Price Discovery and Hedging Effectiveness of Commodity Futures Markets in India

A Thesis submitted for the Degree of

Doctor of Philosophy

In

Economics

By

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Under the Supervision of

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To
My Parents

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Department of Economics
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DECLARATION

I hereby declare that the research embodied in the present thesis entitled, "**Price Discovery and Hedging Effectiveness of Commodity Futures Markets in India**", is an original research work carried out by me under the supervision of **Prof. B. Kamaiah,** Department of Economics, University of Hyderabad in partial fulfillment of the requirement for the award of the degree of Doctor of Philosophy in Economics.

I declare to the best of my knowledge that this thesis or a part thereof has not been earlier submitted for the award of degree at any other university or institute.

Signature of the Candidate

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CERTIFICATE

This is to certify that the research work embodied in the present thesis entitled as "**Price Discovery and Hedging Effectiveness of Commodity Futures Markets in India"** has been carried out by **China Hussain Yaganti** under my supervision, for the full period prescribed under Ph.D ordinances of the University of Hyderabad.

I hereby declare that to the best of my knowledge that no part of this thesis has been submitted earlier for the award of Degree at any other university or institute.

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Hussain Yaganti.

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Chapter-1

Background, Issues and Objectives of the study

1.1 Introduction

Price variability is the most important problem faced by farmers. Along with price variability, agricultural producers are prone to several risks such as high input prices, crop diseases, weather conditions which would bring negative effect to their incomes and adverse impact on farming community. Primary commodity prices and their markets are known to behave differently from those of manufactured goods. In case of agricultural commodities supply variability is high as production is affected by weather conditions. The need for futures trading is because of price variability either directly or indirectly. The price instability can be eliminated by introducing price and distribution control by the government, but all these measures become very costly and difficult to implement because of several reasons. With the lack of price controls, traders acquire considerable supply as per their commercial requirement. This makes discrepancy between demand and supply and leads to high price volatility and this type of situation makes the market imperfect competition like the existence of monopolies and oligopolies. One of the solutions to avoid these unwanted price risks and at the same time benefit farmers as well as consumers is to develop commodities derivatives trading. Of late, Government intervention declined especially after the implementation of Economic reforms in 1991. With these reforms, the Agreement on Agriculture under World Trade Organization

(WTO) was implemented. As a consequence, prices of commodities are essentially determined by market forces. Hence, fluctuations in demand and supply of agricultural commodities are expected to result in high price risk. In order to manage price risk, derivatives entered into commodity markets.

The twin functions of commodity futures market are price discovery and price risk management. Risk management can be done through hedging process. Hedging is the mechanism by which the participants in the cash markets can cover price risk by taking opposite position in the futures market. As the prices   in futures markets and physical markets by and large move in close direction, the losses in physical market, arising from the adverse price movements are offset either wholly or substantially by the gaining in futures markets. So hedging in futures is the one of risk management techniques. The success of hedging can be possible by the involvements of considerable speculation in futures markets. The involvement of all types of traders and speculators for sale and purchase of derivative contracts enables hedges to buy and sell as and when they required. So future trading stabilizes price variation in two aspects, one is trading leads to greater competition in market and brings price in equilibrium under future trading than without it and secondly, this whole interest of different traders either to gain profits or to minimize loss, all this exercises make to them collect market information in dynamic situation of price discovery. In determining the futures price, market participants compare the current futures price with the spot price that is expected to prevail at the maturity of the futures contracts.(Black, 1976).The decisions of market participants leads to efficient price discovery in the market.

The benefits of future markets extend not only to price discovery and hedging, but also for other farmers and traders who are not involved in future trading directly, who use futures prices for the purpose of production and process decisions. One of the most important consequences of the futures market is that it enables an efficient redistribution of risks. It also facilitates storage activity to manage supply and demand shocks.

Trading in commodity futures in India started with the establishment of the Bombay Cotton Trade Association in 1875. After Independence, the Parliament passed Forward Contracts (Regulation) Act, 1952 which regulated forward contracts in the commodities all over India. By mid 1960s, the government imposed ban on futures trading in most of the commodities. In 1994, the Kabra Committee recommended opening up of futures trading in 17 commodities. In 2003 three National exchanges were recognized for futures trading. Commodity futures markets are governed by Forward Markets Commission (FMC) in respect of futures trading. The three most important exchanges in India are Multi Commodity Exchange of India Ltd (MCX), National Commodity and Derivatives Exchange Ltd (NCDEX) and National Multi Commodity Exchange of India Ltd (NMCE). The future trading is permissible in 95 commodities. The Agricultural commodities constitute the largest commodity group in the futures market till 2005-06(55.32%). From 2006-07 onwards, precious metals, energy and base metals have moved into the first position.

1.2 Issues of the present study

In the light of this background, the present study seeks to identify some characteristics of the Indian commodity futures market in order to examine whether contracts trade so far as to enable to reduce spot price risk. More specifically, an attempt is made to compare the basis risk with spot price risk since hedging is expected to reduce price risk when basis variability is less than spot price variability. Besides providing hedging facilities, the futures market performs the functions of price discovery and price reference. In the context of the two markets namely, futures and spot market trading similar commodities, it has been debated whether futures market leads the spot market or the other way round. The issue of the causal linkage between two markets provides a clear motivation for studying the lead –lag relationship between them. Yet another important issue concerns the efficiency of the commodity futures markets. This issue has not been examined in depth empirically. In Indian context there are very few studies on the performance of spices and base metals.

In the light of the issues mentioned above, the following research questions are raised

i) How effectively do futures markets perform the price discovery function? Does price formation in one market influence the same in the other market?

ii) To what extant the existing futures contracts are suitable for hedging? If so, is this hedging effective in minimizing spot price risk?

iii) Is the future price an unbiased predictor of future spot price as, for the futures price to be an unbiased predictor of future spot price, the futures price should lead the spot price?

1.3 Objectives

The main objectives of the study are set as follows:

1) To assess the basis risk with spot price risk for different contracts of Spices and base metals
2) To examine the lead – lag relations between the futures and spot prices
3) To analyse the hedging effectiveness of commodity futures markets.
4) To examine the market efficiency of commodity future markets.

1.4 Nature and Sources of Data

This research work has considered two samples i.e., spices (chilly, jeera, pepper, turmeric and cardamom) and base metals (copper, lead, nickel, zinc) from the different groups of Indian commodity futures markets. The data for the present study are collected from official websites of National Commodities & Derivations Exchange Ltd (NCDEX) and Multi Commodity Exchange (MCX). The daily closing prices of different futures contracts and spot prices for select commodities are considered from both exchanges. Spices (red chilly, jeera, pepper, and turmeric) data is collected from NCDEX. Cardamom and base metals (copper, lead, nickel, zinc) data is collected from MCX.

Red chilly data for the contracts is considered from March'06 to October '08 (20 contracts). In case of jeera, the data for the contracts from March '05 to October '08 (41 contracts) is used. The data for turmeric is taken from December '04 to October '08 (34 contracts). For pepper commodity the data from June 04 to October -08 (49 contracts) is considered from NCDEX. The cardamom data from March '06 to October '08 is collected from MCX. In case of copper the data for 17 contracts from August '05 to November '08 is used. For the data for lead metal, 16 contracts from August '07 to November '08 are considered. For nickel, data for 23 contracts from January 07 to November 08 is taken. In case of zinc the data for 32 contracts from April '06 to November '08 are used. The reason for different time periods for selected commodities is based on the availability of spot and futures prices data.

A pooled price series is constructed with roll over process for two months before maturity (Fd) (that is, far month futures), one month before maturity (Fn) (that is, nearby month futures) and maturity month futures (Fm) for all contracts months. The first day of nearby contract is considered as first day of second month from maturity and ends with the last day of second month. Similarly, the contracts are rolled over to next nearby contracts. As such, the data do not overlap and avoid methodological problems associated with overlapping of data. The procedure is the same for maturity period and far month maturity periods. The pooled series is used to test empirically for long run and short run dynamics.

1.5 Methodology

This study mainly employs time series econometrics techniques. Price volatility analysis is examined by considering the variance of futures and spot price series in order to conclude about efficient utilisation of information in futures market. The basis risk and the spot price risk are compared by variances of the two series. Basis is defined as the difference between spot price and futures price. If the variance of the basis is less than the variance of spot price, then a particular contract is able to reduce risk. The lead lag relation between futures prices and spot prices is examined by using cointegration and error correction models (ECM). The time series data of futures and spot prices is tested for stationary by the Augmented Dickey Fuller (ADF) test. The long run equilibrium relationship between the two markets is examined by the cointegration technique. In order to test this, spot price is regressed upon futures price and the estimated residuals are tested for stationary. If these residuals are found to be stationary, it is concluded that the two series are cointegrated of order one. Once the series are tied together in the long term, it is possible that they might drift apart in the short run and then turn back. To examine the short run dynamics, the error connection mechanism (ECM) is used. When time series are cointegrated there must be at least one Granger causal flow in the system. The error correction variable is the lagged residual series estimated from the cointegrating equation. The error correction model is performed in such a manner that both spot price and futures price changes are regressed on the lagged values of both the variables along with the disequilibrium term. The inference of causality can be assessed by examining the statistical significance and relative magnitudes of the error correction coefficients and coefficients on the lagged variable.

The hedge ratio and hedging effectiveness are analysed by using ordinary least squares (OLS) method and ECM method. In OLS method spot return series is regressed up on futures return series, the regression coefficient is the hedge ratio and coefficient of determination (R^2) value implies hedging effectiveness. In ECM method, errors are considered from spot and futures returns equations. Hedge ratio can be found out by ratio of covariance of spot and futures return error terms to the variance of futures returns error terms and hedging effectives is assessed by ratio the of difference between unhedged position and hedged position to unhedged position.

Futures 'market efficiency hypothesis' is tested by analysing three necessary conditions. The first necessary condition is that there should be a cointegration between two price series. Serial independence of error terms from cointegrated equation is the second necessary conditions for market to be efficient. According to Hakkio and Rush (1989), the short run efficiency of futures market has to be tested once the above two conditions are satisfied. The restrictions test on coefficients in the ECM equation constitutes the third condition for efficiency. If these three conditions are met, then futures market is efficient and futures price is an unbiased estimate of future spot prices, both in the long run and short run.

1.6 Justification of the study

The present study may be justified based on the following grounds: First, India is the World's largest producer, consumer, and exporter of Spices (Red Chilly, Cumin seed, Pepper, Turmeric and Cardamom). All these commodities have well established spot markets. It is known that there should be an efficient commodity futures market to support a well established spot market. So, in the light of this observation, this study tests about market efficiency hypothesis of futures markets for the selected commodities.

The agricultural commodities are facing the problem of price uncertainty because of several reasons. There are no empirical studies available in the literature about how these price risks are minimised especially after the establishment of National Commodity Exchanges. Since the main functions of futures markets are price discovery and risk management, it is essential to confirm these functions empirically. Accordingly, this study empirically tests the lead-lag relationship between futures and spot prices and hedging effectiveness of these markets.

Since 2006 – 07, there has been tremendous change in volume of trade in the base metals futures along with precious metals and energy futures, with a growing market share of 72%. Multi Commodity Exchange is number one in turn over. But there are no empirical studies so far on base metals Futures for the above said functions. In this context it is important to study the base metals price behavior and hedging effectiveness.

1.7 Scope and Limitations of the study

The study is confirmed to spices and base metal futures. The study uses constant hedge ratio models. It would have been better had the analysis based on time varying hedge ratio models. Finally, this study has opened some interesting research questions. First further study could explore the relationship between futures returns and volume of trade for in each month of different contracts. The hedge ratio and hedging effectiveness can be analysed by using time varying hedge ratio techniques. The role of time varying risk premium in the model of the unbiasedness of futures prices constitutes an interesting questions for further research.

1.8 Organization of the Thesis

The present thesis is organized into six chapters. The first chapter introduces the necessary back ground of the study, research problems, objectives and methodology. The second chapter provides history of commodity futures markets and performance analysis of selected contracts using price volatility and basis risk analysis. The third chapter deals with price discovery along with methodological issues and findings. The fourth chapter provides an analysis of hedge ratio and hedging effectiveness. The fifth chapter examines futures market efficiency for different maturity periods. Sixth chapter provides the summary, concluding remarks and policy implications.

Chapter-2

Performance Analysis of Futures Markets

2.1 Commodity Futures Markets in India: A Historical Overview

Commodity derivative trading in India has a long but turbulent history extending over a century. A brief history of futures market in India reveals that Bombay Cotton Trade Association Ltd was the first one to start futures trading during 1875 as a joint stock company. It was established by the European traders and its share capital was held entirely by them. After World War I 1914-1918), the Government of Bombay enacted the Bombay Cotton Contracts Control Act, 1919. In 1921 East India Cotton Association was formed. Next to cotton, oil seeds attracted futures trading; Gujarat Vyapari Mandali was established around 1900 to organize trade in oil seed derivatives at Bombay followed by many others in Gujarat, Saurastra and Punjab. The wheat futures market at Hapur began functioning from 1913. The Hapur market always served as a price setter for wheat in the country. The Calcutta Hessian Exchange Ltd, established in 1919, was the first organized exchange to regulate futures trading in hessian. The Bombay Bullion Association is functioning since 1920 for derivatives trading in gold and silver and most of commodity futures markets were established by the beginning of the twentieth century. In 1927 the East India Jute Association was set up in Calcutta. These two associations combined in 1945 to form the East India Jute and Hessian Exchange Ltd. The markets were under rapid growth between two World Wars. A large number of commodity exchanges trading futures contracts and turn over were increased in cotton, oil seeds, jute, wheat, silver and gold. The Defence of India Act 1943 was involved to prohibit futures during the Second World War. The markets worked under rules and regulation laid down by different trade associations and also there were wide differences in policies of different associations, which resulted in variety of disputes among traders in different association. So there was a need of regulatory body for proper management; later it was fulfilled by enactment of Bombay Forward Contracts Control Act, 1947.

After independence and adoption of the Constitution in 1950, the subject of "Stock Exchanges and Futures Markets" was placed in the union list, hence regulating responsibility shifted to Central Government. The Government set up a committee under the Chairmanship of Shri A.D.Shroff to frame rules and regulations for exchanges. The Forward Contracts (Regulation) bill, 1950 was revised and it referred to Select Committee of Parliament and report was submitted in August 1951, but bill was lapsed with dissolution of parliament in 1952. A new bill was drafted after scrutiny by another Select Committee. Later Forward Contacts (Regulation) Act bill was passed by Parliament in December 1952. The Forward Markets Commission (FMC) was established in 1953 to regulate and develop commodity futures market in India. This frame work continues to exist even today. One of the important Act is to notify a commodity for prohibition or regulation of forward trading. In early 1960's, the futures markets developed in India, but later futures market did not continue for long period of time because of natural calamities and shortage in commodities. As a consequence of these shortages and as a responsibility of government to control the prices of agricultural and essential commodities, future trading was banned in 1966 except the minor ones like pepper, turmeric, castor seed and linseed. Later futures trading in non edible linseed and castor seed was suspended in 1977. Again based on the recommendations of the Professor A.M. Khusro Committee, futures trading in Gur (Muzaffar nagar and Hapur, 1982), Potatoes (Hapur, 1985) and caster seed (Ahmadabad, and Mumbai, 1985) are permitted.

Subsequent to liberalisation of Indian economy in 1991, a series of steps were taken to liberalise the commodity futures markets. In June 1993, the Government appointed another committee under the Chairmanship of Professor K.N.Kabra, and its report was submitted in September 1994. Based on the recommendations of Kabra Committee, futures trading in coffee (Banglore, 1998), cotton (Mumbai 1999), soy oil (Indore 1999), sugar (2001), tea (2002), and bullion (2003) was reintroduced and introduction of International Futures Contracts for pepper (Cochin, 1997) and Castor oil (Mumbai, 1999) was done. In the period in between, the United Nations Conference on Trade and Development (UNCTAD) at Geneva constituted an expert group on commodity exchanges. It was also brought to the notice of UNCTAD that a country like India needs the revival of futures trading. The joint team from the World Bank and UNCTAD visited India in 1994-95 to examine the possibility of reviving the commodity futures markets in the country. UNCTAD and World Bank joint Mission Report "**India: Managing Price Risk in India's Liberalised Agriculture: Can Futures Market Help?**(1996) highlighted the role of futures markets as market based instruments for managing risks and suggested the strengthening of institutional capacity of the Regulator and the

Exchanges for efficient performance of these markets. The National Agricultural Policy, 2000, also expressed support for commodity futures. The Expert Committee (Guru Committee, 2001) on strengthening and developing Agricultural Marketing emphasized the need for and role of futures in price risk management and in marketing of agricultural produce. In 2002-03 with a series of measures by the Central Government provided a real boost to the commodity futures market in India.

At present 22 exchanges are recognised for futures trading in commodities. Most of the commodity exchanges in India are single commodity platforms and cater mainly to the regional requirements. However, three national-level multi-commodity exchanges have been set up in the country to over come the problem of fragmentation. These exchanges are:

1. National Multi Commodity Exchange of India (NMCE)
2. Multi Commodity Exchange of India (MCX)
3. National Commodity & Derivatives Exchange of India (NCDEX)

NMCE, the first state-of-the-art demutualised multi-commodity exchange, commenced futures trading in 24 commodities on November 26, 2002 on a national scale and the basket of commodities has grown substantially since then to include commercial crops, food grains, plantations, spices, oil seeds, and metals & bullion, among others.

MCX is India’s largest independent and demutualised multi-commodity exchange. It was inaugurated on November 10, 2003 and has permanent recognition from the Government of India for facilitating online trading, clearing and settlement operations for commodities futures markets across the country.

NCDEX is a nation-level, technology driven, demutualised online commodity exchange with an independent Board of Directors and professional management. It commenced operations on December 15, 2003. The four institutional promoters of NCDEX are prominent players in their respective fields and contribute significantly to its technological and risk management skills. NCDEX has tied up with NCCL for clearing all trades on the exchange. NCDEX also maintains and manages a settlement guarantee fund in order to deal with defaults.

The exchanges follow best international risk management practices and provide a financially secure environment by putting a suitable risk management mechanism. The performances of the contracts registered by the exchange are guaranteed either by the exchange or it's Clearing House. Clearing Houses put in place a sound risk-management system to be able to discharge their role as counter-party to all participants.

2.2 Performance Analysis of Futures Markets

The usefulness of commodity futures markets in risk management can be evaluated by analysing the risk involved in spot and futures prices and basis risk. In a competitive market, behaviour of price of a commodity is determined by demand and supply factors. In case of agricultural commodities, supply variability is high as production could be affected by natural factors like weather conditions and incidence of pests and other diseases. In case of metals and other energy commodities, deviations originate on the demand side through business cycles and future plan of production. Futures traded commodities in India have been found to have variability in supply [Naik and Jain 1999] and this is reflected in price volatility. In this study, the performance of futures markets is assessed based on price volatility and basis risk analysis. This study compared the extent of volatility in cash and futures prices to examine the extent of information efficiency which is incorporated in futures prices. The main aim of futures trading is reducing price risk by replacing it with relatively small basis risk. So, a high basis risk reduces the utility of futures trading.

2.2.1 Price variability analysis

If markets are efficient, the daily variations in cash and futures prices are purely a result of new information. The extent of variations in both spot and futures markets are supposed to be similar for storable commodities. If the spot market is efficient, the relative magnitude of variation in prices helps us to see whether future market is able to incorporate the information efficiently. In the efficient markets, daily variations in spot and derivatives emanate purely from the new information that is arriving in the market.

The ratio of variance of month-wise futures and spot prices reveals the extent of variability in the futures markets. Assuming that the carrying costs in the month are negligible, a ratio of variance of future and spot prices that is closer to one indicates that futures market is efficient, that is markets are incorporating the information efficiently. A ratio greater than one close to the maturity period indicates speculative activities. Conversely, a ratio less than one shows that markets are not being able to incorporate information fully and efficiently.

For the purpose of analysis, a cut-off has been assumed at 0.8 and 1.2 as the lower and upper levels to provide an indication of extent of variability in the spot and futures markets. This assumption is considered on the same lines as adopted in the previous study (Naik and Jain, 2002)

2.2.1.2 Analysis

Variances of futures and spot prices are calculated based on contract for spices and base metals. The calculated values of spices are reported in tables 2.1 to 2.5. In case of chilly, in most cases, the ratio is greater than one, indicating some speculative trading. December ‘06, April ’07, October ’07, and April ’08, contracts ratio is within framed limits, indicating that there is an efficient utilization of information and to that extent the market is efficient. In remaining contracts, the ratio has been less than 0.8, suggesting that volatility in the futures price is lower than the spot price, this pattern is an indication of inefficient utilisation of information in the market.

In case of Jeera, only three contracts are indicating an efficient utilisation of information. All remaining contracts witnessed speculative trading. In case of Pepper, only 20 percent of contracts are showing efficient utilization of information; remaining are contracts reflecting excessive speculation in them. Only two contracts are underutilization of information efficiently. The ratio for turmeric is less than 0.8 in 30 percent of contracts, this pattern is an indication of inefficient utilization of information. 50 percent of contracts are appearing to attract same speculative trading. Only around 20 percent of contracts are showing that there is an efficient utilization of information. In case of cardamom, six contracts indicating efficient utilisation of information. Besides, the most of the contracts witnessed speculative trading.

Futures price variability as compared to spot price is found to be within bounded range for all base metals. The calculated values are furnished in table 2.6 to 2.9. In case of Copper, almost all contracts are showing ratio around one, indicating that there is an efficient utilisation of information. In lead, a few contracts are showing ratio greater than one, that is the ratio exceeds the upper limit (1.2), indicating higher volatility in futures price than in spot price. 60 percent of contracts are showing that there is an efficient utilisation of information. In case of nickel, most of contracts are revealing that there is an efficient utilisation of information and five contracts out of 23 contracts are indicating inefficient utilisation of information in the market. Similar information of price variability of futures can be observed in case of zinc also.

Table 2.1 Futures price variance Vs Spot price variance for Chilly

Contract	fpv	spv	Ratio	Contract	fpv	spv	Ratio
Jul--06	42745	31742	1.35	Aug--07	140974	22259	6.33
Aug--06	39126	27803	1.41	Sep--07	20024	4118	4.86
Sep--06	69283	106841	0.65	Oct--07	30869	27002	1.14
Oct--06	290630	76344	3.81	Nov--07	3624	2645	1.37
Nov--06	75888	17868	4.25	Feb--08	46088	13186	3.50
Dec--06	82982	74853	1.11	Mar--08	52962	10262	5.16
Mar--07	125499	76054	1.65	Apr--08	26319	33004	0.80
Apr--07	53356	49205	1.08	Jun--08	17808	114106	0.16
Jun--07	11861	8241	1.44	Aug--08	35215	3846	9.16
Jul--07	104146	41214	2.53	Oct--08	10233	32280	0.32

Figure 2.1 Futures price variance Vs Spot price variance for Chilly

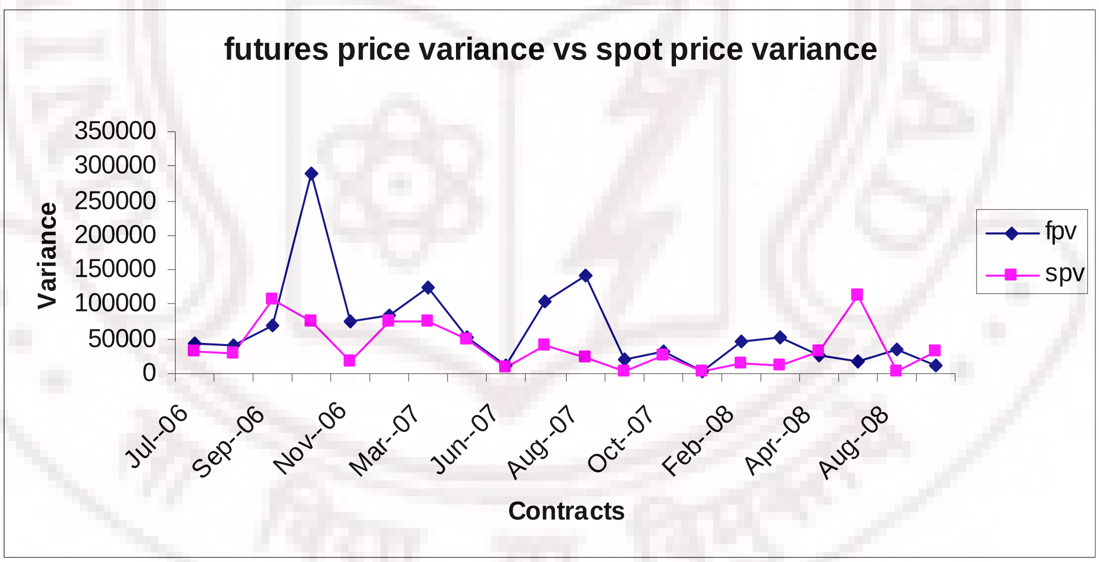


Table 2.2 Futures price variance Vs Spot price variance for Jeera

Contract	fpv	spv	Ratio	Contract	fpv	spv	Ratio
Mar-- 05	40678	17667	2.30	Dec--06	21946	10099	2.17
Apr--05	19451	1604	12.13	Jan--07	44459	15054	2.95
May--05	67068	13323	5.03	Feb--07	226731	173034	1.31
Jun--05	6158	3374	1.82	Mar--07	168240	128803	1.31
Jul--05	36518	1901	19.21	Apr--07	185642	99949	1.86
Aug--05	99867	28273	3.53	May--07	410920	26402	15.56
Sep--05	34122	7062	4.83	Jun--07	761473	91789	8.30
Oct--05	37599	15357	2.45	Jul--07	150118	14562	10.31
Nov--05	6150	1336	4.60	Aug--07	212075	11099	19.11
Dec--05	32375	4394	7.37	Sep--07	210973	126856	1.66
Jan--06	35578	1075	33.09	Oct--07	72994	19499	3.74
Feb--06	17334	13822	1.25	Nov--07	97904	28766	3.40
Mar--06	26074	3365	7.75	Dec--07	44788	35836	1.25
Apr--06	19472	1604	12.14	Jan--08	78473	92945	0.84
May--06	149616	244760	0.61	Feb--08	588420	260409	2.26
Jun--06	41165	5574	7.38	Mar--08	164907	50144	3.29
Jul--06	90521	48993	1.85	Apr--08	40908	21625	1.89
Aug--06	83606	56519	1.48	May--08	414944	320783	1.29
Sep--06	46246	137583	0.34	Jul--08	188119	219284	0.86
Oct--06	466716	47871	9.75	Sep--08	207954	86236	2.41
Nov--06	37622	8860	4.25	Oct--08	117172	62711	1.87

Figure 2.2 Futures price variance Vs Spot price variance for Jeera

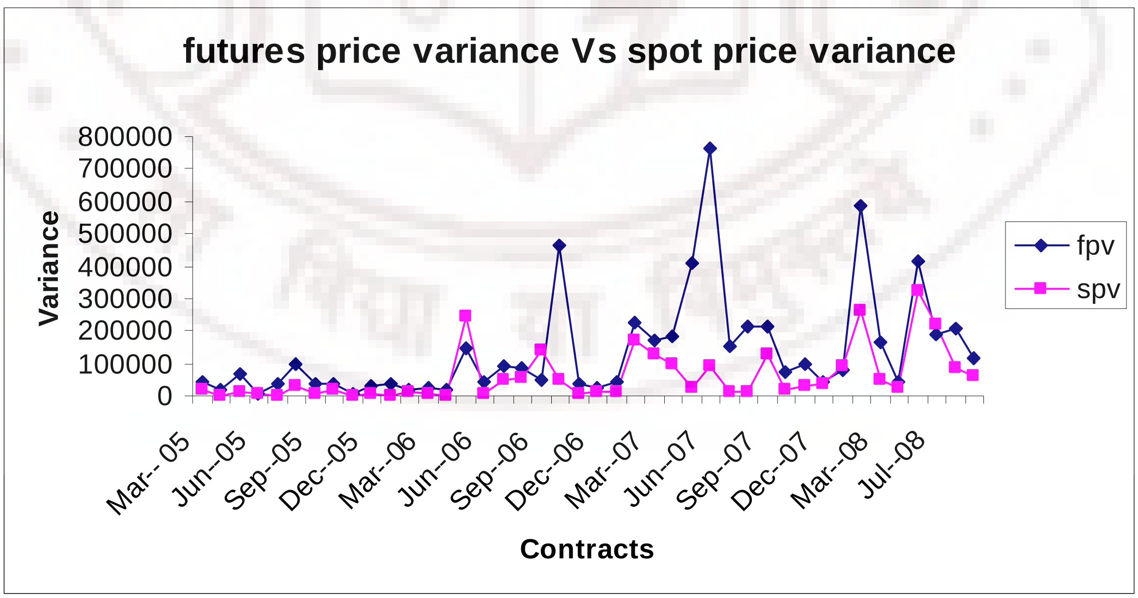


Table 2.3 Futures price variance Vs Spot price variance for Pepper

Contract	fpv	spv	Ratio	Contract	fpv	spv	Ratio
Jun--04	40509	12166	3.33	Sep--06	1565553	1258891	1.24
Jul--04	22696	10367	2.19	Oct--06	762539	186795	4.08
Aug--04	24722	6681	3.70	Nov--06	456257	247187	1.85
Sep--04	39890	29468	1.35	Dec--06	512335	239122	2.14
Oct--04	47596	22490	2.12	Jan--07	280967	268751	1.05
Nov--04	93369	36867	2.53	Feb--07	91780	91738	1.00
Dec--04	53707	68478	0.78	Mar--07	104449	56083	1.86
Jan--05	51474	16388	3.14	Apr--07	1003895	1366851	0.73
Feb--05	78349	44158	1.77	May--07	342507	82227	4.17
Mar-- 05	27005	25957	1.04	Jun--07	80356	38941	2.06
Apr--05	8112	8978	0.90	Jul--07	134491	63986	2.10
May--05	17422	13644	1.28	Aug--07	584109	319820	1.83
Jun--05	6402	3161	2.03	Sep--07	110514	54599	2.02
Jul--05	30953	10817	2.86	Oct--07	694834	384766	1.81
Aug--05	3978	10261	0.39	Nov--07	342654	212653	1.61
Sep--05	4920	1304	3.77	Dec--07	100988	50049	2.02
Oct--05	17443	1670	10.44	Jan--08	348979	267813	1.30
Nov--05	11481	10680	1.08	Feb--08	141207	60899	2.32
Dec--05	32598	53353	0.61	Mar--08	232344	76131	3.05
Jan--06	87193	33651	2.59	Apr--08	124469	41571	2.99
Feb--06	11164	13313	0.84	May--08	52134	14733	3.54
Mar--06	18049	10640	1.70	Jun--08	281008	74411	3.78
Apr--06	9697	1503	6.45	Jul--08	38709	11933	3.24
May--06	37213	9440	3.94	Aug--08	71699	10990	6.52
Jun--06	30287	9086	3.33	Sep--08	588380	341179	1.72
Jul--06	148605	111055	1.34	Oct--08	163735	31244	5.24
Aug--06	379909	496043	0.77				

