

Hedging, Volatility Spillovers, and Efficiency in Indian Commodity Markets: A Study of Five Agri Commodities

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By

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DECLARATION

I, Mr. Sampath.T, hereby declare that this thesis entitled “**Hedging, Volatility Spillovers, and Efficiency in Indian Commodity Markets: A Study of Five Agri Commodities**” submitted by me under the guidance and supervision of **Prof. Debashis Acharya**, School of Economics, University of Hyderabad, is a *bonafide* research work, which is also free from plagiarism. I also declare that it has not been submitted previously in part or full to this university or any other university or institution for the award of any degree or diploma. I hereby agree that my thesis can be deposited in Shodganga/INFLIBNET.

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A. Published in the following publications:

1. Stock prices, Inflation and Output in India: An Empirical Analysis, **Journal of Public Affairs, ABDC-B Ranking and Scopus (Wiley), Volume XX (2020), No. 3.**
2. Macroeconomic Variables and Stock Prices in Emerging Economies: A Panel Analysis, **Journal of Theoretical and Applied Economics, Volume XXV (2018), No. 3(616), Autumn, pp. 91-100, (2018), UGC-Care list**

B. Presented in the following conferences

1. Presented Paper on Volatility Spillovers in Indian Commodity Markets: Empirical Evidence from the MGARCH Model, at the 3rd SEBI-NISM research conference 2022 (hybrid mode) on “Investing in Recovery Challenges and opportunities for Indian Securities Markets” held at NISM, Pathalaganga, Mumbai on February 24-25, 2022.
2. Presented Paper on Hedging Effectiveness of Commodity Markets: Empirical Investigation from India, in the 14th Doctoral Thesis Conference held during May 6-7, 2021 at IBS, Hyderabad.

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3. ECON612	Area paper	6	Pass
4. ECON614	Dissertation	15	Pass
5. ECON616	Viva-voice	3	Pass

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ABBREVIATION

ADF	Augmented Dickey Fuller
AGMARKNET	Agricultural Marketing Information Network
BEKK	Baba Engle Kraft Kroner
CBOT	Chicago Board of Trade
CDE(s)	Commodity Derivative Exchange(S)
CMIE	Centre for Monitoring Indian Economy
CZCE	China Zhengzhou Commodity Exchange
DWT	Discrete Wavelet Transform
ECM	Error Correction Model
FMC	Forward Market Commission
EGARCH	Exponential Generalized Autoregressive Conditional Heteroscedasticity
LIFFE	London International Financial Futures and Options Exchange
LME	London Metal Exchange
MCX	Multi Commodity Exchange
NCDEX	National Commodity & Derivatives Exchange
NCE	National Cheese Exchange
NICR	National Institute of Commodity Research
NMCE	National Multi Commodity Exchange
NYME	New York Mercantile Exchange
OLS	Ordinary Least Square
PP	Philips Perron
SCR A	Security Contract Regulation Act
SEBI	Securities and Exchange Board of India
SOPA	Soya Bean Processors Association
USDA	United States Department of Agriculture
VECM	Vector Error Correction Model

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CHAPTER – I

Background, Objectives and Methodology of the study

1.1. Introduction

In the context of all assets, properties are treated as a distinct commodity class. Futures are regarded as one of the key hedging tools to obtain the economic risk correlated with commodities through the usage of commodity derivatives. Risk transfer and price discoveries are two roles of futures contracts on commodities markets, they also play an important part on the commodity markets. In the Indian economy, potential commodity conditions for agricultural commodities are of crucial significance and several studies have been carried out on potential commodities markets with various data sets and methodologies for different purposes. The analysis focused on three specific goals which are accompanied by performance hedging, spillover uncertainty, and efficiency. For market performers and decision makers, this research is especially relevant for the period. Such concerns play a critical role in government choices and investment opportunities in this area. In current literature, several studies have discussed in commodity markets such as agricultural, energy, and metal commodities, nevertheless, the present research restricted to five main highly traded commercial agricultural commodity futures. Hence, there are few studies on the agricultural commodities industry. In India, agricultural productivity is mainly reliant on rainfall. Irrigation infrastructure is still distant from covering all agricultural land. Rainfall is essential for a big portion of agriculture. The “kharif crop” is highly reliant on rainfall, whereas the “rabi crop” is more reliant on irrigation. The amount of water available in irrigation sources is determined by the amount of rain that has fallen in the preceding months, with a lag, the Rabi crop is also reliant on deluge. Rainfall amounts tend to change year by year, causing agricultural output to fluctuate in response to weather variations. With fluctuating output, agricultural commodity prices are likewise subject to large volatility, as Indian agriculture is still largely based on the "plough to plate" theory. [Bhanumurthy, N. R., Pami Dua, and Lokendra Kumawat. \(2013\).](#)

If buyers on the commodity market feel a certain crop will be in limited supply in the coming season. Futures crop prices are expected to climb now, signalling to farmers that they should plan their seeding selections for the coming season accordingly. Similarly, the price of agricultural crops in the futures market today indicates a rise in future demand. The futures

market system can be extremely beneficial to Indian farmers in this situation, as it protects them from being directly exposed to price fluctuations. The futures market will operate as a buffer between today's and tomorrow's commodities markets. If the price that will prevail in the future is higher than what it is now, arbitragers will want to buy commodities now in order to sell them later. As a result, having a futures market is always beneficial to any economy. For prospective markets for goods, demand exploration, and risk control have two significant economic roles. It is well recognized that farmers are confronted almost every day with various circumstances because of the unpredictable and dangerous performance of agriculture. The possible danger in agriculture is primarily attributed to the various production related ambiguities and costs. [Easwaran, R. S., and Ramasundaram, P. \(2008\)](#) pointed to the technological complexity concerning agricultural output, as it is inextricably based on multiple factors. Prices are specifically commensurate with risks as market instability causes confusion which can place agricultural output at risk as well as having a negative influence on income and health of rural farmers and economically disadvantaged citizens ([World Bank 1997](#)).

Two significant economic roles, such as trading and risk control, occur in commodity futures markets. Any producer's primary and main goal is to optimize benefits and reduce risk. Also in peak season, the decrease in prices during the successful harvests is a major concern farmer are pressured into selling their goods at lower rates. While farmers are postponing selling agricultural products at future good prices with the processing of their crops, they face various challenges due to different storage factors and eventually loss. However, Indian markets, which have a long chain of traders, are deeply competitive and locational. In fact, in some spot markets, the naïve regional operators of domestic markets who play a dominant position do not suit the soft foreign competitors who are also a big danger to post globalization. These market shortcomings inevitably result in farmers not understanding the possible benefits from commodity purchases that adversely affects their income and livelihood health. Future dealing, a risk management technique may require an obligation between customer and seller to meet contract conditions, i.e., pre-determined standard-size contracts entered into today and produced early in the future. Future investing is now becoming extremely relevant and is known as one of the safest and most effective techniques to fight market fluctuations. Many countries worldwide have established and encouraged international commerce, concentrating primarily on their analysis of the advantages they have received. The quickly evolving global economic scenario had an effect on India, as the commodity future had been in a dead state for some time, even contributing to a resurgence of the interest in fostering potential industry. The

future exchanges have therefore risen dramatically in India, which is a very encouraging indication of global growth in effect, [Easwaran, R. S., and Ramasundaram, P. \(2008\)](#).

A study by [Garbade and Silber \(1983\)](#) work found the transition of risk and the determination of values are two key contributors to the economic development of a world on potential markets. The future trade's net economic benefits are progressively recognized by prospective business players, who not promote an interconnected pricing system in the world but also maintain demand stability. It is claimed that it provides industry leaders with many advantages at the micro-level. Farmers or distributors have a limited idea of the rates that will reign shortly. This also offers the customer a strong advance view of the quality of the product at a potential date. The potential forecast is therefore of considerable benefit to exporters because it offers a tentative estimate of the price, they are willing to pay and thereby allows them to recognize fair costs and obtain export contracts on a competitive market. This also allows them to mitigate demand threats by successfully competing on the potential markets following a negotiated export deal [Raghavendra, R. H., Velmurugan, P. S., and Saravanan, A. \(2016\)](#).

The potential exchange often has possible advantages such as a price-stable in periods of extreme volatility in quality, decreased financial asymmetry, credit transparency, and a healthy supply-demand scenario. Research demonstrates that the exploration of demand and risk control plays a crucial role in helping regulate the market cycle and protecting economic agents' interests. The continually moving data on goods in and out of markets is the guiding factor behind twin functions. In addition to these primary advantages, it also plays a significant role in the convergence of different crop ecosystem segments and in the growth of the global agricultural marketing network. Price discovery is an ongoing mechanism in which individual purchases and other sells on a forward-looking contract in a commodity market. The successful market finding genuinely serves a significant economic feature and a big economic advantage for potential trade paves the way for accelerated economic growth. All the usable knowledge is continuously being transferred to potential markets via this market which offers a competitive supply and demand barometer. Therefore, farmers should aspire to seal their crops in value and can afford a price for protection. To exchange for defending against abysmally low costs, they offer up the reasonable chances, ensuring that the economy will run free of hiccups. We arrive on the market to spend and take reasonable chances so that their investment capital will produce large returns. The key goal of the new research report, though, is to have a better picture of how much hedging (risk transfer) can benefit these potential markets. These

hedging can only work if the potential markets discover and transfer demand effectively. With a foreign economy, price fluctuations of agricultural goods will have a direct impact on domestic markets. In fact, volatility in domestic demand can induce market uncertainty, and variations in exchange rates can often strongly mean both domestic and global commodity prices. The recent rise in global commodities prices has both threatened the viability and effectiveness of the environmental management system. Given this claim, an in-depth volatility study of agricultural product domestic prices is most important. Analysis of the volatility level is, therefore, becoming more and more relevant. Commodity futures markets have a long tradition of agricultural commodities dealing with the uncertainties of the business of the global economies ([Lokare, 2007](#)).

In India, although commodity future trade has existed for decades, controlled futures markets have begun with the launch of national exchanges of commodity derivatives, including the “Multi-Commodity Exchange, NCDEX, and the NMCE” in 2003. In most agricultural products in India, the introduction of modern national commodity exchanges has improved their futures ([Expert committee, 2008](#)). Future commodity exchange was criticized because of the on-site exploitation of the Indian agricultural commodity prices in the future market. This claim has been taken more seriously as inflation rates spiked in India at the heels of rises at crucial prices for agricultural goods ([Srinivasan, 2008](#)). Real benefits have been addressed for commodity stakeholders, particularly future market farmers, as well as the position of “spot and futures markets” to decide the prices ([Expert committee, 2008](#)).

Crop product markets are prone to long-term fluctuations and short-term booms and bursts. Prices for all major crops experienced extraordinarily high demand volatility after mid-2007 and rise to peak rates in early 2008 ([dwyer et al., 2011](#)). The highly variable valuation of farm production is mainly influenced instead of domestic performance by foreign market changes ([Pillai, 2007](#)). Price volatility directly affects production, demand, farmers’ incomes and food security ([Rajpuria, 2002](#)). Resources are well known for being at the center of most emerging economies, supplying food, creating employment, and exporting income to directly involved farmers. The Indian demand for goods has also seen immense development over the past ten years into a more mature system. Agriculture and allied industries as a primary industry play a major role in the Indian economy, with almost 17 percent (at a constant price 2004-05) of the Indian “Gross Domestic Product” share throughout 2009-10. The governments’ agricultural strategy appears to protect and promote the agricultural sector through a variety of procurement

methods and controlled business processes was widely seen in most of the farm-driven economy. Historically, policy reference has been noticed at any stage in selling large agricultural goods. This involves the establishment of minimum support levels for specified products and the international control of all selling operations, such as shipping, manufacturing, credit supply, and trading of these products. Nevertheless, policy involvement decreased dramatically amid the introduction of liberalization and economic reforms after 1991. Agricultural resources have an important influence on the development of the Indian economy. The proportion of primary posts represents the market index derivation of food goods in India particular (WPI and CPI).

The usage of different market-based approaches to tackle product price uncertainties relies mainly on the application of derivatives on some commodities markets. In other terms, the concept of creating an efficient futures market for crops is popular for improving the agricultural industry. Internationally it is understood that if financial markets operate right, a market-driven solution may be applied to some of the key policy objectives for fluctuating prices of agricultural commodities. To order to get help for some adjustment to commodity markets, there remains the underlying need for trading to commodity options in general and in commodity futures in specific. It's really what we're called hedging. For a structured futures contract, covering the corresponding (sell or buy) role of the related underlying products the only take a specified sum of counter value (compare or sell). Such counter conditions in the potential deal led to a decrease of the expected failure of the negative demand patterns of the underlying products. This is therefore quite essential that future and other kinds of derivatives trading be developed in all commodities sensitive to large and unpredictable market fluctuations. Futures of goods also help forecast the values of the goods.

In comparison to industrial production, agricultural production has to depend to a large degree on the vagaries of the weather compared to agricultural goods. Experiencing sharp price fluctuations in both foreign and domestic markets. Futures trading is a pricing and market risk management strategy that is useful for all segments of the economy, farmers and customers are included. Forward marketing is a strategy for hedging against major price swings. Distress sales occur when farmers are aware of decreasing prices for their produce during the harvest season and customers are both harmed by market increases that are out of the ordinary (because they must pay higher rates during the lean season to meet their needs). Futures trading allows trades to determine supply and demand dynamics while also addressing market risks over time

and distance. Futures trading not only helps you to diversify your portfolio, but it also allows you to receive market indications in the current as well as the future. It also offers advice to farmers and agricultural product purchasers (consumers). The foreign exchange reserve plays a major role for a developed country's economy to be stable such as India at any point of time, the main ingredients are spices among agricultural commodities in earning a significant a certain amount of foreign money their exports. As a result, it's vital to have a consistent output in connection to marketing information of the "spot and futures prices" as well as their correlation. "Price discovery" is the general method used by futures markets to assess the spot price. It is extremely beneficial to producers since they can get a good understanding of the prices that will possibly dominate in the future, and as a result, they allocate limited resources among different commodities to maximise profit while minimising risk. Consumers can profit knowing the price of products ahead of time.

1.2. Issues of the study

The cotton trade association started trading futures in 1875, and commodity derivatives have been traded in India since then. In 1921, for the first time, there was a structured futures market for different cotton varieties emerged, and it quickly spread throughout India. Following the passage of the regulated commodity trading started with the passage of the "Forward Contract (Regulation) Act of 1952" this established the country's regulatory regime for organized futures transactions as well as commodity exchange registration. In India, a ban on commodity forwarding trading was imposed in the 1960s due to severe drought and commodity market manipulations. The ban lasted until early 2003. The "World Bank and the United Nations Conference on Trade and Development exerted pressure on the government (UNCTAD)" by creating commodity futures exchanges, the Indian government was able to lift the ban on agricultural commodities and allow trading in 54 commodities based on the recommendations of the Kabra and Guru committees, as well as the favorable views of commodity futures trading expressed by the national agricultural policy in 2000. In the other hand, the 2008 ban on four products because they thought trading was a risky business in "chickpea, potato, rubber and soy oil" aggravated the prices latest controversies such as the "Guar futures" fraud in 2012 and "NSEL payment scam" in (2013) and on the one hand, certain commodities are illiquid, and intense trading activity in just a few "bullion, metals, and agricultural markets" have raised several concerns about the asset class's fundamental nature.

Given the above-mentioned view of future products of the Indian agricultural economy, the market opinions of various organizations concerning the usefulness and prospective contract suitability were tried. The “National Commodity Derivatives Exchange Limited (NCDEX) and Multi Commodity Exchange (MCX)” data for the timeframe of 1st December 2010 to 31st May 2019 provide daily pricing information for spot and futures markets. Trade role in commodities future will help to stabilize the underlying commodity market of five major agricultural commodities (spices, pulses, grains and oilseeds and other) in various agricultural categories. This research explores the effect on the Indian agricultural commodity sector of hedging, volatility spillover and efficiency. Unlike other research in the global markets and in India, this analysis has also shown that prices have risen dramatically as future commodity contracts have been launched, leading to the hedging, uncertainty and effectiveness pressuring of commodities, especially agriculture commodities. Empirical findings demonstrate significantly that India’s underlying commodity market could grow successfully due to the comparative benefits of the future market in information dissemination, leading to significant price discovery and risk management.

While the functions and output of commodities exchanges are examined in developing and emerging countries, only a limited number of studies are performed on the Indian commodity markets. Several studies worldwide have shown that commodities markets have managed to minimize risk and demand uncertainty, and therefore dramatically lower hedging costs, but it is not so successful in a nation such as India. Nonetheless, few studies have found Indian product exchanges to both minimize danger and market instability. The effect on commodity exchanges on energy prices from previous reports was very inconclusive. The research, therefore, analyses the success of potential demand in Indian agricultural commodities. The following theoretical concerns are posed in light of the aforementioned problems.

1.3. Research questions of the study

Major economic functions of futures market are price discovery and price risk management. At national exchanges, the commodity futures market has completed 17 years of trading on main agricultural commodities. Commodity futures markets provide to fulfil the price discovery function by stabilizing commodity prices. As a result, the study intends to cover the five highly traded Indian agricultural commodities sector. The following research questions were formulated as a result of this.

1. In relation to hedge ratio and hedging effectiveness, how efficient is the derivatives market?
2. What effect does the formation of price volatility in one market have on the formation of price volatility in another?
3. How efficient is the futures market in pricing agricultural commodities?

1.4. Objectives of the study

Taking the aforementioned topics and research concerns into consideration, this analysis primarily discusses the conduct of Indian agricultural commodities prices. General goals are:

1. To evaluate the efficiency of hedges in both spot and futures commodity markets in India.
2. To examine the volatility spillovers in Indian commodity markets.
3. To study the performance of the Indian commodity market's spot and futures prices.

1.5. Data Source of the study

The “National Commodity Derivative Exchange (NCDEX) and the Multi Commodity Exchange (MCX)” database provided regular details on the closing prices of farming produces “Wheat, Barley, Jeera, Crude Palm Oil, and Mentha Oil” in particular, are the most widely traded. The study period covers 1st December 2010 to 31st May 2019. The aim of this research is to analyze the impact of hedging performance, volatility spillovers, and efficiency in five “spot and futures” prices for agrarian products in India.

1.6. Methodology of the study

The majority of the approaches used in this study are time series econometrics. Price volatility analysis is investigated by taking into account the variation of futures and spot price series to come to a decision on the efficient use of information in the futures market. By comparing the variations of the two series, the basis and spot price risks are evaluated. The gap between the spot and futures prices is referred to as the basis. When the volatility of the basis is less than the variance of the spot price, a contract might minimize risk.

To make the data series stationary, the augmented Dickey-Fuller unit root test is used. Before examining complex econometric models, it's vital to understand the concept of stationary. The ADF unit root test was used as a requirement for studying Johansen's Cointegration test and OLS estimation for hedging in this work. The regression between spot and futures was done using ordinary least square. The “hedge ratio and hedging effectiveness” are determined by the beta coefficient and R square, respectively. For our analysis, the study used first difference data. We have utilized the daily closing prices commodity “spot and futures” of the NCDEX and MCX throughout the period from 1 December 2010 to 31 May 2019.

Volatility, or price fluctuation, is a significant issue for an asset class, yet positive price fluctuation carries less risk than negative price fluctuation. As a result, it's critical to comprehend the asset class's downside risk. A systematic knowledge of risk spillover between two variables, assets, or even markets is provided by MGARCH. It is a significant factor in the derivatives segment because, as we all know, both markets (spot and futures) are interdependent in determining price, and they both affect each other due to risk spillover. The fundamental focus on volatility spillover is when volatility is noticed in one market and how it affects the other market. The asymmetry factor in the variance equation captures informational biasness yet again. To test volatility spillover, we have used the GARCH approach to study effects in Indian commodity futures markets. More specifically, the MGARCH-BEKK models were used. To investigate the problem of volatility spillovers, we used regular closing prices of NCDEX and MCX commodity spot and futures from 1 December 2010 to 31 May 2019. The research examines the relative price uncertainty in agricultural commodities and the degree to which price insecurity in one market in the other affects price uncertainty.

The long-run association among two asset classes and the market is estimated using for “Johansen's cointegration test” data stationarity at the first difference is a requirement. The “Granger causality test” provides a reasonable estimate of the direction in which “Spot and Futures” costs are influenced. For measuring the “Price Discovery Process” Granger causality is also significant. The VECM model is a constrained VAR model that can be utilized when the variables have a long-term relationship. VECM provides data on the link between two assets or markets in terms of lead and lag. Aside from a lead-lag relationship, VECM also provides an estimate of the pace with which the variables adjust to equilibrium. The study utilized daily closing prices of MCX and NCDEX commodity spot and futures from 1 December 2010 to 31 May 2019, to look at how efficient Indian commodity markets are.

1.7. Justification of the study

The following reasons may be used to justify the current study. First and foremost, India is the world's greatest producer, consumer, and exporter of agricultural products such as crude palm oil, mentha oil, wheat, barley, and jeera. There are well-established spot markets for all of these commodities. It is commonly understood that a well-established spot market requires the assistance of an effective commodities futures market. As a result of this fact, this study investigates the market efficacy hypothesis of futures markets for the commodities under consideration. Second, Agricultural commodities are experiencing price volatility due to a variety of factors. There are several empirical studies in the literature on ways to reduce these pricing risks, particularly after the introduction of national commodity exchanges. Because “price discovery and risk management” are the primary objectives of futures markets, empirical confirmation of these activities is critical. As a result, the efficacy of futures and spot price hedging in these markets is empirically tested in this study. It is critical to investigate the pricing behavior of agricultural commodities, the efficiency of hedging, and the effects of volatility spillovers in this environment.

