also confirm the stronger efficiency of futures market, leading the spot market to become more efficient. At the same time, insignificant volatility spillover from futures to spot market also suggests the fact that trading of commodity futures contract shall not essentially be accounted for the rising volatility in the spot market, and the rising inflationary pressure in Indian economy, at least for the essential agricultural commodities.

Besides several facts and figures, what is more important, as claimed in several other reports, is to ensure and strengthen the market structure, such as integration of wide-spread spot markets, wider participation in futures trading (e.g. by bankers, farmers, investors, etc.), availability of necessary transport and storage infrastructure facility, necessary reforms and sufficient clarity in the concerned acts, cohesion in different regulatory bodies (such as FMC, RBI, SEBI), etc. A successful history of futures trading, with a proper regulatory framework, is very essential to develop the underlying commodity market of a fast growing economy, may be with a possibility of short-lived imbalances and difficulties.

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Table T1: Annual Growth in Total and Agricultural & Allied Sector GDP in India

Year	Total GDP (at Current Prices – Rs. In Crore)	% Share in GDP – (Agriculture and Allied Sectors)	Total GDP Growth	GDP Growth (Agri. & Allied Sector)
2000 - 01	1925017 (1864300)	23.35 (23.89)	7.8 (4.4)	0.7 (-0.2)
2001 - 02	2097726 (1972606)	23.20 (23.99)	9.0 (5.8)	8.2 (6.3)
2002 - 03	2261415 (2048287)	20.87 (21.43)	7.8 (3.8)	-0.3 (-7.2)
2003 – 04	2538171 (2222758)	20.97 (21.72)	12.2 (8.5)	12.8 (10)
2004-05	2877706 (2388384)	19.20 (20.20)	13.4 (7.5)	3.8 (0.0)
2005-06	3275670 (2612847)	18.80 (19.56)	13.8 (9.4)	11.5 (5.9)
2006-07	3790063 (2864309)	18.30 (18.51)	15.7 (9.6)	12.9 (3.8)
2007-08	4540987 (3893457)	(17.96)	(9.2)	(4.7)
2008-09	5228650 (4154973)	(17.18)	(6.7)	(1.6)
2009-10	5868331 (4464081)	(17.12)	(7.4)	(0.2)
2010 (Jan. to Mar.)			(8.6)	(0.7)
2010 (July to Sept.)	1664088 (1146637)	25.4 (4.4)	18.7 (8.9)	

Source: Central Statistical Organization (CSO) and Department of Agriculture and Cooperation.
Figures in Parenthesis are expressed at constant price of 1999-2000 or 2004-05 (for 2007-08 Onwards)

Table T2: Growth Rates of Production of Principal Crops in India from 1994-95 to 2009-10

(Taking the Price of 1993-94 as the Base Price, as Rs.100)

Crop	Wheat	Total Cereals	Total Pulses	Total Food Grains	Rapeseed & Mustard	Soyabean	Total Oilseeds	All Principal Crops
1994-95	9.91	3.68	8.93	4.37	6.03	-17.16	1.88	5.77
1995-96	-5.60	-5.51	-14.60	-6.81	4.19	29.60	2.00	-2.54
1996-97	11.69	9.37	16.91	10.43	11.00	5.49	8.96	8.68
1997-98	-4.32	-2.29	-6.57	-2.89	-29.33	20.22	-12.99	-5.08
1998-99	7.45	5.10	15.18	6.44	20.43	10.52	14.07	7.85
1999-00	7.13	4.24	-11.54	1.95	2.20	-0.86	-15.54	-1.79
2000-01	-8.76	-5.57	-18.20	-7.16	-27.66	-25.50	-7.99	-6.00
2001-02	4.43	7.83	22.02	9.41	21.39	13.02	9.98	7.62
2002-03	-9.63	-18.71	12.34	-14.86	-23.67	-21.94	-23.25	-13.20
2003-04	9.73	21.04	33.10	22.57	62.16	67.98	53.74	21.00
2004-05	-4.88	-6.48	-10.74	-7.06	20.69	-12.06	-0.59	-1.63
2005-06	1.05	6.27	2.28	5.75	7.09	20.32	14.34	12.16
2006-07	9.30	3.82	6.29	4.13	-8.53	6.98	-9.56	14.33
2007-08	3.65	6.37	3.97	6.21	-21.57	23.92	11.45	3.17
2008-09	2.68	1.80	-1.32	1.60	23.43	-9.69	-14.74	-6.88
2009-10	0.04	-7.41	0.22	-6.94	-10.94	1.42	6.15	-6.69
Avg. Growth	2.12	1.47	3.64	1.70	3.56	7.02	2.37	2.30

Source: Directorate of Economics and Statistics, Department of Agriculture and Cooperation

Table T3: Economic Growth vs. Growth in Commodity Futures Trading in Different Countries