Figure 2.3 Futures price variance Vs Spot price variance for Pepper

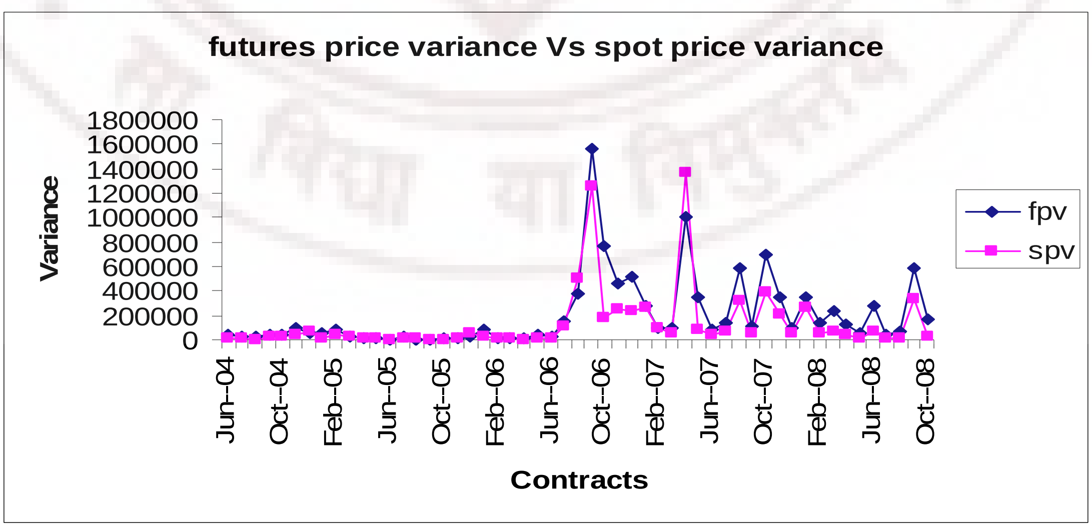


Table 2.4 Futures price variance Vs Spot price variance for Turmeric

Contract	fpv	spv	Ratio	Contract	fpv	spv	Ratio
Dec--04	3010	1991	1.51	Oct--06	30391	4874	6.24
Feb--05	1578	2812	0.56	Nov--06	12417	10995	1.13
Apr--05	2271	2940	0.77	Dec--06	12989	4160	3.12
May--05	1493	750	1.99	Apr--07	2155	4110	0.52
Jun--05	407	1276	0.32	May--07	1590	461	3.45
Jul--05	445	1150	0.39	Jun--07	1373	516	2.66
Aug--05	397	969	0.41	Jul--07	2448	500	4.90
Sep--05	2168	4758	0.46	Aug--07	910	153	5.94
Oct--05	463	1814	0.26	Sep--07	4479	1074	4.17
Nov--05	10940	5342	2.05	Oct--07	3490	111	31.53
Dec--05	1818	1016	1.79	Nov--07	839	1000	0.84
Apr--06	4994	3046	1.64	Dec--07	5003	6838	0.73
May--06	7888	3693	2.14	Apr--08	12462	1373	9.07
Jun--06	13659	1191	11.47	May--08	16672	16429	1.01
Jul--06	1409	585	2.41	Jun--08	14442	28082	0.51
Aug--06	2020	1447	1.40	Aug--08	150668	52409	2.87
Sep--06	863	3244	0.27	Oct--08	29601	5358	5.52

Figure 2.4 Futures price variance Vs Spot price variance for Turmeric

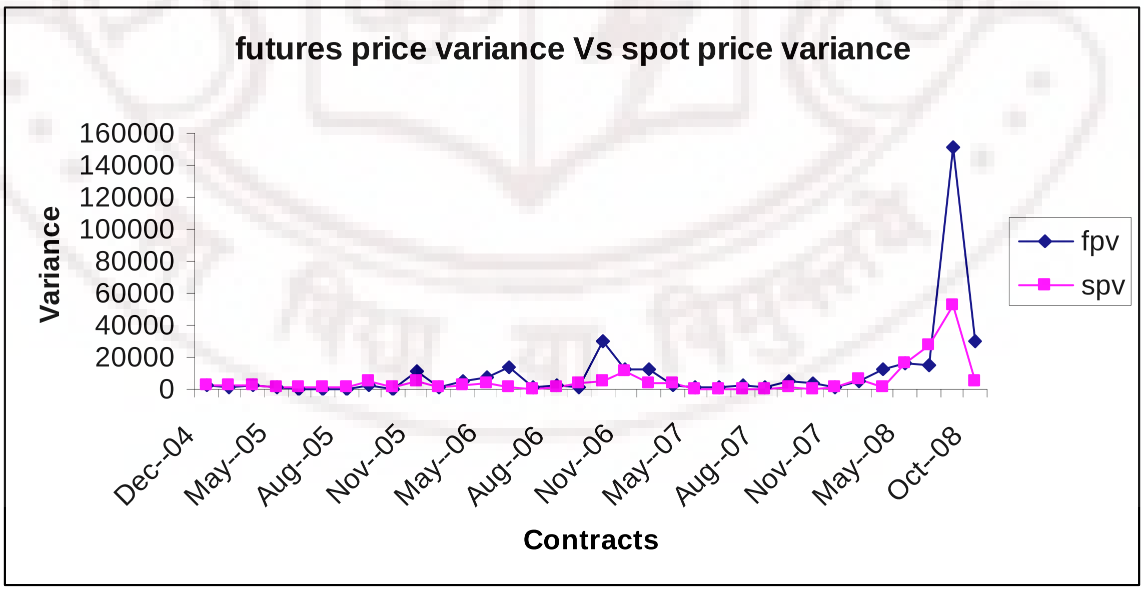


Table 2.5 Futures price variance Vs Spot price variance for Cardamom

Contract	fpv	spv	Ratio	Contract	fpv	spv	Ratio
Mar--06	34	39	0.89	Jul--07	39	32	1.20
Apr--06	13	4	3.58	Aug--07	285	16	17.90
May--06	125	89	1.40	Sep--07	223	6	40.06
Jun--06	16	32	0.51	Oct--07	1022	24	42.93
Jul--06	8	15	0.55	Nov--07	63	58	1.09
Aug--06	673	218	3.08	Dec--07	161	173	0.93
Sep--06	2377	2976	0.80	Jan--08	1130	623	1.81
Oct--06	4828	446	10.82	Feb--08	298	18	16.33
Nov--06	907	679	1.33	Mar--08	172	8	22.04
Dec--06	778	202	3.84	Apr--08	961	44	21.87
Jan--07	158	190	0.83	May--08	177	58	3.06
Feb--07	202	123	1.65	Jun--08	1370	91	15.05
Mar--07	223	9	25.90	Jul--08	326	405	0.80
Apr--07	260	109	2.39	Aug--08	715	155	4.61
May--07	95	27	3.56	Sep--08	489	55	8.94
Jun--07	279	50	5.53	Oct--08	930	677	1.37

Figure 2.5 Futures price variance Vs Spot price variance for Cardamom

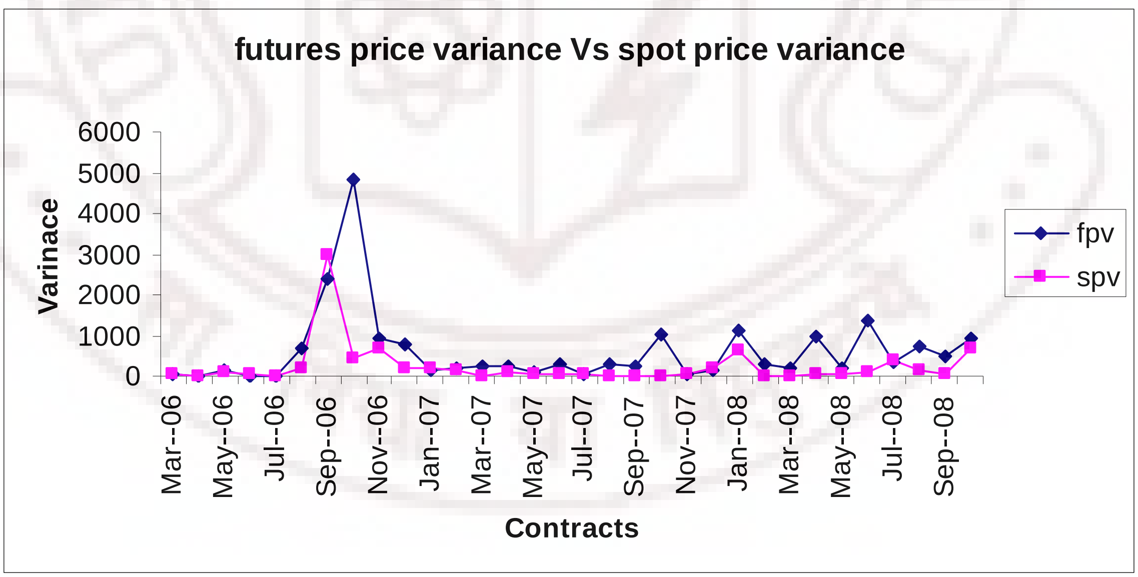


Table 2.6 Futures price variance Vs Spot price variance for copper

Contract	fpv	spv	Ratio	Contract	fpv	spv	Ratio
Aug--05	9	8	1.20	Jun--07	15	19	0.80
Nov--05	59	43	1.38	Aug--07	81	121	0.66
Feb--06	18	17	1.09	Nov--07	153	197	0.78
Apr--06	767	770	1.00	Feb--08	348	374	0.93
Jun--06	331	332	1.00	Apr--08	15	18	0.85
Aug--06	74	91	0.81	Jun--08	143	137	1.04
Nov--06	107	117	0.92	Aug--08	104	136	0.77
Feb--07	172	191	0.90	Nov--08	96	100	0.96
Apr--07	82	98	0.83				

Figure 2.6 Futures price variance Vs Spot price variance for copper

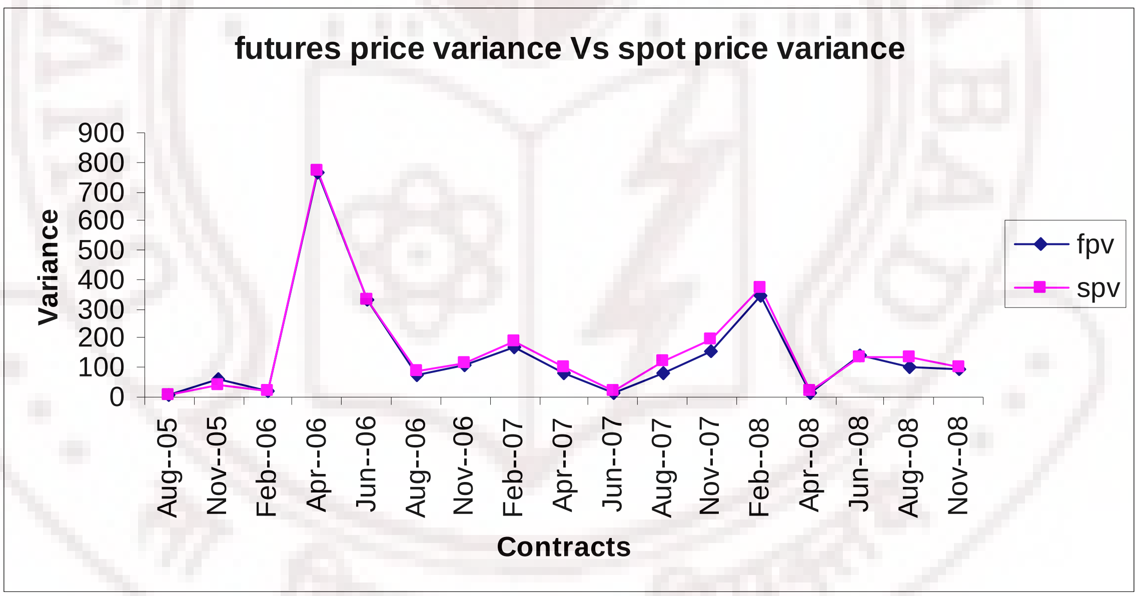


Table 2.7 Futures price variance Vs Spot price variance for Lead

Contract	fpv	spv	Ratio	Contract	fpv	spv	Ratio
Aug--07	35	39	0.89	Apr--08	11	8	1.35
Sep--07	43	54	0.79	May--08	51	50	1.01
Oct--07	14	23	0.59	Jun--08	14	10	1.34
Nov--07	134	142	0.94	Jul--08	80	80	0.99
Dec--07	44	49	0.90	Aug--08	36	27	1.30
Jan--08	6	6	0.90	Sep--08	12	12	0.99
Feb--08	72	70	1.02	Oct--08	40	64	0.62
Mar--08	75	92	0.82	Nov--08	27	24	1.17

Figure 2.7 Futures price variance Vs Spot price variance for Lead

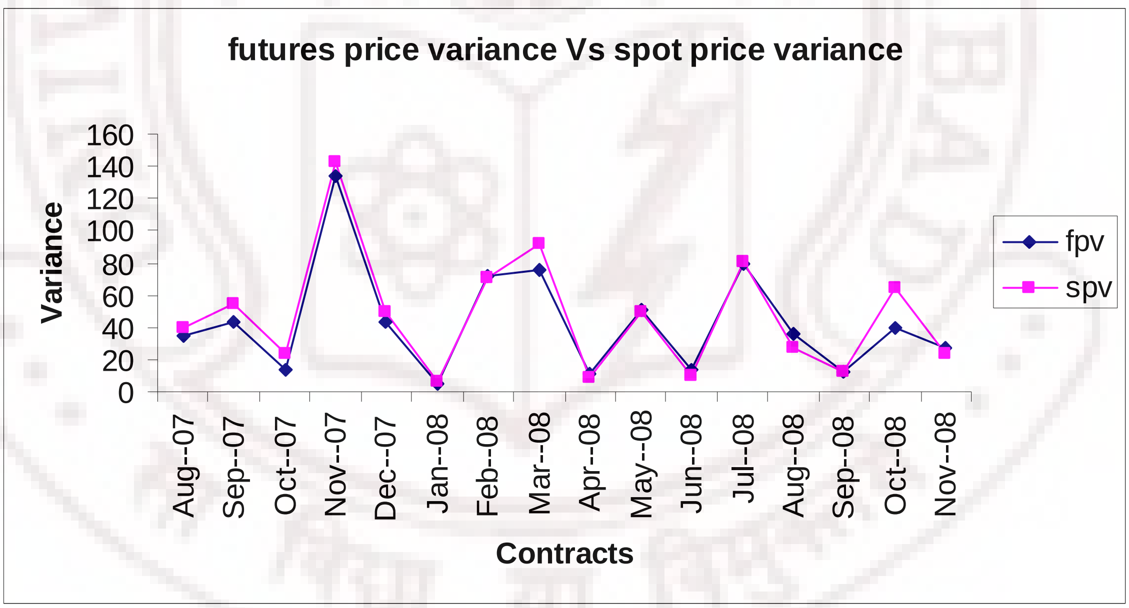


Table 2.8 Futures price variance Vs Spot price variance for Nickel

Contract	fpv	spv	Ratio	Contract	fpv	spv	Ratio
Jan--07	18120	15675	1.16	Dec--07	411	388	1.06
Feb--07	12173	8084	1.51	Jan--08	939	1038	0.90
Mar--07	11072	8084	1.37	Feb--08	1193	1334	0.89
Apr--07	3236	5557	0.58	Mar--08	4459	4117	1.08
May--07	4431	3139	1.41	Apr--08	179	269	0.67
Jun--07	26409	33657	0.78	May--08	4465	4137	1.08
Jul--07	6988	6553	1.07	Jun--08	1696	1614	1.05
Aug--07	2695	3893	0.69	Jul--08	2882	2790	1.03
Sep--07	6047	8376	0.72	Aug--08	3650	4417	0.83
Oct--07	358	1051	0.34	Sep--08	1606	1497	1.07
Nov--07	5803	4205	1.38	Oct--08	6422	7864	0.82
				Nov--08	1171	659	1.78

Figure 2.8 Futures price variance Vs Spot price variance for Nickel

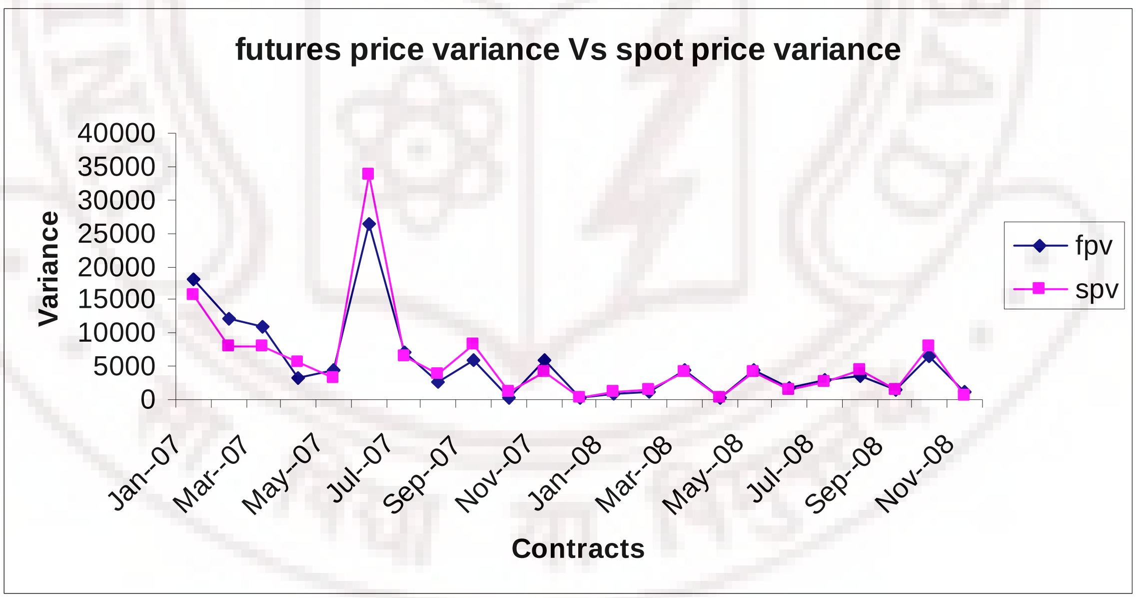
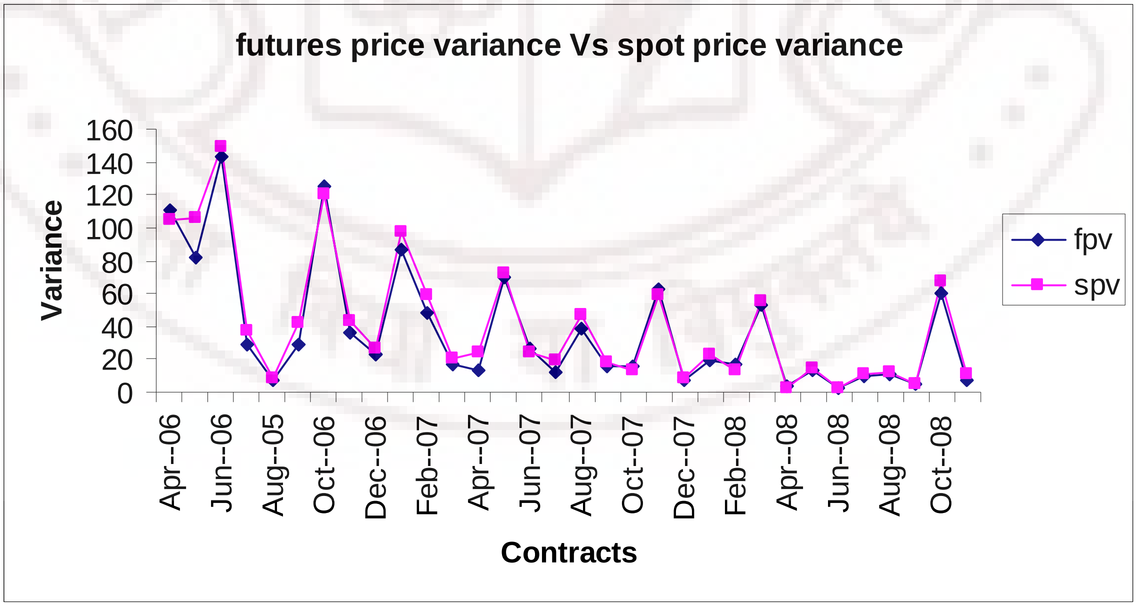


Table 2.9 Futures price variance Vs Spot price variance for Zinc

Contract	fpv	spv	Ratio	Contract	fpv	spv	Ratio
Apr--06	111	105	1.06	Aug--07	38	47	0.82
May--06	82	105	0.77	Sep--07	15	18	0.86
Jun--06	143	150	0.96	Oct--07	16	13	1.20
Jul--06	29	37	0.77	Nov--07	63	59	1.05
Aug--05	8	9	0.87	Dec--07	8	8	0.91
Sep--06	29	42	0.69	Jan--08	19	23	0.82
Oct--06	125	121	1.03	Feb--08	16	13	1.28
Nov--06	36	43	0.84	Mar--08	53	55	0.95
Dec--06	23	26	0.89	Apr--08	4	3	1.59
Jan--07	86	97	0.89	May--08	13	14	0.93
Feb--07	48	59	0.82	Jun--08	3	3	0.90
Mar--07	17	20	0.82	Jul--08	9	10	0.91
Apr--07	13	24	0.56	Aug--08	11	12	0.91
May--07	70	72	0.97	Sep--08	5	4	1.01
Jun--07	26	24	1.10	Oct--08	61	67	0.90
Jul--07	12	19	0.63	Nov--08	7	11	0.68

Figure 2.9 Futures price variance Vs Spot price variance for Zinc



2.2.2 Basis risk Analysis

Generally unhedged producer or trader faces the spot price risk where as hedged investor deals with basis risk. Spot price risk is risk occurred due to variability in the spot price of the commodity. The main purpose and benefit of hedging on the futures market is to minimise possible revenue loss associated with spot price changes. By taking equal but opposite position in spot and futures market, farmers or traders square off their positions in the markets against one another and effect of price changes on their income level is thereby neutralised. The hedging activity can be considered as exchanging price risk for basis risk (Carter, 1984). If the spot price is less than the future price of the underlying asset, the market is said to be in contango. Conversely, if the spot price is more than the future price, the market is said to be in backwardation. When the future contracts expire, the spot and future price converge with each other. Basis is the difference between spot price and futures price. According to Pindyck (2001), the spread between the future price and spot price gives a direct measure of the marginal value of the storage for a commodity termed alternatively, as marginal convenience yield (MCY). Future price could be greater or less than the spot price depending on the magnitude of the net (of storage costs) MCY. If MCY is large, the spot price will exceed the futures price. Producers taking position in the commodity derivatives markets are beset with basis risk.

The basis does have some variability and hedging cannot completely eliminate price risk. Hedging will reduce price risk when the basis variability is less than the cash price variability. Hence, the lower the basis risk, the more effective is the futures market in terms of its function of price risk management. In the efficient markets, future price converges to the spot price and thus, the basis risk becomes zero in the maturity month. In such markets, producer who hedges his price risk can contain his business risk by holding the contract until the maturity of the contract. Thus, if the basis is low, hedging becomes an effective instrument of price risk management. The effectiveness of commodity derivatives markets in terms of the price risk management could be examined by analysing the ratio of variance of basis to the spot price in the maturity month of the contract. If basis risk is less than spot price risk then particular contract is suitable for hedging. A ratio of variance of basis to the spot price of any contract that is less than 0.5 (a benchmark) could be considered to be effective in price risk management and hence, would attract more participants to the derivatives market (Naik and Jain, 2002).

2.2.2.1 Analysis

Basis is calculated for all contracts for nine commodities namely, chilly, jeera, pepper, turmeric, cardamom, copper, lead, nickel and zinc. The best way to understand if futures have been instrumental in minimizing spot price risk is to compare the variance of basis with variance of spot price. If basis risk is lower than spot price risk then the contract is suitable for hedging. The calculated values are mentioned in tables 2.10 to 2.18.

Agricultural Commodities

The contracts are taken from July' 06 to October' 08. Out of 21 contracts only 9 are suitable for hedging since basis risk is less than spot price risk. From the table 2.10 it is observed that during July ’06 to October ’08 in case of chilly trading, the ratio is less than one in 45 percent of the cases, while it is less then 0.5 in about 35 percent of cases. Further, contracts maturing in harvesting period in 2007 March, April, June and July, April 08 and non harvesting period contracts August’ 06, September’ 06, and October ‘07 witnessed the ratio becoming less then the bench mark (the ratio is 0.5). However, contracts of October’ 06, November’ 06, and September’ 07 and August’ 08 display considerable volatility in their basis compared to spot price volatility.

Total 42 contracts are taken for the analysis of jeera. 21 contracts indicate that basis risk is lower than spot price. From table 2.11 the results are observed as follows: Active trading started in Jeera futures market in March 2005. During a trading period of March’ 05 to October 08, total of 42 contracts is traded, out of which 21 contracts are suitable for hedging. So it indicates that the ratio is less than one for about 50 percent of the contracts, among them most of the contracts appear in harvesting period, while it is less than 0.5(bench mark) in about 21 percent of the contracts. Further the contracts April’ 05, July’ 05, June’ 06, March’ 06, April’ 06, October’ 06, November’ 06, May’ 07 and August’ 07 are showing high basis risk as compared to spot price risk. It concludes that speculation is high in these contracts.

In case of pepper total 53 contracts are traded between June’ 04 to October’ 08. Out of which, 29 contracts are suitable for hedging as their basis risk is less than spot price risk. Basis risk results are presented in table 2.12. The ratio below the bench mark is around 47 percent indicating that basis risk in these cases are neither too low nor two high but at the best moderate. So pepper futures market provides better hedging facilities. Speculation is high in some contracts like October' 05, April' 06, May' 07, August' 08 and October' 08 owing to the international demand and supply factors.

The trading period for turmeric is considered between December' 04 to October' 08. In this period 34 contracts are traded, out of which 15 contracts basis risk is less than one. In around thirty percent of cases the ratio is below the benchmark. It is also observed in the year 2006 most of the contracts are revealing high speculation. The contracts June' 06, July' 07, August' 07, October' 07 and April' 08 are showing high risk. Even in harvesting period basis risk of some of contracts is high.

The data for 32 contracts of cardamom are collected from Multi Commodity Exchange. The results are presented in table 2.14. The results indicate that for almost all contracts basis risk is higher than spot price risk. Among all spices, the basis risk turned out to be substantially high in case of cardamom; this reveals that speculation is high in Cardamom futures market. Out of 32 contracts only 9 contracts are suitable for hedging, while the ratio is less than the bench mark in around four cases. All this indicates that hedging efficiency of cardamom is very low, because of high basis variability. Except in a few contracts, speculation is high in almost 75 percent of contracts. Cardamom price show high volatility as it is affected by domestic and international supply and demand parameters. The crop is highly susceptible to pests and weather conditions; this has a strong influence on the prices.

Metals

Four base metals are considered for the basis risk analyses are copper, lead, nickel and zinc. The results of basis risk are presented in tables 2.15 to 2.18. For copper, active trading is considered between August' 05 to November' 08; from the table 2.15, out of 18 contracts, almost all contracts show that the ratio is less than one, while it is less than 0.5 (Bench mark) in 72 percent of the cases. When it comes to lead, the total 18 contracts' basis risk is less than one, while the ratio is below the benchmark in around 94 percent. This can be observed form table 2.16. In case of nickel, total 23 contracts are taken between the trading period of January' 07 to November' 08. The table 2.17 shows that all contracts basis risk is less then spot price risk, while 87 percent cases ratio is less than the bench mark. Among base metals zinc is one of the active futures markets. 32 contracts are selected between the active trading period of April' 06 to November' 08. The results of basis risk are presented in table 2.18. It is observed form the table, for all contracts, basis risk is less than spot price risk. However, its ratio is below the bench mark in 97 percent of the cases, implying, thereby, that trading in zinc is relatively less risky than other base metals.

Table 2.10 Basis risk Vs Spot risk for Chilly

Contract	Basis Risk	Price Risk	Ratio	Contract	Basis Risk	Price Risk	Ratio
Jul--06	87957	31742	2.77	Aug--07	65542	22259	2.94
Aug--06	11936	27803	0.43	Sep--07	22846	4118	5.55
Sep--06	95438	106841	0.89	Oct--07	13283	27002	0.49
Oct--06	254013	76344	3.33	Nov--07	5675	2645	2.15
Nov--06	68000	17868	3.81	Feb--08	13010	13186	0.99
Dec--06	123426	74853	1.65	Mar--08	26958	10262	2.63
Mar--07	24433	76054	0.32	Apr--08	13421	33004	0.41
Apr--07	8236	49205	0.17	Jun--08	193910	114106	1.70
Jun--07	3687	8241	0.45	Aug--08	31930	3846	8.30
Jul--07	19304	41214	0.47	Oct--08	36299	32280	1.12

Figure2.10 Basis risk Vs Spot risk for Chilly

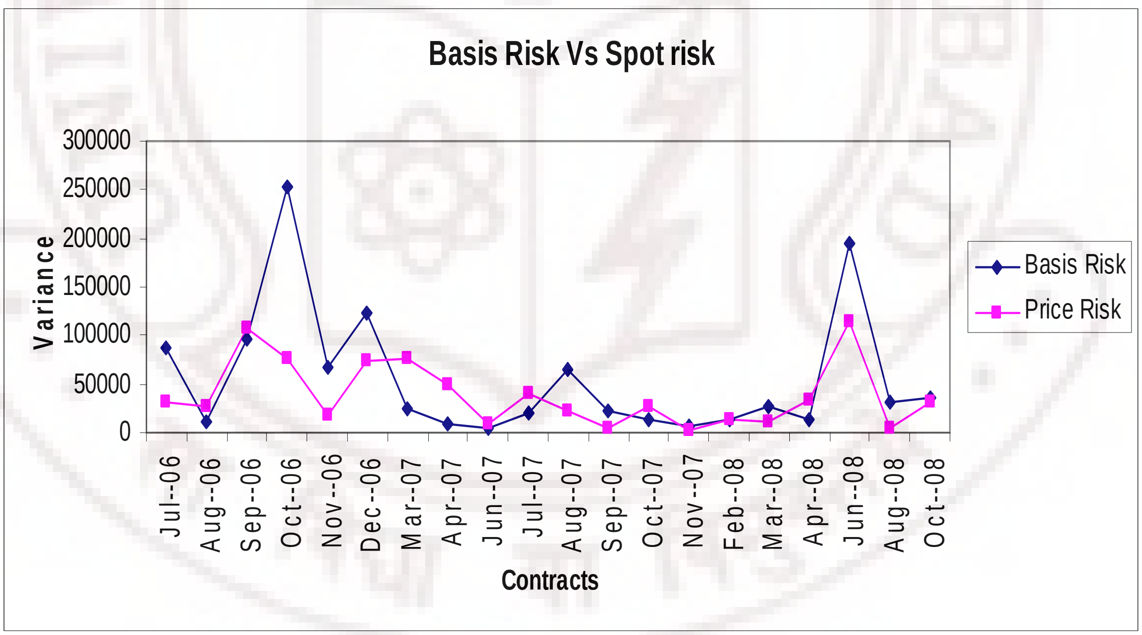


Table 2.11 Basis risk Vs Spot risk for Jeera

Contract	Basis Risk	Price Risk	Ratio	Contract	Basis Risk	Price Risk	Ratio
Mar-- 05	22529	17667	1.28	Dec--06	4671	10099	0.46
Apr--05	12653	1604	7.89	Jan--07	10380	15054	0.69
May--05	27294	13323	2.05	Feb--07	18922	173034	0.11
Jun--05	4536	3374	1.34	Mar--07	29960	128803	0.23
Jul--05	28626	1901	15.06	Apr--07	51563	99949	0.52
Aug--05	23353	28273	0.83	May--07	314371	26402	11.91
Sep--05	12349	7062	1.75	Jun--07	414893	91789	4.52
Oct--05	7050	15357	0.46	Jul--07	101549	14562	6.97
Nov--05	3665	1336	2.74	Aug--07	134267	11099	12.10
Dec--05	13544	4394	3.08	Sep--07	29733	126856	0.23
Jan--06	31765	1075	29.54	Oct--07	62647	19499	3.21
Feb--06	8919	13822	0.65	Nov--07	34857	28766	1.21
Mar--06	25286	3365	7.51	Dec--07	17441	35836	0.49
Apr--06	12653	1604	7.89	Jan--08	78473	92945	0.84
May--06	63556	244760	0.26	Feb--08	95031	260409	0.36
Jun--06	23396	5574	4.20	Mar--08	47989	50144	0.96
Jul--06	8777	48993	0.18	Apr--08	17972	21625	0.83
Aug--06	17290	56519	0.31	May--08	32299	320783	0.10
Sep--06	52039	137583	0.38	Jul--08	7772	219284	0.04
Oct--06	228054	47871	4.76	Sep--08	41334	86236	0.48
Nov--06	37622	8860	4.25	Oct--08	140802	62711	2.25