Another issue that may have harmed market emotions and slowed trade was the National Spot Exchange Limited (NSEL) fraud. In 2012, it was brought to the notice of the general public when the Forward Market Commission (FMC) prohibited NSEL from issuing new contracts. Despite the fact that the case is still being investigated, claims and arrests made as a result of alleged involvement of important stakeholders such as exchange members and government officials harmed the market's trust factor and prevented legitimate players from participating. The drop could also be attributed to the transfer of regulatory responsibilities from the FMC and SEBI. Another aspect that contributed to market volatility was the introduction of the Commodity Transaction Tax (CTT) in 2013.

1.8. Organization of the thesis

The current research is organized into eight chapters. The first section of the thesis introduces context information for the research problems, and research questions, as well as the study's goals, data and methodology specific and extent and constraints. The second chapter is devoted review of literature. The third chapter explains over of the Indian commodity markets. The fourth chapter examine the trend analysis of Indian commodity markets. The fifth chapter deals with analysis hedging effectiveness in commodity exchanges in India. The sixth chapter examines the impact of volatility spillover on commodity markets empirically. Accordingly,

the seventh chapter deals with the efficiency of the Indian agricultural commodity markets. Final chapter includes a rundown of observations and concluding remarks in the light of India's spot and futures markets.

1.9. Scope and Limitations of study

The study's findings are limited to five commodities from National Commodity Exchanges over a ten-year period. It excludes the Regional Exchanges and is limited to secondary information. Despite the fact that the current research mainly looks at the “Multi Commodity Exchange (MCX)” and the “National Commodity and Derivatives Exchange (NCDEX)” from December 2010 to May 2019. This research looks at a few methods for estimating commodities futures volatility, hedging, and efficacy. Future study can employ various approaches to reach more solid conclusions on Indian commodities futures as an investable asset class in India. The determinants and spillovers of commodities futures volatility can also be investigated. As agricultural commodities, we have chosen “wheat, barley, Jeera, crude palm oil, and mentha oil”. Improved study on several agricultural and metal commodities is also possible. The hedge ratio and hedging effectiveness were estimated using OLS regressing in this study. Furthermore, numerous stochastic econometrics models can be used to do research. The spot and futures prices were the main variables in our research for detecting various characteristics of commodities derivatives. In order to test the durability of the derivatives market, there is also more room to include additional micro and macroeconomic variables.

CHAPTER – II

Review of Literature

2.1. Introduction

Agricultural commodities are essential assets for many countries' social strength and food security, especially in developing countries. Policy makers are attempting to devise policies that aim to regulate sharp price fluctuations. Furthermore, they use asset allocation, hedging, and risk management methods in their asset allocation, agricultural commodities are strategic assets for executives and investors. Natural disasters, seasonality, and unbalanced demand and supply are more common with agricultural commodities ([Rout and Rao, 2017](#)). The absence of warehousing facilities for produced commodities has been a contentious issue since its inception, forcing poor farmers to sell their products at a low price due to a lack of storage space. Due to excessive price volatility and a lack of trading information, the Indian cash market has shown to be inefficient. The government of India changed the "Forward Contract Regulation Act" (FCRA, 1952) to control the market after noticing the drawbacks of the physical market, and the "Forward Market Commission" was established as a regulator to the FCRA. With the advent of derivatives, the market now has a second alternative for mitigating unfair pricing fluctuations. Derivatives have a derived value of the underlying asset, which allows two parties to agree on a pre-determined price and delivery date for a certain commodity. Commodities are powerful hedging techniques that allow investors to protect themselves from unforeseen price changes in the cash market ([Gupta et al., 2017](#)).

Following the successful equities market reforms of 1990, the Indian government is attempting to recreate analogous patterns in the commodity derivatives market. In 1999, the Indian government introduced the "Minimum Support Price (MSP)" as a price "hedging" tool. The commodity derivatives industry is hampered by the fragmented spot market. The government has enacted a plethora of laws and regulations that obstruct the free market in commodities derivatives ([Nair, 2014](#)). The prevalence of two-pronged agreements on local exchanges, the lack of futures and spot price information transfer, and the scarcity of warehouses all contributed to major challenges in the commodity derivatives market ([Thomas, 2008](#)). A simple information exchange from one asset to another, or from one market to another market, exists independent of any theory. The relationship has been established with a fair flow of information in the discovery of price or in volatility perception. In a competitive context, such

data not only aids in the analysis of risk and return, but also provides a platform for speculators to profit from risk (Lee and Nancy, 2006). When two markets have a long-term relationship, the riskiness has the potential of spreading from one location to another (Sehgal et al., 2011). In order for volatility spillover to exist among two markets, the volatility of returns in one market must have a considerable impact on the volatility of returns in the other market (Edward and Rao, 2013).

The success of every investment is determined by the investment's returns. Returns, on the other hand, are likely to fluctuate due to a variety of reasons, including production capacity, consumer demand, inflation, exchange currency exchange and rate of interest variations. All of these aspects, separately or in combination, cause variances in the cost of products and services across all industries, including agriculture. The agricultural industry is vulnerable to price risk due to a lack of product standardization, a well-organized market, warehouses, effective marketing, and a thorough understanding of market values and foresight into future prices of its products. Price volatility is a source of anxiety for many in the business world, and it has far-reaching implications for the economy as a whole. National governments have implemented a number of commodities policy measures in response to commodity price protests, including physical capacity utilization programs, stabilisation funds, variable tariff schemes, and marketing boards such programs, on the other hand, are expensive and ineffective, and they frequently place a financial burden on the government. Furthermore, such efforts are only effective in the short run. Various economists advocate the commodities futures market as a realistic and potentially effective alternative to traditional price stabilization techniques. (Bose, S 2008).

2.2. Previous Studies on Price Discovery Mechanism

“Price discovery” in the futures market is a near-term signal with economic ramifications for a variety of market players, including policymakers. Price discovery is used as a barometer by all participants in the futures market, and they apply various tactics to extract gains. Hedgers attempt to implement essential hedging techniques using a variety of market tools in order to keep their cash flow undisturbed. Traders try to plan ahead of time to manage their inventory so that they can deal with futures price swings in the market and profit from them. Speculators are market participants who attempt to profit on short-term price swings in the underlying assets. The market's behaviour is greatly influenced by speculative commodity buying and selling. This holds true for commodity futures as well. Arbitrageurs are continually looking for

price disparities in different marketplaces so that they can profit from the difference in prices. They purchase goods on the lower market and sell them on the more expensive market to benefit from price differences. “Price discovery” is used by customers to determine how much they should spend. Above all, price discovery data is used by regulators and policymakers to try to design regulations that would promote market stability and decrease unnecessary disturbances that could generate economic uncertainty.

One of the most essential roles of the commodity “futures market is price discovery” which is often measured by the rate at which commodity prices in response to new data “(Booth, W. S. and Tse, 1999)”. The commodities futures market must be informationally efficient in order to achieve efficient price discovery. When a commodity futures market uses all available information to calculate prices, it is said to be informationally efficient. Manufacturers and shareholders process the information they have access to and take positions in response to that knowledge as well as their own personal situations, according to the theory behind this idea of efficiency. All of this disparate information is aggregated by the market and reflected in the price discovery process “(Kaminsky and Kumar, 1989; Fama, 1970)”.

2.3. Earlier Reviews on Volatility Spillover in Commodity Markets.

Volatility or risk spillover from one market to another, or from one asset to another, is a significant disadvantage in the commodity derivatives market. As we all know, information transmission is a critical aspect in price discovery in a competitive context. Risk passes from one segment to the next in the same way. A study by Manogna, and Mishra (2019) In the Indian context, researchers looked into the discovery of prices and volatility spillover effect in agricultural commodities. The discovery of prices and spillover effects for nine of the most liquid agricultural commodities traded on the “National Commodity and Derivatives Exchange” (NCDEX) were investigated using “Granger causality, vector error correction” model (VECM), and “EGARCH” (Exponential Generalized Autoregressive Conditional Heteroscedasticity) models. The “VECM” results reveal that discovery of prices occurs in all nine commodities, with the futures market leading the spot market in six of them, namely “soybean seed, coriander, turmeric, castor seed, guar seed, and chana”. For three commodities, “price discovery” takes place on the spot market (“cotton seed, rape mustard seed and jeera”). The “Granger causality tests” reveal that futures markets are better at predicting spot prices. The results of the “EGARCH” volatility test show that there are spillover effects on futures and spot markets.

[Živkov and Jonel Subić \(2020\)](#) investigated the spillover effect of idiosyncratic volatility among the four commodities for agricultural futures, namely rice, soybean maize, and wheat. For the estimation of the volatility spillover, the analysis used the “Markov Switching Generalized Autoregressive Conditional Heteroscedasticity” (MS-GARCH) model. This model offers impartial and reliable measures of uncertainties in farm futures markets. Relatively strong volatility shocks in agricultural commodities due to volatility shocks soybeans and wheat are the agricultural commodities that are witnessing relatively high volatility shocks from other markets. Among all agricultural futures, rice receives the least amount of volatility shocks.

[Gozgor and Memis \(2015\)](#) examined the spillovers in price fluctuations between commodity markets for energy and agriculture. In the global commodity. Between January 1, 2006, and November 29, 2013, the study focuses on spillovers of volatility in future “crude oil, soybeans, corn, wheat and sugar” markets. The empirical results from the Granger causality test “procedures suggest that there is a spillover of price volatility from “crude oil to maize markets”. A unidirectional link exists among the “corn and soybean markets”. Finally, the effects of spillovers of price volatility from both the “soybean and maize markets to the wheat markets” were reported by the authors.

[Rout, B. S., Das, N. M., and Rao, K. C. \(2019\)](#) examined the spillover mechanism for instability in India’s energy and agricultural commodity markets. The agricultural resources, such as “chana, chilli, jeera, soybean and turmeric and aluminium, copper, lead, nickel and zinc, are metal products”. From the research period from January 2010 to December 2015. The outcome indicates that metal commodities are more popular than agricultural commodities and deserving of investment. The findings demonstrate the spillover of bidirectional volatility of both metal and Commodity markets for agriculture and the transmission of uncertainty is targeted at spotting futures in agriculture and spotting futures in metal commodities.

[Sehgal et al. \(2015\)](#) investigated the “price discovery” and volatility spillovers Indian markets. In order to do the analysis, they used VECM, Johansen and Juselius Cointegration, and the GARCH (BEKK) model. They noticed short-term volatility spillovers from “futures to spot” and long-term volatility spillovers from spot to futures.

Rout et al. (2021) the study investigated the futures on Indian primary crops in terms of “price discovery, hedging efficiency and volatility”. The authors employed the “Cointegration, Granger causality test, and VECM, OLS, EGARCH and VaR models”. The spot market appears to be ahead of the futures market. The lead-lag link differs depending on the commodity. Furthermore, both markets have downside risk, and volatility is passed from the “spot market to the futures market”. The agricultural commodities futures market is determined to be inefficient in terms of hedging.

Srinivasan (2011) investigated the process of “price discovery” and volatility spillovers in the Indian spot and future commodity market. Data was collected during the study period. From June 2005 to November 2010, there are four commodities futures indexes on the “MCX”, each with their own underlying spot indices. The findings reveal that the commodity spot market is dominant and successful as a “price discovery mechanism” implying that information flows from the spot to the futures commodity markets.

Rout et al. (2019) examines the volatility spillover mechanism in the Indian commodity derivatives market. It compared agricultural and metal commodity segments, using five agricultural and five metal commodities. The study's goal was to better understand the mechanism at work between spot and futures commodities markets from 2010 to 2015. The degree of volatility transmission, the structure of unpredictability, and the lead-lag link are all checked using the generalised impulse response function. According to the author's conclusions, Metals are more substantial and worthy of investment than agricultural goods.

2.4. Earlier studies on hedging effectiveness

Financial derivatives contracts have become increasingly important as a result of successive global financial crises, particularly when utilized for hedging purposes. It's becoming abundantly evident that financial economic uncertainty has severe effects for a variety of industries. Companies must use various derivatives contracts to hedge their risk, the efficacy of the hedge is critical in preventing the negative consequences of crises. An increase in the number of research “constant and dynamic hedging” models to quantify the hedging efficacy of various underlying assets based on the link among spot and futures market price variation. The fundamental goal of this research is to look at several constant and dynamic hedging models and calculating hedging efficacy in the Indian commodity futures contracts are used to trade in the market. “Wheat, jeera, barley, crude palm oil, and mentha oil” futures contracts are

among the agricultural commodities examined in this study. The key contribution of this study is that it estimates “hedge ratios” and assesses the “hedging efficacy” of commodity derivatives contracts which are most frequently exchanged. In the futures market, the “hedge ratio and hedging efficacy” are not new concepts. There has been a significant amount of research done on this topic efficiency of hedging with futures have been carried out in industrialized countries (Figlewski, 1984; Myers, 1991; Myers and Thompson, 1989; Park and Switzer, 1995; Floro and Vougas, 2014; Cont, 2015). However, there is a scarcity of research on the effectiveness of hedging in India. The key theoretical question that has been studied in the literature is how to calculate an appropriate hedge ratio. Scholars have debated a variety of techniques based on specific objective functions. The most extensively utilized hedging technique is predicated on the goal of lowering the hedged portfolio's variance (Myers and Thompson, 1989; Ederington, 1979; Johnson, 1960).

Bose, (2007) examined the “hedge effectiveness” of commodities futures “MCX” indices in Indian context. According to the findings, national commodity indices operate similarly to equity indices in terms of efficiency and information flow. It was also discovered that the futures market minimizes volatility in spot commodity prices and enables for effective price risk hedging. A study by Kumar et al. (2008) for both “agricultural and non-agricultural commodities” the hedging efficiency of Indian commodity futures was investigated. Non-agricultural commodity futures contracts have a lower hedging efficacy than agricultural commodity futures contracts, according to this research.

Bhaduri and Durai (2008) the study used four econometric models, including “OLS regression, VAR, VECM, and MGARCH” to estimate the hedging effectiveness stock index futures on the NSE. The findings imply that across hedged and unhedged positions, a time-varying hedge ratio delivers a higher mean return and lower average variance reduction. It was also discovered that the GARCH model performs better in terms of variance reduction only over long-time horizons, as opposed to the standard OLS technique, which performs well over short time horizons. Kumar and Pandey (2011) Hedging efficiency in the Indian commodities derivatives market was examined for “agricultural and non-agricultural commodities”. To calculate “constant hedging ratio and dynamic hedging ratio” they used Vector Error Correlation and CCC M-GARCH. According to their findings, agricultural commodities have a higher hedging efficacy than non-agricultural commodities. Hedging efficiency has improved, suggesting that Indian markets are hedging-friendly.

[Srinivasan \(2011\)](#) the multi commodity exchange investigated the efficiency of constant and time-varying hedge ratios in the Indian commodity futures market. Different econometrics models, such as the “OLS model, VECM, and multivariate GARCH with Error – Correction model” estimations, were used to estimate the performance of various hedging ratios. For all commodities indices except MCX Agri, the hedging strategy generated from time variant hedge ratio, which reduces conditional variance, outperforms the alternative models. Risk aversion may play a significant impact in the decision-making process.

[Malhotra \(2015\)](#) the “hedging efficiency of the Indian oil and oilseeds market” was assessed using the “Minimum Variance Hedge Ratio, Ordinary Least Squares (OLS), and VECM” methods. “Crude Palm Oil and refined soya oil” have satisfactory hedging efficacy, while “mentha oil and mustard seeds” have poor hedging effectiveness, according to the author. Finally, the author suggest that the low efficacy is due to the fact that both commodities are price manipulation and cartel-like behaviour by speculators and hoarders are common in limited commodities.

[Gupta et al. \(2017\)](#) the fact that, as indicated by the speculation ratio, traders in the futures market utilise these futures for more speculating than hedging, and that agricultural commodity futures have less speculation activities than metal commodity futures, could be the cause of increased hedging efficiency than metal commodities, is a thought-provoking fact. Despite the low level of speculation, castor seeds have a reduced hedging efficacy, which could be due to the castor seed's inclusion in the Essential Commodity Act. Another finding of the study is that for agricultural commodities futures, near month contracts provide superior hedging efficacy than non-agricultural commodity futures have the opposite relationship to near-month contracts.

[Arora and Chandar \(2017\)](#) they assessed the effectiveness of the futures market for “price discovery” and efficient hedging using “co-integration, causality tests” and a comparison of hedged and unhedged portfolios, and identified bi-directional causation of multiple commodities. Furthermore, as evidenced by the hedged portfolio's low variation when compared to an unhedged portfolio, there is a high degree of hedging efficacy.

2.5. Previous studies on efficiency of commodity markets.

Extensive empirical research has been conducted on the importance of the futures market in delivering “effective price discovery and risk management functions”. Market efficiency is the subject of a considerable body of research. Many scholars have looked into the market efficiency of agricultural commodities futures markets in developed nations, which are expected to perform the “price discovery function” which is the most essential economic function of an efficient market. The relation among commodity spot and futures prices are fascinated by investors, manufacturers, consumers, politicians, and economists all around the country. As a result, employing time series analysis, a vast number of empirical research investigated the association among “spot and futures prices” in commodity markets. The findings of the studies, however, were divided into two groups and applied to other commodity markets such as agriculture, energy, and metals. The first is commodity market efficiency, while the second is the interdependence of commodity spot and futures prices. Plentiful studies have looked into the market efficiency of agricultural commodities futures markets in emerging nations like India, “[Sharma and Sharma \(2018\)](#), [Mohanty and Mishra \(2020\)](#) [Kaur and Rao \(2010\)](#), [Ali and Gupta \(2011\)](#), [Goyari and Jena \(2011\)](#), [Kumar and Pandey \(2013\)](#) [Ranganathan and Anathakumar, \(2014\)](#)”.

[Sharma and Sharma \(2018\)](#) an investigation into the efficacy of the Indian chili futures market, spanning the period 2006 to 2016. The research looks at the long-term correlation among “spot and futures” prices. “Error correction terms” for both spot and futures price series are significant in the long run. In the long run, there is unidirectional correlation between chilli spot and futures prices. Finally, the research implies that futures contracts can be utilized as a hedge.

[Mohanty and Mishra \(2020\)](#) the case of Indian agricultural commodity futures markets regulatory reform and market efficiency of “castor seed, cotton oil cake, rape mustard seed, soybean, refined soya oil, crude palm oil, jeera, chana (chickpea), and turmeric” are nine key Indian agricultural commodities. During both the pre-merger and post-merger periods, commodities futures return series with holding durations of 5, 10, and 15 minutes significantly reject the weak-form of market efficiency hypothesis, according to efficiency measurements of intraday return predictability and variance ratio test results. In the agricultural commodity futures market, there is contradictory evidence in favour of weak-form market efficiency for 30-minute and 60-minute return series.

[Sahoo and Kumar \(2009\)](#) investigated the efficacy and the futures exchange price link of five commodities. The study has considered both agricultural and non-agricultural commodities namely such as “gold, copper, crude oil, chana and chickpea” throughout the months from May 2006 to April 2008. The findings of the co-integration and causality analyses support the effectiveness of futures markets for these five commodities.

The nature of information transmission between commodities markets, specifically agricultural commodity markets, and Indian stock markets have been investigated by [Chakrabarty and Sarkar \(2010\)](#). The study employed the “Cointegration and GARCH model” to examine the market effectiveness of four agricultural commodities, such as “rice, wheat, potato and masoor grain”. Daily data spanning between July 8, 2005, and July 29, 2009. Study conclusions show that all four agricultural commodity futures are efficient markets.

[Pantisa Pavabutr and Piyamas Chaihetphon \(2010\)](#) the research analysed the price discovery process for India's contracts for gold futures for the over a period from 2003 November to 2007 December, regular closing futures prices and trading volume “gold futures and mini gold futures contracts” and data collected from MCX. The study employed used VECM models to describe the futures and spot relationship. The analysis shows that the futures price corresponds to spot prices, indicating that the discovery of prices takes place in the futures market.

[Lakshmi et al. \(2015\)](#) the study examines the association among spot returns and futures contracts from January 2005 to May 2012 for “Multi-Commodity Exchange” traded “crude oil and gold” in India. The autoregressive vector model (VAR), the Wald test for Granger causality, the variance decomposition and the impulse response function tests were employed. The findings showed that the potential volume of trade is determined by its own history for both crude oil and gold than the past spot returns. Bidirectional causation runs from “gold spot returns to gold futures” trading rate. The finding indicates that the volume of gold futures trading responds faster to knowledge and helps to forecast gold spot returns in the Indian commodity markets than crude oil. [Kaur and Dhiman \(2019\)](#) the cointegration between the variables is investigated using the “Autoregressive Distributive Lag” bound test. Using weekly data, researchers looked into the impact of agricultural commodities on the NSE's FMCG index and found no evidence of cointegration or causality, with the exception of “barley, cottonseed, jeera, mustard seed, and wheat” which demonstrate a one-way causal link

[Dey and Maitra \(2014\)](#) the efficiency of commodities futures markets, as well as their other functions, were explored in this research. The research looks at coffee, pepper, and natural rubber futures as well as spot market prices. The effectiveness of futures market dispersion or convergence, as well as the causality between futures and spot, have been emphasized. For understanding the efficiency and relationship between variables, the study used VECM, causality test, and cointegration test. The author discovered that in the pepper market, futures take the lead and provide a superior price discovery process with increased information asymmetry, however in the rubber and coffee markets, futures lag. The spot and futures series for pepper and coffee are converging, whereas the spot and futures price for rubber is diverging. Rubber and coffee, on the other hand, have bidirectional causality, but pepper has a one-way causality.

[Sehgal et al. \(2012\)](#) investigate the “price discovery” function in Indian agricultural commodity markets. They collected data for 10 agricultural commodities traded on the “NCDEX” from November 2003 to March 2012. Except for Turmeric, the price discovery exists in all commodities. Srinivasan (2011) the findings reveal that the spot market for commodities is the most powerful and successful as a “price discovery mechanism” implying that information flows commodities markets ranging from spot to futures.