Country	Indicator Name	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
India (r = 0.76)**	GDP growth (annual %)	4.03	5.22	3.77	8.37	8.28	9.30	9.44	9.63	5.12	7.66
	Agriculture, value added (% of GDP)	23.35	23.20	20.87	20.97	18.88	18.81	18.12	17.96	17.18	17.12
	Growth in Agri. Commodity Derivatives	NA	NA	NA	NA	NA	447.82	39.52	-44.44	-33.52	33.90
China (r = 0.36)*	GDP growth (annual %)	8.40	8.30	9.10	10.00	10.10	11.30	12.70	14.20	9.60	9.10
	Agriculture, value added (% of GDP)	15.06	14.39	13.74	12.80	13.39	12.12	11.11	10.77	10.73	10.35
	Growth in Agri. Commodity Derivatives	NA	234.74	130.34	54.84	17.45	13.27	20.69	81.99	39.67	15.71
France (r = 0.13)	GDP growth (annual %)	3.91	1.85	1.03	1.09	2.47	1.90	2.22	2.37	0.22	-2.63
	Agriculture, value added (% of GDP)	2.84	2.85	2.70	2.48	2.45	2.28	2.10	2.21	2.04	1.74
Germany (r = -0.04)	GDP growth (annual %)	3.21	1.24	0.00	-0.22	1.21	0.75	3.37	2.66	0.99	-4.72
	Agriculture, value added (% of GDP)	1.26	1.36	1.15	0.98	1.10	0.87	0.85	0.96	0.90	0.81
Mexico (r =-0.60)**	GDP growth (annual %)	6.60	-0.16	0.83	1.35	4.05	3.21	4.93	3.34	1.49	-6.54
	Agriculture, value added (% of GDP)	4.17	4.15	3.94	3.99	3.85	3.72	3.67	3.68	3.66	4.27
Spain (r = 0.00)	GDP growth (annual %)	5.05	3.65	2.70	3.10	3.27	3.61	4.02	3.56	0.86	-3.64
	Agriculture, value added (% of GDP)	4.38	4.26	4.02	3.96	3.62	3.20	2.79	2.88	2.66	2.66
U K (r = 0.04)	GDP growth (annual %)	3.92	2.46	2.10	2.81	2.95	2.17	2.85	2.56	0.55	-4.92
	Agriculture, value added (% of GDP)	0.99	0.92	0.94	0.97	1.00	0.67	0.66	0.69	0.78	0.72
Europe	Growth in Agri. Commodity Derivatives	NA	0.40	20.53	17.43	20.54	6.14	15.91	29.77	3.61	-8.34
South Africa (r = 0.74)**	GDP growth (annual %)	4.15	2.74	3.67	2.95	4.55	5.28	5.60	5.49	3.68	-1.78
	Agriculture, value added (% of GDP)	3.27	3.51	4.15	3.43	3.11	2.67	2.88	3.37	3.19	3.03
	Growth in Agri. Commodity Derivatives	NA	122.16	96.75	16.83	-17.73	-6.41	8.01	24.78	7.30	-25.66
USA (r = 0.29)	GDP growth (annual %)	4.17	1.09	1.83	2.50	3.58	3.06	2.67	1.95	0.00	-2.63
	Agriculture, value added (% of GDP)	1.19	1.18	1.01	1.20	1.34	1.21	1.04	1.14	1.23	NA
	Growth in Agri. Commodity Derivatives	NA	-2.92	16.19	-3.89	7.65	22.87	52.10	8.11	14.78	-10.30
World (r = 0.09)	GDP growth (annual %)	4.28	1.60	1.96	2.67	4.08	3.58	4.01	3.93	1.55	-1.95
	Agriculture, value added (% of GDP)	3.58	3.53	3.48	3.45	3.40	3.10	2.90	2.91	2.87	NA
	Growth in Agri. Commodity Derivatives	NA	-15.30	28.64	43.49	5.53	9.59	29.57	52.93	39.64	3.69

Source: Website of World Bank, Respective Commodity Exchanges, and Futures Industry Association (FIA)

P.N.: Agricultural Growth in different European countries is compared with the overall growth in Agricultural Commodity Derivatives traded in NYSE Euronext exchange.
Commodity Derivative Exchanges considered here are: NCDEX (India), DCE (China), Euronext (Europe), JSE (Africa), and CME (USA)
Figures in parenthesis represent the coefficient of correlation between share of agriculture in the GDP and growth of agri commodity derivatives in respective countries.
** indicate strongly significant, and * indicate moderately significant.

Table T4: Descriptive Statistical Measures of Spot and Futures Prices and Returns

Descriptive Statistics	Chana		Chilli		Castor Seed		Jeera		Mentha Oil		Mastard Seed		Pepper		Soya Oil		Wheat	
	Spot	Futures	Spot	Futures	Spot	Futures	Spot	Futures	Spot	Futures	Spot	Futures	Spot	Futures	Spot	Futures	Spot	Futures
Price Series:																		
Mean	2190	2146	4749	4860	988	875	9996	10214	560	586	448	443	10090	10164	448	447	1038	1042
Median	2231	2195	4786	4920	401	395	10587	10942	559	569	424	416	10039	10246	450	449	1005	1033
Maximum	3318	3239	7109	7148	3784	3775	15654	15048	872	869	670	655	16344	15776	719	718	1449	1455
Minimum	1435	1351	2563	2615	270	277	4877	5722	388	405	319	309	5444	5826	339	337	769	718
Range	1883	1888	4546	4534	3514	3498	10777	9326	484	464	351	346	10900	9950	380	381	680	737
Std. Dev.	381	395	816	931	1104	1038	2471	2414	110	99	97	96	3320	3393	60	61	190	198
Skewness	0.01	-0.08	-0.17	-0.40	1.34	1.69	-0.18	-0.25	0.70	0.62	0.46	0.52	0.19	0.17	0.79	0.76	0.39	0.21
Kurtosis	3.20	3.21	3.09	3.19	3.00	4.03	2.01	1.86	2.87	2.75	1.88	2.02	1.37	1.31	4.84	4.80	1.97	2.06
Return Series:																		
Mean	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Median	0.00	0.00	-0.00	-0.00	0.00	0.00	-0.00	-0.00	0.00	0.00	0.00	0.00	-0.00	-0.00	-0.00	-0.00	0.00	0.00
Maximum	0.16	0.09	0.30	0.15	1.59	1.60	0.16	0.07	0.36	0.10	0.13	0.08	0.08	0.06	0.05	0.05	0.13	0.10
Minimum	-0.16	-0.07	-0.37	-0.46	-0.07	-0.17	-0.08	-0.04	-0.31	-0.10	-0.14	-0.05	-0.08	-0.08	-0.27	-0.26	-0.18	-0.12
Range	0.32	0.16	0.66	0.61	1.66	1.76	0.25	0.11	0.67	0.19	0.27	0.14	0.16	0.14	0.32	0.30	0.31	0.22
Std. Dev.	0.02	0.01	0.03	0.02	0.04	0.04	0.02	0.01	0.03	0.02	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.01
Skewness	-0.85	0.16	-0.83	-10.00	33.24	34.00	1.03	1.20	0.93	-0.04	-1.30	0.17	0.20	0.08	-7.25	-9.75	-1.93	-0.40
Kurtosis	21.37	6.94	31	253	1192	1230	10.23	9.01	52.32	8.70	32.59	9.36	5.11	9.11	178	263	35.82	16.39
Obs.	1616	1616	995	995	1389	1389	1585	1585	1177	1177	1858	1858	1413	1413	1811	1811	1015	1015