Figure 2.11 Basis risk Vs Spot risk for Jeera

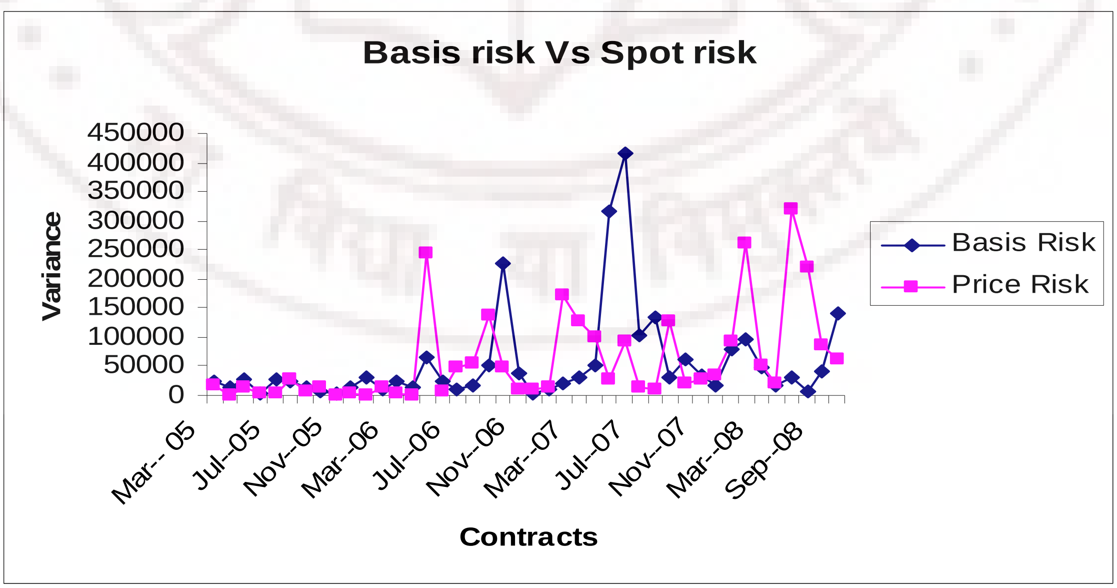


Table 2.12 Basis risk Vs Spot risk for Pepper

Contract	Basis Risk	Price Risk	Ratio	Contract	Basis Risk	Price Risk	Ratio
Jun--04	10662	12166	0.88	Sep--06	56486	1258891	0.04
Jul--04	9210	10367	0.89	Oct--06	256092	186795	1.37
Aug--04	7651	6681	1.15	Nov--06	95746	247187	0.39
Sep--04	5102	29468	0.17	Dec--06	87896	239122	0.37
Oct--04	7387	22490	0.33	Jan--07	27855	268751	0.10
Nov--04	14778	36867	0.40	Feb--07	38818	91738	0.42
Dec--04	4279	68478	0.06	Mar--07	14219	56083	0.25
Jan--05	12749	16388	0.78	Apr--07	98129	1366851	0.07
Feb--05	10143	44158	0.23	May--07	161736	82227	1.97
Mar-- 05	2748	25957	0.11	Jun--07	21744	38941	0.56
Apr--05	1378	8978	0.15	Jul--07	66174	63986	1.03
May--05	2834	13644	0.21	Aug--07	69200	319820	0.22
Jun--05	2726	3161	0.86	Sep--07	52061	54599	0.95
Jul--05	7572	10817	0.70	Oct--07	97418	384766	0.25
Aug--05	12105	10261	1.18	Nov--07	64490	212653	0.30
Sep--05	3932	1304	3.01	Dec--07	33074	50049	0.66
Oct--05	8956	1670	5.36	Jan--08	23942	267813	0.09
Nov--05	3935	10680	0.37	Feb--08	39430	60899	0.65
Dec--05	14936	53353	0.28	Mar--08	80799	76131	1.06
Jan--06	14951	33651	0.44	Apr--08	25711	41571	0.62
Feb--06	7461	13313	0.56	May--08	20088	14733	1.36
Mar--06	9603	10640	0.90	Jun--08	82457	74411	1.11
Apr--06	12810	1503	8.52	Jul--08	13728	11933	1.15
May--06	17699	9440	1.87	Aug--08	29338	10990	2.67
Jun--06	11254	9086	1.24	Sep--08	51877	341179	0.15
Jul--06	9146	111055	0.08	Oct--08	70192	31244	2.25
Aug--06	46648	496043	0.09				

Figure 2.12 Basis risk Vs Spot risk for Pepper

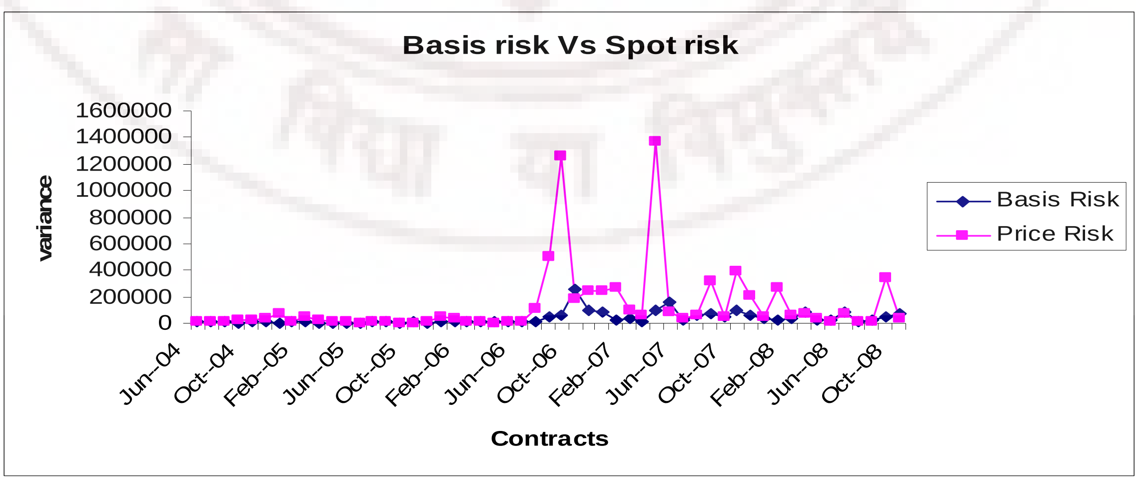


Table 2.13 Basis risk Vs Spot risk for Turmeric

Contract	Basis Risk	Price Risk	Ratio	Contract	Basis Risk	Price Risk	Ratio
Dec--04	578	1991	0.29	Oct--06	12334	4874	2.53
Feb--05	5050	2812	1.80	Nov--06	1818	10995	0.17
Apr--05	1102	2940	0.37	Dec--06	3496	4160	0.84
May--05	557	750	0.74	Apr--07	1432	4110	0.35
Jun--05	1669	1276	1.31	May--07	547	461	1.19
Jul--05	1014	1150	0.88	Jun--07	1325	516	2.57
Aug--05	1430	969	1.48	Jul--07	2951	500	5.90
Sep--05	881	4758	0.19	Aug--07	716	153	4.68
Oct--05	1077	1814	0.59	Sep--07	1391	1074	1.29
Nov--05	2339	5342	0.44	Oct--07	2996	111	27.06
Dec--05	624	1016	0.61	Nov--07	1324	1000	1.32
Apr--06	778	3046	0.26	Dec--07	1781	6838	0.26
May--06	8387	3693	2.27	Apr--08	6944	1373	5.06
Jun--06	10270	1191	8.63	May--08	2317	16429	0.14
Jul--06	1240	585	2.12	Jun--08	8845	28082	0.31
Aug--06	3512	1447	2.43	Aug--08	33860	52409	0.65
Sep--06	4628	3244	1.43	Oct--08	12215	5358	2.28

Figure 2.13 Basis risk Vs Spot risk for Turmeric

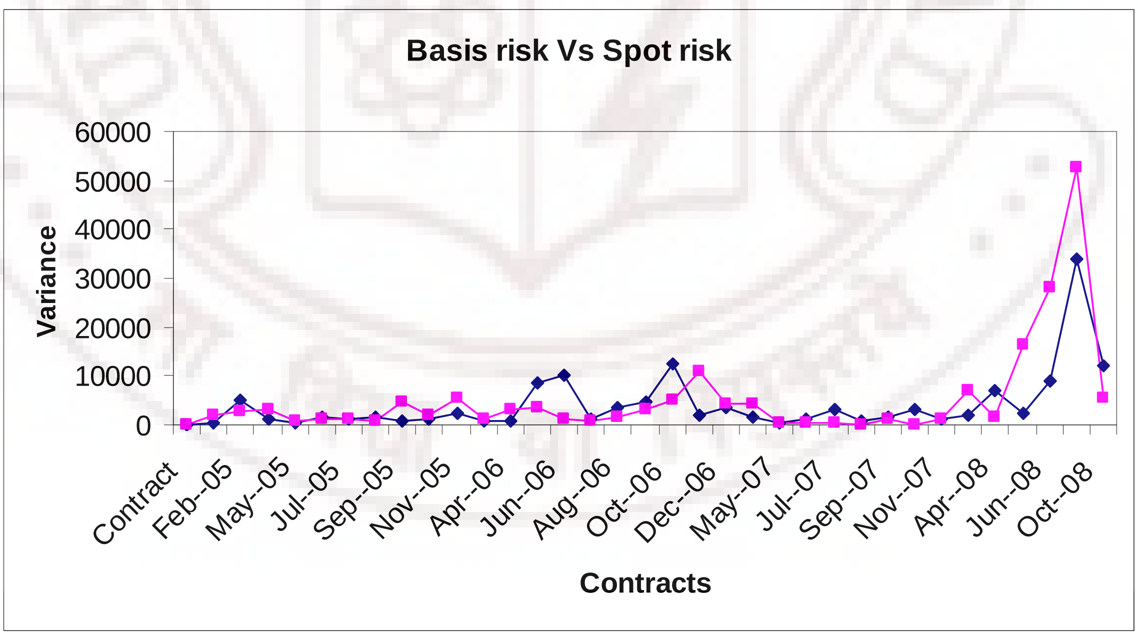


Table 2.14 Basis risk Vs Spot risk for Cardamom

Contract	Basis Risk	Price Risk	Ratio	Contract	Basis Risk	Price Risk	Ratio
Mar--06	32	39	0.82	Jul--07	85	32	2.64
Apr--06	14	4	3.65	Aug--07	210	16	13.15
May--06	76	89	0.85	Sep--07	194	6	34.82
Jun--06	12	32	0.38	Oct--07	956	24	40.15
Jul--06	25	15	1.72	Nov--07	84	58	1.45
Aug--06	315	218	1.44	Dec--07	179	173	1.04
Sep--06	415	2976	0.14	Jan--08	138	623	0.22
Oct--06	3017	446	6.76	Feb--08	275	18	15.04
Nov--06	141	679	0.21	Mar--08	137	8	17.53
Dec--06	207	202	1.02	Apr--08	653	44	14.87
Jan--07	456	190	2.40	May--08	181	58	3.13
Feb--07	174	123	1.42	Jun--08	848	91	9.32
Mar--07	195	9	22.57	Jul--08	434	405	1.07
Apr--07	486	109	4.48	Aug--08	383	155	2.47
May--07	150	27	5.62	Sep--08	378	55	6.91
Jun--07	114	50	2.26	Oct--08	202	677	0.30

Figure 2.14 Basis risk Vs Spot risk for Cardamom

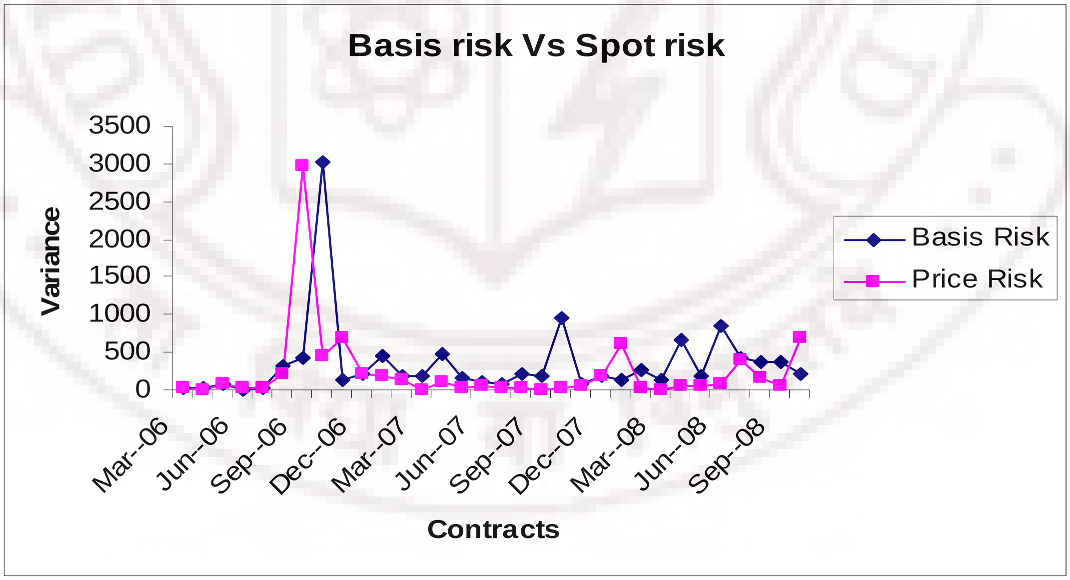


Table 2.15 Basis risk Vs Spot risk for Copper

Basis Risk Vs Spot Risk							
Contract	Basis Risk	Price Risk	Ratio	Contract	Basis Risk	Price Risk	Ratio
Aug--05	6	8	0.81	Jun--07	14	19	0.74
Nov--05	35	43	0.81	Aug--07	26	121	0.22
Feb--06	13	17	0.77	Nov--07	68	197	0.35
Apr--06	55	770	0.07	Feb--08	29	374	0.08
Jun--06	126	332	0.38	Apr--08	21	18	1.21
Aug--06	44	91	0.49	Jun--08	15	137	0.11
Nov--06	39	117	0.33	Aug--08	40	136	0.29
Feb--07	31	191	0.16	Nov--08	44	100	0.44
Apr--07	29	98	0.30				

Figure 2.15 Basis risk Vs Spot risk for Copper

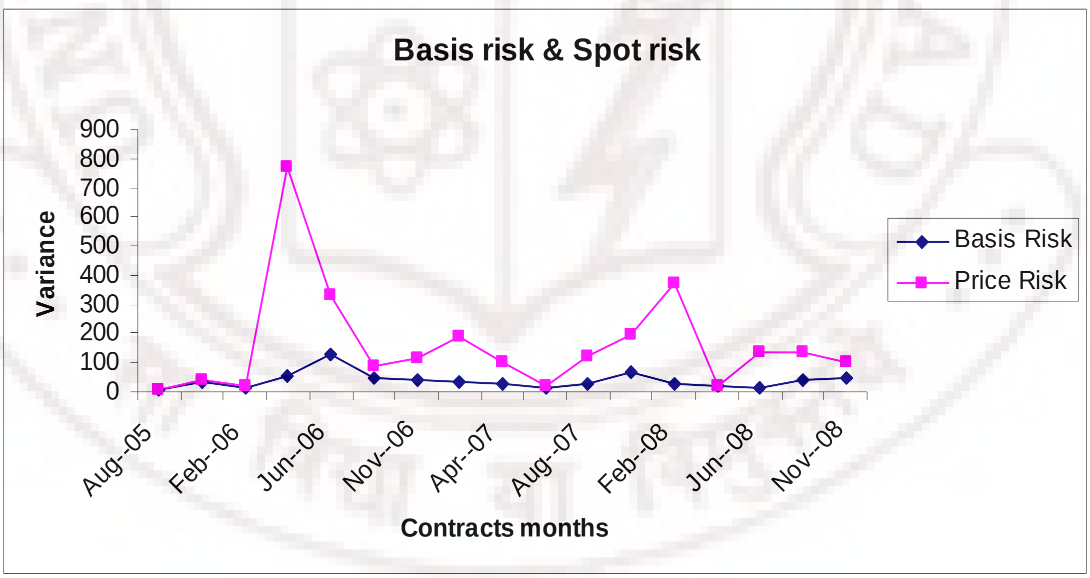


Table 2.16 Basis risk Vs Spot risk for Lead

Basis Risk Vs Spot Risk							
Contract	Basis Risk	Price Risk	Ratio	Contract	Basis Risk	Price Risk	Ratio
Aug--07	8	39	0.20	Apr--08	4	8	0.48
Sep--07	8	54	0.15	May--08	4	50	0.07
Oct--07	4	23	0.17	Jun--08	1	10	0.13
Nov--07	4	142	0.03	Jul--08	2	80	0.03
Dec--07	2	49	0.05	Aug--08	6	27	0.23
Jan--08	5	6	0.85	Sep--08	2	12	0.18
Feb--08	4	70	0.06	Oct--08	9	64	0.14
Mar--08	13	92	0.14	Nov--08	3	24	0.14

Figure 2.16 Basis risk Vs Spot risk for Lead

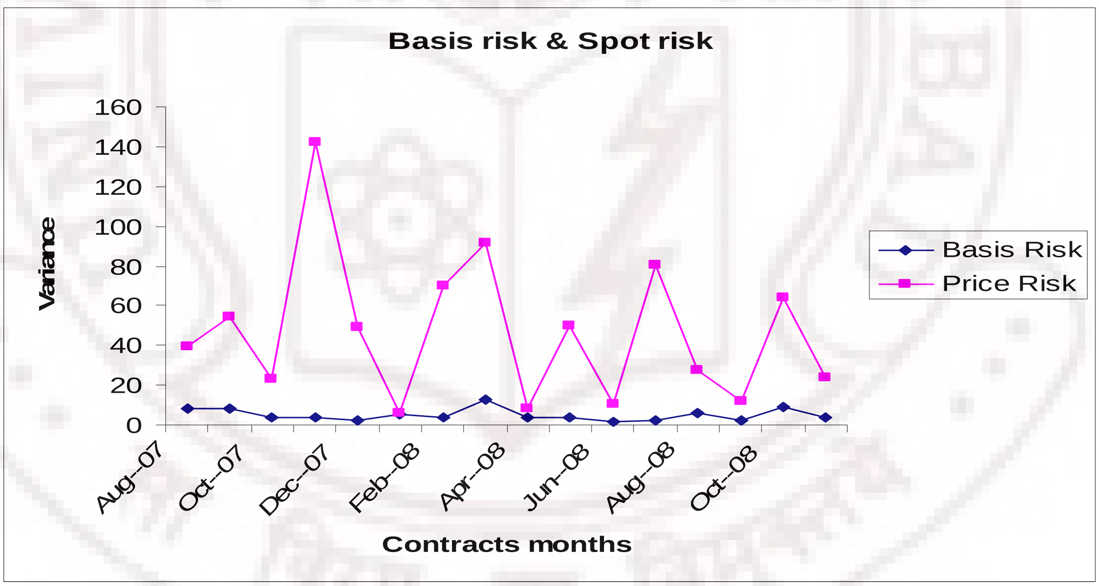


Table 2.17 Basis risk Vs Spot risk for Nickel

Basis Risk Vs Spot Risk							
Contract	Basis Risk	Price Risk	Ratio	Contract	Basis Risk	Price Risk	Ratio
Jan--07	1478	15675	0.09	Jan--08	659	1038	0.63
Feb--07	1705	8084	0.21	Feb--08	155	1334	0.12
Mar--07	1705	8084	0.21	Mar--08	1023	4117	0.25
Apr--07	1853	5557	0.33	Apr--08	146	269	0.54
May--07	1344	3139	0.43	May--08	380	4137	0.09
Jun--07	2071	33657	0.06	Jun--08	283	1614	0.18
Jul--07	317	6553	0.05	Jul--08	172	2790	0.06
Aug--07	534	3893	0.14	Aug--08	201	4417	0.05
Sep--07	760	8376	0.09	Sep--08	103	1497	0.07
Oct--07	534	1051	0.51	Oct--08	631	7864	0.08
Nov--07	566	4205	0.13	Nov--08	377	659	0.57
Dec--07	205	388	0.53				

Figure 2.17 Basis risk Vs Spot risk for Nickel

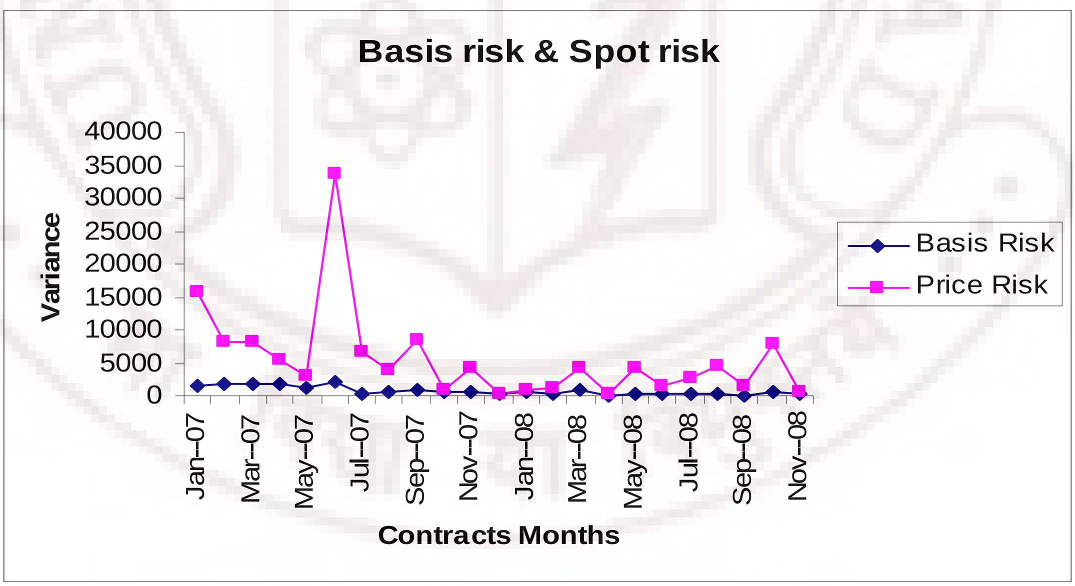


Table 2.18 Basis risk Vs Spot risk for Zinc

Basis risk Vs Spot risk							
Contract	Basis Risk	Price Risk	Ratio	Contract	Basis Risk	Price Risk	Ratio
Apr--06	41	105	0.39	Aug--07	4	47	0.09
May--06	23	105	0.22	Sep--07	3	18	0.19
Jun--06	9	150	0.06	Oct--07	2	13	0.14
Jul--06	6	37	0.17	Nov--07	3	59	0.04
Aug--05	3	9	0.38	Dec--07	1	8	0.15
Sep--06	10	42	0.23	Jan--08	4	23	0.17
Oct--06	3	121	0.02	Feb--08	3	13	0.20
Nov--06	4	43	0.10	Mar--08	5	55	0.09
Dec--06	3	26	0.12	Apr--08	1	3	0.54
Jan--07	12	97	0.12	May--08	2	14	0.13
Feb--07	4	59	0.07	Jun--08	1	3	0.35
Mar--07	3	20	0.13	Jul--08	2	10	0.19
Apr--07	11	24	0.46	Aug--08	1	12	0.07
May--07	6	72	0.08	Sep--08	2	4	0.42
Jun--07	2	24	0.08	Oct--08	6	67	0.09
Jul--07	3	19	0.17	Nov--08	3	11	0.26

Figure 2.18 Basis risk Vs Spot risk for Zinc

Chapter-3

Price Discovery Process

3.1 Introduction

In this chapter the focus is to analyse the price discovery process between futures and spot markets for spices and base metals. These two commodities data are considered from the two national commodities exchanges NCEDX and MCX respectively. The methodology used in this study is cointegration and error correction mechanism.

One of the economic functions of futures markets is price discovery. It reveals information about future spot price through futures market. The price discovery between spot and futures markets has received considerable attention by academicians, investors, and regulators for the following reason; the issue is linked to informational efficiency and arbitrage strategies. Price discovery refers to the use of futures prices for pricing cash market transactions (Working 1948). Price discovery in futures markets is defined as the use of futures prices to determine expectations of (future) cash market prices (Schroeder & Goodwin, 1991). According to Black (1976) the primary benefits from commodity futures markets are informed production, storage and processing decision. The essence of price discovery function is to establish a reference price from which the spot market can be derived and hinges on whether new information is reflected first in changed futures prices or in changed cash prices. The futures price serves as the market's expectation of subsequent spot price.

The significance of price discovery depends upon a close relationship between futures and spot price. The performance of price discovery function can be measured from the temporal relation between futures and spot prices. The causal relation investigates whether the spot market leads the futures market or the futures market leads the spot market or whether there exists bidirectional relation between the two markets. If information is first reflected in futures price and later in spot price, futures price should lead spot price indicating that the futures market performs the price discovery function. An important component in understanding and managing market price risk for different commodities is identifying and comparing the relationship between futures market and spot market by cost of carry relationship.

Silvapulle and Moosa (1999) argue that futures prices respond to new information more quickly than the latter due to lower transaction costs and ease of shorting, while Newberry (1992) postulates that futures market provide opportunities for market manipulation. According to this argument the futures market can be manipulated either by the larger at the expense of the smaller or by the better informed at the expense of the uniformed. There are also arguments for the opposite hypothesis, that spot price lead futures prices (Silvapulle and Moosa, 1999; Quan, 1992; Moosa, 1996). Moosa (1996) presents a model where the change in the spot price will trigger action from the different kinds of market participants, and these actions will subsequently change the futures price.

Based on the above back ground, the main motivation of the present study is to analyse how information is transmitted between spot and futures markets. An investigation of the price discovery role of futures markets helps to understand whether the process of information in the desired manner or not. For the futures to be an unbiased predictor of subsequent spot price the futures price should lead the spot price and not vice versa. This issue needs to be investigated empirically in this study.

3.2 Theoretical relationship between spot and futures prices

There are basically two views on the price formation process for commodity futures prices. Firstly, the intertemporal relationship between cash and futures prices of continuously storable commodities is explained by the cost of carry for the commodity (Kaldor, 1939; Working 1948, 1949; Brennan 1958; Telser, 1958). In the second view one splits the futures price into an expected risk premium and forecast of a future spot price (Cootner, 1960; Dusak, 1973; Breeden, 1980; Hazuka, 1984).

The theory of intertemporal relationship between cash and futures prices can be explained briefly with the cost of carry conditions as a starting point. This condition can, for continuously storable commodities be formulated as

$$F_t^T \geq S_t e^{(r_t + w)(T-t)} \qquad \ldots (3.2.1)$$

where t is the current date, T is the futures contract expiration date, w is storage cost, r is the riskless money rate of interest at t, F_t^T , is the future price at t, and S_t is the spot price at t. This condition says that if you want a commodity at some time T, you can either buy a future contract with delivery at time T, or you can buy the commodity in the spot market and store it until T. A disparity between the left-hand ad right-hand side of cost-of-carry equation might give rise to an arbitrage opportunity. Arbitragers can then go long in the commodity and short the futures contract, and hence lock in a secure payoff. From equation (3.2.1) it seems like the conditions also should hold the other way round, i.e. The futures price never should be less than the spot price plus storage and interest cost. However this is more problematic since one can argue that there is a value associated with having the commodity. This value, the convenience yield, is based in the fact that having the commodity in stock provides flexibility regarding, for instance, unexpected demand.

Supporters of the second view on the price formation process for commodity futures prices argues that the basis can be expressed as a sum of an expected premium and an expected change in the spot price.

$$F_t^T - S_t = E_t[P(t,T)] + [S_t - S_t] \qquad \dots (3.2.2)$$

Here the expected premium $E_t[P(t,T)]$ is defined as the bias of the future price as a forecast of the future spot price.

$$E_t[P(t,T)] = F_t^T - E_t[S_T] \qquad \dots (3.2.3)$$

Fama and French (1988) argue that the theory of storage, equation (3.1) and equation (3.2) are alternative but not competitive views of the basis, and that variation in expected change in the spot price in (3.2.2) translates into variation in the interest rate and the marginal storage cost in (3.2.1). Both theories imply that there should be a long run stable relationship between spot and futures prices. In addition, for the future price to be an unbiased predictor of subsequent spot price, i.e., $E_t[P(t,T)]$ equals zero, the future price should lead the spot price (Garbade and Silber, 1983).

The theories reviewed above have in common that they are bivariate specifications of the relationship between the spot price and the future price. They do not take into account the fact that for most futures, several contracts are traded at the same time. For a trader in the market, buying a futures contract with expiration at time t is similar to buying a futures contract that expires at time t-I and then store the commodity from t-i to t. Hence a similar relationship as in equation (3.2.1) also holds for two futures contracts with different time to expiration.

$$F_t^T \geq F_t^{T-i} e^{(r_t + w)(T-t)} \qquad \dots (3.2.4)$$

However, as mentioned above, this condition only says that there should be a long run relationship between the prices; the condition says nothing about whether any of the prices leads the other. If the longest contract predicts the futures spot price, this should also predict the price of any shorter future contracts. On the other hand, some weights between convenience yield and low transaction costs can lead a shorter contract to be the price leader, and as above spot price can be the price leading if the convenience yield is high enough. It is of interest to note that if equation (3.2.1) holds for all future contracts, then equation (3.2.4) follows.

Empirical tests of the cost-of-carry model come in two flavours: tests of the lead-lag relationship between spot and futures prices and tests of market efficiency as given by the pricing relation in Eq. (3.2.1). The two strands of literature are closely related and complement each other on the basis of the Granger Representation Theorem (Engle and Granger 1987). In particular, when a futures contract is priced efficiently the futures and the underlying spot prices will be linked through Equation (3.2.1), that is, they will be cointegrated. However, if they are cointegrated, then, according to the Granger Representation Theorem there exists some form of lead/lag relationship between the cointegrating variables.

3.3 Review of Literature

The issue of price discovery between futures and spot commodity markets is the topic of interest to regulators, hedgers, speculators, academicians and other stake holders. The lead lag relation between spot and futures markets have been studied world wide. Although futures and spot markets react to the same fundamental information and same product is traded in different markets, the question arises regarding which market reacts first. The futures markets are expected to be risk management tool. It is important to conduct research on price discovery and hedging of commodity futures markets. Based on this back ground the present study is an attempt to review the relevant research works.

Kenourgios (2004) have examined price discovery in the Athens derivatives exchange for the FTSE/ASE – 20 futures market by using cointegration and error correction methodology. The data are considered for three month futures contracts during the period from August 1999 to June 2002. The results indicate the presence of bidirectional causality between the spot index and the futures index markets. The empirical findings suggest that ADEX market provides futures contracts that can be used as vehicles of prices discovery and indicates an important role that future markets plays towards its ultimate maturity, transparency and secure functioning. This implies that investors using these markets can explore significant arbitrage profits and hedging opportunities.

The long run equilibrium relationship in terms of price discovery between the cash and futures market for cheddar cheese have been examined by Fortenbery and Zapata (1997). The examination of price dynamics in the cash and futures markets cheddar cheese is conducted for the period June 1993 to July 1995. The data was collected for coffee, sugar and cocoa from New York mercantile exchange for futures prices and NCE, in Green Bay for spot prices. Based on cointegration tests they found no evidence of stable long run relationship between cash and futures markets for cheddar cheese.

The investigation of the lead lag relationship between futures and spot markets in Athens Derivative Exchange, Greece was done by Floros and Vougas (2007). The study used the FTSE / ASE – 20 and FTSE / ASE mid 40 futures contracts over the period of 1999 to 2001. By employing Bivariate GARCH model, they found that existence of long run relationship between spot and futures markets and empirical results confirmed that futures market play a price discovery role implying that futures prices contain useful information about spot prices. They also found that the futures market is more informationally efficient. The findings suggested that they are helpful to financial managers and traders dealing with Greek stock index futures.

Quan (1992) used monthly crude oil prices in a two step procedure to test the price discovery role of futures prices. In two steps testing procedure, the first step is testing long run relationship between futures and spot price using cointegration and second step is testing lead lag relation with Granger causality test. Quan found that no long term relation ship is found for the spot and other futures prices and crude oil spot market always dominates the futures market. Finally he concluded that Crude oil futures price does not posses the price discovery function.

The price discovery analysis process in futures and cash markets of seven commodities (copper, corn, gold, oats, orange, juice, silver and wheat) was examined by Garbade and Silber (1983). They found that while futures market dominated spot market, the spot market also played a role in price discovery. There is reverse information flow from spot to future markets as well. They also found that market size and liquidity played important role in the price discovery function. The gold and silver markets are highly integrated even over one day. However, the degree of integration varied over the time lag taken into consideration.

Chopra and Bessler (2005) examined of price discovery in the Black pepper market for the period of October, 2001 to February, 2003 by using the methodology of cointegration and error correction model. The data was classified as spot, nearby futures and first distant futures. The results indicate clearly that the futures markets are the center of price discovery. They concluded that spot and first distant futures contract do not respond to shocks in the cointegrating space; only the nearby futures contracts adjusted to shock in the long run.