[Bose \(2008\)](#) the futures prices of commodities in India were examined to see if they indicated effective market functioning over a period from 2005 to 2007. The results of cointegration show that the NCDEX and MCX daily agricultural spot and futures indexes are not integrated. Futures prices, on the other hand, are cointegrated with future spot prices. They also found a bidirectional association for regular multi-commodity indices, and that futures prices lead spot prices for agricultural indices. They also discovered that agricultural commodity hedging is a difficult endeavor. [Mallikarjunappa and Afsal \(2010\)](#) they used VECM, EGARCH, and Cointegration to discover that neither market is superior in terms of “price discovery”. The volatility spillover is asymmetric, with spillovers from futures to spot markets being greater than spillovers from spot markets to futures markets. [Ali and Gupta \(2011\)](#) Using co-integration and causality analysis, researchers looked at the efficiency of India's agricultural commodities futures market from 2003 to 2008. For commodities including “maize, chickpea, black lentil, peeper, castor seed, and soya bean” there is a strong long-run link among futures and spot prices. The potential of futures prices to forecast subsequent spot price fluctuations is also demonstrated by the data. In the near run, however, a bi-directional link is discovered.

[Chhajed and Mehta \(2013\)](#) the market behaviour and price discovery in the Indian agricultural commodity market were explored. The analysis was conducted using data from April 1, 2009, to May 31, 2010. They discovered bi-directional causation between “spot and future prices” as evidenced by the Causality test results. For some commodities, price discovery is clear, and futures prices have a considerable impact on spot prices. “Contango and normal backwardation” estimation were used to investigate market behaviour. It aided in recognizing the market's “hedging” opportunity. They also discovered that if changes in spot prices are followed by changes in future prices, efficient hedging methods may be devised. Effective speculative strategies can be created if changes in future prices reflect changes in current prices.

[Sendhil et al. \(2013\)](#) researchers looked at the growth and efficiency of futures trading, as well as the level of price volatility caused by futures trading for four agricultural commodities such as “wheat, chickpea, barley, and maize”. In the case of wheat, maize, and chickpea, the cointegration test and VECM reveal that the “spot and futures markets” are co-integrated, but not in the case of barley. As a result, it appears that market efficiency for price discovery varies by contract and commodity. Futures, on the other hand, dominate the price discovery process. GARCH analysis also revealed the presence of a large ARCH term.

[Edward and Rao \(2013\)](#) examined the finding of the price Chili futures and spot prices process and volatility spillover. The following data was collected between April 1, 2006, and March 31, 2013. The “cointegration test and the Granger causality test” were applied by the authors. They discovered long-term cointegration between the spot and futures markets, as well as unidirectional causality, in which the futures markets guide the spot market.

[Singh and Singh \(2015\)](#) investigate the chana futures market's efficiency and the impact of seasonality on efficacy for the period of data from May 2005 to December 2014 was used. Using the Johansen Co-integration test and a dummy variable regression to investigate efficiency and seasonality. They discovered that Chana Futures and the spot market have a long-term relationship, indicating that Chana Futures are efficient. It also serves as an effective hedging tool for stakeholders (Farmers, traders). They also discovered that seasonality has an essential impact in the efficiency of the market in the case of agricultural goods.

[Saranya \(2015\)](#) studied the lead-lag relationship among spot and futures returns, as well as the level of price volatility in the spot and futures markets for a variety of commodities spanning the data period from 2008 to 2014. For the majority of commodities, the results of the Causality test and the GARCH model show unidirectional causality from spot to futures. Furthermore, in the current study, the volatility has decreased with time.

[Arora and Chandar \(2017\)](#) they used “co-integration, causality tests” and a comparison of hedged and unhedged portfolios to assess the effectiveness of the futures market for price discovery and efficient hedging, and discovered bi-directional causation of several commodities.

2.6. Gap of the study

However, because futures trading began in India in 2003, few studies have been conducted in this field. The majority of the studies focused on non-agricultural goods. For a limited time, a few research focused on agricultural goods. The majority of the research in India was done at the regional level, taking into account regional markets, APMCs, and other factors. On the basis of “price discovery” and volatility, the efficiency of commodities markets must be examined. Few previous research has looked at the overall effectiveness of the agricultural commodity market at national exchanges. As a result, the study examines five main agricultural commodities traded on national exchanges in an attempt to address this gap.

Finding the right dimension for an existing study has always been a challenging task. A thorough review of the literature is required to discover the flaws in prevailing revisions. The analysis discovered some significant commodities derivatives fissures after evaluating the current literature. In order to continue with the research, the gap must be determined. The research gap also gives us a clear picture of the study's barren branch or dimension. The sections below will offer us with information on the research gap, the study's purpose, methodology, and tools. A careful assessment of the literature revealed that there is a scarcity of information consistency among studies conducted across asset classes, markets, and time periods. Some research supports the idea that volume and open interest have an informative role in the persistence and asymmetry of volatility, while others refute it. Some studies argue that commodity futures have a significant influence in price discovery, whereas others disagree. The explanation for this could be that the formal Indian commodity derivative market is still in its infancy, having only been founded in 2003. Another gap noted was the scarcity of studies that might address price discovery and hedging efficacy in Indian commodities contracts. The

majority of studies undertaken in India either had substantial procedural flaws or were focused on regional exchanges with insufficient liquidity due to the lack of an electronic trading platform. As a result, the literature does not accurately portray the Indian commodity market. Through the current study, an attempt has been made to identify and fill these research gaps.

2.7. Conclusion of the study

The aim of this chapter was to look at the current state of derivatives research by reviewing the literature. According to the current research, there is no consistency among studies undertaken across asset classes, markets, or historical periods. The majority of commodity derivatives trading occurs on over-the-counter (OTC) markets, which have no paper record because they are private agreements. International commodities and financial markets, which have long been a significant focus of derivatives trading, remain out of reach of national statistical agencies even now. As a result, the literature on commodities derivatives is scarce. A number of issues demand specific attention and empirical research in the Indian context, based on careful analysis of previous studies. However, it is important to recognize the previous researchers' contributions in establishing a clear objective for the current research programme in order to further increase the body of knowledge. This research aims to assess the Indian commodity market's informational efficiency, volatility, and hedging efficacy.

CHAPTER-III

An Overview of Commodity Markets in India

3.1. Introduction

A commodity is a product made by corporations or enterprises that has no noticeable distinction in quality. Commodities have emerged as a new asset class in recent years. Commodity investments are also a good way to protect against inflation. When inflation rises, so do commodity prices. However, only a small percentage of investors invest directly in commodities. Physical commodities trading is time-consuming and expensive due to transportation, storage, and insurance fees. Commodity derivative products, which are traded on commodity exchanges, are used by investors to invest in commodities ([Prabina Rajib, 2014](#)). In its most basic form, a commodity futures market or exchange is a public market where commodities are acquired or sold at a predetermined price and delivered on a specific date. This commodities buying or selling must be made through a regulated exchange member broker, and the transaction must follow the terms and conditions of a standardised futures contract. Commodities are considered an alternative asset class in terms of investment, and Investors like commodity futures because they have a lower degree of correlation with other traditional asset types and can be used as an inflation hedge. Apart from being a one-of-a-kind hedging product, it also facilitates portfolio management through diversification benefits, resulting in higher returns for both domestic and international investors. As an asset class, the commodity futures market allows producers and consumers of commercial commodities to price risk is transferred to speculators with no direct economic interest in the goods. Producers protect themselves from price risk by selling futures contracts on the commodity they produce. Consumers must have long positions in futures contracts on their consumption commodities in similar hedging. Depending on their market perspective, arbitrageurs and speculators make long or short wagers on commodity futures contracts ([AK Mishra, 2008](#)).

The Indian commodities derivatives business experienced varied trends during 2016-17, despite a recovery in global commodity markets, strong domestic macroeconomic indicators, price stability, and unprecedented demonetization. While the metals section grew in terms of volume and value traded during the year, the energy, bullion, and agricultural commodities derivatives segments fell. The suspension of liquid chana futures and castor seed futures at

NCDEX had an influence on the agricultural (Agri) segment's overall volumes. During 2016-17, the underlying markets in the agricultural futures segment experienced periodic price volatility caused by demand-supply mismatches. (SEBI Annual Report, 2016-17). Agriculture and allied industries growth are expected to be 4.4 percent in 2016-17, up from 0.8 percent in 2015-16, according to the CSO. Food grains, pulses, oilseeds, and cotton production increased in 2016-17, according to the first advance estimates for Kharif crop production announced in September 2016. Sugarcane production was down from the previous year, according to the company. Food grain output is predicted to expand by 8.1 percent in 2016-17 compared to 2015-16, according to the Ministry of Agriculture's second advance production estimates for 2016-17. The pulse output is predicted to expand by 35.4 percent, followed by oilseeds (33.0 percent). Sugarcane production, on the other hand, is expected to fall by 11.0 percent. Rabi crop sowing was also greater in 2016-17 than in previous years.

3.2. India's Commodity Derivatives Trading History

Humans have exchanged numerous commodities such as cattle, food grains, cotton, salt, and so on since the dawn of humanity. Commodity trading began as a simple barter exchange of items. People traded surplus items for those they didn't have, and producers of various commodities traded things with one another. As civilization progressed, the barter system evolved into a cash system, in which produces were approved of and traded for money. Dealers and manufacturers functioned as middlemen, buying and selling produces for the single purpose of earning from the trade. Over period, those manufacturers and dealers increased their geographical reach as well as the types of commodities they bought and sold. They gathered commodities in one location and transported them to other locations where they were needed. These traders began to form clubs and affiliations as a result of their experiences. They established norms and laws governing the quality of traded commodities, standard quantities of traded commodities, delivery systems, storage, and travel, as well as methods of financing and payment resulting in Commodity exchanges and markets are contemporary and well-organized. These exchanges were used to trade not only raw or primary resources, but also finished goods, but derivatives contracts such as futures and options on commodities began to trade as well ([Prabina Rajib, 2014](#)).

India's commodity futures markets are still mainly undeveloped. This is despite the fact that, in comparison to the US and the UK, Commodity derivatives trading has been practised in the country for many years. The considerable government intervention in the agriculture sector throughout the post-independence era is a major factor to this reality. In actuality, the state still

controls the production and distribution of several agricultural commodities, and forwards and futures trading have just recently been permitted with strict regulatory oversight. The Essential Commodities Act (ECA) of 1955 still restricts free commerce in several commodities. The Forward Contracts (Regulation) Act (FCRA) of 1952 restricts forward and future contracts to particular commodities products ([AK Mishra, 2008](#)).

In India, there is a long history of commodity derivatives markets. “Bombay Cotton Trade Association Limited launched the first Cotton futures trading was first created in 1875”. Many other commodity exchanges began operating in different locations of India soon after the Bombay Cotton Exchange Limited began trading futures in other agricultural crops. Following that, “futures markets in edible oil seeds, raw jute, and jute products commodities” were established. ([Kolamkar, 2003](#); [Ahuja, 2006](#); [Prabina Rajib, 2014](#)). With the establishment of Gujarat vyapari mandali, a futures market for oilseeds such as groundnut, castor, and others were established in 1900. As a result, many new exchanges in Gujarat, Saurashtra, and Punjab began to provide contracts in oilseeds. Hapur's wheat futures market has been in operation since 1913. After that, it spread to various parts of “Punjab and Uttar Pradesh. Calcutta Hessian Exchange Ltd” was founded in 1919 with the goal of providing contracts for “raw jute and jute goods.” In 1927, the East Indian Jute Association Ltd began offering raw jute futures contracts. In 1945, these two companies merged to establish East India Jute & Hessian Ltd. In the year 1920, Bombay became the first city in the country to begin trading gold and silver futures. In 1957, the India pepper and spice trade organization was founded in Cochin, Kerala. Since 1957, it has operated continuously as a “futures exchange for black pepper and other spices”, respectively [Prabina Rajib \(2014\)](#), [Mukherjee \(2011\)](#), [Bhattacharya \(2007\)](#), [Srinivasan \(2012\)](#), [Inani \(2016\)](#), [Mahalik et al. \(2014\)](#), [Reddy and Sebastin \(2009\)](#), [Dummu, \(2009\)](#).

Following independence, the responsibility for regulating the commodity market was transferred to the central government. The “Forward Contracts Regulation Act”, 1952 was enacted by the Indian government in 1952, and the “Forward Market Commission” was established as the regulator. Only recognized associations are allowed to trade futures, according to the “Forward Contracts Regulation Act of 1952”. India's commodity futures markets were regulated by the “Forward Markets Commission (FMC)”. Commodity trading is permitted on 22 Indian exchanges, with six of them being national. The Forward Markets Commission (FMC).and “Securities and Exchange Board of India” (SEBI) combined on “September 28, 2015” to strengthen commodity futures market regulation. In 1953, the

“Forward Contracts (Regulation) Act of 1952” established the organization. Because food futures are traditionally traded in India, the organization was initially supervised by the “Ministry of Consumer Affairs, Food and Public Distribution”. In order to strengthen commodities derivatives trading in India, the forward market commission implemented a number of actions, respectively [Sharma and Malhotra \(2015\)](#), [Chakrabarty and Das \(2010\)](#), [Inani \(2016\)](#), [Mahalik et al. \(2014\)](#), [Reddy and Sebastin \(2009\)](#), [Dummu \(2009\)](#).

3.3. Committees of Experts on the Indian Commodity Derivatives Market

Following independence, the Indian government established numerous committees to give policy guidance to the Indian commodity derivatives market. In 1950, the Indian government's Ministry of Commerce formed an expert group, which was chaired by Shri. A.D. Shorff. In response to the committee's findings, the Forward Contracts Regulation Act of 1952 was adopted. According to the Act, the Forward Market Commission was founded in 1953. In “February 1966, the Indian government established a committee to investigate the role of the forward market, chaired by Prof M.L. Dantwala”. Despite the necessity of commodities forward trading being underlined by the committee. The government of India has outright banned commodity trading. Prof. A.M Khusro was appointed chairman of the Ministry of Commerce, Civil Supplies, and Cooperation in 1980. Commodity derivative trading should be reintroduced in India, according to the committee. The committee's purpose, which was chaired by Prof. K. N. Kabra in 1994, was to assess the functioning of India's commodity markets and provide recommendations to make them comparable to those in other countries. The criteria to strengthen and promote agricultural marketing were evaluated by an expert committee on national agricultural policy in 2000, led by Shri Shankarlal Guru. The Indian government issued notifications allowing commodity futures trading but not commodity options trading, based on the committee's recommendations. The government of India expressed its desire to develop futures trading in agricultural commodities to avoid price swings at the expert committee on national agricultural policy in 2000. In April 2003, the Indian government issued a notification allowing “futures trading in a wide range of commodities”. “An expert committee was formed in 2007 to investigate the impact of futures trading on agricultural commodities” with Prof Abhijit Sen as its chairman. Two panels, the kabra committee and the expert committee established by the National Agricultural Policy of 2000, deserve special note because their suggestions cleared the way for organized commodities trade in India.

These two committees' reports influenced the establishment of “three national multi-commodity exchanges in India”. The following 3 exchanges are

1. “National Multi-Commodity Exchange of India Ltd. (NMCE)”
2. “National Commodity and Derivative Exchange Ltd (NCDEX)”
3. “Multi Commodity Exchange of India Ltd (MCX)”

“NMCE began operations in 2002, while NCDEX and MCX began operations in 2003”. In 2009, the fourth commodities exchange in India is located at the national level. began operations. In India, there are many regional commodity markets in addition to the national level markets. All of these regional commodity markets focus on one or two commodities or commodity categories. In India, all commodities exchanges must be registered with the “Forward Market Commission” of India. The “Forward Market Commission works under the auspices of the Indian government's Ministry of Consumer Affairs, Food, and Public Distribution”.

3.4. “Multi Commodity Exchange of India Ltd (MCX)”

The "Multi Commodity Exchange of India Ltd. (MCX)" is a self-regulating commodity exchange based in Mumbai that was founded in 2003. In the year 2003, the "MCX" was designated as an "Electronic Commodity Futures Exchange." This is a demutualized transaction that has been recognized by the community for a long time. "Government of India" to make online commodity futures trading, clearing, and settlement more accessible across the nation. Over 88 percent of the "Indian Commodity Futures Market" is controlled by MCX. The financial exchange has around 2,590 listed members who operate through over 3, 47,000 "CTCL" trade terminals located in 1,577 cities and towns across India. On its platform, "MCX" offers over forty commodities across several segments such as "Bullion," "Ferrous" and "Non-ferrous metals," "Energy," and a number of "Agriculture Commodities." With respect to the number of futures contracts traded, the exchange is the largest in the world for "Silver" and "Gold," second in "Natural Gas," and third in "Crude Oil." ISO 9001:2008 "Quality Management System Standards," ISO 14001:2004 "Environmental Management System Standard," and ISO/IEC 27001:2005 "Information Security Management System Standard" have all been awarded to MCX. "London Metal Exchange," "New York Mercantile Exchange," "LIFFE Administration and Management," "Baltic Exchange Limited," "Shanghai Futures Exchange," and "Taiwan Futures Exchange" are among the international exchanges with whom MCX has strategic alliances.

3.5. “National Commodity & Derivatives Exchange Limited (NCDEX)”

The Companies Act of 1956 established "NCDEX" On April 23, 2003, the organization became a public limited company. 2003. “NCDEX (National Commodity & Derivatives Exchange Limited)” is a well-managed multi-commodity on-line exchange. The "NCDEX" is the country's only commodity exchange backed by national institutions. "National Level Institutions," "Public Sector Banks," and "Firms" are among NCDEX's stockholders. "ICICI Bank Limited (ICICI)," "Life Insurance Corporation of India (LIC)," "National Bank for Agriculture and Rural Development (NABARD)," and "National Stock Exchange of India Limited” (NSE) are among the major sponsors and shareholders. There are 34 commodities traded on the market, including 23 "Agricultural Commodities," 6 "Precious Metals," 2 "Energy Products," 1 "Polymer," and 2 other metals.

3.6. “National Multi Commodity Exchange of India Limited (NMCE)”

The "NMCE" was established in 2002 and is India's first demutualized "Multi- Commodity Exchange." The "National Multi Commodity Exchange of India Ltd" (NMCE) was approved by commodity-related government agencies, viz., “Central Warehousing Corporation” (CWC), “National Agricultural cooperative Marketing Federation of India” (NAFED), “Gujarat Agro-Industries Corporation Limited” (GAICL), “Gujarat State Agricultural Marketing Board” (GSAMB), “National Institute of Agricultural Marketing” (NIAM), and “Neptune Overseas Limited” (NOL). On November 26, 2002, the "National Multi Commodity Exchange of India Ltd" (NMCE) began national futures trading in 24 commodities, and by the end of October 2009, the "NMCE" had posted "Futures Contracts" on 44 different commodities and had over 300 trading links. the range of commodities has grown significantly since then to include "Cash Crops," "Food Grains," "Plantations," "Spices," "Oil Seeds," "Metal," and "Bullion," between others.

3.7. “Universal Commodity Exchange Ltd. (UCX)”

The "Universal Commodity Exchange Ltd." (UCX) became India's 6th national commodity exchange in 2012. "IDBI Bank," "IFCO," "NABARD," "REC," and "Commex Technology Ltd" are all promoting "UCX." On April 19, 1930, it began operations with eleven contracts in nine commodities. Futures trading in "gold," "silver," "crude oil," "rubber," "mustard seed," "soyabean," "chana," and "turmeric" is made easier by the exchange.

3.8. Indian Commodity Exchange Ltd (ICEX)

The "Indian Commodity Exchange Ltd" (ICEX) was founded in 2009. It is India's online derivative exchange, which has been recognized as a transparent, tried-and-true trading platform. "India Bulls Financial Services Ltd.", "Reliance Exchange Next Infrastructure Ltd.", "MMTC Ltd., Indian Potash Ltd.", "KRIBHCO" and "HDFC bank" have all approved it. It offers warehousing facilities to make physical deliveries easier. The exchange is perfectly positioned to take use of the immense potential of the commodities market and to encourage genuine users to participate in order to take advantage of the commodities markets' hedging and risk management options.

3.9. Ace Derivatives and Commodities Exchange Ltd. (ACE)

On October 26, 2010, India's 5th national commodities exchange, "Ace Derivatives and Commodities Exchange Ltd" (ACE), was launched. The market currently offers contracts on castor seeds, soya beans, and mustard seed, with hopes to expand to include metals, energy, and spices in the future. "Kotak Mahindra Group," "HAFED," "Bank of Baroda," "Corporation Bank," and "Union Bank of India" are among the sponsors. Two hundred and thirty people have signed up for the exchange around the country.