Table T5: Test of Stationarity in Spot and Futures Prices of Selected Commodities and of Residuals

Augmented Dickey-Fuller test statistic (t-Statistic)					
	Spot Price		Futures Price		Residual
	Level	1st Difference	Level	1st Difference	
CHANA	-1.973	-38.919**	-2.393	-40.388**	-7.614***
	(0.299)	(0.000)	(0.144)	(0.000)	(0.000)
WHEAT	-1.380	-34.404**	-1.331	-32.484**	-5.935***
	(0.593)	(0.000)	(0.617)	(0.000)	(0.000)
CHILLI	-2.483	-25.351**	-3.709	-28.577**	-5.232***
	(0.120)	(0.000)	(0.004)	(0.000)	(0.000)
JEERA	-0.939	-18.484**	-1.525	-38.182**	-6.199***
	(0.776)	(0.000)	(0.521)	(0.000)	(0.000)
PEPPER	-1.005	-21.750**	-1.189	-36.925**	-7.108***
	(0.754)	(0.000)	(0.681)	(0.000)	(0.000)
MASTARD SEED	-1.292	-29.637**	-1.439	-40.849**	-5.735***
	(0.635)	(0.000)	(0.564)	(0.000)	(0.000)
CASTOR SEED	0.687	-37.098**	0.569	-37.830**	-3.414***
	(0.992)	(0.000)	(0.989)	(0.000)	(0.011)
SOYA OIL	-1.950	-36.642**	-2.068	-39.693**	-7.684***
	(0.309)	(0.000)	(0.258)	(0.000)	(0.000)
MENTHA OIL	-1.791	-29.146**	-1.781	-21.914**	-4.610***
	(0.385)	(0.000)	(0.390)	(0.000)	(0.000)

P.N. Figures in parenthesis are the respective probabilities of being significant
** represent significant at 1% level; * represent significant at 5% level

Table T6: Test of Hetroscedasticity in Spot and Futures Return of Selected Commodities

	ARCH Test (F - Statistic)		White Heteroskedasticity Test (F - Statistic)	
	Spot Return	Futures Return	Spot Return	Futures Return
CHANA	33.039**	1.064	15.169**	1.155
	(0.000)	(0.345)	(0.000)	(0.329)
WHEAT	6.140	0.825	6.967	7.229**
	(0.002)	(0.438)	(0.000)	(0.000)
CHILLI	0.904	3.824**	1.282	2.382*
	(0.405)	(0.022)	(0.269)	(0.037)
JEERA	37.627**	9.033**	18.458**	14.285**
	(0.000)	(0.000)	(0.000)	(0.000)
PEPPER	41.723**	41.070**	29.776**	20.864**
	(0.000)	(0.000)	(0.000)	(0.000)
MASTARD SEED	57.878**	1.492	32.497	2.713*
	(0.000)	(0.225)	(0.000)	(0.019)
CASTOR SEED	0.001	0.005	33.754**	12.576**
	(0.999)	(0.995)	(0.000)	(0.000)
SOYA OIL	0.137	0.002	1.133	0.098
	(0.872)	(0.998)	(0.341)	(0.992)
MENTHA OIL	54.648**	57.878***	26.173**	32.497**
	(0.000)	(0.000)	(0.000)	(0.000)

P.N. Figures in parenthesis are the respective probabilities of being significant
** represent significant at 1% level; * represent significant at 5% level

Table T7: Daily Spot Price Volatility in Major Agricultural Commodities:

Commodities	Volatility		No. of Observation		Volatility Status (Post Futures)
	Pre Futures	Post Futures	Pre Futures	Post Futures	
Potatoes	245.9	68.4	441	441	Stabilized
Turmeric	90.7	15.3	643	792	Stabilized
Chilly	78.5	43.9	430	430	Stabilized
Jeera	47.7	13.8	665	665	Stabilized
Wheat	43.6	17	814	814	Stabilized
RM Seed	26.5	11.4	938	938	Stabilized
Maize	29.6	14.6	689	689	Stabilized
Urad	36.7	25	312	753	Stabilized
Soybean	27.5	16	792	792	Stabilized
Pepper	28.2	17.8	970	970	Stabilized
Guar Seed	38.5	28.9	895	895	Stabilized
Soybean Oil	18.1	9.7	939	939	Stabilized
Gur	27.7	19.5	689	689	Stabilized
Rubber	24	17.5	574	1062	Stabilized
Sugar	10.8	8.2	818	818	Stabilized
Chana	22.6	22.6	815	895	Unstabilized
Castor Seed	16.9	17	796	1011	Unstabilized
Raw Jute	12.9	16	689	689	Unstabilized
Guar Gum	40.3	43.4	824	824	Unstabilized

Source: NCDEX; Presented in Abhijit Sen Committee Report, 2008.