The relationship between spot and futures prices for energy commodities (crude oil, gasoline, heating oil and natural gas) was studied by Chinn *et al* (2005). The main motivation was to examine whether futures prices were unbiased and accurate predictors of subsequent spot prices for different time horizons. The study concluded that futures prices were unbiased predictors of crude oil, gasoline, and heating oil prices, but not of natural gas prices of the three months horizon. But futures prices typically explain only a small proportion of the variation in under lying commodity price movements. Similarly, Silvapulle and Moosa (1999) examined the relationship between the spot and futures prices of WTI crude oil using daily data. Linear causality test revealed that futures prices lead spot prices, but non linear causality test revealed a bi directional effect. These results suggest that both spot and futures markets react simultaneously to information.

The analysis of price dynamics between cash and futures prices for stocks was examined by Kakati *et al* (2006) and also they analysed the issue of the informational content of the basis role in determining the direction of changes in cash and futures prices. Cointegration technique and error correction method was used for empirical analysis. The results showed that in most of the cases, the causality is unidirectional from the spot market to the futures market. The price discovery role of the futures market is found to be more prominent in two stocks only. The speed of adjustment in response to the deviation from long term equilibrium is slow. The futures market responds more to the deviation from equilibrium than spot market. It was found that basis reveals the direction of changes in futures prices and less extent in spot prices.

Fortenbery and Zapata (1993) examined long term relationship between futures and spot market for corn and soybean by using cointegration techniques. This analysis was done using the Chicago board of Trade (CBOT) futures contracts and two cash markets for each commodity by utilizing daily data of nearby futures for the period 1980-1991. They found that the markets are inefficient and carrying charges and transport rates are stationary. They suggested that bivariate cointegration models are not as powerful in identifying various market relationships in commodity markets as they are in exchange rate markets. The analysis of prices discovery by introducing interest rate as an argument in the cointegration model was done by Zapata and Fortenbery (1996). They concluded that it was an important factor in explaining price discovery relation between futures and spot market for storable commodities.

Sunil (2004) attempted to investigate price discovery function of futures contracts for ensuring better hedge against price uncertainty for some selected commodities. In this econometric study, the daily futures and comparable spot prices for three contracts of each commodity for five sample commodities (castor seed, gur, cotton, pepper, and groundnut) were taken. The study used ordinary least squares method for estimating regression. The study found that the absence of cointegration reflects lack of a long run stable relationship between the spot and future prices. Finally he concluded that futures markets are not efficient.

While discussing the application of cointegration technique to the price discovery performance of futures markets for storable and non-storable commodities Yang *et al* (2001) observed different results. The data were cash and nearby futures prices for storable commodities (corn, oat, soybean, wheat, cotton and pork bellies) and non-storable commodities (hogs, live cattle, feeder cattle) for the period of 1st Jan, 1992, to June 1998. The three month Treasury bill rate was also considered. The findings indicated that asset storability does not affect the existence of long run relationship between cash and futures prices and futures markets share and provide certain long run price information to cash markets for all non storable commodities. They also concluded that futures prices were not unbiased estimates for cash prices of two out of three non-storable commodities.

The investigation of price discovery and volatility in the context of introduction of derivatives trading at National Stock Exchange is explored by Raju and Karande (2003). Cointegration and GARCH techniques were used to study price discovery and volatility respectively. Dailey closing values of Index Futures and BSE 100 index were considered from June 2000 to October 2002 for the analysis. They found that futures markets responds to deviations from equilibrium and price discovery occurs in both futures and spot markets. They also noted that futures market leads spot market. They also concluded that volatility has been found reduced in the spot market after the introduction of derivatives trading.

Schroeder and Goodwin (1991) examined the short term price leadership role and long term efficiency of the futures and cash price relationship for live hogs by using Garbade and Silber methodology and cointegration technique. The cash price data in this study are daily slaughter hog prices from the Omaha market and daily closing futures prices from the Chicago mercantile exchange are used. The results concluded that price discovery generally originates in the futures market and also little short run feed back is generally present from the cash market to the futures market.

The linear and nonlinear causal linkages between daily spot and futures prices are investigated by Bekiros *et al* (2008) for maturities of one, two, three and four months of West Texas intermediate crude oil for the periods of October 1991 – October 1999, and November 1999 – October 2007 by using the techniques of VECM and GARCH – BEKK models. The results suggested that there was causality between spot and futures prices in both periods. They also concluded that the futures market play a bigger role in the price discovery process, the spot market also plays an important role in this respect.

Using VECM-SURE and EGARCH models, Thenmozhi and Thomas (2007) analysed the price discovery function and volatility spillover in Nifty and S&P CNX Nifty futures with reference to near month, next month and far month index futures .The results of VECM-SURE model show that there exists bi-directional Granger causality between spot and futures market, but spot market plays an important role in price discovery. The results indicate that impulse response function and information share indicate that most of the price discovery happens in the index spot market. The results of the EARCH model show that the volatility spillover between spot and futures market is bi-directional. They also concluded that the information flow from spot to futures market is stronger and the spot market dominates the futures market in terms of return and volatility.

Thus the review of literature reveals that the evidences are quite mixed both in India and other studies . In India only few studies are available on commodity futures markets and to the best of knowledge, no study had examined the causal relation between futures and spot prices for spices and base metals. It is there fore felt that there is a need to study the price discovery issue on selected commodities.

3.4 Nature and Data sources

The study considers spices (chilly, jeera, pepper, turmeric and cardamom) and base metals (copper, lead, nickel and zinc). The data for the present study are collected from official websites of National Commodities & Derivations Exchange Ltd (NCDEX) and Multi Commodity Exchange (MCX). The daily closing prices of different futures contracts and spot prices for select commodities are considered from both exchanges. Spices data is collected from NCDEX. Cardamom and base metals data is collected from MCX.

Red chilly data for the contracts from March'06 to October '08 (20 contracts) is considered. In case of jeera, the data for the contracts from March '05 to October '08 (41 contracts) is used. The data for turmeric from December '04 to October '08 (34 contracts) is taken. For Pepper the data from June 04 to October -08 (49 contracts) is considered from NCDEX. For cardamom data from March '06 to October '08 is collected from MCX. In case of copper the data for 17 contracts from August '05 to November '08 is used. For the data for lead metal, 16 contracts from August '07 to November '08 are considered. For Nickel data for 23 contracts from January 07 to November 08 is taken. In the case of zinc the data for (32 contracts) April '06 to November '08 is used. The reason for different time periods for selected commodities is based on the availability of futures prices data.

A pooled price series is constructed with roll over process for two months before maturity (Fd) (that is, far month futures), one month before maturity (Fn) (that is, nearby month futures) and maturity month futures (Fm) for all contracts months. The first day of nearby contract is considered as first day of second month from maturity and ends with the last day of second month. Similarly, the contracts are rolled over to next nearby contracts. As such, the data do not overlap and avoid methodological problems associated with overlapping of data. The procedure is the same for maturity period and far month maturity periods. The pooled series is used to empirically test for long run and short run dynamics.

3.5 Methodology

The price linkage between futures and spot market is analysed using cointegration analysis which offers several advantages. Cointegration analysis measures the extent to which two markets have achieved long run equilibrium. The distinct advantage of the cointegration technique is that it explicitly allows for the divergence from equilibrium in the short run (Fortenbery and Zapata, 1997).

Engle-Granger's (1987) cointegration test is used to investigate the long-run relationship between spot and futures prices. The cointegration implies that the two series (futures and spot prices) are non stationary but a liner combination of two variables is stationary so that both are co-integrated. Further, after confirmation of long run equilibrium error correction mechanism is used to analyse short term deviations whereby markets attempt to find equilibrium relationship.

The first step in the analysis is to determine the order of integration of each price series. Second step is identification of cointegrating equation and estimation using OLS method. In third step, residuals from OLS regression are obtained and tested for the confirmation whether they are stationary or not. Fourth step is construction of error correction model.

Evidence of price changes in one market (future or spot) generating price changes in the other market (spot or futures) so as to bring about a long run equilibrium relation is

$$S_t = \alpha + \beta F_t + Z_t \qquad \text{… (3.5.1)}$$

where F_t and S_t are futures and spot prices at time t. α and β are parameters; and Zt is the deviation from parity. Ordinary least squares (OLS) are inappropriate if F_t and/or S_t are non stationary because the standard errors are not consistent. If F_t and S_t are non stationary but the deviation Z_t is stationary then Ft and S_t are said to be cointegrated and an equilibrium relationship exists between them (Engle and Granger, 1987). For Ft and St to be cointegrated, they must be integrated of same order. Performing unit root tests on each price series confirms the order of integration. If each series (F_t and S_t) is non stationary in the level but the first difference (ΔF_t and ΔS_t) and deviation (Zt) are stationary, the series are said to be cointegrated of order(1,1) with β as the cointegrating coefficient.

Error Correction Methodology

The Granger representation theorem states that when integrated variables are cointegrated a vector autoregressive model on differences will be misspecified (Granger, 1986). The disequilibrium term is missing from the vector autoregressive representation, but when lagged disequilibrium terms are included as explanatory variables then the model becomes well specified. Such a model is called an error correction model because it has self-regulating mechanism whereby deviations from the long term equilibrium are automatically corrected. Building an ECM is the second stage of the cointegration analysis. It is a dynamic model on first differences of the integrated variables that were used in the cointegrating regression.

The ECM provides a short term analysis of dynamic relations, quite distinct from the first stage of cointegration analysis. The connection between the two stages is that the disequilibrium term Z that is used in the error correction methodology. The reason for the name error correction stems from the fact that the model is structured so that short term deviations from the long term equilibrium will be corrected.

The error correction model is as follows:

$$\Delta S_t = \alpha_1 + \gamma_1 Z_{t-1} + \beta_s \Delta S_{t-1} + \delta_s \Delta F_{t-1} + \varepsilon_{S,T} \qquad \ldots \quad (3.5.2)$$

$$\Delta F_t = \alpha_2 + \gamma_2 Z_{t-1} + \beta_f \Delta S_{t-1} + \delta_f \Delta F_{t-1} + \varepsilon_{f,T} \qquad \ldots \quad (3.5.3)$$

each equation is interpreted as having two parts. The first part (Z_{t-1}) is the equilibrium error (from cointegration regression). This measures how the left hand side variable adjusts to the previous period's deviation from long run equilibrium. The remaining portion of the equation is lagged first difference which represents the short run effect of previous period's change in price on current period's price changes. The coefficients of the equilibrium errors γ_1 and γ_2 are the speed of adjustment coefficients and have important implication in an error correction model. At least one speed of adjustment coefficient must be non zero and significant for the model to be an ECM. The coefficient serves the role of identifying the direction of causal relationship and shows the speed at which departure from equilibrium is corrected. The primary purpose of estimating the ECM is to implement price leadership test between futures and spot price. If futures and spot price are cointegrated, then causality must exist in at least one direction (unidirectional causality) and possibly in both directions (bi-directional causality) (Granger, 1986).

Cointegration implies that each series can be represented by an error correction model that includes last period's equilibrium error, as well as lagged values of the first differences of each variable. The temporal causality can be assessed by examining the statistical significance and the relative magnitudes of the error correction coefficients and the coefficients on the lagged variables (Wahab and Lashgari, 1993).

3.6 Empirical Analysis

3.6.1 Agricultural Commodities

In order to determine the order of integration of each price series, we have to test whether series is stationary or not. The Augmented Dickey Fuller (ADF) test is performed on the level form of each price series. The tests on the levels of each series indicates that the null hypothesis of unit root is not rejected; this shows that spot as well as futures prices are not stationary in their level form. Again Augmented Dickey fuller test is done on the first differenced values of spot and futures price series. On the contrary, the results of the test on the first differences indicate that each series is stationary. So this stationary property fulfills the necessary condition to be cointegrated, that is, they should be integrated by the same order. Since both series are I (1) the long run relationship between spot and futures can be tested for five commodities (chilly, jeera, pepper, turmeric and cardamom). The results are shown in table 3.1.

The results in table 3.1 show that the all variables are non stationary in level form since the value of ADF test statistic is less than critical values at one percent and five percent levels. But first difference price series are stationary.

By considering log spot price as the dependent variable and log futures price as independent variable, the regression is performed. Residuals are estimated from fitted regression equation. The Engle - Granger test is performed on the estimated residuals for different time maturity periods on all select commodities. All the estimates show that there is strong relationship between spot and futures prices of given commodities. The results are shown in table 3.2.

The results in the table 3.2 show that the residuals of all select commodities are stationary as the ADF test statistics are larger than the critical values at one percent levels of significance. So this study confirms that spot and futures prices are cointegrated except in case of turmeric and cardamom for far month maturity periods.

The cointegration between spot and futures prices provides the support for analysing short run dynamics between the spot and futures prices by estimating error correction model for each commodity to different maturity periods. The error correction mechanism helps to identify the market which contributes to the price discovery process and also to infer the direction of the causality between spot and futures markets. The estimated values of ECM for each commodity are given in tables from 3.3 to 3.7.

Chilly

In case of maturity month period ADF test is conducted on the residual terms from regression equation. The results indicate that there is a long term relationship between spot and futures prices. In order to study the short run dynamics, error correction model is estimated using ordinary least requires method. The results are presented in table 3.3. From the table 3.3 in futures returns equation, the lagged spot return is significant at 10

% level so the spot market leads the futures market. The lagged disequilibrium error term in future equation is significant of 1 % level with positive value. This implies that the error correction mechanism is operating primarily through the adjustment of futures price rather than spot price but another equilibrium error term in spot return equation is significant at 10 % level. This implies that little correction is required in spot price to adjust to the long term equilibrium with downward adjustment. In far month maturity period case, the spot market leads the futures market with same ECM results that are in spot equation, error correction term is significant at 1 % level. This indicates that spot market respond to the previous period's deviation from equilibrium, so information transmits from spot market to futures markets.

Jeera

Table 3.2 shows that residuals are stationary for different maturity periods so there is a long run relationship between the futures and spot markets. Error correction method is applied to analyse the short run dynamics in the system. The results are presented in table 3.4. From the table 3.4, In case of maturity period, lagged future return variable is highly statistically significant in spot return equation; this implies that futures market leads spot markets. Error correction term is significant in spot equation which indicates that the current period spot innovations respond to the previous period's deviation from equilibrium. The speed of adjustment is operating from spot price rather than futures price. When it comes to the nearby maturity month period, same results appeared as in the case of maturity month period. In case of distant month maturity period, in futures equation, spot return variable is significant at 10 % level and in the spot return equation lagged futures return variable is significant at 1% level. This implies that though there is bidirectional causality between spot and futures market, a strong feedback exists from spot to futures markets. The speed of adjustment coefficient is significant at 1 % level. This implies that spot market innovations responds to previous period's deviation from equilibrium.

Pepper

ADF test is applied on the residuals from estimated regression equation. The results are mentioned in the table 3.2. From the table 3.2 the results reveal that residuals are stationary for different time periods, so there is a long run relationship between futures and spot markets. This makes possible to analyse short run dynamics between two markets by using error correction methodology. The results are presented in table 3.5. The results are consistent and support the results for cointegration. The speeds of adjustment coefficients in both equations for all periods are significant. This shows that both markets respond to the previous period's deviation from equilibrium. In spot return equation, lagged future return is significant for all periods. This shows that the futures market leads the spot market. So price discovery takes place in the futures market. This is because of long history of pepper futures trading and availability of both domestic and international contracts. So the pepper market fulfills the price discovery function.

Turmeric

In Turmeric futures markets only maturity month contracts and nearby month contracts results are significant for cointegration relationship between spot and futures markets. Error Correction method results are consistent along with cointegration results. The results are mentioned in table 3.6, from the table it observed that in Maturity month period there is a bidirectional causality from spot market to futures market and futures market to spot market since the lagged futures return variable in spot return equation is significant at 1% level and lagged spot return variable in future return equation is significant at 10 % level. But error correction term coefficient is significant in spot return equation at 1% level. So this indicates that spot market responds to previous period's derivation from equilibrium.

In order to conclude the direction of causality, consideration of test of significance of lagged variables coefficient along with speed of the adjustment coefficients is important. So in case of nearby maturity month period, no lagged term coefficient is significant in both cases. It is difficult in short run to conclude lead lag relation between the two markets. The speed of adjustment coefficient is significant in spot return equation; this reveals that correction is required is spot prices to establish equilibrium.

Cardamom

The ADF test is conducted on the residual terms from estimated regression for different maturity periods. The results are presented in the table 3.2 and 3.7. The results indicate that there is a long term relationship between spot and futures prices for both maturity (Fn) and nearby maturity month (Fn) periods. Where as in case of distant maturity month (Fd) period there is no cointegration relation between spot and futures markets. Shot run dynamics are analysed by using error correction methodology. The results are consisting with cointegration theory. In case of maturity month lagged future return variable is significant in spot return equation; this concludes that futures market leads the spot market. Error correction term is significant at 1 % level in spot return equation; this means that the spot market responds to previous period's derivation from equilibrium.

In the nearby maturity month period in both equations, lagged futures return variable in spot return equation and lagged spot return variable in future return equation are significant at 1 % and 5 % levels. So there is bidirectional causality from spot market to futures market and futures market to spot market. But corrections takes place in spot market to adjust long term equilibrium since error connection is significant at 1 % level in spot return equation.

3.6.2 Base Metals

In order to confirm about stationary of futures and spot price the Augmented Dickey Fuller test is performed. The test used log values of spot and futures prices. The results are presented in the table 3.8. The null hypothesis of no unit root cannot be rejected in all cases. The futures and spot prices are non-stationary in their level form. Then again ADF test is conducted on the first differenced values of futures and spot prices. The null hypothesis of unit root is rejected that means first difference of both the series are stationary. So the futures and spot prices are integrated of order one, that is, I (1).

One of the necessary conditions for cointegration is that they should be integrated of the same order. All the series are integrated of one, that is, I (1) so the long run relationship between spot and futures can be tested. Residuals are estimated from regression equation. Engle – Granger tests are implemented on the estimated residuals for different maturity periods in order to arrive about the inference of long run relation between spot and futures prices.

Table 3.9 reports the results of ADF tests on the estimated residuals. The results indicate the existence of cointegration relation between futures and spot markets for four base Metals based on the different maturity periods. The cointegration between spot and futures prices provides the support for analysing short run dynamics between the spot and futures prices by estimating Error correction model for each commodity to different maturity periods. The estimated values of ECM for each commodity are given in tables from 3.10 to 3.13.

Copper

The results of the error correction for the different maturity periods are reported in table 3.10. The error correction equation is estimated using ordinary least squares method, only one lag has been taken in ECM as it is found to be sufficient in removing auto correlation. The ECM results are consistent with and support the empirical results for cointegration. At least one error correction coefficient (δ_f or δ_s) is significant in all periods where the cointegration exists between futures and spot markets.

In maturity month period the estimate of δ_s (-0.6331) is significant at 1% level. This indicates that correction is required in spot series to adjust to the long term equilibrium values and δ_s is negative whatever correction takes place in short run in spot price series is downward adjustment. The lagged value of futures return is significant; it shows that spot market reacts to lagged prices in futures market so futures prices lead spot prices.

In case of maturity before one month that is nearby month maturity period (fn), the future market leads spot market as futures return coefficient is significant and error correction term is significant (δ_s = - 0.94433) at 1 % level implies correction is required in spot price. Similar results are observed in the case of far month maturity period.

Lead

The results are presented in table 3.11. In maturity month period the logged future return variable in the spot return equation is highly significant. Hence the futures pries lead the spot prices. The lagged disequilibrium term is significant in the spot returns equation. This indicates that error correction mechanism is operating primarily through adjustment of spot price rather than future price. In case of nearby month maturity period there exists bidirectional causality between futures and spot prices. But error correction mechanism primarily operates from spot price to futures prices. When it comes to the far month maturity period futures prices lead spot prices and error correction mechanism is operating from spot price to futures and futures prices to spot prices.

Nickel

From the table 3.9 it is found that there is cointegration relation between spot and futures prices. This means both markets are integrated and there is an information flow from one market to other market. The results from the error correction are consistent with the results of cointegration. The results are given in the table 3.12. From the table it is observed that in all periods of different maturities, lagged future return is significant in the spot return equation. This indicates that the futures prices lead spot prices. The coefficient of error correction term is significant in spot equations. This implies that the price relationship of spot and future markets deviates away from the long run relation; the spot market will make adjustment to long run equilibrium during next period. So the futures price leads the spot price. In nearby maturity month the spot price also leads the futures price and there is bidirectional causality from the futures to spot and the spot to futures. In far month maturity period price discovery takes place in the futures market.

Zinc

Form the table 3.9 it is found that markets are integrated. Error correction method is performed and results are consistent along with cointegration. The results are cited in table 3.13. In all maturity periods the future price leads the spot price, so there is an information flow from futures to spot prices. The error correction terms are significant and negative; this indicates that correction is required to adjust to the long term equilibrium, since the coefficients are negative; what ever correction takes place in the short run is a downward adjustment. Overall error correction mechanism is operating primarily through adjustment of spot prices rather than futures prices. In case of nearby maturity month period the spot price leads the futures price. So there is a bidirectional information flow between two markets. In far month maturity period lagged futures return variable in spot return equation is significant along with error correction term. This indicates that the futures market leads the spot market.

3.7 Conclusion

In any agriculture dominated economy like India, farmers face not only production risk but also price risk as well. Commodity futures markets have a crucial role in price risk management. The present study has attempted to examine the price discovery function of futures market in India.

The lead-lag relationship between futures and spot prices are analysed by cointegration technique and error correction mechanism (ECM). In case of agricultural commodities, Chilly market has bidirectional causality, but spot market responds more in order to establish equilibrium in the next period. In Jeera market, futures market leads the spot market, In case of nearby and far month contract periods, the spot market also leads the futures markets. In Pepper market there is bidirectional causality between futures and spot markets. When it comes to the turmeric markets the futures market leads the spot market in case of maturity and nearby futures contracts. In case of far month there is no cointegration relationship between spot and futures markets. There is an information flow from futures to spot market in case of maturity and nearby maturity contracts for cardamom. There is no long term relationship between spot and futures markets in case of far month futures because of low volume of trade. But over all the information of futures prices is reflecting in the spot markets, which is a good sign for farmers in order to take right decision regarding selling their produce.

An analysis of price discovery for base metals is also carried out. In case of copper market for all time periods, the futures market leads the spot market. In lead futures, there is an information flow form futures to spot in case of maturity and nearby maturity periods. There is bidirectional causality between spot and futures markets in case of far month maturity. In nickel market for all periods there is a bidirectional information flow between the markets. However, spot responds to the deviations from previous period's equilibrium. This indicates that price discovery takes place in futures markets In Zinc market price discovery takes place in futures market, but in case of maturity and nearby futures maturity periods the spot market also leads the futures markets. Finally the study concludes that though there is a bidirectional relation between spot and futures market, the influence of spot is more on both markets.

Table 3.1 Unit root test statistics for Spices

		Maturity Month (Fm)		Nearby Month (Fn)		Far Month (Fd)	
		ADF Statistics		ADF Statistics		ADF Statistics	
		Level	1st Difference	Level	1st Difference	Level	1st Difference
Chilly	SP	-2.663	-18.211*	-2.456	-16.655*	-2.267	-16.157*
	FP	-3.425	-17.991*	-2.294	-17.495*	-2.210	-15.226*
Cardamom	SP	-1.372	-14.473*	-1.065	-13.782*	-1.178	-13.276*
	FP	-1.552	-30.368*	-1.724	-13.034*	-1.913	-12.215*
Jeera	SP	-0.697	-14.531*	-0.668	-27.750*	-0.390	-13.884*
	FP	-0.924	-30.310*	-1.148	-28.712*	-0.937	-27.918*
Pepper	SP	-0.678	-20.679*	-0.831	-19.866*	-0.864	-26.602*
	FP	-0.964	-35.329*	-1.100	-33.060*	-1.138	-32.164*
Turmeric	SP	-0.705	-24.628*	-1.689	-21.592*	-0.228	-23.847*
	FP	-1.578	-30.360*	-2.190	-23.750*	-1.008	-25.505*

* denotes significant at 1% level

Test critical values:

1%	-3.4465
2%	-2.8685
3%	-2.5705

Table: 3.2 Unit root test statistics of residuals from cointegration equation for Spices

	ADF Statistics		
	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
Chilly	-3.66*	-2.80**	-2.67***
Cardamom	-6.22*	-3.02**	-2.09
Jeera	-4.23*	-3.98*	-3.63*
Pepper	-6.66*	-6.18*	-5.52*
Turmeric	-3.87*	-3.49*	-2.49

*, **, and *** respectively denote 1%, 5% and 10% levels significance

Test critical values:

1%	-3.4465
2%	-2.8685
3%	-2.5705

Table.3.3. Results of Error correction model for Red chilly

Coefficient	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
α_s	0.0015 (0.85)	0.0010 (0.39)	0.0018 (1.05)
β_s	-0.0073 (-0.09)	0.0499 (0.56)	0.0414 (0.60)
γ_s	0.096 (1.563)	-0.0724 (-0.69)	0.0589 (1.019)
δ_s	-0.0387*** (-1.858103)	-0.1023* (-3.4239)	-0.0687* (-4.5729)
α_f	0.001 (0.45)	0.0007 (0.30)	0.0019 (0.88)
β_f	-0.1575*** (-1.767)	0.0073 (0.09)	-0.1650*** (-1.949)
γ_f	0.2092* (2.79)	-0.0541 (-0.58)	0.1631** (2.28)
δ_f	0.034* (2.79)	-0.0341 (-1.28)	-0.0439** (-2.36)

*, ** and *** respectively denote 1%, 5% and 10% levels significance.

t-values are in parenthesis.

Table 3.4 Results of Error correction model for Jeera

Coefficient	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
α_s	0.0003 (1.25)	0.0005 (1.44)	0.0005 (1.75)
β_s	-0.0496 (-1.41)	-0.1787* (-4.5)	-0.1508* (-4.43)
γ_s	0.1517* (9.06)	0.2324* (10.18)	0.2654* (13.6)
δ_s	-0.0308* (-4.76)	-0.0367* (-4.84)	-0.0340* (-5.58)
α_f	0.0003 (0.51)	0.0004 (0.62)	0.0004 (0.696)
β_f	0.0772 (0.97)	-0.1173 (-1.62)	-0.1123*** (-1.66)
γ_f	0.0358 (0.94)	0.1254* (2.96)	0.1263* (3.26)
δ_f	0.0287*** (1.957)	0.0051 (0.35)	0.0004 (0.03)

*, ** and *** respectively denote 1%, 5% and 10% levels significance

t-values are in parenthesis

Table 3.5 Results of Error Correction Model for Pepper

Coefficient	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
α_s	0.0004 (1.55)	0.0004 (1.77)	0.0006 (2.28)
β_s	-0.1110* (-3.98)	-0.1435* (-4.88)	-0.1522* (-5.17)
γ_s	0.3076* (18.38)	0.3244* (18.15)	0.34923* (19.51)
δ_s	-0.0525* (-5.25)	-0.0563* (-5.36)	-0.0501* (-5.04)
α_f	0.0003 (0.68)	0.0004 (0.87)	0.0006 (1.26)
β_f	0.0020 (0.03)	-0.0295 (-0.48	-0.0213 (-0.34)
γ_f	0.0496 (1.42)	0.0864** (2.35)	0.0685*** (1.82)
δ_f	0.0532** (2.56)	0.0465** (2.15)	0.0347*** (1.65)

*, ** and *** respectively denote 1%, 5% and 10% levels significance.

t-values are in parenthesis.

Table3.6 Results of Error correction model for Turmeric

Coefficient	Maturity Month (Fm)	Nearby Month (Fn)
α_s	0.0002 (0.45)	0.0001 (0.18)
β_s	0.0850** (2.39)	0.0602 (0.96)
γ_s	0.0897* (5.08)	0.0545 (1.28)
δ_s	-0.0354* (-5.14)	-0.0399* (-2.86)
α_f	-3.44E-05 (-0.04)	0.0002 (0.18)
β_f	0.1368*** (1.79)	0.1436 (1.54)
γ_f	-0.0238 (-0.63)	-0.0337 (-0.53)
δ_f	0.0168 (1.14)	-0.0076 (-0.36)

*, ** and *** respectively denote 1%, 5% and 10% levels significance.

t-values are in parenthesis.

Table 3.7 Results of Error correction model for Cardamom

Coefficient	Maturity Month (Fm)	Nearby Month (Fn)
α_s	0.0007 (1.94)	0.001 (2.49)
β_s	0.2403* (6.87)	0.217* (5.55)
γ_s	0.0545* (3.95)	0.0725* (3.73)
δ_s	-0.0411* (-4.71)	-0.0205* (-3.88)
α_f	0.0007 (0.65)	0.001 (1.19)
β_f	0.4145 (4.17)	0.199** (2.36)
γ_f	-0.0724 (-1.85)	0.023 (0.54)
δ_f	0.1287 (5.19)	0.013 (1.12)

*, ** and *** respectively denote 1%, 5% and 10% levels significance

t-values are in parenthesis.

Table 3.8 Unit root statistics for Base metals

		Maturity Month (Fm)		Nearby Month (Fn)		Far Month (Fd)	
		ADF Statistics		ADF Statistics		ADF Statistics	
		Level	1st Difference	Level	1st Difference	Level	1st Difference
Copper	SP	-1.910	-11.772*	-2.436	-19.379*	-2.432	-17.432*
	FP	-1.911	-17.273*	-2.301	-17.170*	-2.783	-19.413*
Lead	SP	-0.233	-17.122*	-0.937	-18.400*	-1.108	-18.500*
	FP	0.017	-17.384*	-0.766	-18.658*	-1.158	-16.028*
Nickel	SP	0.508	-20.460*	0.399	-15.327*	-0.385	-22.153*
	FP	0.687	-22.541*	0.301	-23.438*	-0.118	-20.218*
Zinc	SP	-0.048	-26.117*	0.382	-27.378*	-0.653	-26.842*
	FP	0.105	-26.729*	0.647	-27.205*	-0.414	-24.456*

* denotes significant at 1% level

Test critical values:

1%	-3.4465
2%	-2.8685
3%	-2.5705

Table: 3.9 Unit root test statistics of residuals from cointegration equations of Metals

	ADF Statistics		
	Maturity month (Fm)	Nearby month (Fn)	Far month (Fd)
Copper	-10.13*	-18.97*	-19.35*
Lead	-10.48*	-10.21*	-7.17*
Nickel	-12.01*	-5.79*	-6.85*
Zinc	-22.88*	-5.41*	-5.93*

* denotes significant at 1% level

Test critical values:

1%	-3.4465
2%	-2.8685
3%	-2.5705

Table 3.10 Results of Error correction model for Copper

Coefficient	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
α_s	0.0003 (0.145)	0.00087 (0.25)	0.0017 (0.60)
β_s	-0.127 (-1.580)	-0.036 (-0.63)	-0.014 (-0.28)
γ_s	0.2017** (2.214)	0.202*** (1.74)	0.029 (0.228)
δ_s	-0.6331* (-5.75)	-0.9433* (-11.636)	-0.9395* (-13.40)
α_f	0.0004 (0.18)	0.0009 (0.49)	0.0018 (1.479)
β_f	0.080 (0.95)	-0.019 (-0.64)	0.0042 (0.199)
γ_f	0.0314 (0.33)	0.095 (1.547)	0.042 (0.782)
δ_f	0.1102 (0.96)	0.048 (1.117)	-0.0069 (-0.234)

*, ** and *** respectively denote 1%, 5% and 10% levels significance.

t-values are in parenthesis.

Table 3.11 Results of Error correction model for Lead

Coefficient	Maturity Month (Fm)	Middle Month (F2)	Far Month (Fd)
α_s	-0.0022 (-1.35)	-0.0007 (-0.54)	-0.0006 (-0.4177)
β_s	-0.0275 (-0.4062)	-0.0464 (-0.757)	-0.0959 (-1.124)
γ_s	0.2851* (3.3258)	0.369* (4.687)	0.3467* (3.3565)
δ_s	-0.6717* (-6.858)	-0.532* (-6.76)	-0.428* (-4.226)
α_f	-0.0026 (-1.424)	-0.001 (-0.754)	-0.0006 (-0.498)
β_f	0.0972 (1.2677)	0.1059*** (1.6739)	-0.0668 (-0.938)
γ_f	-0.0352 (-0.3628)	-0.0054 (-0.067)	0.237* (2.748)
δ_f	0.013 (0.12)	0.0305 (0.374)	0.2517* (2.976)

*, ** and *** respectively denote 1%, 5% and 10% levels significance.

t-values are in parenthesis

Table 3.12 Results of Error correction model for Nickel

Coefficient	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
α_s	-0.0019 (-1.6375)	-0.0011 (-1.137)	-0.0015 (-1.384)
β_s	-0.0240 (-0.4532)	-0.0968** (-2.008)	-0.1899* (-3.225)
γ_s	0.2426* (3.6)	0.473* (8.0197)	0.3608* (5.1)
δ_s	-0.6270* (-8.36)	-0.3175* (-6.448)	-0.157* (-3.872)
α_f	-0.0023 (-1.713)	-0.0015 (-1.483)	-0.0014 (-1.4417)
β_f	0.114816*** (1.839)	0.0903*** (1.788)	-0.0606 (-1.1536)
γ_f	-0.1209 (-1.537)	-0.0385 (-0.624)	0.1393** (2.2066)
δ_f	-0.0354 (-0.402)	0.0127 (0.248)	0.0556 (1.532)

*, ** and *** respectively denote 1%, 5% and 10% levels significance.

t-values are in parenthesis.