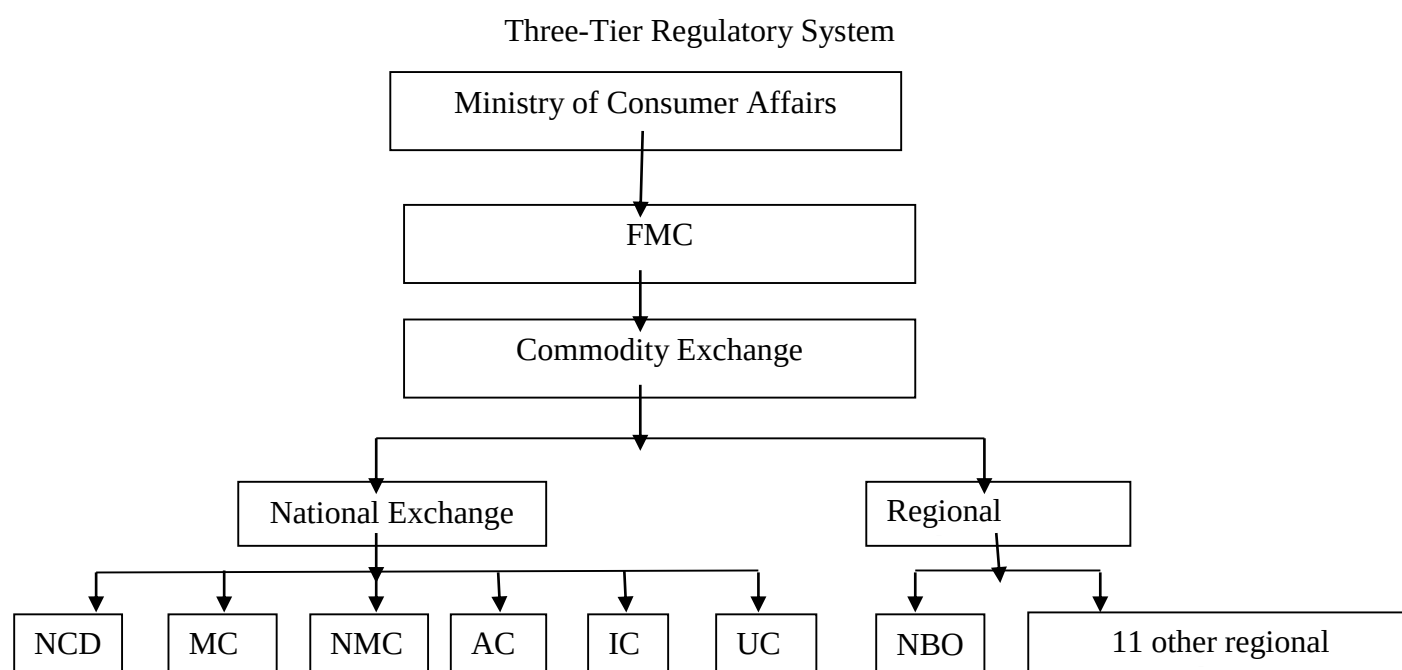
3.10. “Commodity Futures Trading in India”: A Regulatory Framework

The “Forward Market Commission (FMC)” was established as a statutory regulatory entity under the “Forward Contract (Regulation) Act of 1952”. Associations that organize forward trading must apply for FMC recognition, and the Commission must approve the association's rules and bylaws. Approving appropriate contract designs, setting price limitations, “trade margin requirements, open interest limitations, and clearing and settlement of contracts” were all part of the market's regular control. It is required that trade details be reported to the FMC on a daily basis. The causes of unusual market behaviour are fully investigated in order to take corrective measures in order to safeguard the integrity of the market and the financial system. Any infractions of the 64 regulations or attempts to manipulate the market are scrutinized, and participants can only be banned or prevented from trading (as the commodity exchanges have done). However, the “Forward Contract (Regulation) Amendment Bill 2007” includes provisions for monetary penalties for regulatory infractions and market misuse. The autonomy of the regulator, as envisioned in the Amendment Bill, will allow it more power and flexibility to intervene in the market more efficiently and rapidly in the event of a mistake. These adjustments will allow the regulator to maintain market discipline and build faith in the

market's fairness and efficiency ([Commission of Experts, 2008](#)). The Forward Contract (Regulation) Act of 1952 outlines a three-tiered regulatory structure.

1. The exchange that organizes commodity forward trade has the authority to regulate day-to-day trading.
2. Under the authorities given to it by the union government, the Forward Markets Commission performs regulatory control. And
3. The ultimate regulatory authority is the “union government's Department of Consumer Affairs, Ministry of Consumer Affairs, Food and Public Distribution”.

Since 2003, when the “Government of India” approved the establishment of multiple exchanges, India has made significant progress in the commodity derivatives industry. India now has 22 commodity markets, with six of them being multi-commodity exchanges at the national level and the others are regional commodity exchanges. The list is as follows:



Concerns regarding the FMC's empowerment and the amendment of the "Forward Contracts (Regulation) Act, 1952" emphasized the need for a more robust and well-planned regulatory structure from the start. Despite this, commodity futures trading on internet commodities exchanges was allowed without the FMC being sufficiently strengthened or a functioning regulatory structure in place ([Sahadevan, 2012](#)). As a result, rather of preventing problems, the FMC has been able to manage them once they occur. Some market participants took advantage of this and attempted to manipulate markets, resulting in high volatility in futures market prices for some commodities ([Lingareddy, 2015](#)).

Given these issues, there has been a suggestion to integrate FMC and SEBI for over a decade, since the inception of futures trading in 2003-04. Finally, the union finance minister recommended merging the FMC and SEBI in the 2015-16 budget. FMC's troubles are expected to be solved as a result of the merger. With effect from September 28th, 2015, the “Forward Market Commission merged with the Securities and Exchange Board of India (SEBI)”. India's commodity futures trading is currently regulated by SEBI.

3.11. Commodity Profiles

3.11.1. Profile of Mentha oil

Mentha oil is a fragrant herb also known as “Pudina” in India. “Mentha oil” is made by distilling the leaves of *Mentha arvensis*. The “Regional Research Laboratory, Jammu Tawi, was the first to introduce it in India between 1958 and 1964”. Mentha oil is available in two forms: crystals and flakes. It comes in a variety of sizes and shapes, including large, medium, small, and flakes as powder. Pharmaceuticals, Ayurveda, mouth fresheners, toothpaste, and unani medications, pan masala, pain balm, and cosmetics, as well as the fragrance business, all use mentha oil crystals. Every year, it is sown in February or March, and it takes 90 days to mature and produce its first flower. Crop harvesting takes place in May and June after that. It is widely planted in India and is grown in semi-arid climates; its leaves are used in most families to make sauces and chatni. “India is the world's top producer and exporter of Mentha oil”. India, China, Brazil, and the United States are currently the world's top producers of Mentha oil.

The “food, pharmaceutical, fragrance, and flavouring” sectors all use “mentha oil” and its derivatives. According to CSIR-CIMAP, India produced 30000 tons of mentha oil in 2015-16, 32,000 tons in 2016-17, 35000 tons in 2017-18, 37000 tons in 2018-19, and 37000 tons in 2019-20. For the previous five years, India has exported from 15000 to 20000 tonnes of mentha oil and derivatives per year. Cold waves and heavy rains are common weather events that wreak havoc on leaf output. During the harvest season, the amount of individuals who arrive. The demand for pharmaceuticals in the United States often increases in the winter. The demand for exports in importing countries.

3.11.2. Seasonality

Mentha cuttings are planted in December and harvested in March and April. Processing and steam distillation are used to obtain Mentha Oil from mint leaves. It is released in the months of June and July. Mentha can be cut two or three times in one season after it is planted.

3.11.3. Contract specification

The most crucial aspect of commodity trading is contract specificity. Mentha oil is currently traded on the Multi Commodity Exchange. MENTHAOILMMYY is its description. According to the contract launch calendar, contracts are available for trading in June, July, August, and September of each year. From Mondays to Saturdays, this will be traded. The base value is 1 kilogramme, while the minimum trading unit is 360 kg, or 2 drums. Mentha oil has a maximum order quantity of 18000 kg and a tick size of 10 paise. The starting margin is 5%, with a maximum permissible open position of 300 MT for individual clients and 1500 MT or 15% of the market wide open position for member clients, whichever is larger. The minimum delivery unit is 360 kg, with a 25% delivery period margin. Chandausi is the main delivery center, whereas Barabanki is the secondary delivery center. When it comes to Mentha oil futures contracts, delivery is required at the contract's end.

3.12. Profile of Jeera

Jeera (Jeeraum Cyminum), popularly known as Cumin, is an herb seed. Jeera's origins can be traced back to the Levant and Upper Egypt. The Egyptians introduced jeera to the rest of the globe in 5000 BC. In the Middle East and India, jeera is used to flavour tasty recipes. Cumin seed is commonly used as a spice in India. It is also utilized as a component in the production of medications and perfumes. Jeera's flavour can also be found in Mexican, Portuguese, and Spanish recipes. India has the distinction of being the world's largest producer and consumer of jeera. Jeera is one of the most widely traded spices, accounting for up to ten percent of overall export value. "India is the world's largest Jeera exporter, producer, and consumer. Jeera is planted between October and November and harvested between February and May". As a result, beginning in March, the markets are overwhelmed with Jeera. Weather, output, export and domestic demand, worldwide pricing, and carryover stock all have an impact on Jeera markets. Cumin prices are seasonal, based on demand from both domestic and international markets. Between December and February, when demand starts to pick up, prices begin to rise, and these are the months when the overall estimate of crop arrival is calculated. Following that, prices skyrocket between July-August as export chances are seized. This is followed by a period of moderation from October to November, when the new agricultural season begins. Cumin is the most traded and liquid spice commodity, with a volume of trade of INR 55,982.69 trillion in 2011-2012, respectively ("Forward Market Commission, 2012"). "The spice group (chilli, cumin, pepper, and turmeric) has a weight of 17.42 in the NCDEX platform's Dhanya commodity futures index, with pepper and cumin having 3.11 and 4.33 weights, respectively".

Pepper has a systemic risk of 0.68 and cumin has a systemic risk of 1.51 (“NCDEX Institute of Commodities Market and Research Report, 2011”).

3.12.1. Seasonality

The jeera crop's seasonality. Jeera is a Rabi crop that grows for 120 to 150 days and is planted between October and November. Jeera is picked when the plants turn yellowish brown in February and March. The third most popular spice in the export basket is cumin. Cumin exports account for almost 18% of total exports. Cumin exports totaled 2, 10,000 tonnes worth Rs.3225 crore in fiscal year 2019–20, up from 1, 80,300 tonnes worth Rs.2884.80 crore the previous year, marking a 16 percent increase in volume and a 12 percent increase in value. The Board's mandatory sample method contributed in the acceptance of Indian cumin in the worldwide market, resulting in years of consistent growth. China is India's largest cumin importer, accounting for over a quarter of the country's total cumin exports. Other main buyers of Indian cumin include Bangladesh, the United States, Afghanistan, Egypt, and the United Arab Emirates, which account for more than 60% of total export volume.

3.12.2. In the global and India scenario.

China, Iran, Latin America, Syria, Turkey, and India are all productive producers of jeera. In both consumption and production, India ranked 1. Iran, Syria, and Turkey produce between 5300 and 9800 tonnes per year, 7400 tonnes per year, and 6300 to 14800 tonnes per year, respectively. In India, the harvesting season for jeera is from February to March, but in other parts of the world, it is from June to July. Such a temporal difference provides India with a better return in order to maximise earnings. Delhi, Jaipur, Gujarat, and Rajkot are the key commercial centres for jeera in India. Because jeera is harvested in February and March in India, it attracts more attention than other countries because to the delay in arrival schedule. India's biggest export destinations include the United States, Malaysia, and Nepal in the United Kingdom.

3.12.3. Contract Specification

Jeera was first introduced by NCDEX in February 2004. Since its beginning, trading volumes and price fluctuation have increased rapidly. NCDEX issues Jeera contracts for six months in March, April, May, June, July, and August. The major trading centres for jeera are Gujarat, Delhi, and Jodhpur.

3.12.4. Profile of Barley

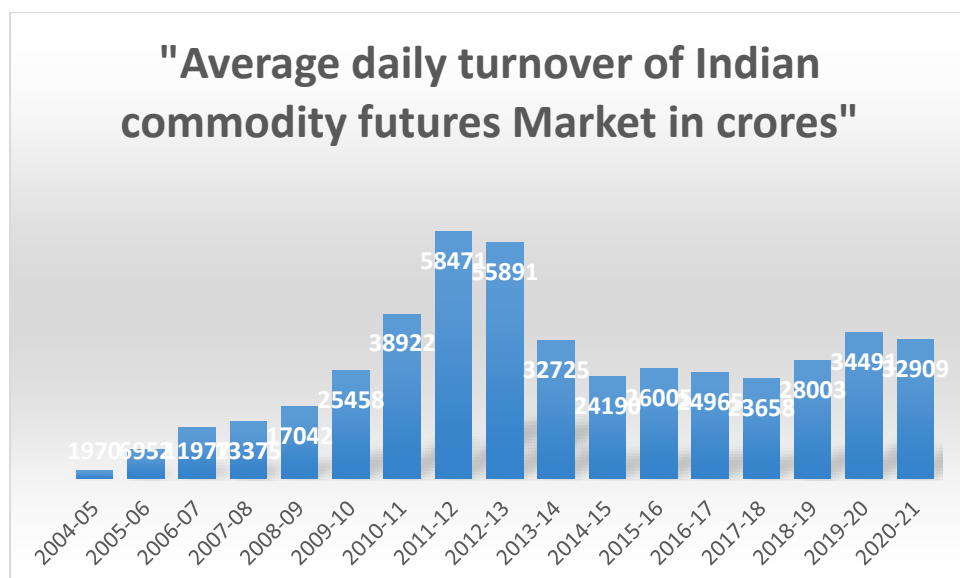
One such commodity is barley, which is a major ingredient in the production of beer. A considerable portion of India's barley output is used for industrial purposes. Barley is a cereal grain that grows every year and is produced from the yearly grass *Hordeum vulgare*. It is in high demand and is mostly used as a food and feed for animals. In India, it's harvested during the Rabi season. Barley is used in a variety of ways, such as a base malt for beer, animal feed, and a component in a variety of health foods. It may be cultivated in nearly every type of weather. It thrives in practically any climate. There are many cereal grains, but barley comes in fourth place, behind maize, wheat, and rice, in terms of cultivation area and output volume. Barley is mostly used as a feed and food for cattle. The leaves of the Barley grass are flowery and densely spiked, and when fully matured, they reach a height of 60 to 120 cm. The crop looks like white berries and is considered an ideal crop for drought-prone areas. Sowing begins in October and continues through December, with reaping occurring in March and April. The states of Uttar Pradesh, Rajasthan, and Madhya Pradesh produce the majority of the country's goods.

Table 3.1 Average daily turnover of Indian commodity futures Market (Rs. Crore)

Year	Crore
2004-05	1970
2005-06	6952
2006-07	11977
2007-08	13375
2008-09	17042
2009-10	25458
2010-11	38922
2011-12	58471
2012-13	55891
2013-14	32725
2014-15	24190
2015-16	26005
2016-17	24965
2017-18	23658
2018-19	28003
2019-20	34491
2020-21	32909

Source: MCX

Figure 3.1. Average daily turnover of Indian commodity futures Market (Rs. Crore)



The figure 3.1. depicts the encouraging policy environment and the exchanges' persistent efforts to reach out to diverse stakeholders in the commodity value chain have given Indian commodity derivatives markets a strong impetus in their growth and development, with a robust increase in their average daily turnover over the last two years or so. Initiatives to develop domestic price benchmarks for base metals, allowing mutual funds and portfolio management services to trade in commodity derivatives, allowing custodial services for commodities, and allowing trade in commodity index futures are just a few of the significant measures taken in the last year. The average daily turnover (ADT) of commodities futures on domestic derivatives markets increased by 18% in 2018-19 compared to the previous year, the largest year-on-year increase since 2012-13. While the increase is significant in terms of scale, the average daily trading volumes in 2018-19 are approaching those seen previous to the implementation of the commodities transaction tax. The Multi Commodity Exchange of India (MCX) made a significant contribution to the increase in volumes, as the ADT on the exchange increased by almost 21% to around 25,648 crores in 2018-19. During the previous two years, the “Average Daily Turnover” (ADT) of commodities futures fell by nearly 5% to Rs.32, 909 crore from Rs.34, 491 crore ([Commodity Insights year book 2021, 2020, 2019 and 2018](#)).

Table 3.2 Data used for the analyzing the for specific objectives

Sl. No	Commodities	Time Period	Near month
1	Wheat	2010-2019	Near month
2	Barley	2010-2019	Near month
3	Jeera	2010-2019	Near month
4	Crude palm oil	2010-2019	Near month
5	Mentha oil	2010-2019	Near month

Source: NCDEX, MCX

3.13. Commodity Price Behavior's Characteristics

The primary goal of this part is to examine the features of the various commodities under consideration. We look at commodities in the research such as wheat, jeera, barley, mentha oil and crude palm oil.

3.13.1. Combined (Spot-Future) Time Series Plots

Figure 1. Spot and Futures Prices of wheat

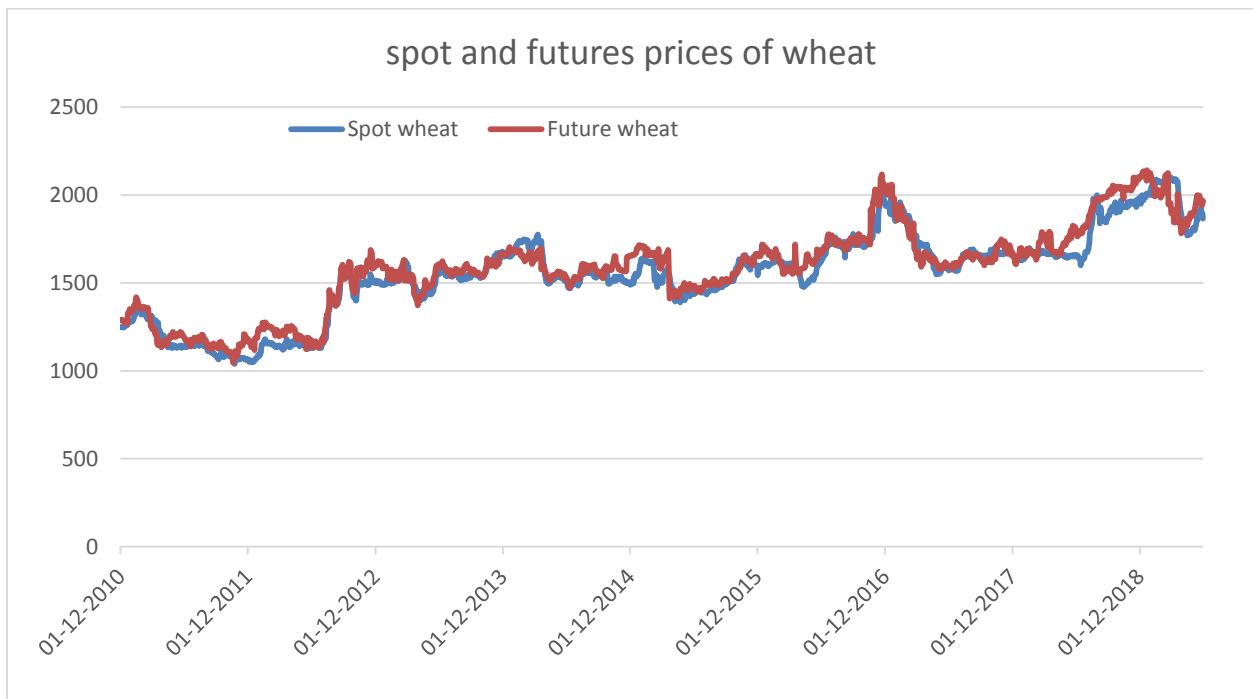


Figure. 1 depicts the spot and future wheat prices in NCDEX from 2010 to 2019. It illustrates that the wheat spot and future prices have an upward and downward trend. The prices were fluctuating over a period of time. Indicates the log values of wheat “spot and futures prices” which shows the existence of break point or outlier in the series. Based on the above figure we can say that there is no break point or outlier in the wheat “spot and future prices”.

Figure 2. Spot and Futures Prices of Barley

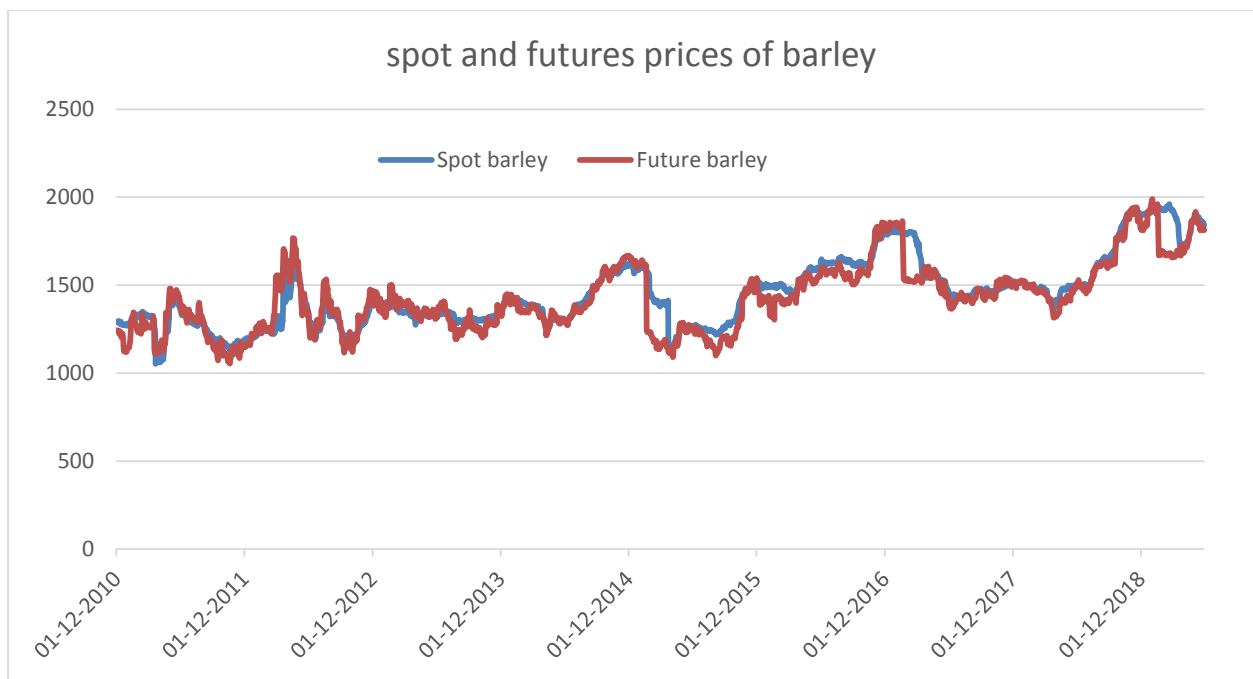


Figure 2. Depicts the spot and future barley prices in NCDEX from 2010 to 2019. It illustrates that the barley spot and future prices have an upward and downward trend. The prices were fluctuating over a period of time. Indicates the log values of barley “spot and futures prices” which shows the existence of break point or outlier in the series. Based on the above figure we can say that there is no break point or outlier in the barley “spot and future prices”.