Table T8: Result of Regressing Spot Return on Its Own Lagged Return, and the Lagged and Lead Futures Return

Agri Commodity	Constant	Spot (-1)	Spot (-2)	Futures (-2)	Futures (-1)	Futures (0)	Futures (1)	Futures (2)	ECT (-1)	F-stat (LR-stat)	
										Futures (-1 & -2)	Futures (1 & 2)
CHANA	0.000	-0.163**	0.041	-0.018	0.316**	0.379**	0.046**	0.049**	0.000**	167.77**	10.07**
	(0.516)	(-4.273)	(1.385)	(-0.776)	(7.495)	(11.639)	(2.684)	(2.598)	(-5.156)	(306.35)**	(20.12)**
WHEAT	0.000	-0.056	0.083	0.079**	0.093**	0.159**	0.012	0.030	0.000**	9.67**	0.79
	(1.026)	(-1.121)	(1.778)	(3.134)	(3.365)	(3.952)	(0.397)	(1.154)	(-5.011)	(19.32)**	(1.59)
CHILLI	0.000	0.091	-0.031	0.221	0.061**	0.175**	0.030**	-0.028	0.000**	82.92**	2.96
	(0.369)	(1.520)	(-0.645)	(1.948)	(2.385)	(3.133)	(2.361)	(-1.544)	(-3.357)	(154.63)**	(5.96)
JEERA	0.000	-0.067	0.028	0.000	0.158**	0.218**	0.024*	0.021*	0.000**	117.72**	6.50**
	(1.680)	(-1.771)	(0.866)	(0.029)	(9.459)	(17.848)	(2.177)	(2.098)	(-7.986)	(220.64)**	(13.01)**
PEPPER	0.000	-0.192**	0.048	0.047**	0.329**	0.305**	0.004	0.041**	0.000**	318.99**	9.10**
	(1.064)	(-5.785)	(1.844)	(2.873)	(16.850)	(20.178)	(0.287)	(3.767)	(-7.971)	(529.00)**	(18.19)**
MASTARD SEED	0.000	0.010	-0.081**	-0.002	0.200**	0.311**	0.066**	0.043**	0.000**	73.09**	14.80**
	(0.565)	(0.238)	(-2.706)	(-0.084)	(5.476)	(9.283)	(3.728)	(2.493)	(-5.704)	(141.35)**	(29.52)**
CASTOR SEED	0.002	0.020	0.024	0.018	0.016	-0.070*	0.003	-0.014	0.000	0.39	0.14
	(1.517)	(0.735)	(0.540)	(0.462)	(0.538)	(-2.078)	(0.482)	(-0.738)	(-1.034)	(0.79)	(0.29)
SOYA OIL	0.000	-0.173**	-0.040	0.051*	0.265**	0.679**	0.022	-0.014	0.000**	86.13**	2.60
	(0.084)	(-3.443)	(-1.305)	(1.980)	(8.578)	(8.250)	(0.823)	(-0.834)	(-6.163)	(165.32)**	(5.22)
MENTHA OIL	0.000	-0.040	-0.121**	0.049	0.132**	0.362**	0.100**	0.059	0.000**	23.89**	27.44**
	(0.668)	(-0.694)	(-2.653)	(1.862)	(2.759)	(5.884)	(3.859)	(1.701)	(-2.690)	(47.18)**	(54.04)**

P.N. Figures in parenthesis are the respective t-statistics to exhibit the level of significant of the respective variable
** represent significant at 1% level; * represent significant at 5% level

Table T9: Result of Regressing Spot Return on Its Own Lagged Return, and the Lagged and Lead Futures Return and their Volatilities

Agri Commodity	Constant	Spot (-1)	Spot (-2)	Futures (-2)	Futures (-1)	Futures Vol. (-1)	Futures (0)	Futures Vol. (0)	Futures (+1)	Futures (+2)	Futures Vol. (+1)	ECT (-1)
CHANA	0.000	-0.169**	0.043	-0.015	0.333**	-21.87	0.387**	11.948	0.050**	0.051**	11.401	0.000**
	(-0.937)	(-4.472)	(1.461)	(-0.671)	(7.485)	(-1.455)	(11.662)	(0.557)	(2.958)	(2.787)	(0.773)	(-5.229)
F-stat (LR-stat)				120.16** (327.50**)			342.17** (573.88**)		9.96** (29.82**)			
WHEAT	0.000	-0.064	0.083	0.077**	0.095**	-0.080	0.191**	-0.441	0.014	0.035	1.762	0.000**
	(-0.136)	(-1.252)	(1.774)	(2.955)	(3.369)	(-0.180)	(3.769)	(-0.686)	(0.477)	(1.307)	(1.872)	(-4.986)
F-stat (LR-stat)				6.16** (18.53**)			25.44** (50.21**)		5.05** (15.21**)			
CHILLI	0.002	0.084	-0.074	0.201**	0.073**	-0.847	0.153**	0.268**	0.028**	-0.023	-0.072	0.000**
	(1.484)	(0.985)	(-0.862)	(2.790)	(4.223)	(-1.526)	(5.127)	(2.356)	(2.336)	(-1.349)	(-0.369)	(-4.062)
F-stat (LR-stat)				110.23** (288.32**)			60.13** (114.82**)		1.96 (5.93)			
JEERA	0.001*	-0.068	0.033	-0.006	0.171**	2.230**	0.220**	-2.427*	0.024**	0.019	-0.520	0.000**
	(2.056)	(-1.740)	(1.025)	(-0.386)	(11.039)	(2.691)	(17.075)	(-2.048)	(2.178)	(1.972)	(-0.523)	(-7.682)
F-stat (LR-stat)				81.96** (230.15**)			305.71** (520.18**)		4.39** (13.21**)			
PEPPER	0.000	-0.189**	0.053*	0.044**	0.327**	10.781	0.309**	12.938	0.004	0.041**	-22.847	0.000**
	(-0.266)	(-5.854)	(2.024)	(2.645)	(17.364)	(0.764)	(19.552)	(0.566)	(0.301)	(3.756)	(-1.450)	(-7.805)
F-stat (LR-stat)				207.44** (519.00**)			495.16** (754.77**)		8.80** (26.37**)			
MASTARD SEED	0.000	0.004	-0.076**	-0.001	0.218**	-0.694	0.321**	0.617	0.066**	0.044**	0.962	0.000**
	(-0.620)	(0.099)	(-2.580)	(-0.059)	(5.079)	(-1.520)	(7.942)	(0.634)	(3.753)	(2.558)	(1.010)	(-5.880)
F-stat (LR-stat)				55.24** (159.72**)			233.45** (418.81**)		14.33** (42.77**)			
CASTOR SEED	0.001	-0.006	0.015	0.422	0.355	-0.165	0.333*	-0.134	0.016	-0.015	-0.159**	0.000
	(1.345)	(-1.705)	(0.796)	(0.988)	(1.890)	(-0.986)	(2.000)	(-1.936)	(1.343)	(-0.703)	(-2.357)	(-1.065)
F-stat (LR-stat)				11.01** (32.91**)			12.43** (24.85**)		5.55** (16.71**)			
SOYA OIL	0.000*	-0.079	-0.009	0.016	0.249**	-9.163**	0.565**	38.530**	0.027	-0.015	-27.329**	0.000**
	(-2.062)	(-1.849)	(-0.382)	(0.753)	(8.358)	(-4.633)	(23.027)	(13.319)	(1.028)	(-0.928)	(-13.056)	(-7.897)
F-stat (LR-stat)				63.34** (181.82**)			1755.36** (1957.56**)		91.40** (256.86**)			
MENTHA OIL	0.001*	-0.054	-0.136**	0.071*	0.135**	-2.800	0.365**	1.207	0.113**	0.044	0.312	0.000**
	(2.092)	(-0.976)	(-3.017)	(2.244)	(2.738)	(-1.901)	(5.899)	(0.413)	(4.435)	(1.783)	(0.105)	(-3.145)
F-stat (LR-stat)				28.26** (82.67**)			247.96** (417.10**)		19.82** (58.59**)			