Table 3.13 Results of Error correction model for Zinc

Coefficient	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
α_s	-0.0009 (-1.009)	-0.0008 (-0.97)	-0.0006 (-0.8046)
β_s	-0.023 (-0.49)	-0.0875** (-2.138)	-0.1327* (-2.81)
γ_s	0.1289** (2.25)	0.31215* (6.138)	0.3884* (6.458)
δ_s	-0.6967* (-10.721)	-0.3926* (-9.325)	-0.416* (-8.109)
α_f	-0.0013 (-1.226)	-0.001 (-1.333)	-0.0008 (-1.165)
β_f	0.0975*** (1.85)	0.078*** (1.9329)	0.0667 (1.544)
γ_f	-0.091 (-1.414)	-0.0302 (-0.6003)	0.0287 (0.517)
δ_f	0.036 (0.48)	0.00035 (0.008)	0.0146 (0.3108)

*, ** and *** respectively denote 1%, 5% and 10% levels significance.

t-values are in parenthesis.

Chapter-4

Hedge Ratio and Hedging Effectiveness

4.1 Introduction

Hedging is one of the main functions provided by futures market and also the reason for the existence of futures markets. The main purpose and benefit of hedging on the futures markets is to minimize possible revenue losses associated with adverse cash price changes. The risk of price variability of an asset can be managed by the mechanism of hedging. The hedging activity can be considered as exchanging price risk for basis risk. The basis defined as cash price minus nearby futures price. The basis between a futures contract and its underlying commodity is an important measure of the cost of using the futures contract to hedge. Basis risk is attributed to location, quality and timing discrepancies between commodities traded in the cash market and that deliverable on futures contracts. Normally, the basis does have same variability, however, and hedging cannot completely eliminate price risk. It will reduce price risk, but only as long as the basis variability is less than the cash price variability (Carter, (1984)).

The effectiveness of a hedge becomes relevant only in the event when there is a significant change in the value of the hedged item. According to Pennings and Meulenberg (1997) a determinant in explaining the success of financial futures contracts is the hedging effectiveness of futures contracts. According to Ghosh (1993) factors that influence the hedge construction and its effectiveness include basis risk, hedging horizon, and correlation between changes in futures prices and cash prices.

The traditional hedging strategy emphasizes the potential for futures contracts to be used to minimise risk. It is a simple strategy that the spot position is hedged by taking an equal but opposite position in futures market, that is h=-1. If the proportionate price changes in the spot market rates match exactly those in the futures market then the price risk will be eliminated. However, practically it is unlikely for a perfect relation between the spot and futures returns.

Johnson (1960) and Stein (1961) introduced the concept of portfolio theory through hedging cash positions with futures. The portfolio approach recognises the existence of basis risk and determines the optimal futures position by minimizing the variance of spot-futures portfolio. The application of portfolio theory to hedging has attracted a great deal of attention from academicians, regulators and market participants. Edernigton (1979) applied this concept in determining a risk minimising hedge ratio and derived a measure of hedging effectiveness. Edernigton defined hedging effectiveness as the reduction in variance. The objective of a hedge is to minimise the risk of a given position. This risk is represented by the variance of returns. The hedge ratio that generates the minimum portfolio variance should be the optimal hedge ratio, which is also known as the minimum variance hedge ratio. This has been followed by number of studies like Figlewski (1984); Myers and Thomas (1989); Myers (1991). One of the important theoretical issues in hedging is the determination of the optimal hedge ratio and hedging effectiveness. The optimal hedge ratio can differ significantly depend up on the time horizon and estimation techniques used.

Using OLS regression the hedge ratio and hedging effectiveness can be analysed by assessing regression coefficient and R-square, but this has been criticized on the two grounds. Firstly, Kroner and Sultan (1993) criticised the hedge ratio obtained from OLS regression method saying that it becomes a biased one if there is a cointegration relationship between the spot and futures prices. The same issue is addressed by a number of authors about the important role of the cointegration between spot and futures prices in estimating optimal hedge ratio. Ghosh (1993), in an analysis of stock index futures and underlying stock price index incorporating cointegration relationship, finds that the minimum variance hedge ratio estimates are biased downwards due to the misspecification; if spot and futures prices are cointegrated and error correction term is not included in the regression. Secondly, the constant hedge ratio does not consider the time varying nature of the joint distribution of the spot and futures prices. This back ground makes the study apply error correction model to the calculation of hedge ratio along with OLS method.

In last five years Indian commodity futures markets have grown rapidly. Indian commodity futures markets are going through many ups and downs and allegations of speculative activity become popular in press. Despite controversies, there is a need for systematic investigation of commodity futures markets to assess their effectiveness in transferring risk. And also Indian commodity futures have not been researched empirically on the estimation of hedge ratio and hedging effectiveness. So this study investigates the hedging effectiveness of commodity futures markets. This research would help in understanding the usefulness of Indian commodity futures markets in containing and there by protecting the interests of farmers and traders. This study investigates optimal hedge ratio and hedging effectiveness of spices and base metal futures from Indian commodity futures markets.

4.2 Review of Empirical Studies

There are some empirical studies which have analysed hedge ratio and hedging efficiency of stock futures and commodity futures markets. The examination of hedging is not a new phenomenon and it is as old as the history of futures market is at international level. Some of the studies are Figlewski (1984), Myers and Thompson (1989). Myers (1999), Park and Switzer (1995), Choudhry (2004), Floros & Vougas (2006), Bhaduri and Durai (2008) examined the hedging effectiveness of financial and commodities derivatives markets. Especially in the context of Indian commodity futures markets, there are very few studies about hedge ratio and hedging effectiveness. The review covers past studies of different markets.

Holbrook Working(1953) wrote a series of articles about “traditional” concept of the nature of hedging and the function of a futures market. “He envisages the hedger as one who does not seek primarily to avoid risk but one who hedges because of an expected return arising from anticipations of favourable relative price movements in the spot and futures markets. The trader does not somehow find himself with a given size inventory that has to be hedged against, but he takes positions in both markets as a form of arbitrage".

The outline of the theory of hedging and speculation in commodity futures is analysed by Johnson (1960). He constructed a model that may both assist in clarifying the concepts of hedging and speculation and contribute to a better understanding of market phenomenon. The major part of this analysis is summarized as follows. If a trader has expectations regarding only relative price changes, he necessarily takes a unit for unit position in the two markets. However the study mentioned that hedge may contain a speculative element, depending on his reaction to expected relative price changes.

Pennings and Meulenberg (1997) analysed hedging efficiency including both the risks and costs of the hedge. The potato futures contract was used for the period of September 1995 to April 1996. This study tested hedging performance over two short periods one day and one week. In this study a concept of overall risk reduction and a new measure of hedging efficiency were described. They proposed measure which takes commission costs into account. They concluded that both basis and the market depth risk contribute to the relatively inefficient hedging possibilities of the potato futures contract. The empirical results indicate that the measure should be useful to the futures exchange management.

The examination of hedge ratio and hedging effectiveness in Australian futures markets were tested by Yang (2001) for the period January 1988 – December 2000. He considered only three months futures contracts and rolled over to next three months contracts on the first day of delivery month. OLS Regression, BVAR, ECM and MGARCH methods have been used. The study finds that out of three constant hedges ratios derived from three methods, ECM generates highest hedge ratio value. He concluded that MGARCH dynamic hedge ratios provide the greatest degree of variance reduction but generates smallest rate of return and hedge ratio calculated from the conventional regression model performs the worst in terms of reducing portfolio variance, but yields the highest rate of return. It is also found that in long term hedging, the time varying hedge ratios out perform the constant hedge ratio in terms of reducing portfolio variance.

Bhadurai and Durai estimated optimal hedge ratio and analysed hedging effectiveness of stock index futures of National Stock Exchange for the period from 4th September to 4th August 2005. This study used four econometric models, OLS Regression, VAR, VECM and M-GARCH. The effectiveness of the optimal hedge ratios derived from these models are examined in two ways. At first, the mean returns of the hedged and the unhedged position and then, the average variance reduction between the hedged and the unhedged position with the hedge ratios for 1, 5, 10 and 20 days horizon. The results concluded that the time varying hedge ratio derived from the Multivariate GARCH model provides higher mean return and higher average variance reduction across hedged and unhedged position. It also observed that in the performance of variance reduction GARCH model gives better results only in long time horizons compared to the simple OLS method that scores well in the short time horizons.

The effect of the maturity on the hedging effectiveness of futures is examined by Ripple and Moosa (2007). Daily and monthly data of crude oil futures and spot prices are used to work out hedge ratio and measure of hedging effectiveness for near month and distant month contracts. The optimal hedge ratio is measured as the slope coefficient in a regression. The empirical results reveal that futures hedging is more effective when the near-month contract, rather than distant month contract is used. This result is explained in terms of the higher correlation between spot prices and near month futures prices than that with more distant futures prices. The results also revealed that hedge ratios are lower for near month hedging, which is explained in terms of the Samuelson (1965) findings about the volatility of contracts with short and long maturities. Moosa (2003a) has shown that the use of alternative models to estimate hedge ratio does not make any significant difference for hedging effectiveness.

The estimates of the risk minimizing futures hedge ratios for three types of stock index futures S&P 500, MMI Futures and Toronto 35 index Futures are analysed by Park and Switzer (1995). The spot and futures prices are first analysed to adjust for non-stationary and cointegration. Using a Bivariate Cointegration model with a generalized ARCH error structure, they estimated the optimal hedge ratio as a ratio of the conditional covariance between spot and futures to the conditional variance of futures. The GARCH based hedge ratios show considerable variations between June 1988 and December 1991, such a variation in the hedge ratio indicates the unreliability of the constant hedge ratio based on the conventional risk minimising estimation methods. The results concluded that both within sample and out of sample comparisons the Bivariate GARCH method is potentially superior over the conventional constant hedging strategy.

The hedging effectiveness of time varying Bivariate GARCH and GARCH – X hedge ratios against time invariant methods for six non ferrous methods examined was by Mc Millan (2005). The data was taken from London metals exchange based on daily cash and three months futures settlement prices. The results indicated that hedging reduces the portfolio standard deviation by over 50% regardless of the methods of hedging. Finally he concluded that GARCH – X model produces the best performance of effective hedge and out of six cases five cases are considered effective, among the four cases GARCH model provides the second most effectives hedge. It is also observed that only in one case OLS optimal hedge ratio out perform the time varying ratios, so these results support the belief that incorporating time variation into the optimal hedge ratio improves the hedging performance.

Ghosh (1993) estimated hedge ratio by using Error correction method for S&P 500 index based on daily closing prices from January 1991 to December 1999. The study finds that hedge ratios obtained from traditional methods are underestimated. This study tested the presence or absence of cointegration relation between spot and futures price series. The final inference from this study is that hedge ratio from error connection method shows significant improvement from OLS regression method. The study concludes that out of sample performance is better for the ECM compared to the Edernigton model.

Using Bivariate GARCH model for beef, coffee, cotton, gold, soybean, Baillie and Myers (1991) estimated minimum variance hedge ratios based on daily data for two futures contracts maturing in 1982 and 1986. The optimal hedge ratio is calculated as a ratio of the conditional covariance between cash and futures to the conditional variance of futures. They found that the estimated optimal hedges ratios are confirmed to time variation; it reveals that the assumptions of constant optimal hedge ratios are inappropriate. It is also observed that GARCH models provide a good description of the distribution of changes in these commodity prices, and results appear more satisfactory than previous attempts in the literature about modeling the unconditional distribution of commodity price changes. They concluded that both in sample and out of sample GARCH based hedge ratios are found more effective as compared to constant hedge ratios.

Sephton (1993) analysed hedge ratio performance based on the daily data for the Crop year 1981-1982 for the commodities feed wheat and canda futures by using GARCH (1.1) model. Reduction in portfolio variance is used as a measure of hedging effectiveness. The results concluded that the GARCH based ratio performs well, compared to the conventional hedge ratio. The estimation of the minimum variance hedge ratio using the OLS and cointegration methods for various lengths of hedging horizon based on weekly data of German mark, Swiss franc, Japanese yen, S&P 500 and municipal bond index was done by Geppert (1995). The results indicated that the in sample results indicate that for both methods, hedging effectiveness increases with the length of the hedging horizon and is case out of sample hedging effectiveness decreases as hedging horizon decreases.

Ederington (1979) examined the hedging performance of the futures markets in financial securities by using a basic portfolio model that was previously applied to the analysis of commodities futures markets by Johnson (1960) and Stein (1961). The study concludes that two week hedges using 90 day Treasury bill futures are rather ineffective in reducing exposures to price change risk. With the frame work of the model that Ederington has applied to hedging with financial futures, Franckle (1980) found that by investing the futures prices with correct cash T-bill price the effectiveness of this market is much better than for two week hedge.

Another issue addressed by a number of authors is the important role that the cointegration between spot and futures prices plays in determining optimal hedge ratios. Lien and Luo (1994) argues that although GARCH (Generalised Autoregressive Conditional heteroskedasticity) may characterize the price behaviour, the cointegration relationship is the only truly indispensably component when comparing the ex post performance of various hedge strategies. Ghosh (1993), in an analysis of stock index futures and underlying stock price index incorporating the cointegrating relationship, finds that minimum variance hedge ratio estimates are biased downwards due to misspecification if spot and futures are cointegrated and the error-correction term is not included in the regression. Lien (1996) provided theoretical support for the importance of the cointegrating relationship and pointed out that: "A hedge who omits the cointegration relationship will adopt a smaller than optimal futures position, which results in a relatively poor hedging performance."

Lien et al (2000) compared the performances of the hedge ratios estimated from the OLS method and the constant – correlation VGARCH (Vector generalized autoregressive conditional heteroskedasticity) model. They examined ten spot and futures markets covering currency futures, commodity futures and stock index futures and three methods were evaluated based on the out of sample optimal hedge ratio forecasts. The constant hedge ratio and the time varying hedge ratio were estimated in day-by-day rollover in order to benefit of time varying hedging strategy. They find that the OLS hedge ratio performs better than the VGARCH hedge ratio. This also indicates that the forecasts generated by the VGARCH models are too variable.

The investigation of optimal hedging using cointegration is analysed by Alexander (1999). This study focused on the use of cointegration for hedging performance of international equity portfolio. The results indicated that the spot and futures prices are cointegrated. She also observed that if price series are not cointegrated then hedging performance of futures markets is not effective. This study concluded that the hedging in cointegrated market has long term implications and also mentioned that error correction method based results provide better results if the series are cointegrated.

Choudhry (2004) investigated the hedging effectiveness of Australian, Hong Kong and Japanese stock futures markets. This study compares the hedging effectiveness of futures markets by OLS method and the generalized autoregressive conditional heteroskedasticity (GARCH) model with consideration of the time varying distribution of the cash and futures price changes. The daily stock returns from the spot and futures markets of Australian, Hong Kong and Japanese from January 1990 to December 1998 are used. In the analysis of empirical tests for each country two sets of futures prices based on two different expiration dates of the futures contract are used. The study concluded that the time varying GARCH hedge ratio out performs the constant hedge ratios. These results are also true for out of sample periods.

The empirical investigation of the hedging effectiveness of S&P 500 stock index futures contract was carried out by Kenourgios (2003). The weekly settlement prices for the period July, 1992 to June 2002 were used. The conventional OLS method and time varying hedge ratio methods are used for the analysis. The findings of the study suggest that in terms of risk reduction, the error correction model is the appropriate method for estimating optimal hedge ratios, since it provides better results than the conventional OLS method. The evidence presented in this study strongly suggest that the S & P 500 stock index futures contract is an effective tool for hedging risk.

The foregoing review shows the various studies on the hedging effectiveness of different derivatives markets. The evidences are quite mixed. While there has been some work in the area of hedging efficiency of the Indian stock index futures, Indian commodity futures have not been researched empirically on the hedging effectiveness of commodity futures markets. It is, therefore, felt there is a need to conduct empirical study on the hedging efficiency of the select commodity futures markets. Hence, the present study makes an attempt to examine the hedging effectiveness of commodity futures markets. This study helps concerned exchanges and regulator to implement better risk management tools and it may also help hedgers in framing better hedging strategies.

4.3 Data sources and Description

The required data for the present study are collected from official websites of National Commodities & Derivations Exchange Ltd (NCDEX) and Multi Commodity Exchange (MCX). The daily closing prices of different futures contracts and spot prices for selected commodities are considered from both exchanges. Spices (red chilly, jeera, pepper, and turmeric) data are collected from NCDEX. Cardamom and base metals (copper, lead, nickel, zinc) data are collected from MCX.

A pooled price series is constructed with roll over process for two months before maturity (Fd) (that is, far month futures), one month before maturity (Fn) (that is, nearby month futures) and maturity month futures (Fm) for all contracts months. The first day of nearby contract is considered as first day of second month from maturity and ends with the last day of second month. Similarly, the contracts are rolled over to next nearby contracts. As such, the data do not overlap and avoid methodological problems associated with overlapping of data. The procedure is the same for maturity period and far month maturity periods. The pooled series is used to empirically test for long run and short run dynamics. In this study daily returns are calculated using the formula $R_t = \log (P_t/P_{t-1})$ where R_t is the daily returns, P_t is the price of the commodity at time t and P_{t-1} is the price of the commodity at time t-1.

4.4 Methodology

4.4.1The OLS Regression Method

This is simplest model of the OLS regression, which is just a linear regression of change in spot prices on change in futures prices. Let S_t and F_t be logged spot and futures prices, respectively. The one period minimum variance constant hedge ratio can be estimated from the expression

$$\Delta S_t = c + h^* \Delta F_t + \varepsilon_t \qquad \text{… (4.1)}$$

where ε_t is the error term from OLS estimation, ΔS_t and ΔF_t represent spot and futures price changes. The minimum hedge ratio h* is the slop of equation. The R-square of this model indicates the hedging effectiveness.

4.4.2 The Error Correction Model

It is obvious that OLS model ignored the effect that the two series are cointegrated, which is further addressed in Ghosh (1993), Lien and Luo (1994) and Lien (1996). They argue that if the two price series are found to be cointegrated, a VAR model should be estimated along with the error-correction term which accounts for the long-run equilibrium between spot and futures price movements. If the futures and spot series are cointegrated of order one, then the error correction model of the series is given as follows:

$$R_{st} = \alpha_s + \sum_{i=1}^{m} \beta_{si} R_{ft-m} \sum_{j=1}^{n} \gamma_{si} R_{st-n} + \lambda_s Z_{t-1} + \varepsilon_{st} \quad \ldots (4.2)$$

$$R_{ft} = \alpha_f + \sum_{i=1}^{m} \beta_{ft} R_{ft-m} + \sum_{j=1}^{n} \gamma_{ft} R_{st-n} + \lambda_f Z_{t-1} + \varepsilon_{ft} \quad \ldots (4.3)$$

where α_s and α_f are the intercepts and ε_{st} & ε_{ft} are error terms. Z_{t-1} is the error correction term, which measures how the dependent variable adjusts to the previous period's deviation from long-run equilibrium.$Z_{t-1} = S_{t-1} - \alpha F_{t-1}$ where α is the cointegrating vector. The coefficients λ_s and λ_f have the interpretation of speed of adjustment parameters. The larger λ_s is the greater the response of S_t to the previous period's deviation from long-run equilibrium. The constant hedge ratio can be calculated as follows.

$\text{var}(\varepsilon_{st}) = \sigma_{ss}$,

$\text{var}(\varepsilon_{ft}) = \sigma_{ff}$ and

$\text{Covariance}(\varepsilon_{st}, \varepsilon_{ft}) = \sigma_{sf}$ then

$h^* = \sigma_{sf} / \sigma_{ff}$

where h* is defined as hedge ratio

4.4.3 Estimating Hedging Effectiveness

The performance of the hedging strategies can be examined by finding the hedging effectiveness of each strategy. In order to compare the performances of each type of hedging strategy unhedged position is constructed on the spot market and the hedged position in particular commodity is constructed with the combination of both the spot and the futures contracts. The hedge ratios estimated from each strategy determines the number of futures contracts to be held for minimization of risk. The hedging effectiveness is calculated by the variance reduction in the hedged position compared to unhedged position for each time horizon. According to Baillie and Myers (1991) and Park and Bera (1987) the returns on un-hedged and hedged positions are calculated as follows:

$$R_{unhedged} = S_{t+1} - S_t$$

$$R_{hedged} = (S_{t+1} - S_t) - h^* (F_{t+1} - F_t)$$

Where $R_{unhedged}$ and R_{hedged} are returns on un-hedged and hedged positions. S_t and F_t are logged spot and futures prices at time t and h* is optimal hedge ratio. Similarly, the variances of the un-hedged and hedged positions are expressed as follows:

$$\text{Var (u)} = \sigma_s^2$$

$$\text{Var (h)} = \sigma_s^2 + h^2\sigma_f^2 - 2h^*\sigma_{s,f}$$

Where Var(u) and Var(h) are variances of un-hedged and hedged positions. Here σ_s, σ_f and σ_{sf} are standard deviations of spot , futures prices and covariance between spot and futures returns respectively. Edernigton (1979) proposed a measure of hedging effectiveness as the percentage reduction in variance of the hedged and the un-hedged positions. The hedging effectiveness is calculated as

$$\frac{Var(u) - Var(h)}{Var(u)}.$$

4.5 Main Findings

4.5.1 Metals

Copper

The optimal hedge ratio is calculated for all maturity periods from OLS regression equation. Table 4.1 reports the results from the OLS regression model. The slope of the regression coefficient gives the hedge ratio and hedging effectiveness is decided by R-square. The hedge ratios of maturity, nearby and distant month maturity periods are 0.70, 0.60 and 0.65 respectively. Hedging effectiveness results are 0.42, 0.05 and 0.04, so risk reduction in maturity month is 42% and remaining two maturity periods risk reduction is very low. It indicates that though hedge ratios are high, investors are unable to reduce risk. It can be observed that the hedging effectiveness decrease as it moves from maturity month to distant futures in case of copper futures markets.

Residual errors are estimated from error correction model. Hedge ratio and hedging effectiveness are calculated through ECM model. The results are reported in table 4.3 ECM considers long run relationship between spot and futures prices and short run dynamics; it is supposed to be the best model for the estimates of hedge ratio and hedging effectiveness. The hedge ratios from the ECM are high as compared to OLS estimates but hedging effectiveness values are similar to OLS estimates, hence there is no change in the variance reduction performed by both methods. The overall performance of hedging of copper futures markets is low.

Lead

The optimal hedge ratios are calculated from simple OLS regression method for all cases. The results from the regression model are presented in Table 4.4. The optimal hedge ratios for three different maturity periods are 0.626, 0.662 and 0.877 respectively. This reveals that hedge ratio is high in far month maturity, so hedgers are able to reduce risk in far month contracts since hedging effectiveness is also high as compared to two remaining maturity periods.

Engle and Granger show that if a pair of prices series is cointegrated, then an error correction model can be estimated. Error correction coefficients are statistically significant in all cases. The results are presented in table 4.6. It shows that the equilibrium error has significant impact in the adjustment process of the subsequent price changes in the sport market. Estimated hedge ratios from ECM model are higher than the OLS method. Hedging effectiveness values from ECM are similar to OLS method. The ECM model provides better variance reduction then the OLS model. On an average, the hedging effectiveness of lead futures markets is around 39%.

Nickel

The optimal hedge ratios for nickel are estimated from the OLS method for different maturity cases. The results are presented in table 4.7. From the table, the hedge ratios of three maturity periods are 0.58 1, 0.628 and 0.75 respectively; hedge effectiveness values are 0.303, 0.302 and 40.7 respectively. This indicates hedge ratio and hedging effectiveness values are high in distant month maturity period. So hedgers can reduce 41 % of risk reduction.

Since spot and futures prices are cointegrated, the error correction model is estimated. Error correction coefficients are significant in all cases. The results are presented in table 4.9. The hedge ratios of three different maturity periods are 0.62, 0.647 and 0.749 respectively. Further, it is observed that there is no difference in the performance of the hedging effectiveness from both OLS and ECM methods.

Zinc

The optimal hedge ratios are calculated from OLS method for different maturity cases. The results are mentioned in table 4.10. The optimal hedge ratios of maturity, nearby and distant month maturity periods are 0.57, 0.611 and 0.736 respectively. The results clearly conclude that far month maturity period gives higher mean returns compared to other maturity periods. Hedge ratio values are increasing as time to maturity is increasing; this reveals that in distant month more contracts are needed for trading in futures market for better returns. Hedging effectiveness is high in far month maturity period as compared to other two maturity periods. It concludes that far month maturity period is able reduce considerable variance risk.

Error correction method results are indicated in table 4.12. The results of hedge ratios from ECM are slightly higher than OLS method. It explains ECM results are providing better returns. In ECM results, far month maturity period hedge ratio is high. The hedging effectiveness values of three maturity periods are 0.635, 0.627 and 0.743 respectively. All this closely indicates that as time to maturity decreases the hedging effectiveness of zinc futures market is also decreasing. The capacity of variance reduction is high in far month maturity period.

4.5.2 Agricultural commodities

Chilly

The optimal hedge ratios are estimated for all cases from OLS regression method. The slope of the regression equation gives the hedge ratio and R-square explains hedging effectiveness. Table 4.13 shows results. The hedge ratios of maturity, nearby and far month maturity periods are 0.60, 0.86 and 0.54 respectively. This implies in case of nearby futures hedge ratio is high as compared to nearby and distant future contracts. The hedging effectiveness estimates of three cases are 0.53, 0.56 and 0.42 respectively. This indicates the hedging effectiveness decreases as move from maturity month futures to distant month futures. This concludes that a farmer who is trying to minimise price risk by hedging in futures markets is able to reduce the risk by 56% by selling 86% of produce in nearby futures contracts.

Engle and Granger show that if a pair of series is cointegrated then an error correction model exists. Error correction model is estimated, the results are presented in table 4.15. The results of ECM are coinciding with results of OLS method. The optimal hedge ratio of nearby month maturity period is 0.8653 and hedging effectiveness is 0.5684; this concludes that 56% of risk can be minimized by selling 86% produce in futures markets. The study also indicates hedging effectiveness of maturity and far month contracts are less than nearby contracts. So it reveals that the nearby futures contracts are suitable for hedging. Further, it observed that performance of ECM model and OLS model are same.

Jeera

The optimal hedge ratios for jeera are calculated from the OLS method. The results are presented in table 4.16. It is observed from the table that the optimal hedge ratios for three maturity periods are 0.248, 0.371 & 0.298 respectively. Hedging effectiveness values for three cases are 0.275, 0.909 & 0.2751 respectively.

It is found among all maturity periods that nearby maturity period provides better results. Error correction model is estimated since two series are cointegrated, results are presented in table 4.18. The results are also most similar to OLS method and there is no difference in the variance reduction by these two methods. Hedge ratios are similar for all cases. The over all hedging performance is low in jeera futures markets.

Pepper

The optimal hedge ratios and hedging effectiveness are estimated from OLS method and ECM model. The results are presented in tables 4.19 and 4.21. The optimal hedge ratios of maturity, nearby and far month maturity periods are almost similar. Hedging effectiveness values are also similar in nearby and far month maturity except a slight difference in maturity month period. The hedging effectiveness values of maturity, nearby and far month maturity periods are 0.2954, 0.3295 and 0.3297 respectively. Similar results are observed from ECM method for all cases. It is found that the performance of Pepper futures is not effective in minimizing the spot price risk.

Turmeric

The optimal hedge ratios are calculated by using OLS method and results are presented in table 4.22. The hedge ratio of maturity month, nearby month and far month periods are 0.228, 0.521 and 0.566 respectively. This reveals that hedge ratios of nearby month and fair month maturity period are high compared to maturity month period. Hedging effectiveness for nearby and far month maturity periods are also high. This indicates that hedgers are able to reduce risk in nearby contracts.

Error correction method results are mentioned for maturity month and nearby month maturity period in table 4.24. There is no cointegration relationship between spot and future prices in cases of far month maturity period. From table 4.16 it is observed that the results are similar to OLS method in case of maturity and nearby futures contracts. The turmeric futures market shows a better variance reduction in case of nearby futures contacts.

Cardamom

It is observed from the OLS method that hedge ratios and hedging effectiveness are very low for all maturity periods. The results are presented in tables 4.25 and 4.27. This indicates that hedge performance of Cardamom futures is not effective to minimize spot price risk. Similar results are mentioned from ECM method for two cases, that is, maturity and nearby month maturity periods. In case of distant month maturity period there is no cointegration relation between the spot and futures prices. Hedging effectiveness increases as move from nearby futures to far month futures. Further, the performance of Cardamom futures market does not provide better solution for spot price risk.

4.6 Conclusion

In emerging market like India, where commodity futures markets are growing at fast rate, it is important to evaluate the hedging effectiveness of commodity futures markets. In agricultural commodities, especially in the case of red chilly, hedge ratios and hedging effectiveness are high compared to other spices like jeera, pepper, and turmeric. In case of turmeric, hedge ratio and hedging effectiveness values are high in nearby and far month maturity periods. Hedging efficiency of jeera in nearby maturity is better than pepper and cardamom. Pepper commodity has similar estimates of hedge ratio and hedging effectiveness for the entire period of time. Hedging performance of cardamom is very poor because low volume of trade. There is no significant difference in hedging performance among different maturity periods. Further, there is no difference in the estimates of hedging effectiveness of OLS method and Error correction method.

Hedging efficiency of base metals is high as compared to agricultural commodity futures. It is because the underlying nature of both commodities is entirely different. Copper futures market hedge ratio is high in maturity period and in the remaining two periods it is low, but there is no significant difference in hedging effectiveness among all periods. In case of the three base metals (lead, nickel, zinc) hedge ratios and hedging effectiveness values are quite moderate and also hedging effectiveness increases in the case of nearby and far month maturity periods. There is also difference in the estimates of OLS method and error correction method since spot and futures prices are strongly cointegrated. It also observed the hedging in nearby futures contracts provides better results than in maturity and distant month futures contracts.

Results of Hedge ratio and hedging effectiveness for Copper

Table 4.1 OLS method results

Coefficient	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
h*(Hedge Ratio)	0.698576	0.590548	0.655532
R^2(Effectiveness)	0.415181	0.051796	0.041185
D-W Stat	3.021953	3.006002	2.958671

Table 4.2 Optimal Hedge ratio from ECM Model

	Maturity Month (Fm)	Middle Month (F2)	Far Month (Fd)
Covariance(ε_s ε_f)	0.001085	0.000787	0.000387
Variance(ε_s)	0.001451	0.001212	0.000619
h*(Hedge ratio)	0.747762	0.648727	0.62555
Hedging Effectiveness	0.413135	0.051286	0.041101

*, ** and *** denote 1%, 5% and 10% levels of significance respectively.

t-values are in parenthesis.

Results of Hedge ratio and hedging effectiveness for Lead

Table 4.3 OLS method results

Coefficient	Maturity Month(Fm)	Nearby Month (Fn)	Far Month (Fd)
α			
h*(Hedge Ratio)	0.625508	0.661604	0.877465
R^2(Effectiveness)	0.315573	0.316110	0.479061
D-W Stat	2.745575	2.686417	2.713840

Table 4.4 Optimal Hedge ratio from ECM Model

	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
Covariance(ε_s ε_f)	0.000669	0.000494	0.0005
Variance(ε_s)	0.001034	0.000727	0.000537
h*(Hedge ratio)	0.646301	0.679437	0.931217
Hedging Effectiveness	0.315252	0.315883	0.477246

*, ** and *** denote 1%, 5% and 10% levels of significance respectively.

t-values are in parenthesis.