Figure. 3. Spot and Futures Prices of Mentha Oil

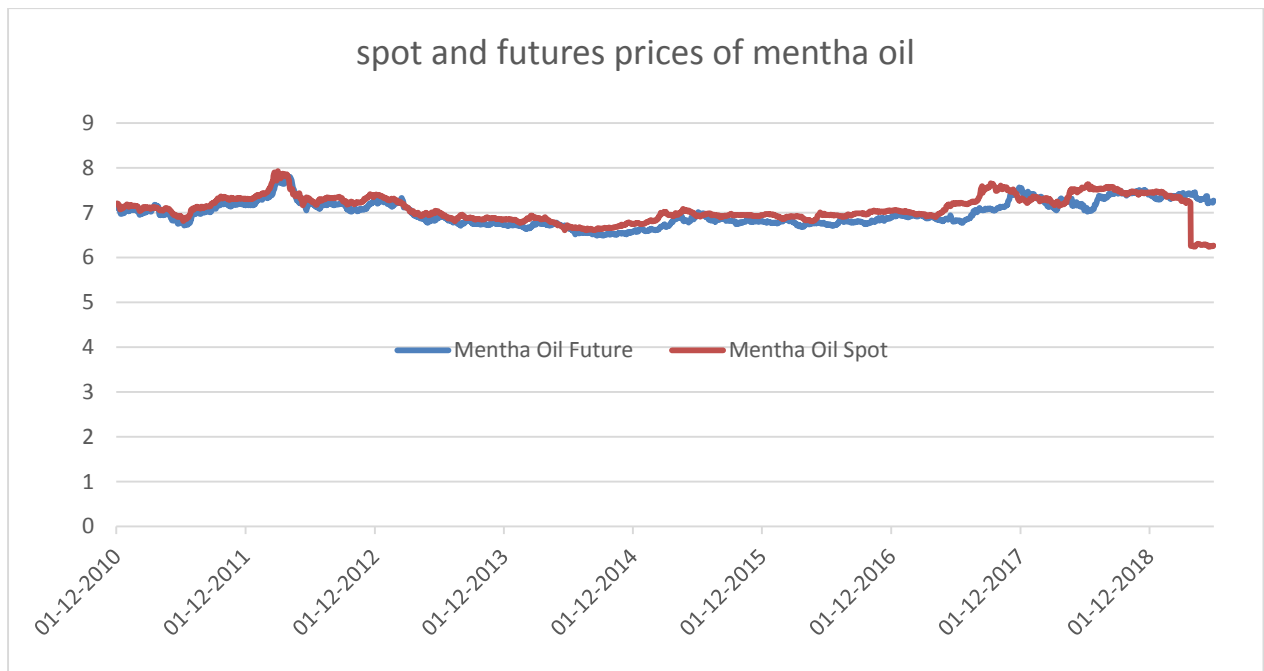


Figure 3. Depicts the spot and future barley prices in MCX from 2010 to 2019. It illustrates that the mentha oil spot and future prices have an upward and downward trend. The prices were fluctuating over a period of time. Indicates the log values of mentha oil “spot and futures prices” which shows the existence of break point or outlier in the series. Based on the above figure we can say that there is no break point or outlier in the mentha oil “spot and future prices”

Figure. 4. Spot and Futures Prices of Jeera

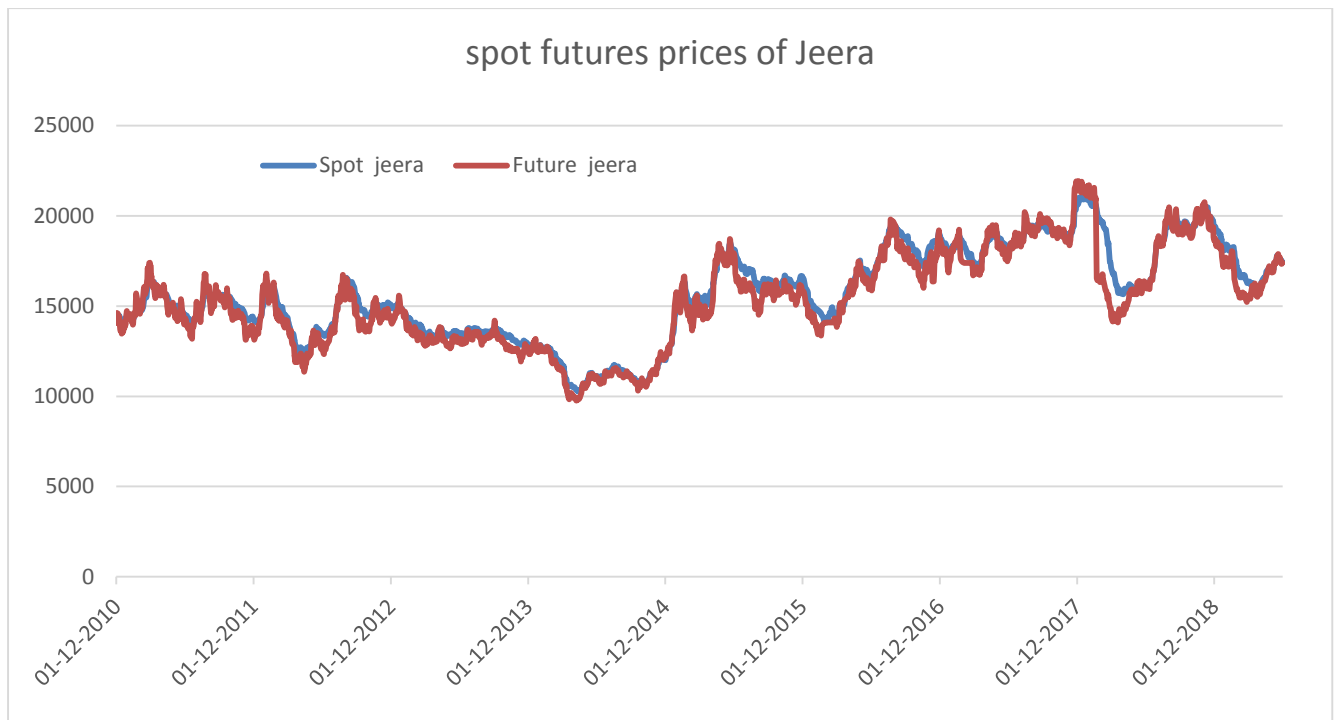


Figure 4. Depicts the spot and future jeera prices in NCDEX from 2010 to 2019. It illustrates that the jeera spot and future prices have an upward and downward trend. The prices were fluctuating over a period of time. Indicates the log values of jeera “spot and futures prices” which shows the existence of break point or outlier in the series. Based on the above figure we can say that there is no break point or outlier in the jeera “spot and future prices”.

Figure. 5. Spot and Futures Prices of Crude Palm Oil

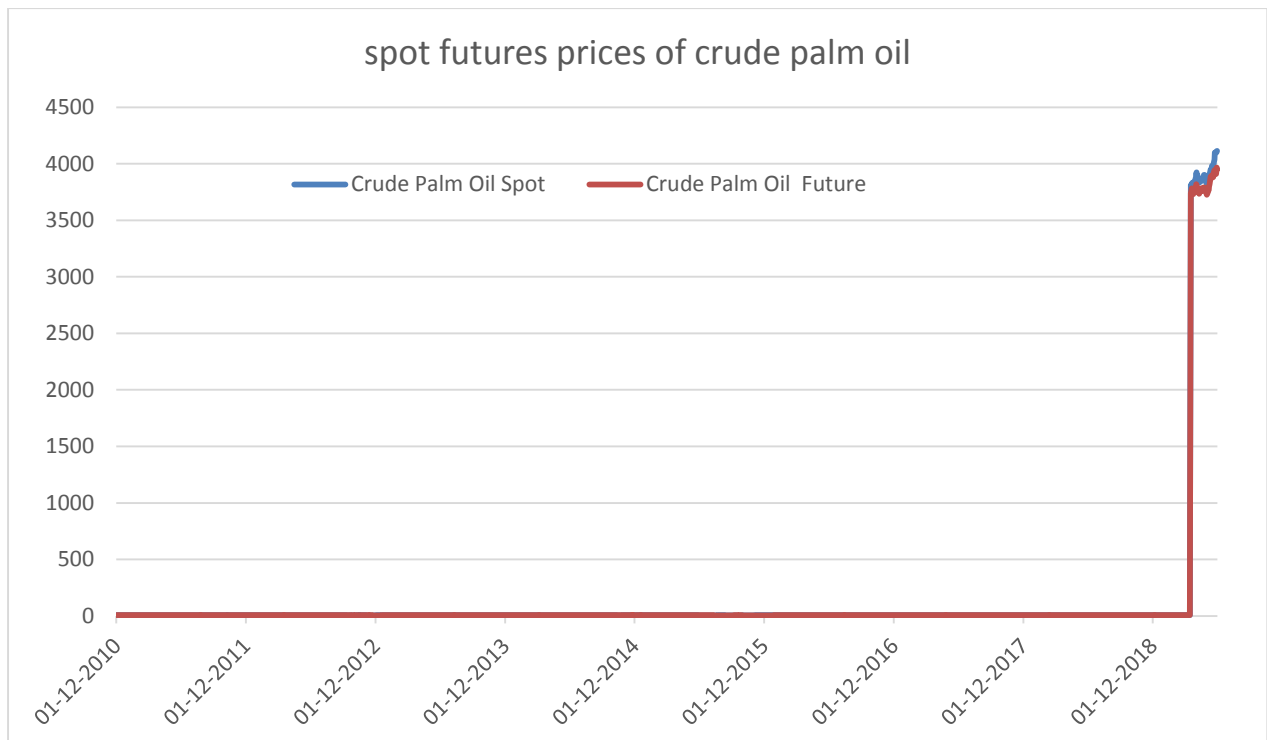
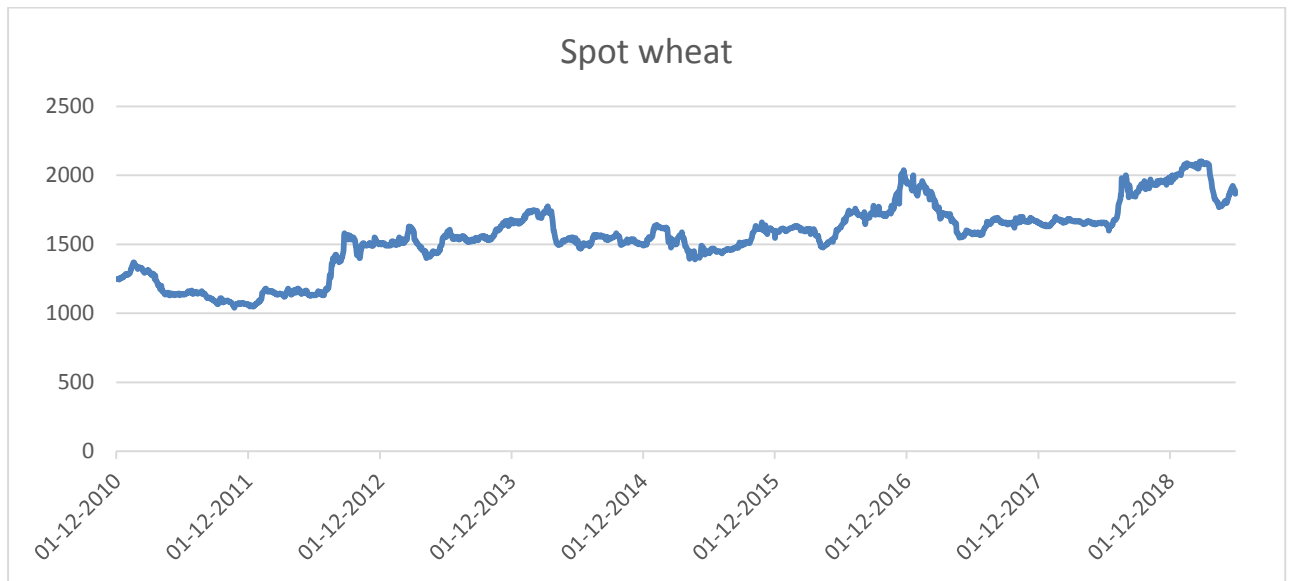


Figure 5. Depicts the spot and future jeera prices in MCX from 2010 to 2019. It illustrates that the “crude palm oil spot and future prices” have an upward and downward trend. The prices were fluctuating over a period of time. Indicates the log values of crude palm oil “spot and futures prices” which shows the existence of break point or outlier in the series. Based on the above figure we can say that there is no break point or outlier in the crude palm oil “spot and future prices”.

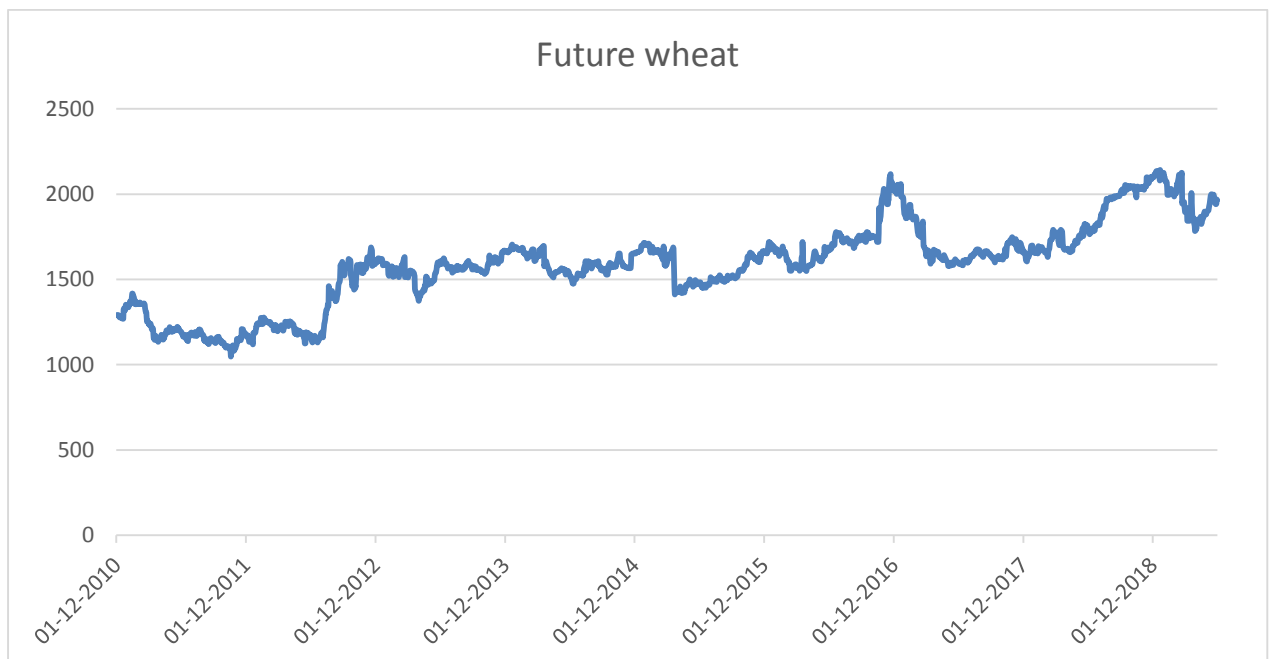
3.13.2. Individual Spot-Future Prices of Time Series Plots

Figure 1. Spot prices of wheat



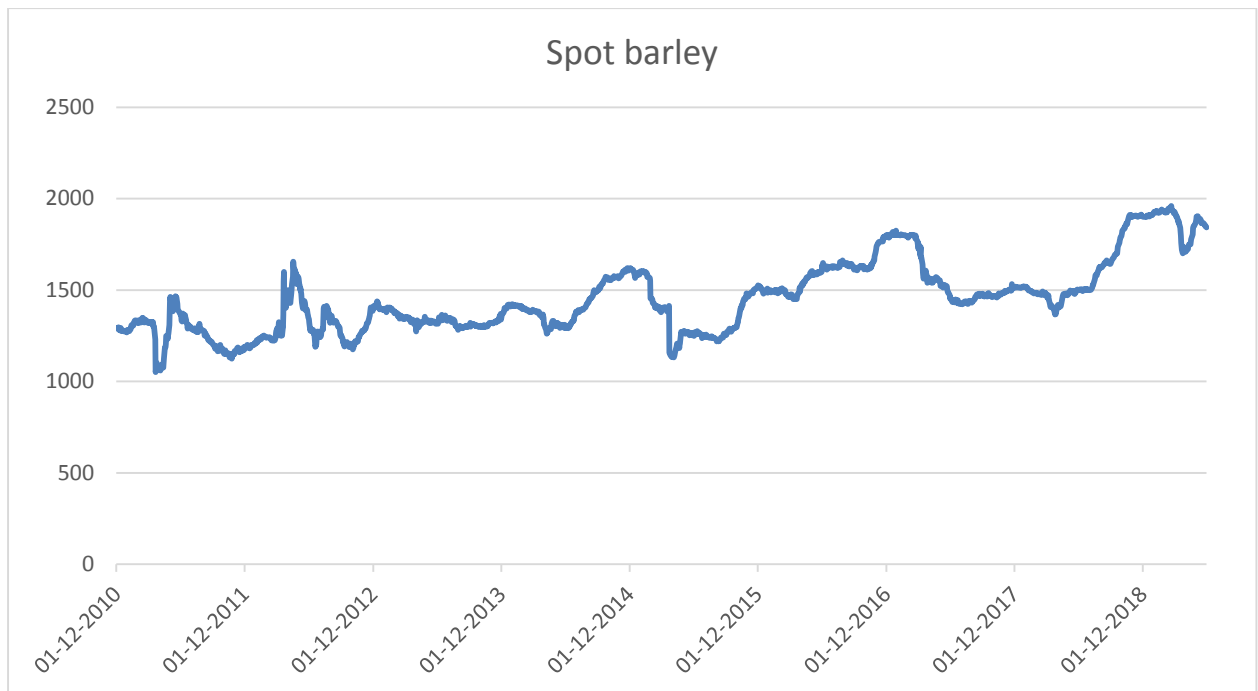
The Figure 1. Indicates the log values of wheat spot prices which show the existence of break point or outlier in the series. Based on the above figure we can say that there is no break point or outlier in the wheat spot prices.

Figure 2. Future Prices of wheat



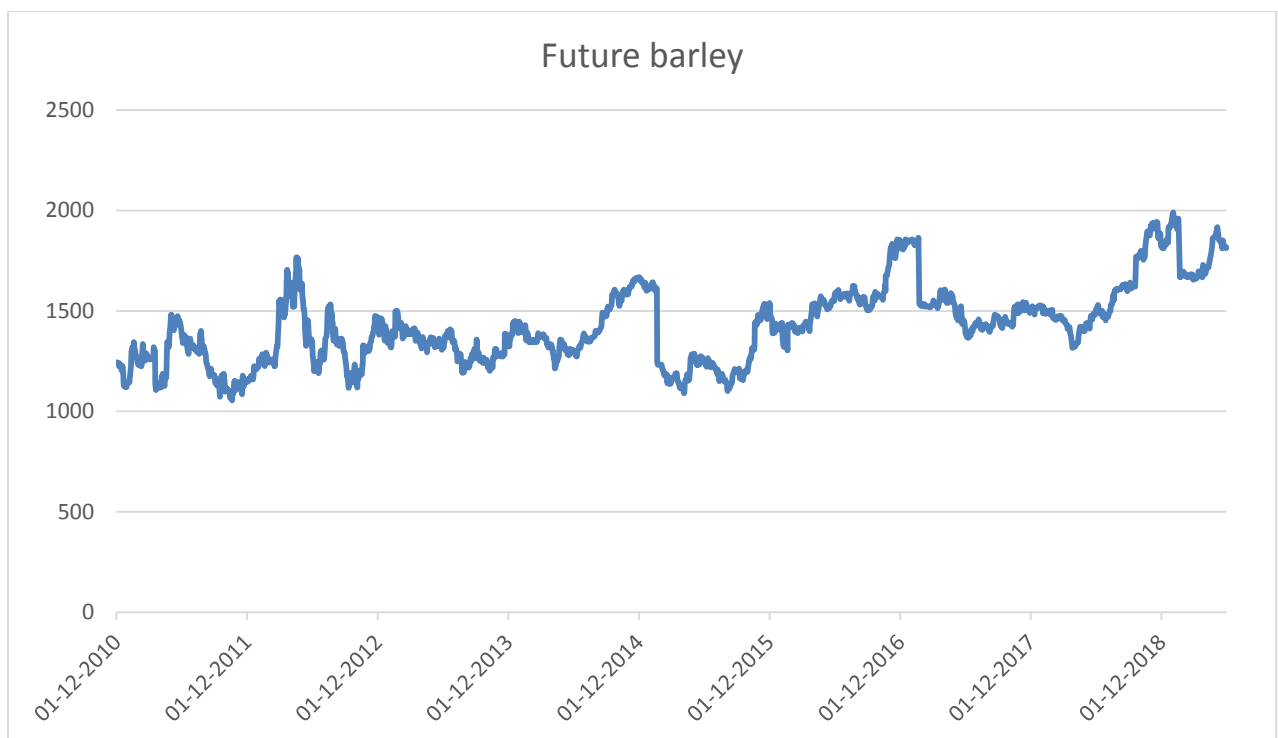
The Figure 2. Indicates the log values of wheat future prices which show the existence of break point or outlier in the series. Based on the above figure we can say that there is no break point or outlier in the wheat future prices.