P.N. Figures in parenthesis are the respective t-statistics to exhibit the level of significant of the respective variable

** represent significant at 1% level; * represent significant at 5% level

Table T10: VAR Results among Spot and Futures Return of Selected Commodities

$$R_{S,t} = \alpha_0 + \sum_{i=1}^{p} \alpha_i R_{S,t-i} + \sum_{j=1}^{q} \beta_j R_{F,t-j} + \delta Z_{t-1} + \varepsilon_{S,t} \qquad R_{F,t} = \alpha_0 + \sum_{i=1}^{p} \alpha_i R_{F,t-i} + \sum_{j=1}^{q} \beta_j R_{S,t-j} + \delta Z_{t-1} + \varepsilon_{F,t}$$

	CHANA		**WHEAT**		**CHILLI**	
	Spot	Futures	Spot	Futures	Spot	Futures
Constant	0.000	0.000	0.000	0.000	0.000	0.000
	(0.757)	(0.450)	(1.198)	(0.851)	(0.442)	(0.178)
Spot (-1)	-0.126**	0.084*	-0.050	0.013	0.099**	0.053
	(-4.266)	(2.025)	(-1.616)	(0.352)	(3.268)	(0.938)
Spot (-2)	0.084**	0.105**	0.092**	0.034	-0.054	-0.128*
	(3.166)	(2.823)	(2.991)	(0.900)	(-1.826)	(-2.327)
Futures (-1)	0.309**	-0.012	0.086**	-0.038	0.077**	0.078*
	(14.257)	(-0.409)	(3.213)	(-1.149)	(4.138)	(2.276)
Futures (-2)	-0.055*	-0.093**	0.065*	-0.084	0.227**	0.043
	(-2.420)	(-2.887)	(2.423)	(-2.578)	(12.193)	(1.258)
ECT (-1)	0.000**	0.000**	0.000**	0.000	0.000**	0.000
	(-3.790)	(3.236)	(-5.595)	(1.235)	(-4.255)	(1.426)
Futures cause Spot	249.927**		14.705**		162.084**	
Spot cause Futures	10.124**		0.902		5.714	
	JEERA		**PEPPER**		**MASTARD SEED**	
	Spot	Futures	Spot	Futures	Spot	Futures
Constant	0.000	0.000	0.000	0.000	0.000	0.000
	(1.763)	(0.648)	(1.038)	(0.330)	(0.840)	(0.540)
Spot (-1)	-0.021	0.179*	-0.198**	-0.023	0.062*	0.142**
	(-0.735)	(2.576)	(-6.022)	(-0.335)	(2.402)	(3.972)
Spot (-2)	0.063*	0.131*	0.104**	0.182**	-0.057*	0.071*
	(2.393)	(2.056)	(4.021)	(3.375)	(-2.342)	2.095)
Futures (-1)	0.158**	0.011	0.357**	0.088*	0.198**	0.006
	(12.773)	(0.356)	(20.510)	(2.422)	(10.575)	(0.247)
Futures (-2)	-0.024	-0.101*	0.040*	-0.039	-0.029	-0.074**
	(-1.868)	(-3.235)	(2.105)	(-0.972)	(-1.503)	(-2.783)
ECT (-1)	0.000**	0.000	0.000**	0.000**	0.000**	0.000**
	(-6.645)	(1.658)	(-5.187)	(2.979)	(-4.132)	(2.677)
Futures cause Spot	183.096**		452.140**		121.430**	
Spot cause Futures	10.474**		11.896**		19.985**	
	CASTOR SEED		**SOYA OIL**		**MENTHA OIL**	
	Spot	Futures	Spot	Futures	Spot	Futures
Constant	0.002	0.002	0.000	0.000	0.000	0.000
	(1.292)	(1.456)	(0.116)	(0.102)	(0.880)	(0.384)
Spot (-1)	0.019	0.003	-0.128**	0.069	0.078*	0.244**
	(0.727)	(0.118)	(-3.111)	(1.400)	(2.239)	(4.792)
Spot (-2)	0.025	-0.015	-0.102**	-0.089	-0.062	0.091
	(0.933)	(-0.556)	(-2.677)	(-1.935)	(-1.811)	(1.810)
Futures (-1)	0.019	-0.039	0.280**	0.019	0.127**	0.039
	(0.712)	(-1.429)	(7.881)	(0.451)	(5.374)	(1.130)
Futures (-2)	0.019	-0.018	0.083*	0.045	-0.003	-0.079*
	(0.722)	(-0.648)	(2.381)	(1.070)	(-0.108)	(-2.290)
ECT (-1)	0.000**	0.000	0.000**	0.000	0.000	0.000**
	(-4.433)	(0.058)	(-4.208)	(1.035)	(-1.742)	(3.751)
Futures cause Spot	0.982		62.182**		29.307**	
Spot cause Futures	0.321		7.209*		25.496**	