Results of Hedge ratio and Hedging effectiveness for Nickel

Table 4.5 OLS Method results

Coefficient	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
α			
h*(Hedge Ratio)	0.581200	0.628153	0.755034
R^2(Effectiveness)	0.303111	0.301935	0.406904
D-W Stat	2.660497	2.474134	2.466960

Table 4.6 Optimal Hedge ratio from ECM Model

	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
Covariance(ε_s ε_f)	0.000545	0.000393	0.000352
Variance(ε_s)	0.000879	0.000608	0.00047
h*(Hedge ratio)	0.620091	0.646512	0.748782
Hedging Effectiveness	0.301787	0.301689	0.406877

*, ** and *** denote 1%, 5% and 10% levels of significance respectively.

t-values are in parenthesis.

Results of Hedge ratio and Hedging effectiveness for Zinc

Table 4.7 OLS Method results

Coefficient	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
h*(Hedge Ratio)	0.574203	0.611435	0.736034
R^2(Effectiveness)	0.290604	0.274804	0.347287
D-W Stat	2.739878	2.578475	2.749782

Table 4.8 Optimal Hedge ratio from ECM Model

	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
Covariance(ε_s ε_f)	0.000442	0.000299	0.000289
Variance(ε_s)	0.000696	0.000476	0.000388
h*(Hedge ratio)	0.634853	0.627411	0.742868
Hedging Effectiveness	0.287396	0.274606	0.347249

*, ** and *** denote 1%, 5% and 10% levels of significance respectively.

t-values are in parenthesis.

Results of Hedge ratio and hedging effectiveness for Chilly

Table 4.9 OLS Method results

Coefficient	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
h*(Hedge Ratio)	0.6058*	0.8653*	0.5404*
R^2(Effectiveness)	0.5391	0.5684	0.4257
D-W Stat	1.8474	1.9617	1.7294

Table4.10 Optimal Hedge ratio from ECM Model

	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
Covariance(ε_s ε_f)	0.001231	0.001365	0.000788
Variance(ε_s)	0.002013	0.001602	0.00151
h*(Hedge Ratio)	0.611417	0.851907	0.522223
Hedging Effectiveness	0.5391	0.5683	0.4252

*, ** and *** denote 1%, 5% and 10% levels of significance respectively.

t-values are in parenthesis.

Results of Hedge ratio and Hedging effectiveness for Jeera

Table 4.11 OLS Method results

Coefficient	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
h*(Hedge Ratio)	0.2482*	0.3713*	0.2987*
R^2(Effectiveness)	0.2756	0.4097	0.2768
D-W Stat	2.088	2.2319	2.1879

Table 4.12 Optimal Hedge ratio from ECM Model

	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
Covariance(ε_s ε_f)	0.000105	0.000131	8E-05
Variance(ε_s)	0.000423	0.000367	0.000291
h* (Hedge ratio)	0.247093	0.356588	0.274705
Hedging Effectiveness	0.2756	0.4091	0.2751

*, ** and *** denote 1%, 5% and 10% levels of significance respectively.

t-values are in parenthesis.

Results of Hedge ratio and Hedging effectiveness for Pepper

Table 4.13 OLS Method results

Coefficient	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
h*(Hedge Ratio)	0.3122*	0.3348*	0.3297*
R^2(Effectiveness)	0.2954	0.3295	0.3169
D-W Stat	2.1825	2.2210	2.2473

Table 4.14 Optimal Hedge ratio from ECM Model

	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
Covariance(ε_s ε_f)	0.000103	0.000107	0.000107
Variance(ε_s)	0.000328	0.00033	0.000334
h*(Hedge ratio)	0.31304	0.32508	0.320175
Hedging Effectiveness	0.2954	0.3293	0.3161

*, ** and *** denote 1%, 5% and 10% levels of significance respectively.

t-values are in parenthesis.

Results of Hedge ratio and hedging effectiveness for Turmeric

Table 4.15 OLS Method results

Coefficient	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
h*(Hedge Ratio)	0.2285*	0.5209*	0.5666*
R^2(Effectiveness)	0.2174	0.5944	0.5803
D-W Stat	1.8522	2.0305	2.1053

Table 4.16 Optimal Hedge ratio from ECM Model

	Maturity Month (Fm)	Nearby Month (Fn)
Covariance(ε_s ε_f)	0.000119	0.000332
Variance(ε_s)	0.000516	0.000641
h*(Hedge ratio)	0.229806	0.517516
Hedging Effectiveness	0.2174	0.5945

*, ** and *** denote 1%, 5% and 10% levels of significance respectively.

t-values are in parenthesis.

Results of Hedge ratio and hedging effectiveness for Cardamom

Table 4.17 OLS Method results

Coefficient	Maturity Month (Fm)	Nearby Month (F2)	Far Month (Fd)
h*(Hedge Ratio)	0.0926*	0.2070*	0.2283*
R^2(Effectiveness)	0.0614	0.1742	0.1808
D-W Stat	1.5391	1.6063	1.6223

Table 4.18 Optimal Hedge ratio from ECM Model

	Maturity Month (Fm)	Nearby Month (Fn)
Covariance(ε_s ε_f)	9.83E-05	0.000101
Variance(ε_s)	0.000896	0.000513
h*(Hedge ratio)	0.109649	0.196047
Hedging Effectiveness	0.0593	0.1734

*, ** and *** denote 1%, 5% and 10% levels of significance respectively.

t-values are in parenthesis.

Chapter-5

Efficiency of Futures Markets

5.1 Introduction

Instability of commodity prices has always been a major concern of the producers, investors, and traders in an agriculture dominated economy like India. The low prices for basic commodities limit the income of farmers and higher variability of prices make it very difficult for them to invest in other profitable activities. There are various ways to solve this problem. Apart from increasing stability of the market through direct government intervention, farmers and other stock holders can better manage their activities in an environment of price variability through derivatives markets. Commodity derivatives are instruments that have been devised to achieve price risk management based on the value of underlying commodity.

Commodity futures have been in existence in India since 1875, but their growth has been controlled due to restrictive policies. Prior to implementation of economic liberalisation policy in 1991, the government intervened at every stage of marketing of major agricultural commodities. The process of withdrawal of government intervention initiated with economic liaberalisation policy and implementation of the Agreement on Agricultural of the World Trade Organization. As a consequence of these new structural adjustment policies, prices of agricultural commodities and other non-agricultural commodities are determined by market forces, therefore fluctuating demand and supply of commodities expected to result in high price risk. So in this context, an understanding of price management alternatives other than government programmes is important for producers and market participants to minimise risk. In order to minimise price risks, the Central government has been encouraging revival of futures trading. So the importance of commodity futures markets as price risk management and hedging tool has become a control issue with the establishment of national commodity derivatives exchanges.

An unbiased futures market could be used as a risk management tool for all market participants, including producers, traders, invertors and processors. Unbiasedness has important implications for forecasting future spot price and for derivation of optimal hedge ratios. Benninga, Eldor and Zilcha (1984) note that the minimum variance hedge ratio, which often calculated in empirical hedging models, is only optimal if futures markets are unbiased. The empirical analysis of the performance of futures markets in terms of unbiasedness and market efficiency provides critical inputs to hedgers and policy makers. Numerous studies have examined the efficient market hypothesis for agricultural commodities and for non-agricultural commodities with mixed results (Mckenzie and Holt, 2002; Fortenbery and Zapata, 1997; Beck, 1994). Mckenzie and Holt (2002) used cointegration and error connection with GARCH – in – mean process to examine efficiency of four agricultural commodity futures markets (live cattle, hogs, corn and Soybean meal). Their results indicate that each market is efficient and unbiased in the long run. However, cattle, hogs and corn futures markets exhibit short run inefficiencies and pricing biases. Fortenbery and Zapata (1997) tested market efficiency in the cheddar cheese futures market. Their results do not support the market efficiency hypothesis. Beck (1994) used the Engle – Granger two step cointegration procedures to test market efficiency for several agricultural commodity futures markets. Her results indicated that market efficiency hypothesis was rejected most of the time. Recent studies on assessing performance of the commodities futures markets have been very few in India (Naik and Jain 2001; Sunil, 2004; Sahadevan, 2002). Results of all these studies confirmed commodity futures markets are inefficient. Given this back ground, the present study focuses on assessing the efficiency of spices and base metals futures markets in India using the cointegration theory and error correction methodology.

5.2 Futures Market Efficiency: Theory and Testing

Fama defines three categories of market efficiency tests: weak form, semi strong form and strong form. The weak-form test examines whether current prices fully reflect the information contained in historical prices. The semi strong form test examines how quickly prices reflect the announcement of public information. The strong-form test examines whether investors have private information that is not fully reflected in the market prices. The concept of unbiasedness is a more restrictive version of Fama's weak-form efficiency. Unbiasedness implies that the current futures price of a commodity should equal the expected cash price of the same commodity at contract maturity. A common approach for the unbiasedness test is to regress cash prices S_t on the futures price F_{t-1} sometime prior to contract maturity and test the null hypothesis that is a=0 and b=1.

$$S_t = a + bF_{t-1} + e_t \quad \ldots (5.1)$$

where e_t is a rational expectations error with the classical properties of a zero mean and constant variance. Previous studies that have utilized this approach with respect to agricultural commodity futures markets include Tomek and Gray (1970) study on corn, soybeans, and potatoes; Kofi (1973) study on wheat, potatoes, soyabeans, corn, cocoa, and coffee; and Kahl and Tomek (1986)study on corn, soybeans, and live cattle.

The theory of market efficiency suggests that an efficient futures pricing instruments reflects all available information at any point time. In general if the efficient market hypothesis holds, the current futures price of a contract expiring at time t, f_{t-1} should equal the expectation of the spot price, S_t, to prevail at time t. Other wise, market participants will use additional information to profitably buy or sell futures contracts. Market efficiency implies that the futures price (f_{t-1}) for a contract expiring at time t is the unbiased predictor of the future spot price.

Mathematically, this can be expressed as

$$E_{t-1}(S_t) = f_{t-1} \quad \ldots (5.2)$$

where $E_{t-1}(S_t)$ is expected future spot prices formed at time t-1.

$$S_t = E_{t-1}(S_t / \Omega_{t-1}) + \varepsilon_t \quad \ldots (5.3)$$

where Ω_{t-1} is the information set available in period t-1. By combining (5.2) and (5.3)

$$S_t = f_{t-1} + \varepsilon_t \qquad \dots (5.4)$$

Equation (5.3) forms the basis for conventional unbiasedness and market efficiency tests between spot and futures prices. To carry out these tests, the standard form of the equation is

$$S_t = a + b + f_{t-1} + e_t \qquad \dots (5.5)$$

typically estimated. If the null hypothesis of market efficiency (a=0 and b=1) can not be rejected, the futures price is an unbiased estimator of the future spot price. If the null hypothesis (b=1) can not be rejected, then it implies that market is efficient. As a result, the hypothesis that a futures price is an unbiased estimator of spot price is a joint hypothesis that markets are efficient and that there is no risk premium.

5.3 Review of Empirical Studies

The study of market efficiency in commodity futures markets is important to both regulators and users. From the government policy point of view, an efficient market is better alternative to market interventions such as implementation of price stabilization policies in market and other distribution control policies; and in case of producers and other traders, it provides reliable estimates of future spot prices for effective risk management. It is important to review some of empirical works about market efficiency of futures markets. So this section provides brief review of earlier empirical work on the market efficiency of futures markets.

The investigation of efficiency of copper futures in London Metal Exchange (LME) was done by Kenourgios and Samitas (2004) by testing joint hypothesis of market efficiency and unbiasedness of futures prices. The data contains prices from two different copper futures contracts with three months and fifteen months maturity and daily copper spot prices for the period between 3rd of January 1989 and 30th April 2000. Cointegration and Error correction model used for the testing both long run and short run efficiency. The empirical results suggest that copper futures market on the London Metal exchange is inefficient and three & fifteen months of futures prices do not provide unbiased estimates of the future spot prices in both long run and short run, this is an important implication for the uses of this market.

Naik and Gopal (2001) examined the efficiency and unbiasedness of Indian commodity futures markets for nine commodities in twenty exchanges by using co-integration theory. Commodities selected for the study are pepper, castor seed, potato, gur, turmeric, hessian, sacking, coffee and cotton. The prices were collected from different regional commodity exchanges. The results indicated that performance of the Indian commodity futures markets is varied across the commodity exchanges. Among different commodity exchanges, Ahmedabad castor seed futures market is an efficient and unbiased market, while hessian and turmeric futures markets are inefficient. In other futures markets efficiency and unbiased varied during maturity and also one month prior to the maturity. Futures markets of pepper, gur traded in Muzaffarnagar, castor seed traded in Mumbai and potato show efficiency in forward pricing in the months prior to the maturity. But their forward pricing ability is weak in the maturity month because of low volume of trading in the maturity month. The study concluded that the main reason for poor performance of Indian futures markets is lack of participation of traders in these markets. The efficiency of the Chinese commodity futures markets is examined by Holly and Ke (2002). Two agricultural commodities, wheat and soybean futures are considered from the China Zhengzhou Commodity Exchange (CZCE) and Dalian Commodity Exchange (DCE) respectively. Weekly futures price data of wheat and soybeans during the period of January 1998 to March 2002 are used for the analysis. Futures market efficiency is tested for six forecasting horizons, ranging from one week to six months. Futures prices are taken for six forecasting horizons prior to the maturity of each contract. The empirical test was conducted through Johnsen's cointegration approach. The study concludes that long run equilibrium relationship between the DCE soybean futures price and cash price of TGWM, and between the soybean futures price and the national average cash price is established. Weak short term efficiency is also implied. The results also revealed that the wheat futures market in China is inefficient; the wheat futures market is not cointegrated with any wheat cash markets. The conclusion of inefficiency in wheat futures market is because of over speculation and government intervention. Similarly for China futures markets, Williams *et al* (1998) analysed the development and characteristics of mung bean trading in the CZCE. By examining price spreads between different futures contracts in the same crop year, they concluded that the conditions for arbitrage existed on the CZCE.

Mckenzie and Holt (2002) examined market efficiency and unbiasedness for four agricultural commodity futures (live cattle, hags, corn and soybean meal) using cointegration and error correction model with GQARCH-in-mean process. The data set includes both futures and spot prices over the period 1959 – 2000. Chicago Board of Trade futures settlement price data for corn and soybean meal, and Chicago Mercantile Exchange futures settlement price data for live cattle and hogs were taken from the Bridge database of futures prices. The sample data was divided in two sub periods: an in-sample period from September 1959 to October 1995, and out-of-sample period from December 1995 –to October 2000. The results indicated that live cattle, hogs, corn and soybean meal futures markets are both efficient and unbiased in long run, however, the results showed some inefficiencies and pricing biases. They observed that conditional variance dynamics were also important in explaining the nonlinear dependence between current spot price changes and previous spot futures price information. They concluded that models for cattle and corn out perform futures prices in out of sample forecasting.

The empirical examination of futures market efficiency using cointegration tests for the commodities copper, led, tin, zinc is carried by Chowdhary (1991). The data used are monthly average spot on the futures (three months) prices from the London Metal Exchange for the sample period of July 1971 to June 1988. Two equivalent procedures have been used for unit root test are namely ADF test and the Philips – Perron test statistic and he found that the data is non stationary and applied cointegration tests in order to test about efficiency of futures market. Based on the empirical results, the study concluded that the rejection of the efficient market hypothesis for four nonferrous metals copper, lead, tin and zinc. This study analysed the problems of conventional hypothesis testing in the futures market literature and suggested how the cointegration approach can be used to test the market efficiency.

Beck (1994) tested market efficiency in commodities futures markets based on the hypothesis that futures prices are unbiased predictors of spot prices. It is a joint hypothesis that markets are efficient and risk premia are absent. Cointegration techniques are used to test market efficiency by permitting the presence of risk premia. In this study five commodities (cattle, orange juice, corn, copper, and cocoa) were tested at eight and twenty fair week horizon. The results are conditional on the assumed form of the risk premium. The results concluded that all five markets are sometimes inefficient but no market rejected efficiency all the time, the results also indicate that cases where the error correction model rejects unbiasedness are those where efficiency is also rejected, implying inefficiency rather than the presence of risk premia responsible for rejection of unbiasedness in commodities futures prices.

The efficiency of natural gas futures markets is examined by Mazighi (2003) using monthly data from January 1999 to July 2002 on the spot and one month, the quarterly and half yearly forward prices on both the New York Mercantile Exchange (NYMEX) in US and International Petroleum Exchange (IPE) in London. The results indicated that efficiency is almost completely rejected on both exchanges NYMEX and IPE. Further, both the NYMEX and the IPE failed with regard to the hypothesis that the forward price is an optimal predictor of the future spot price.

Raizada and Sahi (2006) studied about the commodity futures market efficiency in India and analysed its effect on social welfare and inflation in the economy. Three month wheat futures contracts from National Commodities & Derivative Exchange Ltd (NCDEX) were selected for anaysis. The spot market rates and futures prices were collected from NCDEX database for the period from July 2004 to July 2006. The efficiency was examined using Johansen's cointegration approach for different futures forecasting horizons ranging from one week to three months. The results indicate that the commodity futures market is not efficient in short run. The social loss statistics for commodities future market indicate poor price discovery process. The study concludes that the growth in commodity futures markets has a significant impact on the inflation in the economy.

The investigation of short – run and long – run unbiasedness in the U.S. rice futures market was performed by Mckenzie *et al* (2002). The forecasting performance of the rice futures market is analysed and compared to out-of-sample forecasts derived from an additive ARIMA model and the error connection model. The data used in this study consist of daily long-grain rough rice futures prices traded at the Chicago board of trade for September 1986 to November 1999. Six futures contracts January, March, May, July, September and November were considered. The results of unbiasedness tests and the forecasting performance of the rice futures market provide supporting evidence that the U.S. long grain rough rice futures market is efficient. This study concluded that the results have important price risk management and price discovery implications for Arkansos and U.S. rice industry participants.

Fama and French (1987) examined two models of commodity futures prices. In their study, theory of storage explains the difference between contemporaneous futures and spot prices (the basis) in terms of interest charges, warehousing costs and convenience yields. The second model spills a futures price into an expected premium and forecast of maturity spot price. The results provided evidence of forecast power for 10 of 21 commodities and time varying expected premiums for five commodities.

The efficiency of the Dojima rice futures market is investigated by Wakita (2001). Cointegration analysis is applied to historical data (1760 – 1864) from the world's first well established futures market in rice at Dojima (in Osaka, Japan). It has been found that the Dojima rice market was an economically rational institution where the movement of rice price followed a clear cut seasonal pattern. In the summer market, where transactions in futures for the forthcoming crop of rice were possible, both prices remained low. On the other hand, in the spring and autumn market, where such transactions were impossible, both prices stayed high. It is observed that the spring and autumn markets were characterised by unbiasedness in the sense of rational expectations, suggesting that the factors peculiar to a commodity futures market did not significantly affect the futures premium. The study also revealed that futures premium in the summer market increased on a regular basis; a phenomenon that is not ascribed to an increase in the convenience yield of actual rice, but rather to the producers' risk-hedging behavior.

The relative efficiency of commodity futures markets are analysed by Kellard *et al* (1999). In this study they examined unbiasedness and efficiency across a range of commodities and financial future markets, using a cointegration methodology and developed a measure of relative efficiency. The findings suggested those spot and futures prices are cointegrated. However, there is an evidence that the long run relationship does not hold in the short run, especially changes in the spot price are explained by lagged differences in spot and futures prices as well as the basis. The findings of the study represented an extension of the work of Fama and French(1987) whether the coefficient on the basis is equal to one, but this research work has examined the forecasting ability of the futures price and linked forecast power to the information contained in the basis. The study concludes that there are some evidences about market inefficiencies, especially for cattle and hog markets, that lagged futures and spot prices influence current spot prices. The study reveals that past information can be used by agents to predict spot price movements.

Sahadevan (2003) investigated derivative markets in agricultural commodities in India. A quantitative analysis of the relationship between price return, volume, market depth and volatility was done on a sample of 12 markets in six commodities over a period of 38 months from January 1999 to August 2001. The result shows that markets volume and depth are not significantly influenced by the return and volatility of futures as well as spot markets. The results indicate that the futures and spot market are not integrated. The price volatility in the spot markets does not have any impact on the markets conditions in futures market. Finally, the study concludes that the exchange – specific problems like low volume and market depth, lack of participation of trading numbers and irregular trading activities along with state invention in many commodity markets are major ills retarding the growth of futures markets.

By using a cointegration test, Lai and Lai (1991) examined market efficiency of exchange rates. They considered monthly spot and forward rates for five major currencies namely the British pound, Deutsche mark, Swiss frank, Canadian dollar and Japanese yen against the U.S. dollar for the period July 1973 to December 1989. When the series are nonstationary, conventional statistical procedure are no longer valid in providing results for a test of market efficiency. This study suggested that the use of the cointegration techniques developed by Johansen (1988, 1990) to test the simply efficiency hypothesis. The study concluded that the evidence found is not favorable to the joint hypothesis of market efficiency and no risk premium.

There are numerous studies, both theoretical and empirical that analyse the efficiency of futures markets in developed countries like the US and the UK. Empirical studies of efficiency of futures markets have provided mixed results. In addition, the literature on emerging commodity futures markets in developing countries is sparse, lack of meaningful data and there few studies on efficiency of commodity futures markets. Therefore, the present study made an attempt to analyse the efficiency of Indian commodity futures markets especially for spices and base metals.

5.4 Data sources

The data for the present study are collected from official websites of National Commodities & Derivations Exchange Ltd (NCDEX) and Multi Commodity Exchange (MCX). The daily closing prices of different futures contracts and spot prices for selected commodities are considered from both exchanges. Spices (red chilly, jeera, pepper, and turmeric) data are collected from NCDEX. Cardamom and base metals (copper, lead, nickel, zinc) data are collected from MCX.

A pooled price series is constructed with roll over process for two months before maturity (Fd) (that is, far month futures), one month before maturity (Fn) (that is, nearby month futures) and maturity month futures (Fm) for all contracts months. The first day of nearby contract is considered as first day of second month from maturity and ends with the last day of second month. Similarly, the contracts are rolled over to next nearby contracts. As such, the data do not overlap and avoid methodological problems associated with overlapping of data. The procedure is the same for maturity period and far month maturity periods. The pooled series is used to empirically test for long run and short run dynamics.

5.5 Methodology

According to Fama (1970), a financial market can be considered as efficient if prices fully reflect all available information and no profit opportunities are left unexploited. The agents from their expectations rationally and rapidly arbitrage away any deviations of the expected returns consistent with supernormal profits.

Under conditions of risk neutrality, market efficiency implies that

$$S_t = F_{t-n,t} + u_t \qquad \text{.... (5.5)}$$

this equation states that the futures price, $F_{t-n,t}$ for delivery at time t, is an unbiased predictor of the future spot price, S_t, at contract expiration, given the information set available at time t-n. It is the algebraical representation of the Unbiasedness Hypothesis or Simple Efficiency (Hansen and Hodrick, 1980) or Speculative Efficiency (Bilson, 1981), under this hypothesis, deviations between $Ft_{-n,t}$ and S_t should have a mean zero and will be serially uncorrelated. This equation provides a pricing model specification and enables the efficiency of future markets to be examined.

Fama (1991) supports that market efficiency involves testing a joint hypothesis of efficiency and the asset pricing model. Empirical analysis of Equation (5.5) allows the examination of the joint hypothesis of market efficiency and unbiasedness in futures prices. Equation (5.5) can also be written by regress the sport price at maturity on the futures price some time prior to maturity:

$$S_t = a + bF_{t-n,t} + u_t \quad \text{…. (5.6)}$$

Market efficiency requires that a=0 and b=1. It is also normal to assume that futures prices closer to the expiration dates will provide better estimates of the future spot price than do those further away. Rejection of the restrictions imposed to the parameters a and b means that either the market is inefficient or a non- zero risk premium (a≠0) existed in futures market.

Cointegration and Market Efficiency

Standard statistical techniques of parameter restrictions as those presented in relation to equation (5.6) are not reliable in circumstances where data are non- stationary. However, cointegration provides a satisfactory means to investigate equation (5.6), in the presence of non- stationary series. When two price series, such as the future and the sport price series, are both integrated of the same order d, a linear combination of two I(d) series can be integrated of an order lower than d. more specifically, it is possible that two series that are non-stationary and contain a unit root, for example I (1), can generate a linear combination that is stationary, I(0). These two series are said to be cointegrated with a cointegrating relationship of the following form:

$$S_t - a - b\, F_{t-n} = U_t \qquad \text{.... (5.7)}$$

cointegration of two price series is a necessary condition for market efficiency. If the two series are cointegrated, S_t and F_{t-n} move together and will not tend to drift apart over time. If this is the case, then the futures price is an unbiased predictor of the future spot price. In order to test for cointegration between the two markets, the ADF test on the cointegrating regression residuals as described by Engle and Granger (1987) is implemented

Hakkio and Rush (1989) demonstrate that, while cointegration is a necessary condition for market efficiency, it is not a sufficient one for two reasons. Firstly, it is necessary to consider the values of the parameters a and b in the equation (5.6). For the futures price to be an unbiased predictor of the future spot price it is required that a=0 (for zero expected profits) and b=1 furthermore, along with the restricted cointegration test, a test for serial correlation of $S_t - F_{t-n}$ is needed to infer about the efficient market hypothesis (Liu and Maddala, 1992). The acceptance of the above restrictions imposed to a and b (both jointly and individually) and the serial independence of U_t is a second necessary condition for market efficiency.

If both necessary conditions are met, according to Hakkio and Rush (1989), the short-run efficiency of the futures market (third condition) has to be tested, since in the short-run it is possible that there will be considerable departures from the long-run equilibrium relationship. This can be tested by using an error-correction model (ECM) in the following form:

$$\Delta St = \alpha - \rho u_{t-1} + c\Delta F_{t-1} + \sum_{i=1}^{m} \beta_i \Delta S_{t-1} + \sum_{i=1}^{n} \gamma_i \Delta F_{t-1} + \varepsilon_t \quad \text{.... (5.8)}$$

where α is the intercept, ΔS_t is the changes in spot prices, ΔF_{t-1} the changes in futures prices, and $U_{t-1} = S_t - a_1 F_{t-1} + a_2$ is the error-correction term (ECT). In equation (5.8) cointegration implies only that $\rho > 0$ because spot prices changes respond to deviations from the long-run equilibrium as this is described in equation (5.7). Short-term efficiency can be investigated by testing the following restriction in equation (5.8); $c \neq 0$ (in this way all new information concerning future spot price changes is immediately reflected in a change in the current futures price), $\beta_i = \gamma_i = 0$ (in this way past information is already completely incorporated in the current futures price) and $\rho = 1$ and $\rho c_1 = b$ do not hold then the efficient market hypothesis is violated as past futures and spot prices (and not only the futures price of the last period F_{t-1}) contribute useful information for the formation/ prediction of the sport price of the present period.

a_1 is the coefficient of F_{t-1} in the cointegrating relationship and that for the market efficiency to hold this should be equal to 1. It can be finally concluded that the restrictions imposed for testing market efficiency are the following: $\beta_i = \gamma_i = 0$, $\rho=1$, $c=1$ and $\alpha=0$ (not allowing the presence of risk premium according to the unbiasedness hypothesis).If the above restrictions hold, then equation (5.8) can be simplified to equation (5.6). These restrictions constitute the third condition for efficiency. If the three conditions are met, then the futures market is efficient and futures prices provide unbiased estimates of future spot prices both in the long-run and the short-run.

A theoretical justification for including risk terms in models of agricultural futures markets is based on the intertemporal hedging theory first advanced by Keynes (1930). Short hedgers, such as producers, sell futures contracts at a price below the expected futures spot price to avoid price risk. The difference between the two prices, the risk premium, compensates purchasers of futures contracts for bearing the spot price risk. In this circumstance future prices will risk over the life of the contract and the market is said to be in normal backwardation. Conversely, long hedgers may be willing to buy futures contracts at a price above the expected future spot price to avoid price risk. Whichever type of hedger dominates in terms of trading volume over a particular time period will determine whether the risk effect is positive or negative

5.6 Empirical analysis

Data from five spices namely red chilly, jeera, pepper, turmeric, cardamom, and four base metals - copper, lead, nickel and zinc are analysed. The data included both futures and spot prices for all these markets over the period October 2004 to October 2008. A pooled series is constructed for one month time horizon is analysed based on different maturity periods, that is maturity period (fm), nearby month maturity period (fn) and far month maturity period (fn).

An initial consideration must be to test the data for non – stationary or stationary; It is important to establish the number of unit roots that a series contain when testing for cointegration, for two non-stationary series to be cointegrated they must be integrated of the same order. Each series described above is first tested for the existence of a unit root by using Augmented Dickey Fuller (ADF) test. The results from ADF tests are reported in tables 5.1 and the 5.2 for spices and base metals respectively. The tables show that both spot and future prices are non stationary (have unit roots). However, the first difference of each time series shows that both the futures price and spot price remain stationary. Given that spot and futures prices are integrated of the same degree, cointegration technique can be used to determine if a long run relationship exists between the spot and futures prices. The two stage Engle-Grange cointegration tests, based on ADF statistics, indicated that the residuals of OLS regression equation (5.6) are stationary except in two cases of turmeric and cardamom of far month maturity periods. The results are presented in tables 5.3 to 5.25 as commodity wise. The terms a and b table are intercepts and futures price coefficients in the cointegrating regressions. These coefficients appear to be close the (0.1). The results which are showing in tables suggest that futures prices for chilly, jeera, pepper, turmeric, cardamom, copper, lead, nickel and zinc provide unbiased forecasts of future spot prices in the long run. However, the evidence suggests that turmeric and cardamom far month futures prices may have been biased predictors of two month a head spot prices.

5.5.1.1 Agricultural Commodities

Although the above tests, with the exception of turmeric and cardamom distant futures provide support the hypothesis of long run market efficiency, all of these futures markets may exhibit short run inefficiencies. Given the long run efficiency results, the short run dynamics for all spices and base metals are modeled using equation (5.7). The results are shows in tables from 5.5 to 5.17. Restrictions imposed for testing market efficiency are the following: p = 1, c = 1 and $\beta i = \gamma i = 0$.

The magnitude of error correction term coefficient indicates the speed of adjustment of any disequilibrium towards the long run equilibrium. The coefficients on the error correction terms are significant in all regressions. This is consistent with results that futures and spot markets are cointegrated. The error correction results of Chilly and presented in table (5.5). it is evident from the table that the chilly futures market appears to have the lowest adjustment rate for three different maturity periods, with error correction term coefficients 0.052, 0.065 and 0.036 respectively. The table demonstrates all significant ECM coefficients and the model is highly significant. The test investigates market efficiency hypothesis, imposing restrictions ρ = c = 1, $\beta i = \lambda i = o$ and no restrictions to the intercept, allowing the existence of risk premium. The test rejects the imposed restrictions and there by ruled out market efficiency. The results presented here suggest that futures price is not an unbiased predictor of the future spot price for all cases (all maturity periods). In case of Jeera, the results of ECM are consistent with cointegration relation. In three maturity cases ECM coefficients are significant but adjustment rates are low. The results are presented in table 5.8; it is observed from the table that ECM model for there maturity periods is significant. Based on the result of Wald test on restrictions, the tests reject the market efficiency hypothesis for all cases. It concludes that Jeera futures market is not efficient.

Pepper commodity futures market has almost similar results to chilly; the error correction terms are significant for all cases. These results are consistent with long run relation of futures and spot prices of pepper. Table 5.11 presents coefficient of error correction terms and other lagged variables. The ECM model is significant for all cases. In order to confirm about market efficiency of pepper futures market, Wald test on restrictions is carried. Based on these results, market efficiency of pepper futures markets for all cases is rejected. Hence, the pepper futures market is also inefficient.

In case of turmeric futures markets, there exists a long run relationship between spot and futures for delivery period and near by month maturity period, but for distant month maturity period, there is no long run relation between spot and futures markets. This can be observed from the table 5.13. Error correction model is performed to drive about short run dynamics for two cases; that is, delivery and nearby month maturity periods. Table 5.14 shows the results of error correction model. The coefficients on the error correction terms are significant in two regressions. The coefficients of error correction terms of two periods are 0.037 and 0.032 respectively; this shows very low adjustment rates. The Wald test on parameters restrictions ρ= c =1, $\beta i = \lambda i = 0$ is conducted and no restriction to the intercept, allowing the existence of risk premium. The test rejects the imposed restrictions not accepting market efficiency. The result suggests that the turmeric futures market is not efficient.