Figure 3. Spot prices of Barley



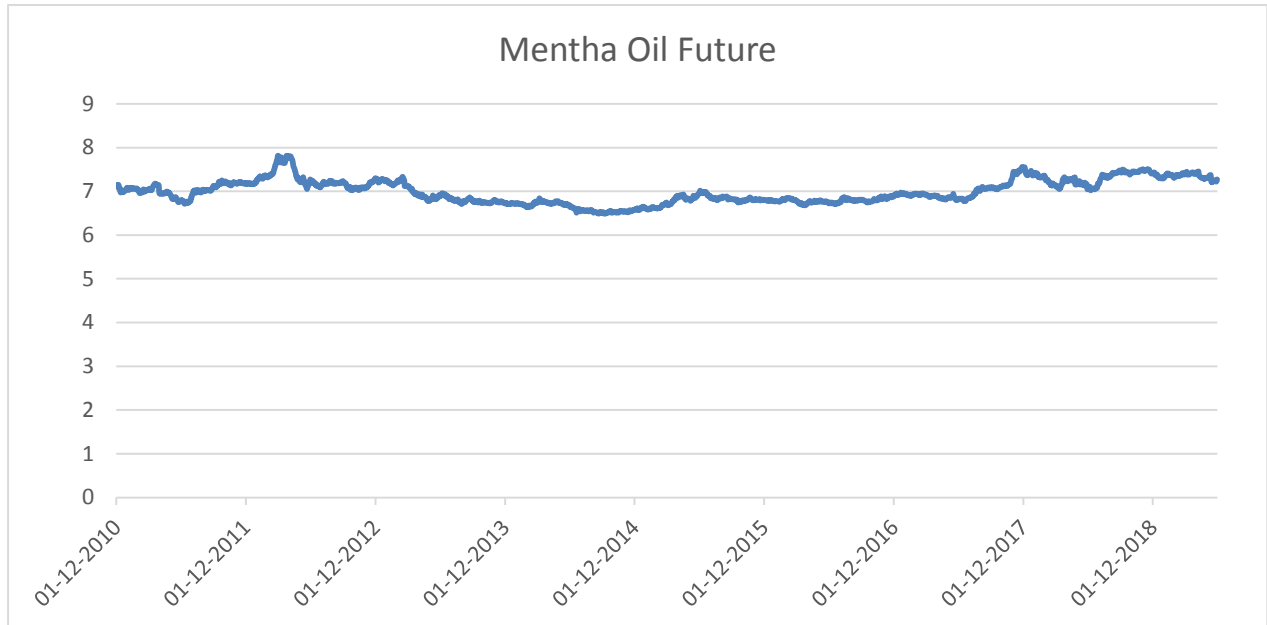
The Figure 3. Indicates the log values of barley spot prices which show the existence of break point or outlier in the series. Based on the above figure we can say that there is no break point or outlier in the barley spot prices.

Figure 4. Future prices of Barley



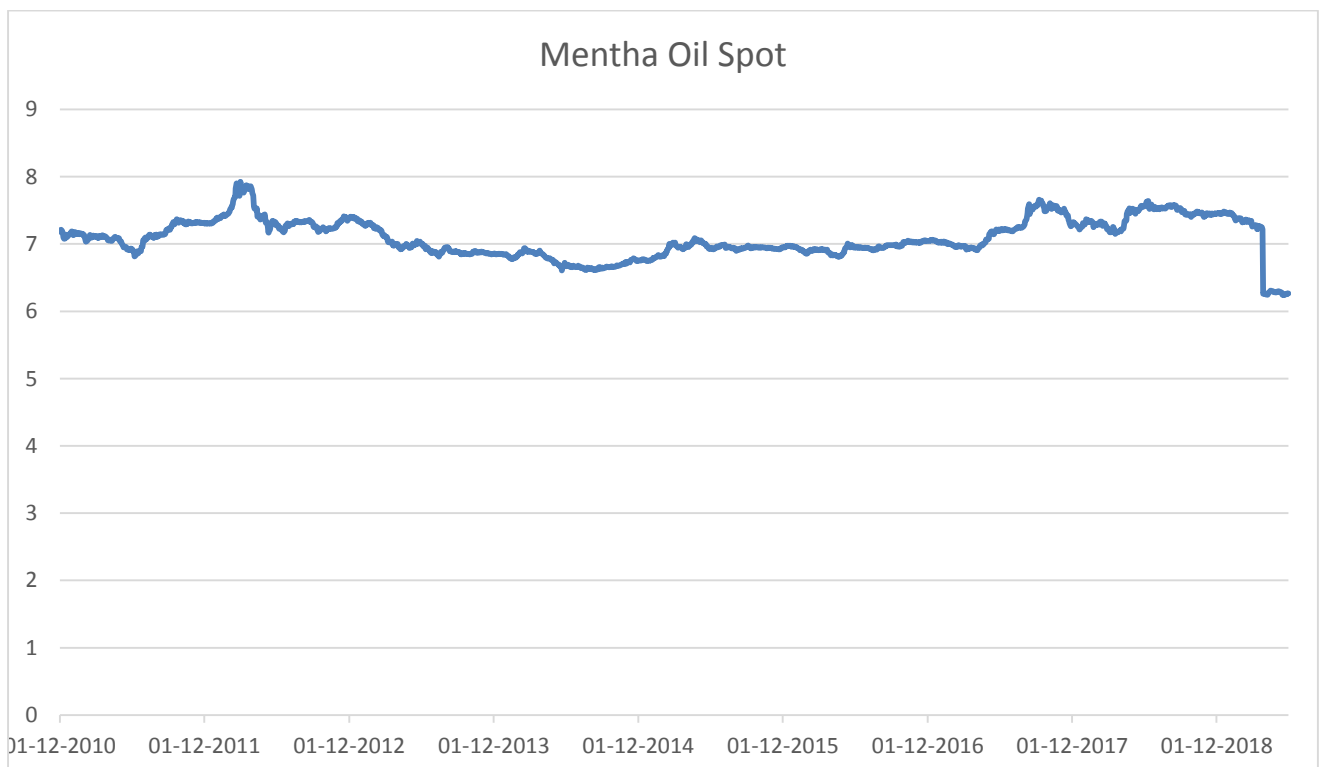
The figure 4. Indicates the log values of barley future prices which show the existence of break point or outlier in the series. Based on the above figure we can say that there is no break point or outlier in the barley future prices.

Figure 5. Future prices of Mentha Oil



The Figure 5. Indicates the log values of mentha oil future prices which show the existence of break point or outlier in the series. Based on the above figure we can say that there is no break point or outlier in the mentha oil future prices.

Figure 6. Spot prices of mentha oil



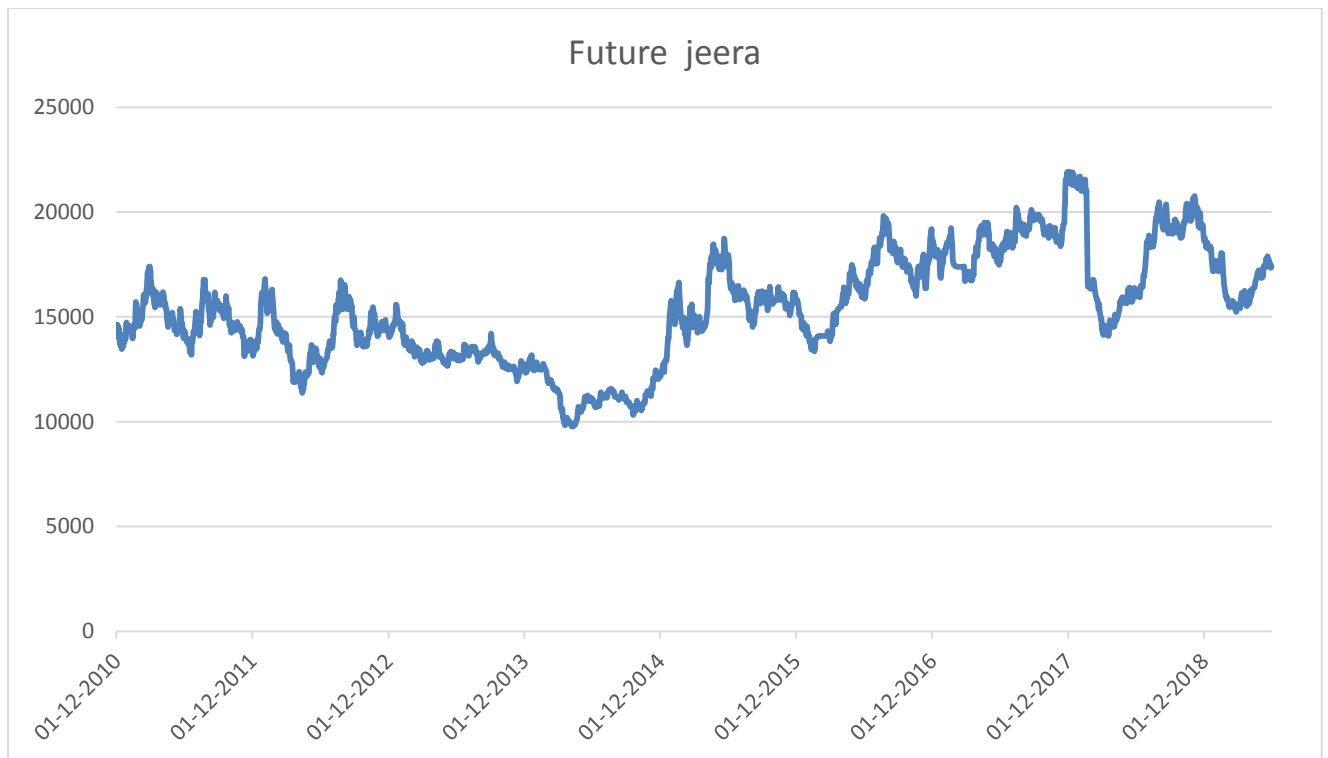
The figure 6. Indicates the log values of mentha oil spot prices which show the existence of break point or outlier in the series. Based on the above figure we can say that there is no break point or outlier in the mentha oil spot prices.

Figure 7. Spot prices of Jeera



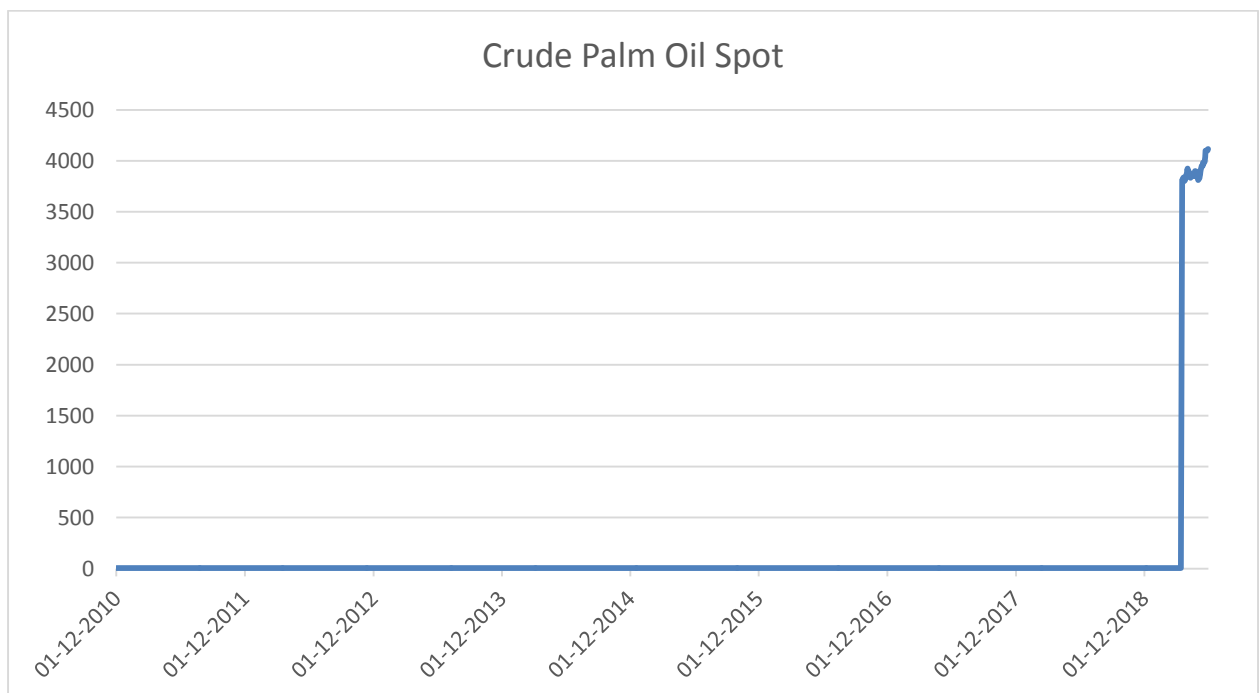
The figure 7. Indicates the log values of jeera spot prices which show the existence of break point or outlier in the series. Based on the above figure we can say that there is no break point or outlier in the jeera spot prices.

Figure 8. Futures prices of Jeera



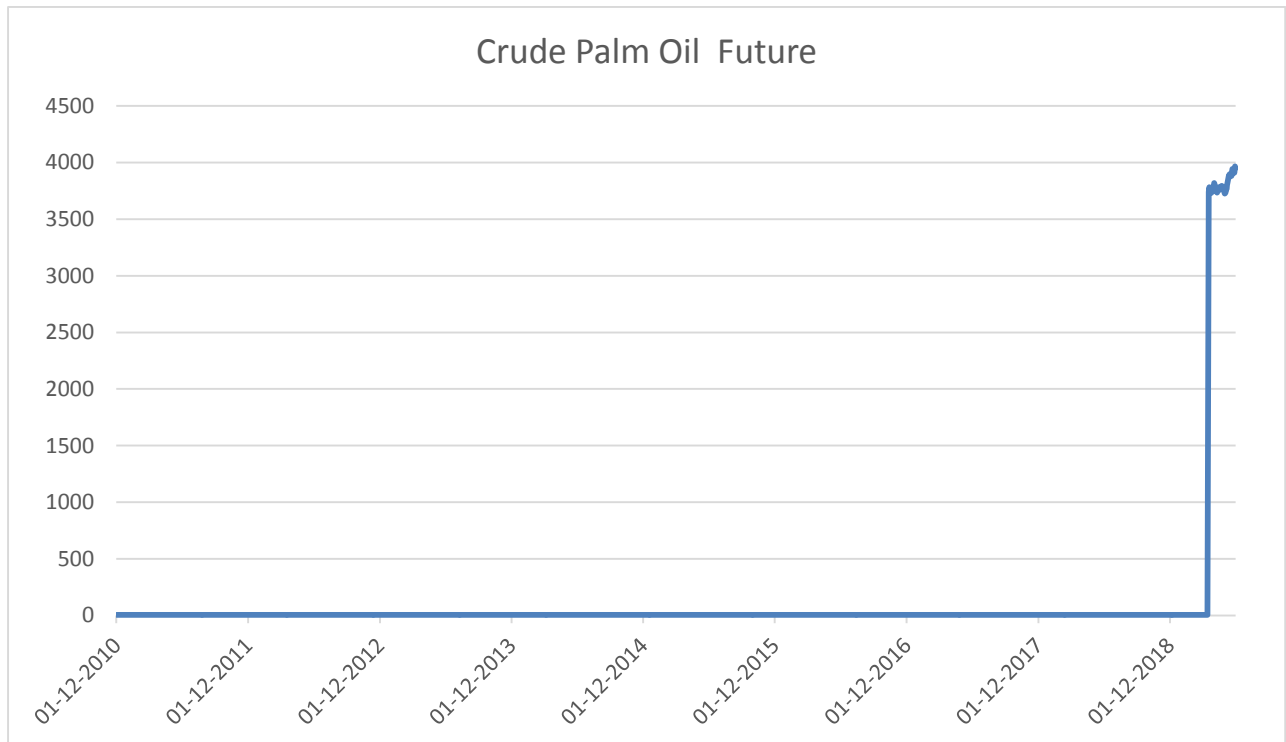
The figure 8. Indicates the log values of jeera future prices which show the existence of break point or outlier in the series. Based on the above figure we can say that there is no break point or outlier in the jeera future prices.

Figure 9. Crude Palm Oil spot prices



The figure 9. Indicates the log values of crude palm oil spot prices which show the existence of break point or outlier in the series. Based on the above figure we can say that there is no break point or outlier in the “crude palm oil spot prices”.

Figure 10. Crude palm oil future prices



The figure 10. Indicates the log values of crude palm oil future prices which show the existence of break point or outlier in the series. Based on the above figure we can say that there is no break point or outlier in the crude palm oil future prices.

3.13. Conclusion of the study

This chapter discusses the derivative market's concepts, importance, types, and functions, as well as national and regional exchanges, structure, agro commodity profiles, contract specifications, and various terminologies. The combined and individual spot and future prices of time series plots are also illustrated in this chapter.

CHAPTER - IV

Trend Analysis in Indian Commodity Markets

4. 1. Introduction

India is an agriculturally based country that ranks second in the world in agricultural production. Due to commodities market volatility, Indian farmers are exposed to price risk. As a result, commodities futures markets are vital to the economy “price discovery mechanism” for price stabilization. For a variety of reasons, the majority of participants prefer to trade in the “spot market” rather than the “futures market”. The majority of the research focused on the early stages of agri commodity futures markets' price discovery. Furthermore, the majority of these research are focused on regional markets. Government intervention, production, demand and supply concerns, recurrent floods and droughts, transportation and warehousing issues, and other factors are all contributing to severe volatility in agricultural commodity prices in India. These are the variables that contribute to price volatility. In this setting, the “futures market” is crucial to the economy. “Price discovery, price risk management, and price volatility” are the three distinct economic roles of the commodity derivatives market. Price risk from price variability is avoided or reduced via commodity derivative instruments. Price discovery is a futures market that discloses information about future spot prices. Academicians, investors, and regulators have paid close attention to price discovery between the spot and futures markets for the following reasons: informational inefficiency, excessive volatility, and speculation.

Agricultural commodity derivatives trading has risen in terms of trade volume and value over the years. Between 2003-04 and 2009-10, the volume of commodity futures trading increased at a CAGR of 97 percent. Gold, silver, and crude oil, of course, account for a significant portion of the commodities trading activity. Since its inception agricultural commodity futures trading in India has been fraught with controversy. The forward market commission (FMC) has periodically banned futures trading in a variety of farming produces, including “rice, wheat, urad, tur, rubber, chana, potato, and soy oil” claiming that futures trading causes spot prices to spiral out of control and price volatility to rise. Many other studies have documented the impact of futures trading on spot pricing and volatility. Financialization of commodity trading is influencing commodity prices, according to a UNCTAD analysis from 2009. "A major new feature in commodity trading in recent years has been the increased presence on commodity futures markets of financial investors who treat commodities as an asset class," according to

the research. Because these market participants do not trade based on fundamental supply and demand linkages and hold, on average, very substantial positions in commodity markets, they can have a significant impact on commodity price trends."

4.2. Factors affecting spot prices of agricultural commodities in India

The dynamics of supply and demand determine the price of any item, whether it is an agricultural commodity or not. Other factors, such as seasonality in production, seasonality in consumption, storage availability, export–import connections, and regulatory considerations influencing future spot prices, such as the government of India's minimum support price, influence agricultural commodity prices. Almost all agricultural commodities are seasonal in character, meaning that their production is affected by the seasons. The price differential between before and after harvest reflects this. Price usually rises during the pre-harvest phase due to falling inventory, and then drops after harvest. Of course, the magnitude of the price drop is determined by the volume of post-harvest output. The price can drop dramatically if the production is good. The frequency of harvest determines production-based seasonality. Many commodities are produced in both the Rabi and the Kharif seasons in India, thanks to advances in agricultural practices. For example, around 75% of groundnut is produced between June and September, with the remainder produced between November and March. As a result, seasonality will be more obvious for commodities produced only once a year as opposed to those produced numerous times throughout the year. The spot price volatility is also influenced by seasonality in consumption. During times of high demand, the spot price is higher than during times of low demand. However, due to the development of the processing sector, very few agricultural products demonstrate significant seasonality in consumption. Most of these products have more or less consistent demand throughout the year.

Seasonality is also influenced by the availability of storage space. If there is adequate storage and warehousing, farmers are not obliged to engage in distress sales, lowering the spot price during the post-harvest season. Seasonality in consumption is reduced with efficient storage facilities and items available throughout the year. Any commodity's supply availability must be considered in a global context. With the growth of global trade, agricultural products are no longer limited to the amount produced within a country. The availability of agricultural commodities is influenced by the export and import of these commodities. However, government engagement in agricultural commodity export and import is not uncommon. The government of India regulates agricultural product export and import, affecting availability and pricing in the domestic market.

Even without any export-import relations, the Indian government has a degree of control over the pricing of numerous agricultural commodities. The Government of India's Minimum Support Price (MSP) has an impact on the spot price of commodities covered by the MSP as well as commodities that are not covered by the MSP but are substitutes. Also, if an item is an important commodity, the government of India controls all aspects of the commodity, including production, supply, distribution, inventory, and price.

4.3. Seasonality in agricultural commodity prices

Seasonality in agricultural commodity pricing can be seen in higher prices before harvest and lower prices after harvest. The seasonal index compares the price of each month to the annual average price. The seasonal index is higher before harvest and lower after harvest. Seasonal indexes imply that the index is greater than 1 during periods of higher prices and less than 1 during periods of lower prices. For example, an index value of 1.07 for a given month indicates that the price of that month is 7 percent higher than the average price. An index value of 0.88 indicates price during that month is 12 percent lower than the average price.

One of the simplest methods for calculating seasonal index is as follows.

- Calculate the average price for season
- Calculate the average price over time

$$\text{seasonal index} = \frac{\text{average price for season}}{\text{average price over time}} \times 100$$

4.4. Futures Prices of Agricultural Commodities, Seasonality and Cost of Carry Model.

The pricing of agricultural commodities futures are highly seasonal. Those maturing during the pre-harvest period have higher futures prices than contracts maturing immediately after the harvest period.

4.4.1. Cost of Carry Model

Cost of Carry Model explains the relationship between the spot and futures prices in terms of associated cost (shipping, storage, insurance, financing charges) of holding the physical asset.

$$F_{(t-T)} = S_t + CC_{(T-t)} \dots\dots\dots (4.1)$$

With

$$CC_{(T-t)} = \left(S_t \times r_{(t,T)} \times \frac{T-t}{365} \right) + G_{(T-t)} + OC_{(T-t)}$$

Where

S_t = Spot price of the underlying assets at t .