P.N.: Figures in parenthesis are the respective t-statistics; Overall Causation is tested through VAR Granger Causality/Block Exogeneity Wald Tests (Chi-sq statistic)

Table T11: VAR Results among Spot and Futures Return Volatility (OLS Residual)

	CHANA		WHEAT		CHILLI	
	Spot Volatility	Futures Volatility	Spot Volatility	Futures Volatility	Spot Volatility	Futures Volatility
Constant	0.000	0.000	0.000	0.000	0.000	0.000
	(0.028)	(0.003)	(-0.018)	(-0.001)	(0.002)	(-0.006)
Spot Vol (-1)	-0.179**	0.106**	-0.051	0.006	-0.099**	0.056
	(-6.149)	(2.582)	(-1.593)	(0.152)	(-3.234)	(0.989)
Spot Vol (-2)	0.014	0.115**	-0.026	0.030	-0.129**	-0.106
	(0.525)	(3.062)	(-0.815)	(0.780)	(-4.247)	(-1.896)
Futures Vol (-1)	0.332**	-0.041	0.129**	-0.001	0.095**	-0.007
	(16.040)	(-1.420)	(4.842)	(-0.016)	(5.218)	(-0.205)
Futures Vol (-2)	-0.043	-0.070*	0.095**	-0.007	0.246**	0.019
	(-1.932)	(-2.219)	(3.539)	(-0.215)	(13.459)	(0.554)
Futures Volatility Granger Cause Spot Volatility		F-stat = 147.376**	F-stat = 17.534**		F-stat = 100.879**	
Spot Volatility Granger Cause Futures Volatility		F-stat = 6.465**	F-stat = 0.312		F-stat = 2.391	
	JEERA		**PEPPER**		**MASTARD SEED**	
	Spot Volatility	Futures Volatility	Spot Volatility	Futures Volatility	Spot Volatility	Futures Volatility
Constant	0.000	0.000	0.000	0.000	0.000	0.000
	(-0.041)	(-0.056)	(-0.016)	(0.039)	(-0.007)	(0.015)
Spot Vol (-1)	-0.201**	0.158*	-0.426**	-0.043	-0.116**	0.154**
	(-6.847)	(2.262)	(-12.696)	(-0.610)	(-4.513)	(4.293)
Spot Vol (-2)	-0.045	0.114	-0.073**	0.119*	-0.010	0.103**
	(-1.632)	(1.742)	(-2.587)	(2.024)	(-0.410)	(2.959)
Futures Vol (-1)	0.181**	-0.036	0.395**	0.015	0.216**	-0.052*
	(14.752)	(-1.237)	(24.443)	(0.438)	(11.720)	(-2.025)
Futures Vol (-2)	0.004	-0.045	0.080**	-0.023	-0.011	-0.058*
	(0.271)	(-1.434)	(4.132)	(-0.580)	(-0.561)	(-2.200)
Futures Volatility Granger Cause Spot Volatility		F-stat = 113.872**	F-stat = 313.781**		F-stat = 71.749**	
Spot Volatility Granger Cause Futures Volatility		F-stat = 3.334*	F-stat = 3.167*		F-stat = 11.834**	
	CASTOR SEED		**SOYA OIL**		**MENTHA OIL**	
	Spot Volatility	Futures Volatility	Spot Volatility	Futures Volatility	Spot Volatility	Futures Volatility
Constant	0.000	0.000	0.000	0.000	0.000	0.000
	(0.010)	(0.025)	(0.014)	(0.008)	(0.048)	(-0.045)
Spot Vol (-1)	0.001	0.003	-0.324**	0.080	-0.104**	0.271**
	(0.045)	(0.110)	(-8.061)	(1.650)	(-3.009)	(5.330)
Spot Vol (-2)	0.002	-0.015	-0.110**	-0.060	-0.042	0.124**
	(0.078)	(-0.552)	(-2.784)	(-1.265)	(-1.219)	(2.454)
Futures Vol (-1)	0.033	0.000	0.330**	-0.052	0.134**	-0.108**
	(1.217)	(-0.002)	(9.823)	(-1.291)	(5.776)	(-3.134)
Futures Vol (-2)	0.031	-0.001	0.117**	0.034	0.021	-0.053
	(1.141)	(-0.053)	(3.413)	(0.824)	(0.885)	(-1.529)
Futures Volatility Granger Cause Spot Volatility		F-stat = 1.395	F-stat = 48.251**		F-stat = 16.701**	
Spot Volatility Granger Cause Futures Volatility		F-stat = 0.158	F-stat = 3.262*		F-stat = 15.338**	

Table T12: VAR Results among Spot and Futures Return Volatility (GARCH Residual)

$$\sigma_{S,t} = c_1 + \sum_{k=1}^{p} \alpha_{S,k}\sigma_{S,t-k} + \sum_{l=1}^{q} \beta_{S,l}\sigma_{F,t-l} + \upsilon_{S,t} \qquad \sigma_{F,t} = c_2 + \sum_{k=1}^{p} \alpha_{F,k}\sigma_{F,t-k} + \sum_{l=1}^{q} \beta_{F,l}\sigma_{S,t-l} + \upsilon_{F,t}$$