Cardamom futures market results are similar to turmeric futures markets. The cointegration results are presented in table 5.16. Form the table it is observed that long run relation exists between spot and futures markets for maturity and nearby month maturity periods. In case of distant month maturity period there is no cointegration relation between spot and futures markets. For explaining short run dynamics between spot and futures prices, error correction model is estimated; the results are presented in table 5.17. The results are consistent with cointegration relation; error correction terms coefficients are significant for two cases, but rate of adjustment process to establish equilibrium is very low. The Wald test is conducted on coefficient restrictions, the test rejects market efficiency hypothesis. Thus as in case of other commodities, cardamom futures market is biased and inefficient.

5.5.1.2 Base metals

Market efficiency test is conducted for copper, lead, nickel and zinc. Futures and spot prices are cointegrated for all base metals for all maturity periods. In case of copper, after confirmation of cointegration between spot and futures prices, error correction model is performed to analyse about short run dynamics. The results are furnished in table 5.20. The error correction terms are significant for all cases. The coefficients of error correction terms of there periods are 0.610., 0.953 and 0.920 respectively. It is observed that as compared to spices, in base metals speed of adjustment rates are high. Wald test is conducted by implying restriction ρ=c=1, $\beta i = \lambda i = 0$. Based on results it is confirmed that copper futures market is inefficient.

In case of lead, error correction coefficients are significant along with other lagged variables. The speeds of adjustment coefficients are moderate in all cases. Results are shown in table 5.23. In maturity month period adjustment rate is high as compared to other periods. Wald test is conducted by considering restrictions on coefficients ρ=c=1, $\beta i = \lambda i = 0$. The test rejects market efficiency hypothesis. It concludes that lead futures market is not efficient. Similar results are observed in case of nickel and zinc. The results of error correction models are reported in tables 5.23 and 5.26. All error correction coefficients are significant for different maturity periods. In case of nickel, speed of adjustment process rate is high in maturity period as compared to the remaining two time periods. Similar results are found in case of zinc. Wald test on coefficient restrictions is examined and results rejects market efficiency hypothesis. Thus, nickel and zinc futures markets are inefficient.

5.6 Conclusion

After five years of establishment of national commodity exchanges in India, the commodity futures markets in India are among the most active ones in the world. However, only a few quantitative studies have been conducted to evaluate the efficiency of commodity futures markets in India. The objective of this study is to test market efficiency without relying on the assumption that risk premia do not exist. This condition is under the existence of risk premium and/or transportation cost even when market is efficient. The study is conducted for spices namely chilly, jeera, pepper, turmeric and cardamom and base metals - copper, lead, nickel and zinc. The results indicate that spices and base metals are cointegrated, so the necessary condition for market efficiency holds. However, in short-run that there will be considerable departures from the long run equilibrium relationship, so efficiency in short run is considered. It is tested by using error correction methodology; the results suggest that all spices and base metal futures markets are inefficient. Turmeric and cardamom futures markets are not cointegrated in far month maturity period. Over all, the empirical results suggest that spices and base metals futures markets on Indian commodity exchanges are inefficient. All these futures prices do not provide unbiased estimates of the future spot price. Finally the findings have two important implications for market participants. Firstly, it suggests that there are opportunities for consistent speculative profit. Secondly, the information incorporated in futures prices is not alone considered as important in order to forecast future spot prices.

Table 5.1 Unit root test statistics for Spices

		Maturity Month (Fm)		Nearby Month (Fn)		Far Month (Fd)	
		ADF Statistics		ADF Statistics		ADF Statistics	
		Level	1st Difference	Level	1st Difference	Level	1st Difference
Chilly	SP	-2.663	-18.211*	-2.456	-16.655*	-2.267	-16.157*
	FP	-3.425	-17.991*	-2.294	-17.495*	-2.210	-15.226*
Cardamom	SP	-1.372	-14.473*	-1.065	-13.782*	-1.178	-13.276*
	FP	-1.552	-30.368*	-1.724	-13.034*	-1.913	-12.215*
Jeera	SP	-0.697	-14.531*	-0.668	-27.750*	-0.390	-13.884*
	FP	-0.924	-30.310*	-1.148	-28.712*	-0.937	-27.918*
Pepper	SP	-0.678	-20.679*	-0.831	-19.866*	-0.864	-26.602*
	FP	-0.964	-35.329*	-1.100	-33.060*	-1.138	-32.164*
Turmeric	SP	-0.705	-24.628*	-1.689	-21.592*	-0.228	-23.847*
	FP	-1.578	-30.360*	-2.190	-23.750*	-1.008	-25.505*

* denotes significant at 1% level

Test critical values:

1%	-3.4465
2%	-2.8685
3%	-2.5705

Table 5.2 Unit root statistics for Base metals

		Maturity Month (Fm)		Nearby Month (Fn)		Far Month (Fd)	
		ADF Statistics		ADF Statistics		ADF Statistics	
		Level	1st Difference	Level	1st Difference	Level	1st Difference
Copper	SP	-1.910	-11.772*	-2.436	-19.379*	-2.432	-17.432*
	FP	-1.911	-17.273*	-2.301	-17.170*	-2.783	-19.413*
Lead	SP	-0.233	-17.122*	-0.937	-18.400*	-1.108	-18.500*
	FP	0.017	-17.384*	-0.766	-18.658*	-1.158	-16.028*
Nickel	SP	0.508	-20.460*	0.399	-15.327*	-0.385	-22.153*
	FP	0.687	-22.541*	0.301	-23.438*	-0.118	-20.218*
Zinc	SP	-0.048	-26.117*	0.382	-27.378*	-0.653	-26.842*
	FP	0.105	-26.729*	0.647	-27.205*	-0.414	-24.456*

* denotes significant at 1% level

Test critical values:

1%	-3.4465
2%	-2.8685
3%	-2.5705

Chilly

Table 5.3 Cointegration equation results (($S_t = a + bf_t + u_t$)

Coefficient	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
a	-0.7897	-0.9959	0.7223
b	1.0955*	1.1203*	0.9073*
R^2	0.7979	0.7805	0.7419

Table 5.4 Unit root test for error terms: ($\Delta\hat{u}_t = \theta_1 \hat{u}_{t-1} + \zeta_t$)

	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
ADF Test Statistic	-3.6645*	-2.80008***	-2.667732***

Table 5.5 Results of Error correction model

Estimates of ECM Coefficients						
	Maturity Month (Fm)		Nearby Month (Fn)		Far Month (Fd)	
Variables	Estimate	t-value	Estimate	t-value	Estimate	t-value
C	0.001	0.786	0.000	0.276	0.001	0.507
U_{t-1}	-0.052*	-3.663	-0.065*	-3.245	-0.036*	-3.033
ΔF_t	0.613*	22.164	0.864*	19.676	0.545*	15.813
ΔS_{t-1}	0.085	1.712	0.041	0.711	0.116**	2.209
ΔF_{t-1}	-0.035	-0.849	-0.019	-0.286	-0.029	-0.648
ΔS_{t-2}	-0.073	-1.479	-0.144**	-2.481	-0.038	-0.715
ΔF_{t-2}	0.102**	2.451	0.154**	2.254	0.129*	2.923
R^2	0.572		0.599		0.486	
D. W Stat	2.012		1.989		2.040	
Wald Test	6370.001		3136.584		9082.434	

, * and ******* denote significant at 1%, 5% and 10% respectively.

Jeera

Table 5.6 Cointegration equation results ($(S_t = a + bf_t + u_t)$)

Coefficient	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
a	0.3762	0.1759	0.1448
b	0.9623*	0.9813*	0.9817*
R^2	0.9656	0.9679	0.9653

Table 5.7 Unit root test for error terms ($\Delta\hat{u}_t = \theta_1 \hat{u}_{t-1} + \zeta_t$)

	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
ADF Test Statistic	-4.2329*	-3.9753*	-3.6345*

Table 5.8 Results of Error correction model

Estimates of ECM Coefficients						
	Maturity Month (Fm)		Nearby Month (Fn)		Far Month (Fd)	
Variables	Estimate	t-value	Estimate	t-value	Estimate	t-value
C	0.000	1.099	0.000	1.339	0.000	1.555
U_{t-1}	-0.037*	-6.725	-0.037*	-6.258	-0.033*	-6.284
ΔF_t	0.246*	20.921	0.357*	27.136	0.273*	19.749
ΔS_{t-1}	-0.061**	-1.956	-0.151*	-4.783	-0.117*	-3.654
ΔF_{t-1}	0.141*	9.954	0.193*	10.976	0.232*	13.865
ΔS_{t-2}	0.046	1.581	0.019	0.634	0.046	1.575
ΔF_{t-2}	-0.017	-1.143	0.014	0.781	-0.011	-0.616
R^2	0.404		0.517		0.457	
D. W Stat	2.005		2.007		2.000	
Wald Test	7881.682		6535.132		8061.806	

***** and ****** denote significant at 1% and 5% respectively.

Pepper

Table 5.9 Cointegration equation results (($S_t = a + bf_t + u_t$)

Coefficient	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
a	-0.0876	-0.1046	-0.1255
b	1.0102*	1.0094*	1.0091*
R^2	0.9941	0.9942	0.9934

Table 5.10 Unit root test for error terms ($\Delta\hat{u}_t = \theta_1 \hat{u}_{t-1} + \zeta_t$)

	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
ADF Test Statistic	-6.6638*	-6.1777*	-5.5172*

Table 5.11 Results of Error correction model

Estimates of ECM Coefficients						
	Maturity Month (Fm)		Nearby Month (Fn)		Far Month (Fd)	
Variables	Estimate	t-value	Estimate	t-value	Estimate	t-value
C	0.000	1.343	0.000	1.478	0.000	1.757
U_{t-1}	-0.059*	-7.561	-0.059*	-7.327	-0.050*	-6.694
ΔF_t	0.310*	30.637	0.322*	31.323	0.317*	30.638
ΔS_{t-1}	-0.168*	-6.290	-0.212*	-7.677	-0.239*	-8.377
ΔF_{t-1}	0.315*	22.629	0.328*	22.665	0.363*	24.987
ΔS_{t-2}	0.063*	2.976	0.062*	2.834	0.055**	2.504
ΔF_{t-2}	0.031	2.078	0.047*	3.036	0.059*	3.647
R^2	0.607		0.632		0.656	
D. W Stat	2.017		2.033		2.041	
Wald Test	5731.592		5410.718		5847.164	

***** and ****** denote significant at 1% and 5% respectively.

Turmeric

Table 5.12 Cointegration equation results (($S_t = a + bf_t + u_t$)

Coefficient	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
a	0.5471	1.0789	0.8588
b	0.9294*	0.8555*	0.8829*
R^2	0.9329	0.8262	0.8002

Table 5.13 Unit root test for error terms ($\Delta\hat{u}_t = \theta_1 \hat{u}_{t-1} + \zeta_t$)

	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
ADF Test Statistic	-3.8723*	-3.4912*	-2.4869

Table 5.14 Results of Error correction model

Estimates of ECM Coefficients				
	Maturity Month (Fm)		Nearby Month (Fn)	
Variables	Estimate	t-value	Estimate	t-value
C	0.000	0.596	0.000	0.052
U_{t-1}	-0.037*	-6.020	-0.032*	-3.627
ΔF_t	0.229*	17.223	0.517*	30.760
ΔS_{t-1}	0.032	1.000	-0.034	-0.865
ΔF_{t-1}	0.102*	6.527	0.082*	3.055
ΔS_{t-2}	-0.018	-0.598	-0.012	-0.303
ΔF_{t-2}	0.037**	2.358	0.052**	1.960
R^2	0.330		0.625	
D. W Stat	2.007		1.989	
Wald Test	6285.280		2598.586	

***** and ****** denote significant at 1% and 5% respectively.

Cardamom

Table 5.15 Cointegration equation results ($S_t = a + bf_{t-1} + u_t$)

Coefficient	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
a	0.0346	-0.2475	-0.1729
b	0.9852*	1.0272*	1.0120*
R^2	0.9785	0.9404	0.8832

Table 5.16 Unit Root test for error terms ($\Delta\hat{u}_t = \theta_1 \hat{u}_{t-1} + \zeta_t$)

	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
ADF Test Statistic	-6.2222*	-3.0172**	-2.094

Table 5.17 Results of Error correction model

Estimates of ECM Coefficients				
	Maturity Month (Fm)		Nearby Month (Fn)	
Variables	Estimate	t-value	Estimate	t-value
C	0.001	1.7115	0.001**	2.003
U_{t-1}	-0.049*	-5.5862	-0.018*	-3.838
ΔF_t	0.110*	8.8985	0.199*	12.654
ΔS_{t-1}	0.164*	4.5397	0.124*	3.356
ΔF_{t-1}	0.070*	5.1364	0.077*	4.409
ΔS_{t-2}	0.035	1.0207	0.026	0.727
ΔF_{t-2}	0.026**	1.9654	0.084*	4.785
R^2	0.248		0.320	
D. W Stat	1.999		2.000	
Wald Test	4943.939		9086.876	

***** and ****** denote significant at 1% and 5% respectively.

Copper

Table 5.18 Cointegration equation results (($S_t = a + bf_{t-1} + u_t$)

Coefficient	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
a	0.1073	0.2836	0.2727
b	0.9809*	0.9502*	0.9517*
R^2	0.9894	0.9413	0.9515

Table 5.19 Unit root test for error terms ($\Delta\hat{u}_t = \theta_1 \hat{u}_{t-1} + \zeta_t$)

	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
ADF Test Statistic	-10.125*	-18.973*	-19.3515*

Table 5.20 Results of Error correction model

Estimates of ECM Coefficients						
	Maturity Month (Fm)		Middle Month (Fn)		Far Month (Fd)	
Variables	estimates	t-value	estimates	t-value	estimates	t-value
C	0.000	-0.055	0.000	0.062	0.000	0.128
U_{t-1}	-0.610*	-7.758	-0.953*	-10.188	-0.920*	-11.202
ΔF_t	0.748*	23.139	0.652*	6.807	0.621*	5.483
ΔS_{t-1}	-0.317*	-4.516	-0.047	-0.608	-0.033	-0.486
ΔF_{t-1}	0.295*	4.055	0.156	1.298	0.013	0.096
ΔS_{t-2}	-0.100*	-1.954	-0.020	-0.372	-0.011	-0.219
ΔF_{t-2}	0.163*	2.846	0.057	0.509	0.108	0.871
R^2	0.712		0.539		0.503	
D. W Stat	2.073		1.999		1.999	
Wald Test	1562.654		1450.950		1601.605	

***** and ****** denote significant at 1% and 5% respectively.

Lead

Table 5.21 Cointegration equation results (($S_t = a + bf_{t-1} + u_t$)

Coefficient	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
a	-0.1022	-0.3056	-0.4376
b	1.0212*	1.0639*	1.0915*
R^2	0.9909	0.9900	0.9923

Table 5.22 Unit root test for error terms ($\Delta\hat{u}_t = \theta_1 \hat{u}_{t-1} + \zeta_t$)

	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
ADF Test Statistic	-10.4797*	-10.2087*	-7.1667*

Table 5.23 Results of Error correction model

Estimates of ECM Coefficients						
	Maturity Month (Fm)		Nearby Month (Fn)		Far Month (Fd)	
Variables	Estimate	t-value	Estimate	t-value	Estimate	t-value
C	-0.0005	-0.4470	0.0001	0.0692	0.0000	-0.0147
U_{t-1}	-0.6692*	-8.6603	-0.5272*	-8.3598	-0.4991*	-6.9281
ΔF_t	0.6479*	19.0869	0.6770*	19.3652	0.9473*	23.8452
ΔS_{t-1}	-0.1037	-1.4886	-0.1808*	-2.9679	-0.2150*	-3.2928
ΔF_{t-1}	0.3212*	4.2166	0.4200*	6.0605	0.3041*	4.0737
ΔS_{t-2}	-0.0144	-0.3086	-0.0119	-0.2699	-0.2382*	-4.5236
ΔF_{t-2}	0.0138	0.2245	0.0991	1.6774	0.2668*	4.1629
R^2	0.7095		0.6683		0.6873	
D. W Stat	1.9937		1.9957		2.0565	
Wald Test	1895.6860		2006.6760		1240.2170	

***** and ****** denote significant at 1% and 5% respectively.

Nickel

Table 5.24 Cointegration equation results (($S_t = a + bf_{t-1} + u_t$)

Coefficient	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
a	-0.2090	-0.4874	-0.6555
b	1.0287*	1.0668*	1.0893*
R^2	0.9964	0.9947	0.9902

Table 5.25 Unit root test for error terms ($\Delta\hat{u}_t = \theta_1 \hat{u}_{t-1} + \zeta_t$)

	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
ADF Test Statistic	-12.0123*	-5.7889*	-6.8542*

Table 5.26 Results of Error correction model

Estimates of ECM Coefficients						
	Maturity Month (Fm)		Nearby Month (Fn)		Far Month (Fd)	
Variables	Estimate	t-value	Estimate	t-value	Estimate	t-value
C	-0.000409	-0.508012	4.62E-05	0.06367	-0.000399	-0.480598
U_{t-1}	-0.589297*	-10.0379	-0.30692*	-7.993613	-0.186616*	-5.906708
ΔF_t	0.618883*	22.66452	0.645965*	21.95918	0.758289*	19.86165
ΔS_{t-1}	-0.122366*	-2.234462	-0.23943*	-5.212871	-0.179305*	-3.775062
ΔF_{t-1}	0.341485*	5.697588	0.557072*	11.17264	0.275276*	5.051472
ΔS_{t-2}	-0.011157	-0.298376	-0.004869	-0.13516	-0.029415	-0.665287
ΔF_{t-2}	0.033114	0.674755	0.136845*	2.841782	0.117732**	2.176965
R^2	0.698939		0.635044		0.512614	
D. W Stat	1.998393		1.973512		2.042284	
Wald Test	3001.401		3114.758		2060.847	

***** and ****** denote significant at 1% and 5% respectively.

Zinc

Table 5.27 Cointegration Equation Results (($S_t = a + bf_{t-1} + u_t$)

Coefficient	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
a	-0.0776	-0.1642	-0.2248
b	1.0141*	1.0296*	1.0407*
R^2	0.9964	0.9948	0.9958

Table 5.28 Unit Root test for Error Terms ($\Delta\hat{u}_t = \theta_1 \hat{u}_{t-1} + \zeta_t$)

	Maturity Month (Fm)	Nearby Month (Fn)	Far Month (Fd)
ADF Test Statistic	-22.8783*	-5.4133*	-5.9333*

Table 5.29 Results of Error correction model

Estimates of ECM Coefficients						
	Maturity Month (Fm)		Nearby Month (Fn)		Far Month (Fd)	
Variables	Estimate	t-value	Estimate	t-value	Estimate	t-value
C	0.000	-0.002	0.000	-0.111	0.000	0.189
U_{t-1}	-0.747*	-14.063	-0.331*	-9.328	-0.351*	-8.762
ΔF_t	0.634*	26.203	0.632*	22.340	0.753*	25.332
ΔS_{t-1}	-0.086	-1.840	-0.238*	-6.051	-0.326*	-7.650
ΔF_{t-1}	0.182*	3.538	0.421*	9.442	0.496*	10.034
ΔS_{t-2}	0.001	0.015	-0.097*	-3.001	-0.152*	-4.385
ΔF_{t-2}	0.023	0.562	0.178*	4.317	0.249*	5.519
R^2	0.674		0.555		0.616	
D. W Stat	1.997		2.039		2.070	
Wald Test	3726.585		3436.658		2907.202	

***** and ****** denote significant at 1% and 5% respectively.

Chapter-6

Summary and Conclusions

6.1 Introduction

Commodity futures markets in India have a long history. Trading in commodity in India started with the establishment of the Bombay cotton trade association. A few commodities trading associations such as oil seeds (Bombay, 1900), jute (Calcutta, 1912) and bullion (Mumbai, 1920) were set up in at the beginning of twentieth century. Commodity futures trading have grown rapidly in India till late 1960's but later because of shortage of supply of some essential goods; futures trading was banned in order to have control over the price. Based on the recommendations of the A.M. Khusro Committee (1980), futures trading were reintroduced in Gur (1982) and castor seed (1985). The turning point for commodity futures trading in the country was the setting up of the Kabra Committee in 1993, which recommended allowing futures trading in 17 commodities. The support for commodity futures market was articulated in the National Agricultural Policy of the Central Government in 2000, which was followed by removal of the ban on futures trading for all commodities in 2003. Commodity future markets in India are regulated by the Forward Markets Commission (FMC) set up in 1953 under the Forward Contracts (Regulation) Act, 1952.

The government intervened at every stage of the marketing of major agricultural commodities during last three decades. In order to protect farmers from risks and to maintain price stability, every activity of marketing of essential commodities such as procurement, distribution control and administrated price mechanism is under Government control. Government regulation has declined after implementation economic reforms in 1991. In similar lines, to reduce support to agriculture sector under the Agreement on Agriculture (WTO), policies are shifted towards market oriented system. Because of all these policy implications, commodities price volatility has increased, to manage these price risks, the government has been encouraging commodity futures market.

In the light of this background, the present study seeks to identity some characteristics of futures markets. More specifically, an attempt is made to compare the basis risk with spot price risk since hedging is expected to reduce price risk. Besides providing hedging facilities, the futures market performs the functions of price discovery and price reference. Yet another important issue concerns the efficiency of the commodity futures markets. With these broad issues, the objectives of the study are to assess the basis risk with spot price risk for different contracts for selected agricultural commodities and base metals, to examine the lead – lag relationship between the futures and spot prices, to analyse the hedging effectiveness of commodity futures markets and finally to examine the market efficiency hypothesis of future markets.

The study is based on spices and base metals. The study covers the period December 2004 to November 2008. The time period varies based on availability of the data for each commodity. The data collected include daily closing prices of both futures and spot from

NCDEX for spices and MCX for base metals. The selection of contracts for different commodities is based on the availability of data with minimum volume of trade. A pooled price series is constructed with roll over process on three maturity periods. Three maturity periods are far month, nearby month and delivery month. The first day of nearby month of any given contract is considered as first day of second month from maturity and ends with the last day of second month. Similarly, the contracts are rolled over to next nearby months. The pooled series is used to test empirically for long run and short run dynamics.

This study mainly employs time series econometrics techniques. The basis risk and the spot price risk are compared by variances of the two series. If the variance of the basis is less than the variance of spot price, then a particular contract is able to reduce risk. Cointegration and Error correction models (ECM) is used for analysing the price discovery process in the futures market. While cointegration tests show whether long-run relationship exists between spot and futures prices, the ECM reveals the process of price discovery. Thus, the examination of price discovery process between spot and futures markets involves two steps. At first, the spot prices is regressed upon futures prices and get residuals from this equation, if these residuals confirms about stationary, it reveals that spot and futures markets are cointegrated. . Once the series are tied together in the long run, it is possible that they might drift apart in the short run and turn back. The second step is to examine the short run dynamics is the second step; this can be done with estimation of error correction model. The error correction model is performed in such a manner that both spot price and futures price changes are regressed on the lagged values of both the variables along with the disequilibrium term. The inference of causality can be assessed by examining the statistical significance and relative magnitudes of the error correction coefficients and coefficients on the lagged variables. Specifically, if error correction term included in spot market is found to be statistically significant, while that in the futures equation is insignificant, it indicates that spot market adjusts to the deviation from the long-run relationship and futures market is exogenous to the system. If the error correction term in both equations is found to be significant, it implies that directional causality exists between the markets.

The hedge ratio and hedging effectiveness are analysed by using ordinary least squares (OLS) method and ECM method. In OLS method spot return series is regressed up on futures return series, the regression coefficient is the hedge ratio and coefficient of determination (R^2) value implies hedging effectiveness. In ECM method, errors are considered from spot and futures returns equations. Hedge ratio can be found out by the ratio of covariance of spot and futures return error terms to the variance of futures returns error terms. Hedging effectives is assessed by ratio of difference between unhedged position and hedged position to unhedged position. Futures 'market efficiency hypothesis' is tested by analysing three necessary conditions. The first necessary condition is that there should be a cointegration between two price series. Serial independence of error terms from cointegrated equation is the second necessary condition for market to be efficient. According to Hakkio and Rush (1989), the short run efficiency of futures market has to be tested once the above two conditions are satisfied. The restrictions test on coefficients in the ECM equation constitutes the third condition for efficiency. If these three conditions are met, then futures market is efficient and futures price is an unbiased estimate of future spot prices, both in the long run and short run.

6. 2 Main Findings

Major findings of the study are as follows.

i) First objective is to assess the basis risk with spot price risk. In futures markets, the main purpose of hedging is to minimise possible revenue loss associated with spot price changes. Hedging will reduce price risk when basic variability is less than the cash price variability. The results of the study show that for agricultural commodities only 40% of the contracts have basis variability less than spot price risk. In case of chilly commodity out of 21 contracts, only 9 are suitable for hedging. For jeera commodity, out of 42 contracts, only 21, for pepper, out of 53 contracts, 29 are able to reduce risk. Turmeric futures markets are able to reduce risk only for 15 contracts out of 32. In case of Cardamom commodity basis is higher than spot price risk for most of the contracts with the exception of 9 contracts. The reason for this high basis variability is because of the liquidity problem, seasonal variations and high speculation.

Four base metals are considered for the basis risk analyses are copper, lead, nickel and zinc. For copper, active trading is considered between August' 05 to November' 08; out of 18 contracts, almost contracts show a ratio which is less than one. When it comes to lead, the total 18 contracts basis risk is less than one, In case of nickel, total 23 contracts are taken between the trading period of January' 07 to November' 08. All contracts basis risk is less then spot price risk, among base metals zinc is one of the active futures markets. 32 contracts are selected between the active trading period of April' 06 to November' 08. It is observed that for all contracts, basis risk is less than spot price risk. Finally, it implies that trading in metals is relatively less risky than others.

ii) The lead-lag relationship between futures and spot prices are analysed by Cointegration Technique and Error Correction Mechanism (ECM). In case of agricultural commodities, Chilly market has bidirectional causality, but spot market responds more in order to establish equilibrium in the next period. In Jeera market, futures market leads the spot market, In case of nearby and far month contract periods, the spot market also leads the futures markets. In Pepper market there is bidirectional causality between futures and spot markets. When it comes to the Turmeric markets the futures market leads to the spot market in case of maturity and nearby futures contracts. In case of far month there is no cointegration relationship between spot and futures markets. There is an information flow from futures to spot market in case of maturity and nearby maturity contracts for Cardamom commodity. There is no long term relationship between spot and futures markets in case of far month futures because of low volume of trade.

An analysis of price discovery for base metals is also carried out. In case of Copper market for all time periods, the futures market leads the spot market. In Lead futures there is an information flow form futures to spot in case of maturity and nearby maturity periods. There is bidirectional causality between spot and futures markets in case of far month maturity. In Nickel market for all periods there is a bidirectional information flow between the markets. However, spot responds to the deviations from previous period's equilibrium. This indicates that price discovery takes place in futures markets In Zinc market price discovery takes place in futures market, but in case of maturity and nearby futures maturity periods, the spot market also leads the futures markets.

iii) The hedging performance of agricultural commodities and base metals are analysed as the third objective of this study. In agricultural commodities, especially in the case of red chilly, hedge ratios and hedging effectiveness are high compared to other spice commodities like jeera, pepper, and turmeric. In case of turmeric, hedge ratio and hedging effectiveness are high in nearby and far month maturity periods. Hedging effectiveness of jeera in nearby maturity is better than Pepper and Cardamom. Pepper commodity has similar estimates of hedge ratio and hedging effectiveness for the entire time period. Hedging performance of Cardamom is very poor because of high speculation and other fundamental factors. There is no significant difference in hedging performance among different time periods. Also there is no difference in the estimates of hedging effectiveness of OLS and Error correction method.

Hedging efficiency of base metals is high as compared to agricultural commodity futures. It is because of the fact that the underlying nature of both the commodities is entirely different. Copper futures market hedge ratio is high in maturity period and in the remaining two periods it is low, but there is no significant difference in hedging effectiveness among all periods. In case of the three base metals(lead, nickel, zinc) hedge ratio and hedging effectiveness are moderate and also hedging effectiveness increases in case of nearby and far month maturity periods. There is also difference in the estimates of OLS and ECM

iv) The Fourth objective of the study is to test the market efficiency without relaying on the assumption that risk premium does not exist. The results suggest that the cointegration relationship between the spot and futures markets confirmed the first necessary condition of market efficiency. The futures market is not efficient both in long run and short run according to the results of restrictive tests to short run dynamics for different time maturity periods. This indicates that future markets are inefficient and future price is not an unbiased estimate of future spot price in the case of both agricultural and base metals commodities. Finally the study concludes that the futures prices do not matter alone while forecasting future spot prices.

6.3 Concluding Remarks

The above observations clearly reveal that utilisation of futures price information is not efficient in spices, but in case of metals most of information in futures prices is efficiently used. Most of the contracts in spices showing high basis risk, it reveals that contracts are not suitable for hedging. In case of metals basis risk is less than spot price risk, so all most all contracts are able to reduce spot price risk. Even though all contracts of base metals are suitable for hedging, their hedging effectiveness is low. In case of spices, though some of the contracts show high basis risk, their hedging effectiveness is moderate in case of chilly and turmeric as compared to other spices and base metals. Spices and base metals show long-run relation between spot and futures prices for all maturity periods except in far month cases of cardamom and turmeric. There exists bidirectional causality between spot and futures markets in case of spices. In metals, futures price leads spot price in copper and zinc. Lead and nickel markets are showing bidirectional causality between spot and futures markets. Market efficiency of futures markets is examined for all commodities. Though in long-run markets are integrated , but overall spice and base metal futures markets are inefficient , so futures prices of theses markets are not unbiased predictors of futures spot prices.

6.4 Policy Implications

1. It is observed that commodity futures and physical markets are not integrated. There is an important need to establish electronic spot exchange in the country. Any futures market will be efficient only when spot market is efficient. So, the development of spot markets should be given top priority.

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2. The warehouse receipt system should be developed in such a way that it will benefit small and marginal farmers. The working group recommends that a system needs to be evolved by which Warehouse receipts become freely transferable between holders as it would reduce transaction costs and increase usage.

3. The structure of markets, contracts design, margin requirements and other measures should be favourable to all categories of farmers to participate in these markets.

4. It is observed that most of the contracts in spices are showing high basis risk that it reveals futures markets ability to provide instruments of risk management is quite poor. This is because of dominance of speculators and also some other fundamental factors like supply variability. This issue needs to be addressed both by exchanges and regulator.

5. Strong effects have to be considered to bring different participants to the market in order to achieve minimum liquidity and depth of the market.

6. The government should continue its efforts to strengthen the commodity exchanges and implementation of awareness programmes among farmers and other market players for increasing participation in futures markets.

7. The farmers are likely to find it difficult to take positions in futures market of their own, so enhancing the capacity building of farmers' organizations through groups, Co-operative societies are vital and there is a need for intervention for facilitating active participation in futures markets.

8. The Forward Contracts (Regulation) Act, 1952 may be suitably amended and FMC may evolve a suitable framework for options trading in agricultural and non-agricultural commodities in India.

References

Antonioiu, A. and Foster, A.J. (1994) “Short term and long term efficiency in commodity spot and futures markets, Financial Market , Institutions, All instruments, 3, 17 – 35.

Aulton, A. J, C. T. Ennew and A. J. Rayner (1997), “Efficiency Test of futures markets for UK agricultural commodities,” Journal of Agricultural Economics, Vol. 48 No.3, September, PP. 408 – 423.

Baillie R T and Myerse R.J. (1991), ‘Bivariate GARCH Estimation of Optial commodity futures hedge’. Journal of Applied Econometrics, vol.6, PP 109 – 124.

Beck, S. (1994) “Cointegration and market efficiency in commodities futures markets”, Applied Economics, 26, 249-57.

Benninga, S. R., R. Eldor, and I. Zilcha. “The Optimal Hedge Ratio in Unbiased Futures Markets.” Journal of Futures Markets 4, (1984): 155-59.

Bera A K, Garcia P and Roh J S (1997), ‘Estimation of time varying hedge ratios for Corn and Soyabeans: BGARCH and Randam coefficient approaches’, The office for futures and options research, Department of Agricultural and Consumer Economics, University Illinois, Urbana – Champian, Paper Number 97 – 0.

Bessenbinder, H. and P.J. Segain (1993), ‘ Price volatility, Trading volume and market Depth: Evidence future markets’, Journal of Financial and Quantative Analysis , Vol. 28, PP. (105 – 34) 21 – 39.