$r_{(t,T)}$ = The annualized riskless interest rate

$G_{(T-t)}$ = Total storage cost incurred during $(T - t)$,

$OC_{(T-t)}$ = Other associated cost like insurance, shipping and transportation cost and miscellaneous cost incurred during $(T - t)$.

This model is also known as full carry model.

Equation (4.1) shows that with a positive cost of carry, futures prices ($F_t T$) is greater than spot price S_t to account for the carrying cost. With a positive cost of carry, longer maturity futures price will always be higher than shorter maturity future price. Hence, with positive cost of carry.

$$\text{futures price}(F_{t_1,T}) > \text{futures price}(F_{t_2,T}) > S_t$$

Where, $t_1 > t_2$ the forward curve is upward sloping. The commodity forward curve slopes upward in case of contango market.

Cost of carry model also takes into consideration the benefits received by holding physical inventory, known as convenience yield.

$$F_{(t-T)} = S_t + CC_{(T-t)} - Y_{(T-t)} \dots \dots \dots (4.2)$$

$Y_{(T-t)}$ = Convenience yield from holding the physical asset during $(T - t)$. the convenience yield cannot be measured directly. It is implied in the $F_{(t-T)}$.

If supply of commodity remains uncertain over a long period of time, it may so happen that the futures price of a longer maturity contract month is lower than the futures price of a near month contract month. In other words, when

$$\text{futures price}(F_{t_2,T}) < \text{futures price}(F_{t_1,T}) < \text{Spot}_{t_0}$$

Where $t_2 > t_1 < t_0$ the forward curve is downward sloping. The commodity forward curve slopes downward in case of backwardation market.

Backwardation is quite common in agricultural commodities as during pre-harvest period as holding physical inventory is far more valuable than holding futures contract. Seasonality in commodities contributes significantly to commodity backwardation.

4.4.2. Seasonal Cost of Carry Model

The cost of carry model factoring seasonality was considered by [Borovkov and Geman \(2007\)](#). Their model proposes that forward price can be derived from the average forward price by factoring Seasonal premium or discount.

The seasonality adjusted cost of carry model is

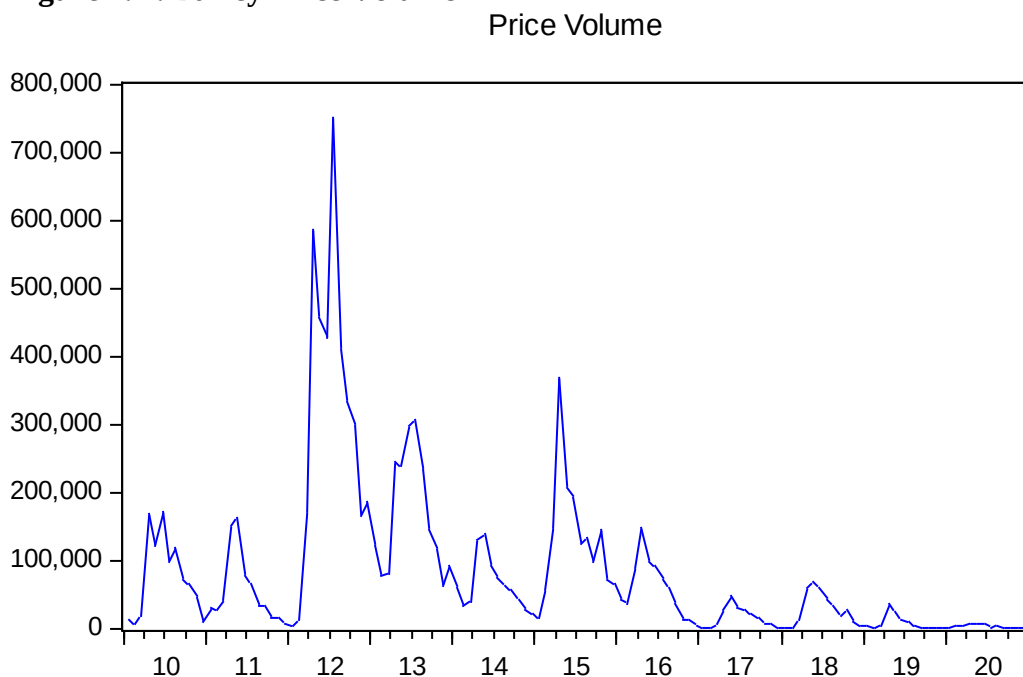
$$F_{(t-T)} = F_t + \text{Seasonal premia/discount}$$

F_t Is the geometric average of current futures prices prevailing at time t. Seasonal premium/discount is the historical premium or discount associated for a given calendar month when the future contract expires.

An agricultural commodity with seasonality in supply quotes at a premium (discount) to average futures price during pre-planation (post-harvest) period. Similarly a commodity with seasonality in demand (edible oil during October- November) quotes at a premium to the average futures price during periods of high demand. Seasonal premium or discount is expressed as an absolute quantity and is arrived by analyzing the past futures prices.

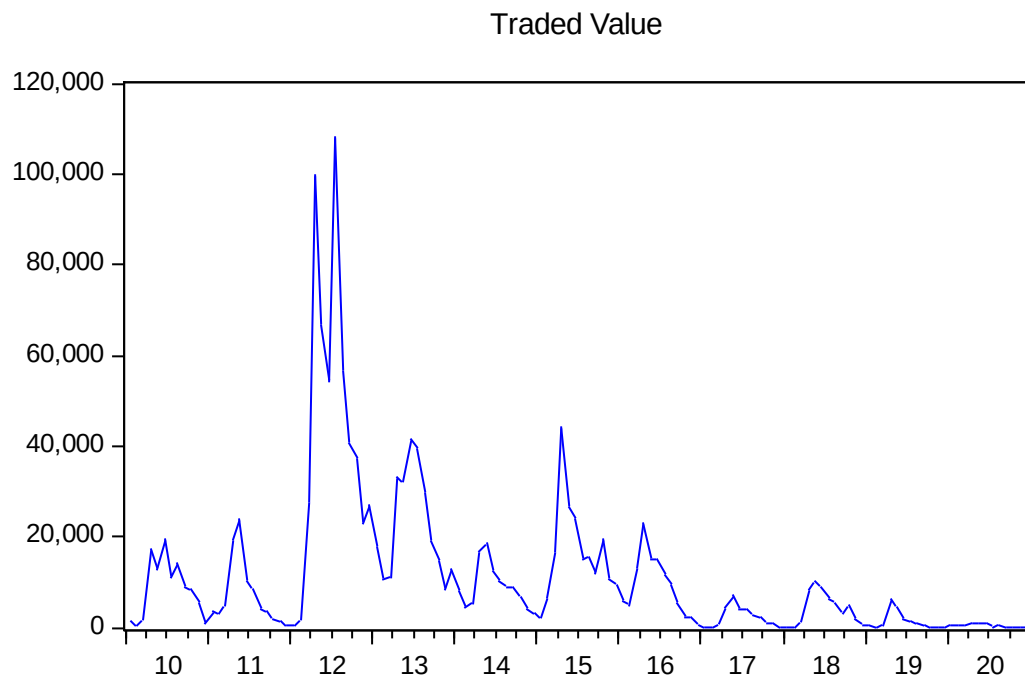
4.5. The Price Volume and Traded Value of Barley, Jeera and Wheat

Figure 4. 1. Barley Price Volume



The figure 4.1. shows the barley price volume of agricultural commodities derivatives trading has also attracted substantial price volume in India. It indicates the price volume of barley which show the existence of break point or outlier in the series. Based on the above figure we can say that there is no break point or outlier in the barley price volume.

Figure 4.2. Barley Traded Value



The barley traded value of agricultural commodities futures trading has also attracted significant price value in India, as seen in figure 4.2. It shows the traded value of barley and indicates the presence of a break point or outlier in the series. Based on the following graph, we may conclude that the barley traded value has no break point or outlier.

Figure 4. 3. Barley Price Volume and Traded Value

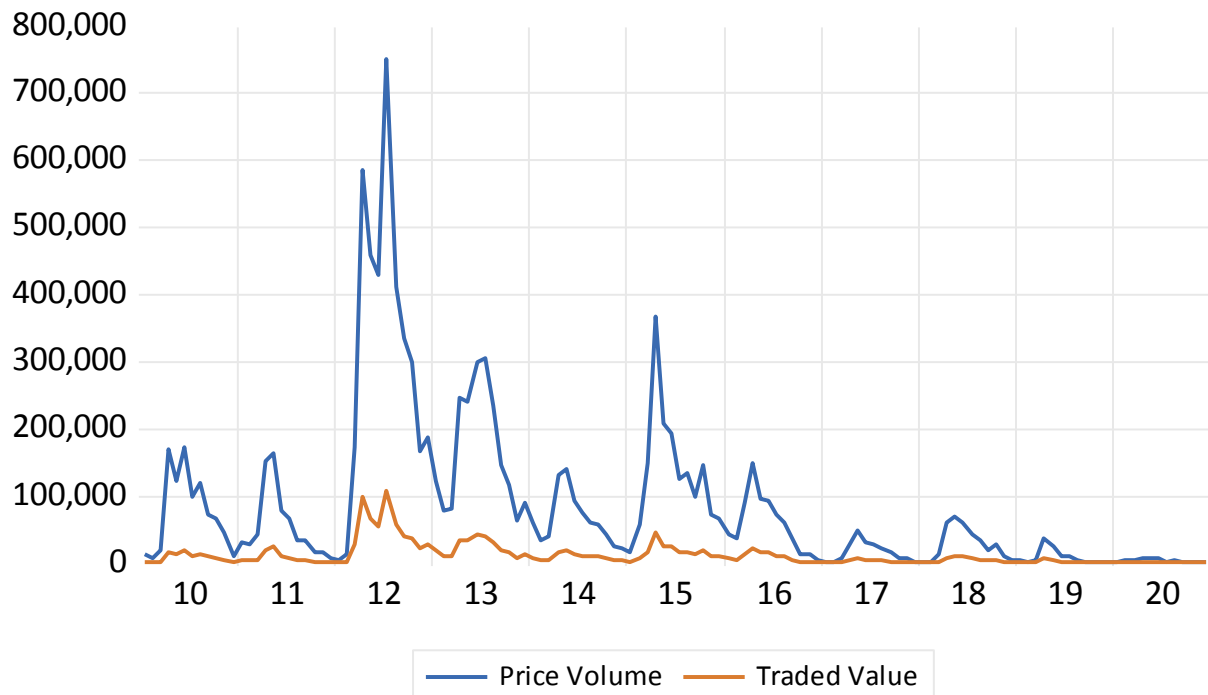


Figure 4.3. shows the barley price volume and traded value of agricultural commodities derivatives trading has also attracted substantial price volume and value in India. It indicates the price volume and traded value of barley which show the existence of break point or outlier in the series. Based on the above figure we can say that there is no break point or outlier in the barley price volume and traded value.

Figure 4.4. Wheat Price Volume and Traded Value

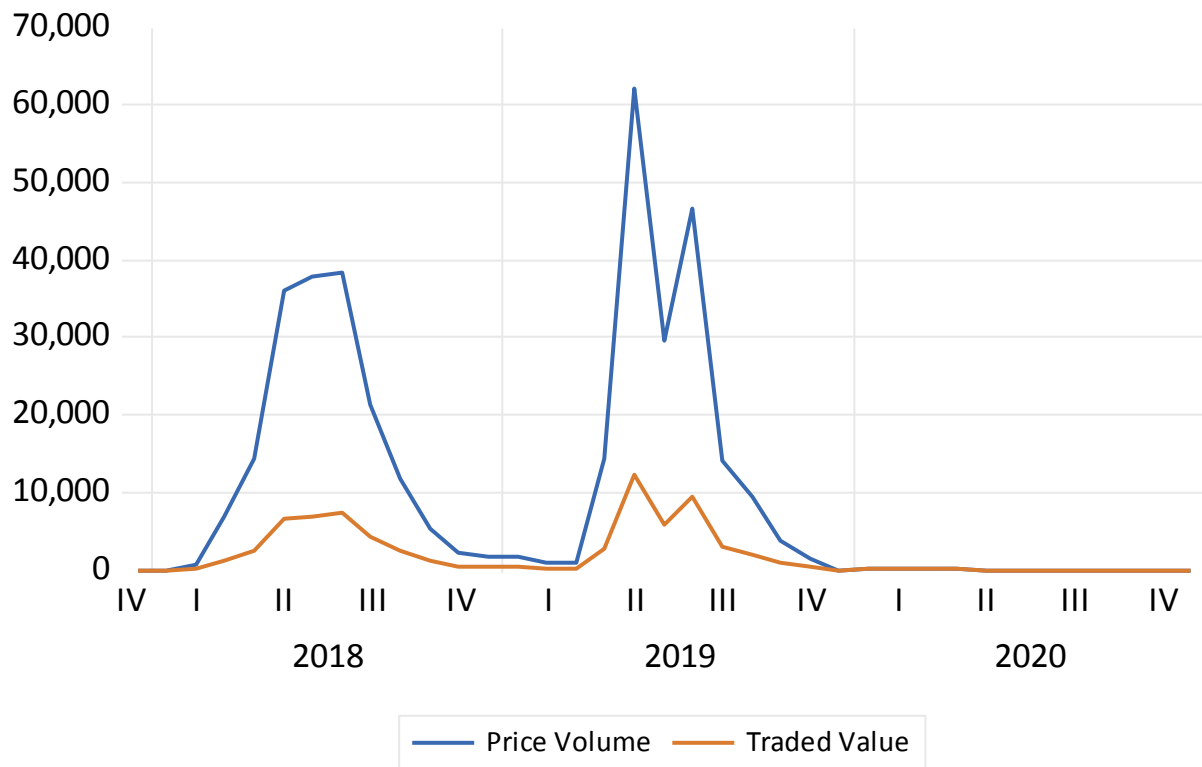


Figure 4.4. Shows the wheat price volume and traded value of agricultural commodities derivatives trading has also attracted substantial price volume and value in India. It indicates the price volume and traded value of wheat which show the existence of break point or outlier in the series. Based on the above figure we can say that there is no break point or outlier in the wheat price volume and traded value.

Figure 4.5. Wheat Price Volume

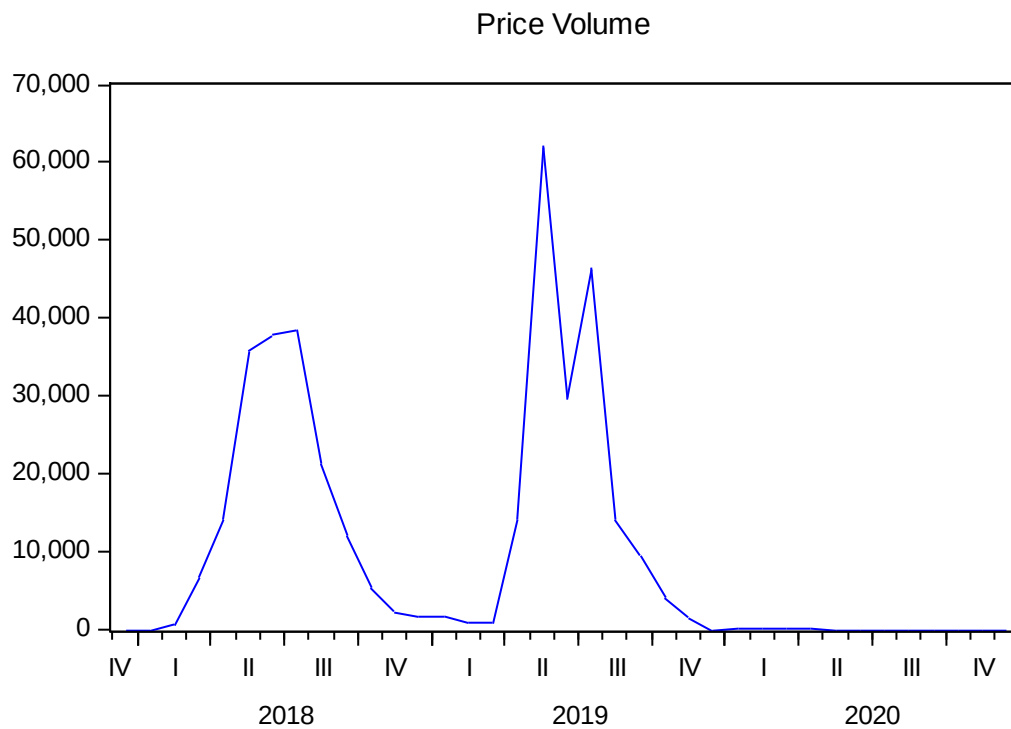
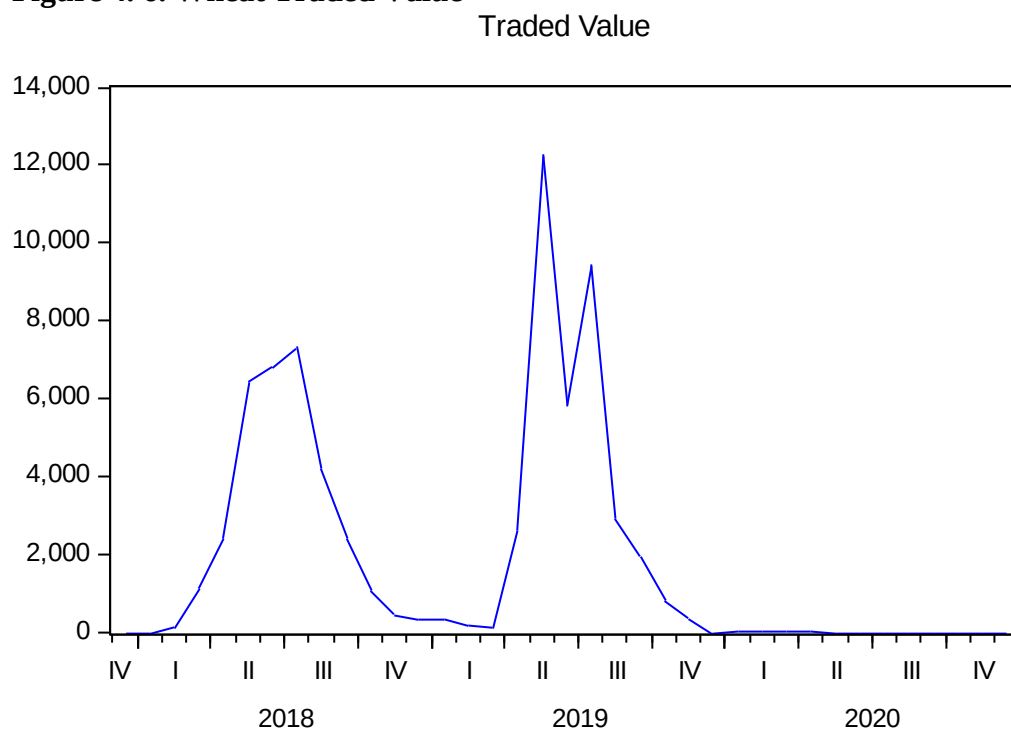


Figure 4.5 shows the wheat price volume of agricultural commodities derivatives trading has also attracted substantial price volume in India. It indicates the price volume of wheat which show the existence of break point or outlier in the series. Based on the above figure we can say that there is no break point or outlier in the wheat price volume.

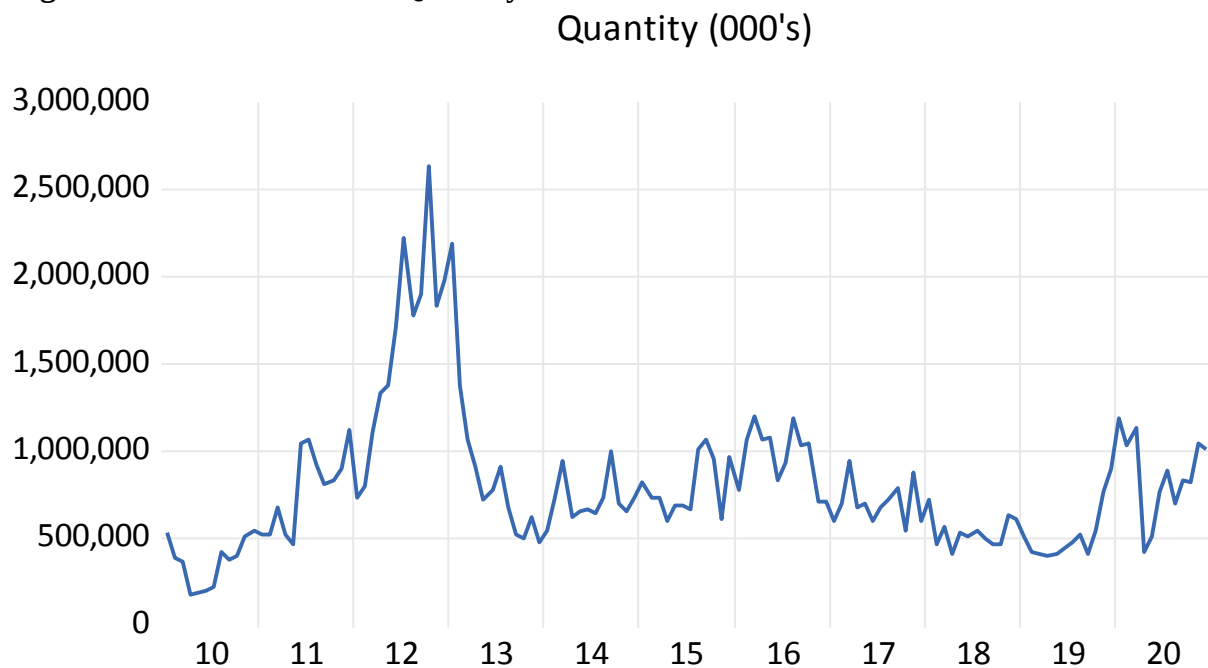
Figure 4. 6. Wheat Traded Value



The wheat traded value of agricultural commodities futures trading has also attracted significant price value in India, as seen in figure 4.6. It shows the traded value of wheat and indicates the presence of a break point or outlier in the series. Based on the following graph, we may conclude that the wheat traded value has no break point or outlier.