	CHANA		WHEAT		CHILLI	
	Spot Volatility	Futures Volatility	Spot Volatility	Futures Volatility	Spot Volatility	Futures Volatility
Constant	0.000**	0.000	0.000	0.000	-0.003**	0.001**
	(4.062)	(1.843)	(5.587)	(5.236)	-(-4.573)	(4.808)
Spot Vol (-1)	0.920**	-0.033	0.675	-0.010	-0.101**	-0.016
	(36.415)	(-0.928)	(21.341)	(-0.141)	(-4.038)	(-1.464)
Spot Vol (-2)	0.016	0.064	-0.027	0.043	-0.116**	-0.019
	(0.635)	(1.828)	(-0.840)	(0.598)	(-4.683)	(-1.748)
Futures Vol (-1)	0.023	0.973**	-0.003	0.511	-0.002	0.327
	(1.256)	(38.544)	(-0.228)	(16.159)	(-0.027)	(10.113)
Futures Vol (-2)	-0.011	-0.006	0.012	0.015	2.016**	0.170**
	(-0.602)	(-0.256)	(0.864)	(0.465)	(26.404)	(5.158)
Futures Volatility Granger Cause Spot Volatility		F-stat = 3.693*	F-stat = 0.406		F-stat = 388.664**	
Spot Volatility Granger Cause Futures Volatility		F-stat = 3.913*	F-stat = 0.234		F-stat = 2.574	
	JEERA		**PEPPER**		**MASTARD SEED**	
	Spot Volatility	Futures Volatility	Spot Volatility	Futures Volatility	Spot Volatility	Futures Volatility
Constant	0.000**	0.000**	0.000	0.000**	0.000	0.000
	(4.116)	(9.855)	(1.619)	(2.354)	(4.087)	(3.355)
Spot Vol (-1)	1.019**	-0.107	0.860**	0.049**	1.028	0.389
	(40.012)	(-0.391)	(31.288)	(4.663)	(44.194)	(0.708)
Spot Vol (-2)	-0.080**	0.289	0.009	-0.034**	-0.070	0.288
	(-3.142)	(1.060)	(0.330)	(-3.325)	(-2.992)	(0.524)
Futures Vol (-1)	0.006**	0.707**	0.591**	1.085**	0.000	0.477
	(2.634)	(27.645)	(8.077)	(39.038)	(-0.082)	(20.454)
Futures Vol (-2)	-0.005*	-0.031	-0.558**	-0.098**	0.001	0.002
	(-2.075)	(-1.223)	(-7.700)	(-3.557)	(0.929)	(0.066)
Futures Volatility Granger Cause Spot Volatility		F-stat = 3.545*	F-stat = 35.211**		F-stat = 0.515	
Spot Volatility Granger Cause Futures Volatility		F-stat = 2.235	F-stat = 12.153**		F-stat = 9.585**	
	CASTOR SEED		**SOYA OIL**		**MENTHA OIL**	
	Spot Volatility	Futures Volatility	Spot Volatility	Futures Volatility	Spot Volatility	Futures Volatility
Constant	0.002	0.003	0.000*	0.000**	0.000**	0.000
	(1.117)	(1.104)	(2.112)	(2.392)	(4.672)	(0.585)
Spot Vol (-1)	0.025	-0.001	0.753**	0.019	0.970**	0.432**
	(0.912)	(-0.030)	(4.257)	(1.100)	(33.216)	(2.557)
Spot Vol (-2)	0.000	-0.001	-0.089	-0.011	-0.048	-0.127
	(-0.013)	(-0.022)	(-0.822)	(-1.093)	(-1.638)	(-0.746)
Futures Vol (-1)	0.000	0.001	-1.683	0.765**	0.016**	0.733**
	(-0.015)	(0.051)	(-0.905)	(4.323)	(3.132)	(25.086)
Futures Vol (-2)	0.000	-0.001	1.686	0.194	-0.015**	0.105**
	(0.017)	(-0.026)	(0.944)	(1.143)	(-2.979)	(3.613)
Futures Volatility Granger Cause Spot Volatility		F-stat = 0.000	F-stat = 0.863		F-stat = 5.157**	
Spot Volatility Granger Cause Futures Volatility		F-stat = 0.001	F-stat = 0.608		F-stat = 10.822**	

P.N.: Figures in parenthesis are the respective t-statistics; ** and * represent significant at 1% and 5%

Table T13: Contemporaneous and Dynamic Return and Volatility Spillover between Spot and Futures Market (in GARCH Framework)