Bhaduri, S.N., & Durai, S. N. S. (2008) “Optimal hedge ratio and hedging effectiveness of stock index furures: evidence from India” Macroeconomics and Finance in Emerging Market Economies, 1, 121 – 134.

Bilson, J. F. O. (1981), “The Speculative Efficiency Hypothesis”, Journal of Business, Vol. 54, PP 435 – 451

Bollerslev T. (1986) “Generalized Autoregressive Conditional heterosecdasticty”, Journal of Econometrics 31, pp 307-327.

Breeden, D.T. (1980) “Consumption risks in future markets”. Journal of Finance, 35:503-520.

Brooks C, ‘*Introductory Econometrics for Finance’*, Cambridge University Press, Cambridge, United Kingdom, 2002

Brooks C, Henry O and Persand G (2002), “The effect of Asymmetries on optimal hedge ratios”, Journal of Business, Vol. 75, No.2, PP 333 – 352.

Cargills, T..F and Rausser, G. C (1975), “Temporal prices behavior in commodity futures Markets”, Journal of Finance, Vol. 30 No. 4 PP. 1044 – 1053.

Chen, N., C. J. Cuny and R.A. Haugen (1995) “Stock volatility and levels of the basis and open interest in futures contracts; Journal of Finance, Vol, 50, PP 281 – 330.

Chicago Board of Trade, Financial instruments Guide, 1991.

Chowdhury, A. R. ((1991), “Futures Market Efficiency: Evidence from cointegration Tests”, Journal of Futures Markets, Vol.11 No.5 PP.577-589

Cootner, P.H. (1960). Return to speculators: Telser vs. Keynes, Journal of Polotical Economy, 68,396-404.

Damodar N Gujarati, ‘*Basic Econometrics’*, Mc Graw – Hill, Inc., 2004.

Dasgupta, Basab (2004): “Role of Commodity Futures Market in spot price stabilization, Production and Inventory decisions with reference to India,’ Indian Economic Review, Vol 39, No 2.

Deaton, A and Laroque, I (1992), “On the bahaviour of commodity prices”, Review of Economic Studies, PP 139 – 151.

Deaves, R. and Krinshy, I (1992) “Risk premiums and efficiency in the market for crude oil futures “The Energy Journal, 13. PP 93 – 117.

Dimitris F Kenougious (2004), “Testing Efficiency of the copper futures market: New Evidence from London Metal Exchange”, Global Business and Economics Review – Anthology, PP 261 – 271.

Dickey D.A. and W.A. Fuller (1981), “Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root”, Econometrica 49, 1057-72.

Dusak, K. (1973). Futures trading and investor returns: An investigation of commodity market risk premiumas. Journal of political Economy, 81, 1387-1406.

Ederington, L. H. (1979), “The Hedging Performance of the new Futures Market’ Journal of Finance, Vol 34. PP 157 – 170.

Enders, Walter. (2003), Cointegration and Error Correction Models. Applied Econometric Time Series, Second edition, John Wiley and Sons (ASIA) Pte Ltd, 319-386. ISBN 9812-53-126-2.

Engle, R. F. (2002), "Dynamic conditional correlation: A simple class of multivariate GARCH models", Journal of Business and Economic Statistics, vol.20 No.3, PP. 339 – 350.

Engle, R and Granger, C. (1987), "Co-integration and Error correction: Representation, Estimation and Testing", Econometrica, Vol. 55, PP. 251 – 70.

Engle, R. F. and Kroner, K. F. (1995), "Multivariate Simultaneous Generalized ARCH" Econometric Theory vol. 11, PP. 122 – 150.

Engle, R. F. and Sheppard, K. (2001), "Theoretical. and Empirical Properties of Dynamic conditional correlation Multivariate GARCH' Discussion paper 2001 – 15, University of California, San Diego and NBER Working paper series No. 8554.

Fama, E.F. (1970), "Efficient Capital Markets: A Review of Theory and Empirical Work", Journal of Finance, Vol.25, PP. 383-417

Fama, E.F. (1997), "Efficient Capital Markets: II", Journal of Finance, Vol. 60, No.5, PP. 1575 – 1617

Fama, E.F. and French, K. (1987), "Commodity Futures Prices: Some evidence on forecast power, premiums and Theory of storage", Journal of Business, Vol 60, 1987, PP 55 – 73.

Floros, C. and Vougas, D. V. (2006). "Hedging effectiveness in Greek Stock index futures market 1999-2001" International Research Journal of Finance and Economics, 5, 7-18.

Fortenbery, T .R. and H.O. Zapata (1993), "An Examination of Cointegration relations between futures markets and local gain grain markets", Journal of Futures Markets Vol. 13, No. 8, PP 921 – 932.

Frenk, J. and Garcia, P. (2008), 'Time – varying risk premium: Further evidence in Agricultural Futures Markets', Applied Economics, 1 – 11.

Frida Youssef (2000) "Integrated report on Commodity Exchanges and Forward Markets Commission", World Bank project for the improvement of the Commodities Futures Markets in India.

Ghosh, A. (1993), Cointegration and Error Correction Models: Intertemporal causality between index and futures prices, Journal of Futures Markets, 13(2):193-198.

Naik,G and Jain, S. K (July 2002), 'Indian Agricultural Commodities Futures Markets: A performance survey, Economic and Political Weekly, July 27, Vol. 37 No. 30.

Government of India : (2001): ‘Report of the Group on “Forward and Derivatives Markets’, Department of Agriculture and Cooperation, New Delhi.

_____ : Forward Markets Bulletin, various issues

--------: Forward Markets Commission, Mumbai, Annual Report, various issues,

Granger, C (1969), “Investgating casual relations by econometric models and cross – spectral methods”, Econometrica, vol. 37, PP 423 – 38.

Granger, C. W. J. (1981), “Some properties of Time series data and their use in Econometric model specification”, Journal of Econometrics, Vol.16, PP. 121 – 130.

Granger, C. W. J. (1986), “Development in the Study of Cointegrated Economic Variables”, Oxford Bulletin of Economics and Statistics 48, 213-28.

Hakkio, C. S. and Rush, M. (1989) “Market Efficiency and Cointegration: An application to the sterling and deutschemark exchange markets”, Journal of International Money and Finance, 8, 75-88.

Hall, J.C., *‘Options, Futures and Other Derivatives’* Pearson Education Asia, 2002.

Holbrook Working (February 1960) “Price effects of futures trading” Food Research Institute Studies 1, 3-31.

Holmes, P. (1995). “Ex ante hedge ratios and the hedging effectiveness of the FTSE-100 stock index futures contract”, Applied Economics Letters, 2, 56-59.

Jeffrey H. Dorfamn (1993) “Bayesian Efficiency test for commodity futures Markets” American Journal of Agricultural Economics, 75, PP 1206 – 1210.

Johnson, L. (1960), “The theory of hedging and speculation in commodity futures”, Review of Economic Studies, PP 139 – 151.

Jotinder Bir Singh (2001), “The weak form Efficiency of Indian commodity futures”, SGGSC, University of Delhi.

Kabra Committee Report (1994), “Report of the Committee on Forward Markets”, Ministry of Consumer affairs, Food and Public distribution, Government of India, September.

Kabra, K. N. (2006), “Commodity Futures in India”, Economic and Political Weekly, March 31, 2007, pp. 1163-1170.

Kahl, K. H., and W. G Tomek. “Forward Pricing Models for Futures Markets: Some Statistical and Interpretative Issues.” Food Research Institute Studies 20 (1986): 71-85.

Kellard, N., P. Newbold, T. R and C. Ennew,(1999) “The Relative Efficiency of Commodity futures markets”, The Journal of Futures Markets, 19 : 413 – 432.

Kofi, T. A. “A Framework for comparing the Efficiency of Futures Markets”. American Journal of Agricultural Economics. 55(1973): 584-94.

Kolamkar D. S (2003) ‘Regulation and Policy issues for Commodity Derivatives in India, in Susan Thomas (ed), Derivatives markets in Indian, Oxford University Press, India.

Kaldor, N.,(1939). Speculation and Economic Stability. Review of Economic Studies, 7, 1-27.

Kamara, A. (1982), “Issues in Future Markets; A survey”, Journal of Futures Markets, vol. 220 PP. 261 – 94

Karande, Kiran D. (2006), “A Study of Castor seed Futures Market in India”, available at http://ssrn.com/abstract=983342

Kavussanos, M. G., & Nomikos, N. K. (2000) “Constant vs. time varying hedge rations and hedging efficiency in the BIFFEX market”, Transportation Research Part E, 36, 229-248.

Lai K.S. and M. Lai (1991),” A cointegration test for Market Efficiency”, Journal of Futures Markets, Vol. 11, No.5, PP567-575.

Lien, D., and Luo, X. (1994) “ Multi-Period Hedging in the Presence of Conditional Heteroskedasticity”, Journal of Futures Markets, 14, 927-955

Lein, D. Tse, Y.K. and Tsui, A.K.C. (2002), ‘Evaluating the Hedging Performance of the Constant Correlation GARCH model’, Applied Financial Economics, 12:11, 791 – 798.

Lence, S. H. and Hayes, D. J. (1994a), ‘The Empirical minimum variance Hedge, American Journal of Agricultural Economics, 76, 94 – 104.

Lence, S.H. (1995b), “The Economic value of minimum variance hedges”, American Journal of Agricultural Economics, 77, 353 – 364.

Lester Telser and Harlow Higibotham (1977), “Organized Futures Markets: Costs and Benefits”, Journal of Political Economy, vol.85.

Lypny ,.G., and Powalla, M. (1998), ‘The Hedging effectiveness of DAX Futures, European Journal of Finance, 4, 345 – 355.

Maberly, E.D., (1985) “Testing futures market efficiency – A Restatement”. Journal of Futures Markets, 5: 425 – 432.

MacDonad, R. and Taylor, M. P., (1988a), “Metal Prices, Efficiency and Cointegration: Some Evidence from LME”, Bulletin of Economic Research, Vol. 40, PP 235-39.

Mananyi, A. and struthers. J.J. (1997) “Cocoa market Efficiency: A Cointegration approach, Journal of Economic Studies 24, PP 141 – 51.

Mckenzie, A.M. and M.T.Holt, “Market efficiency in agricultural futures markets”, Applied Economics, 34:12, 1519 -1532.

Myers, R. J., & Thompson, S. R. (1989). “Generalized optimal hedge ratio estimation”, American Journal of Agricultural Economics, 71, 858-868.

Myers, R. J., (1991) “Estimating time-varying optimal hedge ratios on futures markets”, Journal of Future Markets 11, 139-153.

Nelson, D.B (1991) ‘Conditional Heteroskedasticity in Asset returns: A new approach, Econometrica, 59, PP. 347 – 70.

Pavaskar, M. (2004), “Commodity Exchanges are not Stock Exchanges”, Economic and Political Weekly, 39 (48), PP 5082 – 85.

Pavaskar, M, (2005) “Death trap for commodity futures”, Economic and Political Weekly, 40 (1), PP 14 – 99.

Pavaskar, M (2007), “Myths and Relatives of Commodity Derivatives Markets”, Commodity Vision, Vol. 1 (1), PP.18 -28.

Pavaskar, M. G. (1970) “Futures trading and price variations” Economic and Political Weekly , February

Pennings, J M E., and Meulenberg, M. T. G. (1997), ‘Hedging Efficiency: A Futures Exchange Management Approach’, Journal of Futures Markets, 17, 599 – 615.

Powers, M. J (1970) “Does future trading reduce prices fluctuations in the cash markets?” American Economic Review. Vol.60, PP. 460 – 464.

Quan, J (April 1992) “Two step testing procedure for price discovery role of futures prices”, The Journal of Futures Markets 12(2) 139-49.

Raju, M. T. and Karande, K (2003), "Price discovery and volatility on NSE futures Market, SEBI Belletin Vol. 1 No.3 PP 5 – 15.

Ramanathan Ramu (2002), *Introductory Econometrics with applications*, 5th edition, Thomson Learning Inc.

Sabuhoro, J.B and Larue, B (1997) "The market efficiency hypothesis: the case of coffee and cocoa futures, Agricultural Economics, 16, 171 – 84.

Sahadevan K G (2000 2a): "Derivatives and Price Risk Management: A study of Agricultural commodity futures in India", the ICFAI Journal of applied finance Vol. 8 No.5 PP. 25 – 39.

Sahadevan, K. G. (2002) "Risk management in agricultural commodity markets: A study of some selected commodity futures", Udyog Pragati, special issue on Money and Finance, Part I, 26(1): 65-74.

Sahadevan K. G. (2002): "The Sagging Agricultural Commodity Exchanges: Growth Constraints and Revival Policy Options", Economic and Political Weekly, Vol XXXVII No.30, July 27-Aug. 02, PP.3153-60.

Satyanarayan S. (1998) A note on a risk – return measure of hedging effectiveness – Journal of Futures Markets, 18, 867 – 870.

Sekhar, C. S. C. (2004), "Agricultural Price Volatility in International and Indian Markets", Economic and Political Weekly, Vol XXXIX, No 43, Oct 23-39, pp 4729-4736.

Sephton. P. S and Cochrane, D.K., "The Efficiency of the London Metal Exchange: another look at the evidence", Applied Economics, Vol 23. PP 669-74.

Shenbagaruman P (2002), "Do futures and options trading increase stock market volatility?" National Stock Exchange, Mumbai.

Silvapulle, Param and Imad A. Moosa (April 1999) "The relationship between spot and futures Prices: evidence from the crude oil market", The Journal of Futures Markets 19(2) 175-93.

Susan Thomas and Kiran Karande, (2001) "Price Discovery across multiple markets", Technical Paper, IGIDR, Mumbai.

Telser, L.G. (1958). Futures trading and the storage of cotton and wheat. Journal of political Economy, 66, 233-255.

Thenmozhi M (2002), “Futures Trading, Information and spot price volatility of NSE – 50 index futures contract”, National stock exchange, Mumbai.

Tomek, W. G., and R. Gray. W. “Temporal Relationship among Prices on Commodity Futures Markets: Their Allocative and Stabilizing Roles”, American Journal of Agricultural Economics. 52 (1970): 372-80.

Tomek, W. G. and Myers, R. J. (1993) “Empirical analysis of agricultural commodity prices: A Viewpoint”, Review of Agricultural Economics, 15, 181-202.

Tse, Y. (1999), “Price discovery and volatility spillovers in the DJIA index, Journal of Futures Markets”, 19, 911-930.

Turnovsky S J (1983), “The Determination of Spot and Futures prices with storable commodities”, Econometrics, Vol. 51, PP. 1364 – 87.

Turnovsky SJ (1979), “Futures Markets, Private storage and Price stabilization”, Journal of Public Economics Vol.12 PP. 301 – 27.

Venkataraman, L S (1965) *‘The Theory of Futures Trading’*, Asia publishing house, Bombay..

Wang H. H. and B. Ke (2005), “Efficiency Tests of Agricultural Commodity Futures Markets in China”, The Australian Journal of Agricultural and resource Economics, 49(2), 125-141.

Wahab, M. and m. Lashgari (1993), “Price Dynamics and Error Correction in Stock Index and Stock Index Futures Markets: A Cointegration Approach”, Journal of Future Markets 13(7), 711-42.

Williams, J.A. Peck, A.Park and S. Rozzele, (1998) “The Emergency of a futures Market: Mung beans on the China Zhengzhou commodity exchange” Journal of Futures Markets, 18, 427 – 448.

World Bank, (1999) “Using markets to deal with commodity price volatility”, Poverty reduction and economic management network notes.

World Bank South Asia Region (1996), “India managing price risks in India’s liberalized agriculture: can futures markets help?” Report No. 15453, in Agriculture and water operations division; Commodity Division, UNCTAD.

Working H (1948), “Theory of inverse carrying charges in futures markets”, Journal of Farm Economics, Vol. 30 PP. 1 – 28.

Working H (1949) “The theory of price of storage”, American Economic Review, Vol.39 PP. 1254 – 1262.

Working, H. (1953), Futures Trading and Hedging – American Economic Review, 48, 314 – 459.

Working, H. (1953) “Futures trading and hedging”, American Economic Review Vol. 43, PP 314 – 343.

Working, H. (1962), ‘New concepts concerning futures markets and prices, American Economic Review, vol. 52. PP 432 – 59.

Working, H. (1960) “Price effects of futures trading; Food Research Institute studies Vol. 1.

Yang, Jian., D. A. Bessler and D. Leatham (2001), “Asset Storability and Price Discovery in Commodity Futures Markets”, Journal of Futures Markets, 21, pp. 279-300.

Yang, W. (2001). “M-GARCH hedge ratios and hedging effectiveness in Austrailan futures markets”, Paper, School of Finance and Business Economics, Edith Cowan University.

Appendix A

Futures Terminology

Futures Contract: A legally binding agreement, made on the trading floor of a futures exchange, to buy or sell a commodity or financial instrument sometime in the future. Futures contracts are standardized according to the quality, quantity and delivery time and location for each commodity. The only variable is price, which is determined on an exchange trading floor.

Hedging: The practice of offsetting the price risk inherent in any cash market position by taking an equal but opposite position in the futures market. Hedgers use the futures markets to protect their business from adverse price changes.

Basis: The difference between the current cash price and the futures price of the same commodity for a given contract month.

Convergence: A term referring to cash and futures prices tending to come together as the futures contract nears expiration.

Daily trading limit: The maximum price changes set by the exchange each day for a contract.

Long position: One who has bought futures contracts or plans to own a cash commodity.

Open interest: For a given commodity, the total number of futures or options contracts that have been neither offset by an opposite futures or option transaction nor fulfilled by delivery of the commodity or option exercise. Each option transaction has a buyer and a seller, but for calculation of open interest, only one side of the contract is countered.

Short position: One who has sold futures contracts or plans to sell a cash commodity. Selling futures contracts or initiating a cash forward contract sale without offsetting a particular market position.

Volume: The number of purchases or sales of a commodity futures contract made during a specified period of time, often the total transactions for one trading day.

Cost of carry: The relationship between futures price and spot price can be summarized in terms of cost of carry. It measures the storage cost, transportation cost plus the interest paid to finance.

Initial margin: The amount a futures market participant must deposit into a margin account at the time an order is placed to buy or sell a futures contract.

Maintenance Margin: A set minimum margin (per outstanding futures contract) that a customer must maintain in a margin account. This is lower than the initial margin. This is to ensure that the balance in the margin account never become negative. If the balance becomes negative, then investors receive a margin call and expected to top up the margin account to the initial margin level before the trading commences in the next day.

Marking-to-market: This is a process of adjusting the margin account according to the price movements in the spot market. It ensures the adherence to contract by participants.

Appendix B: Contract Specifications

	Contract Specifications of Chilly
Commodity	Chilly
Description	CHLL334GTR
Trading System	NCDEX Trading System
Trading Period	Monday to Saturday
Trading Session	Monday to Friday: 10:00 a.m. to 5:00 p.m. Saturday : 10:00 a.m. to 2:00 p.m.
Trading Unit	10 MT
Delivery unit	10 MT
Position limits	Member : 4500 MT or 15% of Market OI for all contracts whichever is higher Client : 1500 MT for all contracts For near month contracts: The following limits would be applicable from one month prior to expiry date of a contract: Member: Maximum up to 1500 MT or 15% of the market-wide near month open position, whichever is higher. Client: Maximum up to 500 MT
Quotation/base value	Rs. Per Kg
Tick size	Rs 1 per kg
Special margin	In case of additional volatility, a special margin of such percentage as deemed fit, will be imposed immediately on both buy and sale side in respect of all outstanding position, which will remain in force for next 2 days, after which the special margin will be relaxed.
Daily price fluctuation limit	Daily price limit will be 2%. If the price touches 2%, trading will continue with 2% limit for the 15 minutes period from the time 2% limit was reached. Thereafter, price limit would be extended by another (+)/ (-) 2%. No trade would be permitted during the day beyond the price limit of (+)/(-)4% from the previous day's closing price
Delivery logic	compulsory
Delivery Center	Guntur (up to the radius of 50 Kms from the municipal limits)
Special Margins	Special margin of 5% of the value of the contract will be levied whenever the rise or fall in price exceeds 20% of the 90-day prior settlement price. The margin will be payable by the buyer or the seller depending on whether price rises or falls respectively. The margins shall remain in force so long as the price stays beyond the 20% limit and will be withdrawn as soon as the price is within the 20% band.

	CONTRACT SPECIFICATIONS OF JEERA
Commodity	Jeera
Description	JEERAUNJHA
Trading System	NCDEX Trading System
Trading Period	Monday to Saturday
Trading Session	Monday to Friday: 10:00 a.m. to 5:00 p.m. Saturday : 10:00 a.m. to 2:00 p.m.
Trading Unit	3 MT
Delivery unit	3 MT
Position limits	Member : 1000 MT or 15% of Market OI for all contracts whichever is higher Client : 300 MT for all contracts For near month contracts: The following limits would be applicable from one month prior to expiry date of a contract: Member: Maximum up to 300 MT or 15% of the market-wide near month open position, whichever is higher. Client: Maximum up to 100 MT
Quotation/base value	Rs. Per Kg
Tick size	Rs 1 per kg
Special margin	In case of additional volatility, a special margin of such percentage as deemed fit, will be imposed immediately on both buy and sale side in respect of all outstanding position, which will remain in force for next 2 days, after which the special margin will be relaxed.
Maximum allowable open position	For individual clients: 160 MT For a member collectively for all clients: 600 MT or 15% of the market-wide open position, whichever is higher. Near Month Limits For individual clients: 40 MT For a member collectively for all clients: 160 MT or 15% of the market-wide open position, whichever is higher
Delivery logic	compulsory
Delivery Center	At the accredited warehouse(s) in Unjha (up to the radius of 50 Km from the municipal limits)
Price Band	Daily price limit will be (+/-)2%. If the trade hits the prescribed daily price limit there will be a cooling off period for 15 minutes. Trade will be allowed during this cooling off period within the price band. Thereafter, price limit would be extended by another (+/-) 2% and the trade will be resumed. If the price hits the revised price band (4%) again during the day, trade will only be allowed within the revised price band. No trade/order shall be permitted during the day beyond the revised price limit of (+/-)4%.

	Contract Specifications of Pepper
Commodity	Pepper
Description	PPRMLGKOC
Trading System	NCDEX Trading System
Trading Period	Monday to Saturday
Trading Session	Monday to Friday: 10:00 a.m. to 5:00 p.m. Saturday : 10:00 a.m. to 2:00 p.m.
Trading Unit	1000 kgs (=1 MT)
Delivery unit	1000 kgs (=1 MT)
Position limits	Member : 3000 MT or 15% of Market OI for all contracts whichever is higher Client : 900 MT for all contracts For near month contracts: The following limits would be applicable from one month prior to expiry date of a contract: Member: Maximum up to 1000 MT or 15% of the market-wide near month open position, whichever is higher. Client: Maximum up to 300 MT
Quotation/base value	Rs. Per Kg
Tick size	Rs 1 per kg
Price Band	Daily price limit will be (+)/(-)3%. If the trade hits the prescribed daily price limit there will be a cooling off period for 15 minutes. Trade will be allowed during this cooling off period within the price band. Thereafter the price band would be raised by another (+/-)1%.
Delivery logic	compulsory
Delivery Center	Kochi (within a radius of 50 km from the municipal limits)
Special Margins	Special margin of 4% of the value of the contract will be levied whenever the rise or fall in price exceeds 20% of the 90 days prior settlement price. The margin will be payable by buyer or seller depending on whether price rises or falls respectively. The margin shall stay in force so long as price exceeds the 20% limit and will be withdrawn as soon as the price is within the 20 % band

	CONTRACT SPECIFICATIONS OF TURMERIC
Commodity	Turmeric
Description	TMCFGRNZM
Trading System	NCDEX Trading System
Trading Period	Monday to Saturday
Trading Session	Monday to Friday: 10:00 a.m. to 5:00 p.m. Saturday : 10:00 a.m. to 2:00 p.m.
Trading Unit	10 MT
Delivery unit	10 MT
Position limits	Member : 1000 MT or 15% of Market OI for all contracts whichever is higher Client : 300 MT for all contracts For near month contracts: The following limits would be applicable from one month prior to expiry date of a contract: Member: Maximum up to 300 MT or 15% of the market-wide near month open position, whichever is higher. Client: Maximum up to 100 MT
Quotation/base value	Rs. Per Kg
Tick size	Rs 1 per kg
Special margin	In case of additional volatility, a special margin of such percentage as deemed fit, will be imposed immediately on both buy and sale side in respect of all outstanding position, which will remain in force for next 2 days, after which the special margin will be relaxed.
Maximum allowable open position	For individual clients: 160 MT For a member collectively for all clients: 600 MT or 15% of the market-wide open position, whichever is higher. Near Month Limits For individual clients: 40 MT For a member collectively for all clients: 160 MT or 15% of the market-wide open position, whichever is higher
Delivery logic	compulsory
Delivery Center	Nizamabad (up to the radius of 50 Km from the municipal limits)
Price Band	Daily price limit will be (+/-)2%. If the trade hits the prescribed daily price limit there will be a cooling off period for 15 minutes. Trade will be allowed during this cooling off period within the price band. Thereafter, price limit would be extended by another (+/-) 2% and the trade will be resumed. If the price hits the revised price band (4%) again during the day, trade will only be allowed within the revised price band. No trade/order shall be permitted during the day beyond the revised price limit of (+/-)4%.

	CONTRACT SPECIFICATIONS OF CARDAMOM
Symbol	CARDAMOM
Description	CARDAMOM MMMYY
Trading Period	Monday to Saturday
Trading Session	Monday to Friday: 10:00 a.m. to 5:00 p.m. Saturday : 10:00 a.m. to 2:00 p.m.
Trading Unit	500 kgs (5 quintals)
Quotation/base value	Rs. Per Kg
Tick size	25 paise per kg
Daily price limit	3%
Initial margin	5%
Special margin	In case of additional volatility, a special margin of such percentage as deemed fit, will be imposed immediately on both buy and sale side in respect of all outstanding position, which will remain in force for next 2 days, after which the special margin will be relaxed.
Maximum allowable open position	For individual clients: 160 MT For a member collectively for all clients: 600 MT or 15% of the market-wide open position, whichever is higher. Near Month Limits For individual clients: 40 MT For a member collectively for all clients: 160 MT or 15% of the market-wide open position, whichever is higher
Delivery logic	compulsory
Delivery Center Additional Delivery Center	At Exchange designated warehouse at Vandanmedu in Idukki Dist of Kerala State; and Exchange designated Cold Storage within 50 km radius of Bodinayakanur in Madurai District of Tamil Nadu State.
Delivery unit	Due date rate for 7 mm cardamom (basis variety) is calculated on the last day of contract maturity by way of taking the simple average of last 3 days spot price of the Vandanmedu & Bodinayakanur market for the basis variety (i.e. 7mm cardamom).
Due date rate calculation (DDR)	DDR is calculated on the last day of the contract expiry by taking an average of the LME official cash closing prices (i.e. mid-value of bid and ask) of zinc, and it would be multiplied by rupee - US$ rate, as notified by the Reserve Bank of India on that particular day.

	Contract Specifications of Copper
Symbol	COPPER
Description	COPPER MMMYY
Trading Period	Monday to Saturday
Trading Session	Monday to Friday: 10:00 a.m. to 11:55 p.m. (Winter) Monday to Friday 10:00 a.m. to 11:30 p.m. (Summer) Saturday : 10:00 a.m. to 2:00 p.m.
Contract months	Bi-monthly contracts
Expiry date	Last day of the contract month
Trading Unit	1 MT
Quotation/base value	Rs. Per Kg
Tick size	5 paise
Daily price limit	4%
Initial margin	5%
Special margin	In case of additional volatility, a special margin of such percentage (as deemed fit) will be imposed immediately on both buy-side and sell-side in respect of all outstanding position, which will remain in force for next two days after which ther special margin will be relaxed
Maximum allowable	For individual clients : 1000 MT;
open position	For a member collectively for all clients: Not more than 25% of the market-wide open position in a contract at any point in time
Delivery logic	Both options
Delivery Center	Within 20 km outside Mumbai octroi limit.
Delivery unit	9 MT with tolerance limit of +/- 1% (90 kg)
Due date rate (DDR) calculation	Calculated on the last trading day of the contract expiry on the basis of international spot price on that day multiplied by 2.204623 to convert the price from per pound to per kilogram and multiplied by rupee-US $ rte, as notified by the Reserve Bank of India on that particular day.

	CONTRACT SPECIFICATIONS OF LEAD
SYMBOL	LEAD
Description	LEAD MMMYY
Trading Period	Monday to Saturday
Trading Session	Monday to Friday: 10:00 a.m. to 11:55 p.m. (Winter) Monday to Friday 10:00 a.m. to 11:30 p.m. (Summer) Saturday : 10:00 a.m. to 2:00 p.m.
Contract months	Monthly contracts
Expiry date	Last day of the contract
Trading Unit	5 MT
Quotation/base value	Rs. Per Kg
Tick size	5 paise
Daily price limit	4%
Initial margin	5%
Special margin	In case of additional volatility, a special margin of such percentage (as deemed fit) will be imposed immediately on both buy-side and sell-side in respect of all outstanding position, which will remain in force for next two days after which ther special margin will be relaxed
Maximum allowable	For individual clients : 1,500 Tonnes For a member: 6,000 tonnes or not more than 20% of the market's open position, whichever is higher.
Maximum order size	100 tonnes
Delivery logic	Both options
Delivery unit	10 MT with tolerance limit of +/- 1% (100 kg)
Delivery center(s)	Within 20 kilometers outside Mumbai octrolimit
Due date rate (DDR)	The DDR is calculated on the last day of the contract expiry by taking an average of the LME official cash closing prices (i.e. mid-value of bid and ask) of lead, and it is be multiplied by rupee - US$ rate, as notified by by the Reserve Bank of India on that particular day.

	CONTRACT SPECIFICATIONS OF NICKEL
SYMBOL	NICKEL
Description	NICKEL MMMYY
Trading Period	Monday to Saturday
Trading Session	Monday to Friday: 10:00 a.m. to 11:55 p.m. (Winter) Monday to Friday 10:00 a.m. to 11:30 p.m. (Summer) Saturday : 10:00 a.m. to 11:00 p.m.
Contract months	Monthly contracts
Expiry date	Last day of the contract
Trading Unit	250 kg
Quotation/base value	Rs. Per Kg
Tick size	10 paise
Daily price limit	6%
Initial margin	8%
Special margin	In case of additional volatility, a special margin of such percentage (as deemed fit) will be imposed immediately on both buy-side and sell-side in respect of all outstanding position, which will remain in force for next two days after which ther special margin will be relaxed
Maximum allowable open position	For individual clients : 200 MT For a member collectively for all clients: Not more than 25% of the market-wide open position in a contract at any point of time
Delivery logic	Both options
Delivery unit	3 MT with tolerance limit of +/- 1% (30 kg)
Delivery center(s)	Within 20 kilometers outside Mumbai octroi limits
Due date rate (DDR)	DDR is calculated on the last day of the contract expiry by taking an average of the LME official cash closing prices (i.e. mid-value of bid and ask) of nickel, and it would be multiplied by rupee - US$ rate, as notified by the Reserve Bank of India on that particular day.

	CONTRACT SPECIFICATIONS OF ZINC
Symbol	ZINC
Description	ZINC MMMYY
Trading Period	Monday to Saturday
Trading Session	Monday to Friday: 10:00 a.m. to 11:55 p.m. Saturday : 10:00 a.m. to 2:00 p.m.
Contract months	Monthly contracts
Expiry date	Last day of the contract
Trading Unit	5 MT
Quotation/base value	Rs. Per Kg
Tick size	5 paise
Daily price limit	4%
Initial margin	5%
Special margin	In case of additional volatility, a special margin of such percentage (as deemed fit) will be imposed immediately on both buy-side and sell-side in respect of all outstanding position, which will remain in force for next two days after which ther special margin will be relaxed
Maximum allowable open position	For individual clients : 1500 MT For a member: 6000 tonnes or not more than 25% of the market open position whichever is higher
Delivery logic	Both options
Delivery center	Within 20 kilometers outside Mumbai octroi limits
Delivery unit	10 MT with tolerance limit of +/- 1% (100 kg)
Due date rate calculation (DDR)	DDR is calculated on the last day of the contract expiry by taking an average of the LME official cash closing prices (i.e. mid-value of bid and ask) of zinc, and it would be multiplied by rupee - US$ rate, as notified by the Reserve Bank of India on that particular day.