	Conditional Mean Equation: $R_{S,t} = \alpha_0 + \sum_{i=1}^{2} \alpha_i R_{S,t-i} + \sum_{j=-2}^{2} \beta_j R_{F,t+j} + \sum_{k=-1}^{1} \delta_k h_{F,t+k} + \varepsilon_t$										
	C	**S (-1)**	**S (-2)**	**F (-1)**	**F (-2)**	**F (0)**	**F (+1)**	**F (+2)**	**F-Vol (-1)**	**F-Vol (0)**	**F-Vol (+1)**
CHANA	0.00**	-0.23**	-0.01	0.03	0.51**	0.47**	0.02	0.05**	-5.84	10.63	-7.02
	(3.160)	(-8.233)	(-0.530)	(1.102)	(23.130)	(23.786)	(1.661)	(4.885)	(-0.521)	(0.606)	(-0.496)
WHEAT	0.00	-0.20**	0.03	0.12**	0.16**	0.12**	0.03	0.03	-0.20	-2.08*	3.11**
	(1.843)	(-5.690)	(0.765)	(3.436)	(6.246)	(3.573)	(1.244)	(1.053)	(-0.155)	(-2.233)	(2.867)
CHILLI	0.00	0.35**	0.05	0.06**	0.06**	0.15**	0.04*	-0.02	-0.09	0.11	-0.01
	(0.734)	(8.723)	(1.096)	(3.286)	(4.545)	(8.027)	(2.497)	(-1.100)	(-1.208)	(0.947)	(-0.054)
JEERA	0.00	-0.07**	0.05	0.01	0.18**	0.20**	0.02**	0.02*	1.96	-1.82	-0.71
	(0.612)	(-2.604)	(1.899)	(0.739)	(16.257)	(20.538)	(2.758)	(2.342)	(1.780)	(-1.151)	(-0.504)
PEPPER	0.00*	-0.18**	0.05**	0.05**	0.37**	0.32**	0.00	0.02*	12.85	24.40	-38.81**
	(2.189)	(-6.710)	(2.941)	(3.066)	(23.505)	(25.528)	(0.415)	(2.280)	(0.893)	(1.064)	(-2.528)
MASTARD SEED	0.00	-0.08**	-0.06**	0.00	0.33**	0.41**	0.05**	0.05**	-0.89	1.22	-0.35
	(1.513)	(-3.483)	(-2.891)	(0.070)	(16.684)	(20.718)	(3.514)	(4.029)	(-1.072)	(1.559)	(-0.523)
CASTOR SEED	0.00**	-0.42**	-0.14**	0.12**	0.32**	0.50**	0.08**	0.01**	-0.19	-6.89**	-1.14**
	(9.553)	(-10.811)	(-5.322)	(4.604)	(10.490)	(20.245)	(8.194)	(5.933)	(-1.016)	(-23.381)	(-18.165)
SOYA OIL	0.00*	-0.18**	-0.03	0.08**	0.38**	0.59**	0.03**	0.00	-9.00	30.16	-22.94
	(2.027)	(-6.279)	(-1.412)	(3.613)	(20.460)	(40.069)	(3.836)	(0.189)	(-0.821)	(1.569)	(-1.275)
MENTHA OIL	0.00**	-0.22**	-0.09**	0.03	0.26**	0.57**	0.04**	0.01	0.11	2.47	-4.45**
	(2.977)	(-7.034)	(-3.264)	(1.310)	(11.077)	(33.234)	(3.785)	(0.533)	(0.062)	(1.155)	(-2.538)
	Conditional Variance Equation: $h_{S,t} = \gamma_0 + \gamma_1 \varepsilon_{S,t-1}^2 + \gamma_2 h_{S,t-1} + \sum_{k=-1}^{1} \varphi_k h_{F,t+k}$						**Joint Test of Significance: F-stat (LR-stat)**				
	C	**ε (-1)^2**	**σ (-1)^2**	**F-Vol (-1)**	**F-Vol (0)**	**F-Vol (+1)**	**F (-1, -2)**	**F (1, 2)**	**F-Vol (0)**	**F-Vol (-1)**	**F-Vol (+1)**
CHANA	0.00**	0.12**	0.23**	-1.07**	-1.20**	2.47**	201.55**	8.62**	2.04	18.84**	-15.57
	(3.695)	(4.457)	(3.166)	(-2.842)	(-2.377)	(8.904)	(471.89**)	(15.66**)	(0.36)	(0.22)	(0.25)
WHEAT	0.00	0.13**	0.78**	0.06**	-0.11**	0.10**	9.69**	0.36	-19.50	1.40	-13.49
	(0.401)	(8.840)	(33.115)	(3.139)	(-2.763)	(3.475)	(49.47**)	(2.52)	(3.85**)	(0.04)	(6.31**)
CHILLI	0.00**	0.09**	0.08	0.00	-0.03**	0.07**	75.77**	-19.57	NA	-0.96	NA
	(11.467)	(2.548)	(1.138)	(1.735)	(-5.077)	(21.072)	(19.06**)	(241.05**)		(64.48**)	
JEERA	0.00**	0.12**	0.83**	0.02*	-0.13**	0.12**	148.24**	4.38*	9.18**	11.36**	0.31
	(-2.971)	(8.136)	(42.536)	(2.032)	(-5.385)	(7.761)	(267.20**)	(11.56*)	(2.29)	(4.89**)	(0.42)
PEPPER	0.00	0.05**	0.19**	-1.07**	-0.19	1.38**	440.60**	5.23**	1.10	0.11	5.07**
	(-1.101)	(1.970)	(2.811)	(-4.619)	(-0.576)	(7.633)	(468.45**)	(5.84)	(1.27)	(0.81)	(7.26**)
MASTARD SEED	0.00	0.05**	0.91**	0.00	-0.12**	0.13**	72.79**	9.34**	-11.62	5.21**	-12.21
	(0.006)	(9.045)	(155.206)	(-0.215)	(-3.509)	(6.179)	(257.07**)	(27.96**)	(1.40)	(1.72)	(0.16)
CASTOR SEED	0.00*	1.47**	0.00**	0.01	0.06**	0.11**	730.51**	-568.36	-1358.45	-1361.47	-1352.83
	(-2.301)	(13.757)	(-3842.16)	(0.958)	(5.597)	(7.253)	(967.60**)	(160.53**)	(484.34**)	(4657.49**)	(1819.04**)
SOYA OIL	0.00**	0.17**	0.31**	0.24	-1.78**	1.63**	143.75**	4.69*	375.19**	106.52**	335.92**
	(3.783)	(9.004)	(4.535)	(1.534)	(-6.678)	(9.006)	(340.22**)	(7.57*)	(2.97)	(1.28)	(2.77)
MENTHA OIL	0.00**	0.07**	0.84**	0.26**	-0.82**	0.59**	45.74**	12.64**	NA	NA	NA
	(-5.546)	(6.997)	(60.444)	(22.974)	(-870.389)	(39.797)	(87.87**)	(35.78**)			

P.N.: Figures in parenthesis are the respective z-statistics; ** and * represent significant at 1% and 5%; S=> Spot, F=> Futures, F-Vol => Futures Volatility