4.6. Crude Palm Oil Quantity and Total Value, Mentha Oil Quantity and Total Value.

Figure 4. 7. Crude Palm Oil Quantity



The figure 4.7 shows the crude palm oil quantity of agricultural commodities derivatives trading has also attracted substantial price volume in India. It indicates the crude palm oil quantity which show the existence of break point or outlier in the series. Based on the above figure we can say that there is no break point or outlier in the crude palm oil quantity.

Figure 4. 8. Crude Palm Oil Total Value

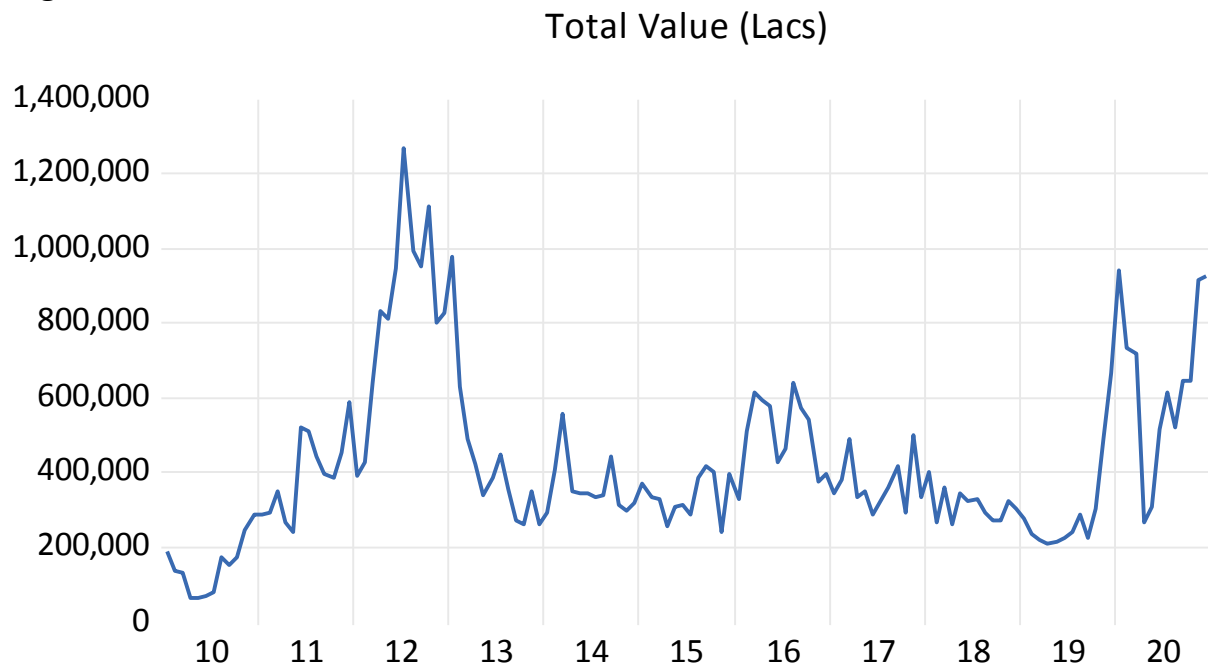


Figure 4.8. Shows the crude palm oil total value of agricultural commodities derivatives trading has also attracted substantial price volume in India. It indicates the crude palm oil total value which show the existence of break point or outlier in the series. Based on the above figure we can say that there is no break point or outlier in the crude palm oil total value.

Figure 4.9. Crude Palm Oil Quantity and Total Value

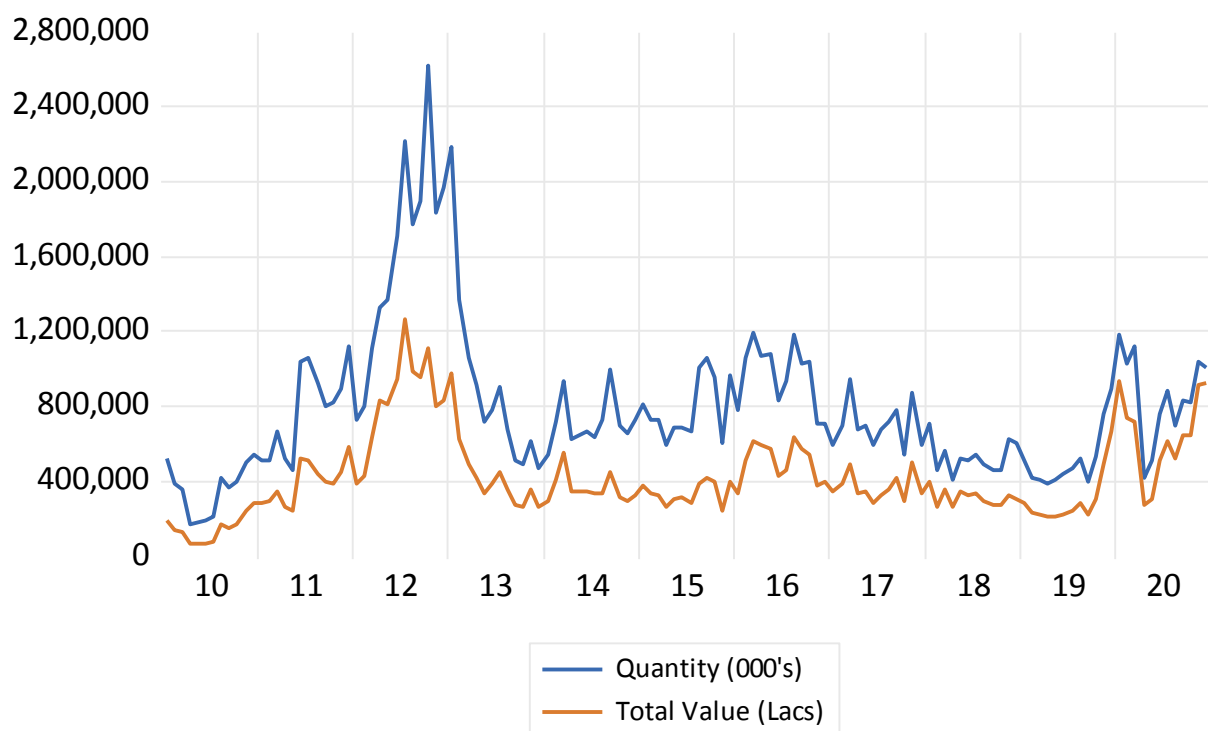


Figure 4.9. Shows the crude palm oil quantity and total value of agricultural commodities derivatives trading has also attracted substantial crude palm oil quantity and total value in India. It indicates the crude palm oil quantity and total value which show the existence of break point or outlier in the series. Based on the above figure we can say that there is no break point or outlier in the crude palm oil quantity and total value.

Figure 4.10. Mentha Oil Quantity

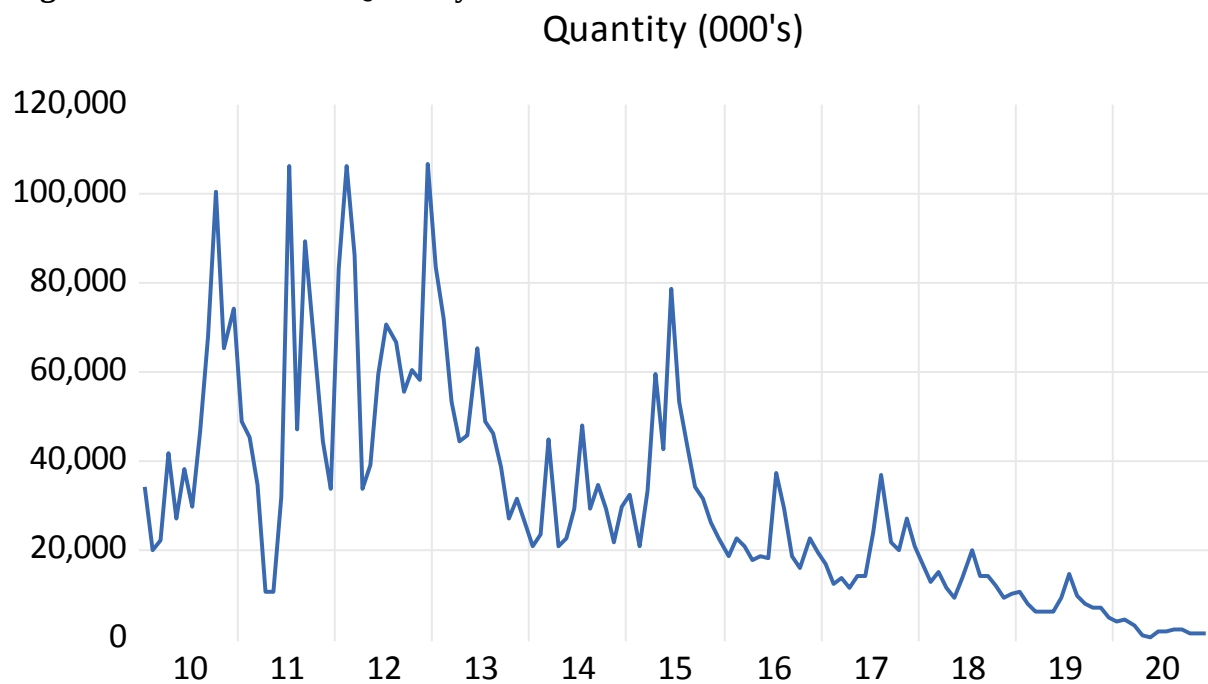


Figure 4.10 shows the mentha oil quantity of agricultural commodities derivatives trading has also attracted substantial price volume in India. It indicates the mentha oil quantity which show the existence of break point or outlier in the series. Based on the above figure we can say that there is no break point or outlier in the mentha oil quantity.

Figure 4.11. Mentha Oil Total Value

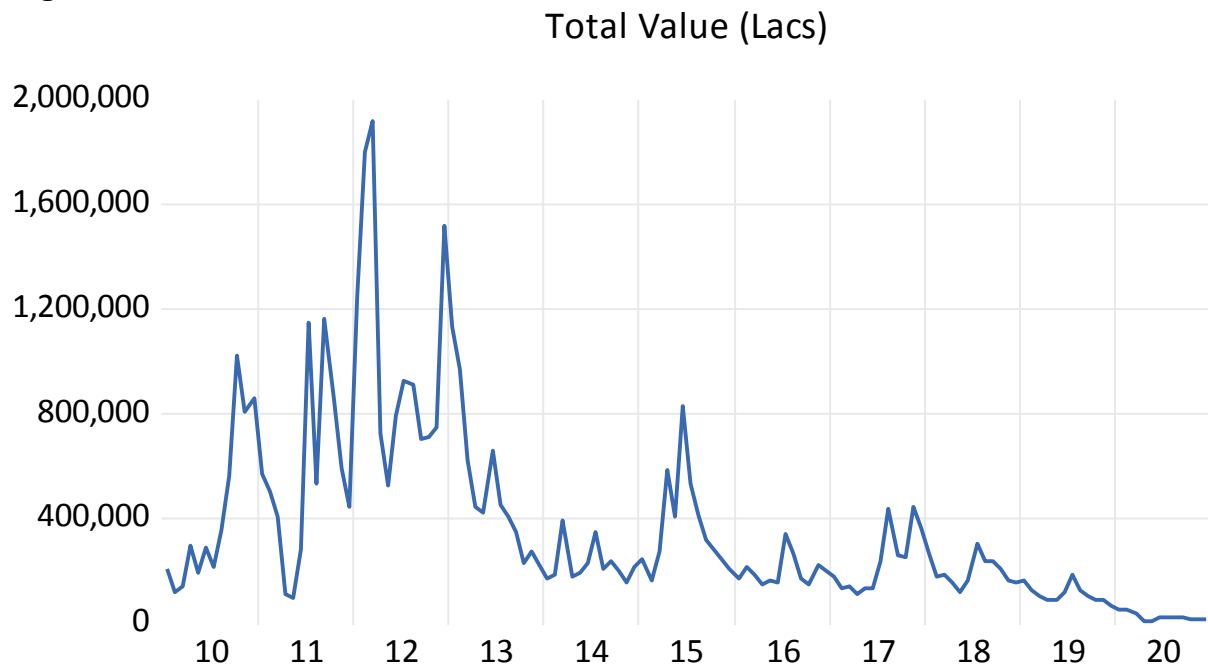


Figure 4.11. Shows the mentha oil total value of agricultural commodities derivatives trading has also attracted substantial price volume in India. It indicates the mentha oil total value which show the existence of break point or outlier in the series. Based on the above figure we can say that there is no break point or outlier in the mentha oil total value.

Figure 4.12. Mentha Oil Quantity and Total Value

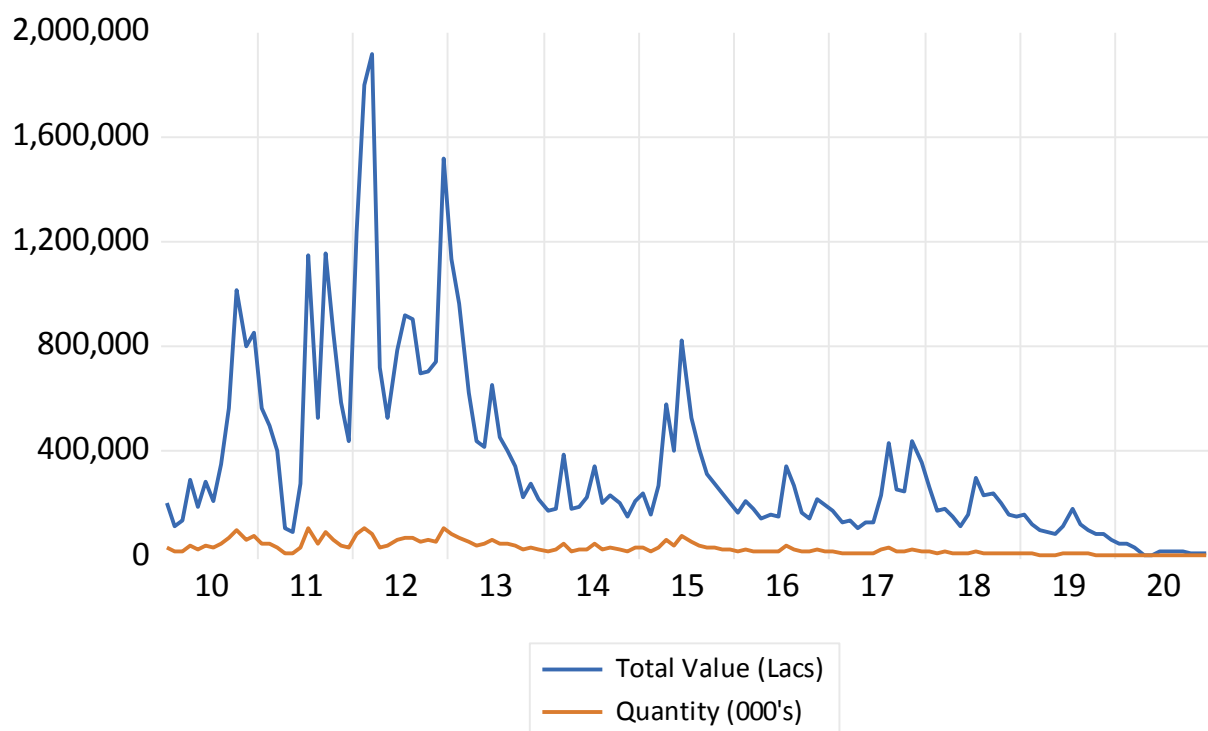


Figure 4.12. Shows the mentha oil quantity and total value of agricultural commodities derivatives trading has also attracted substantial mentha oil quantity and mentha oil total value in India. It indicates the crude palm oil quantity and total value which show the existence of break point or outlier in the series. Based on the above figure we can say that there is no break point or outlier in the mentha oil quantity and mentha oil total value.

Figure 4.13. Jeera Price Volume and Traded Value

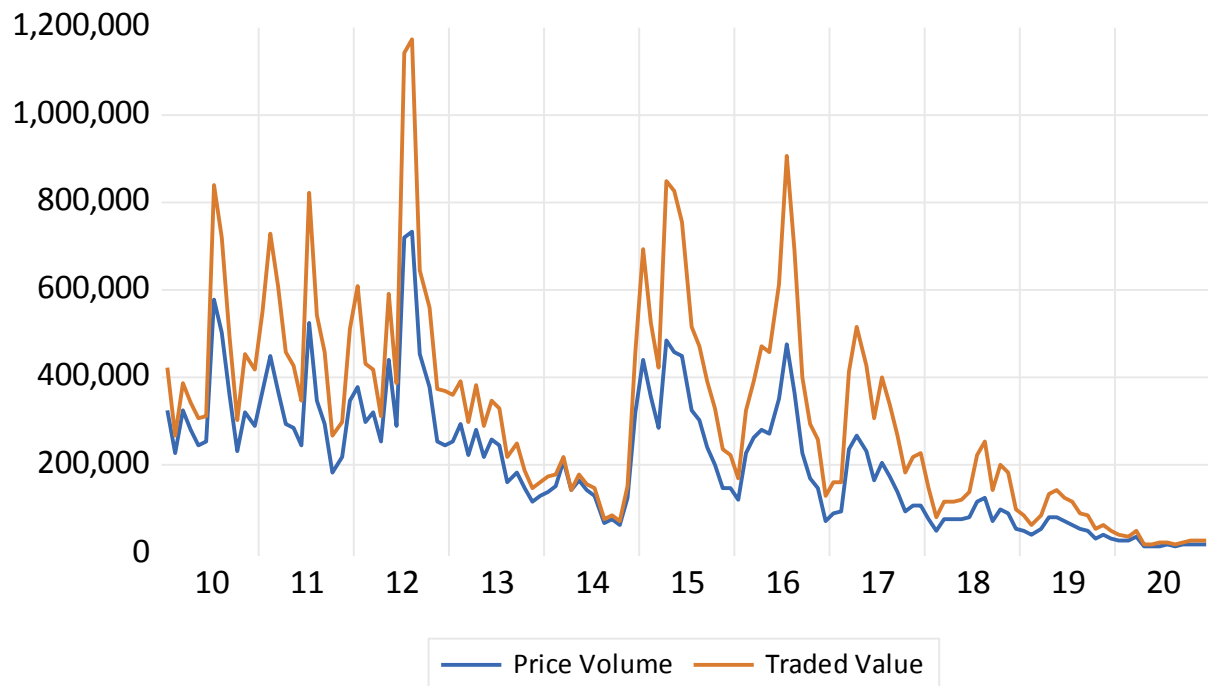


Figure 4.13. Shows the jeera price volume and jeera traded value of agricultural commodities derivatives trading has also attracted substantial jeera price volume and jeera traded value in India. It indicates the jeera price volume and jeera traded value which show the existence of break point or outlier in the series. Based on the above figure we can say that there is no break point or outlier in the jeera price volume and jeera traded value.

Figure 4.14. Jeera Price Volume

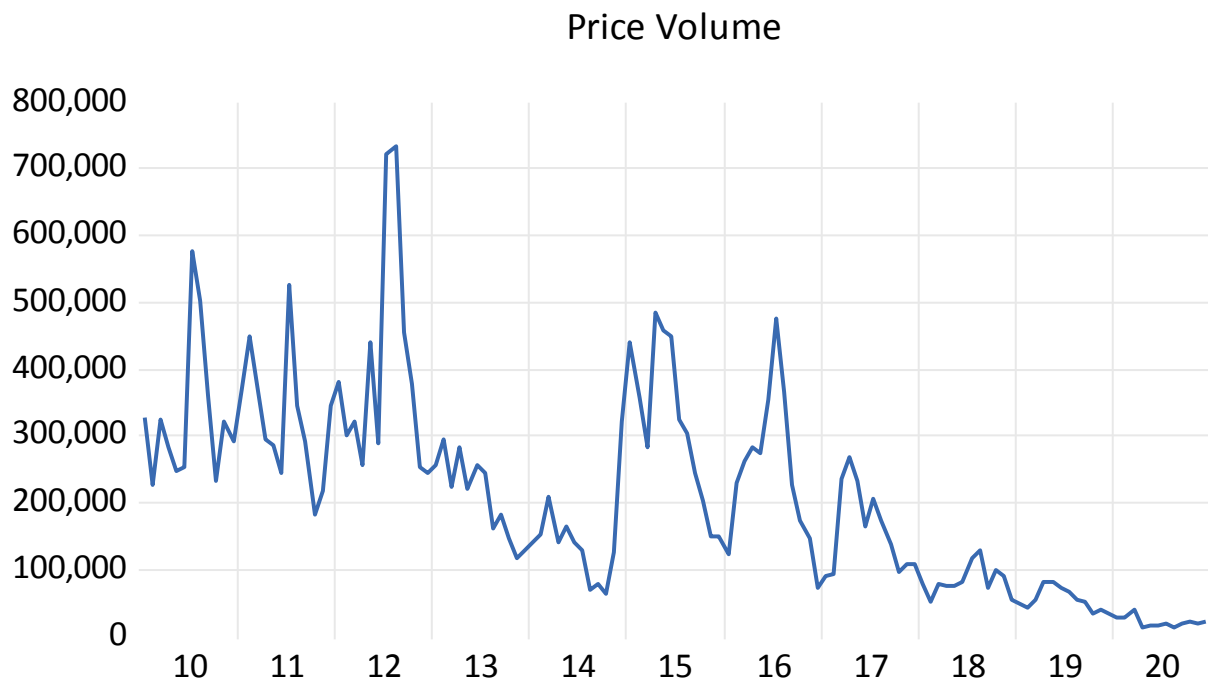
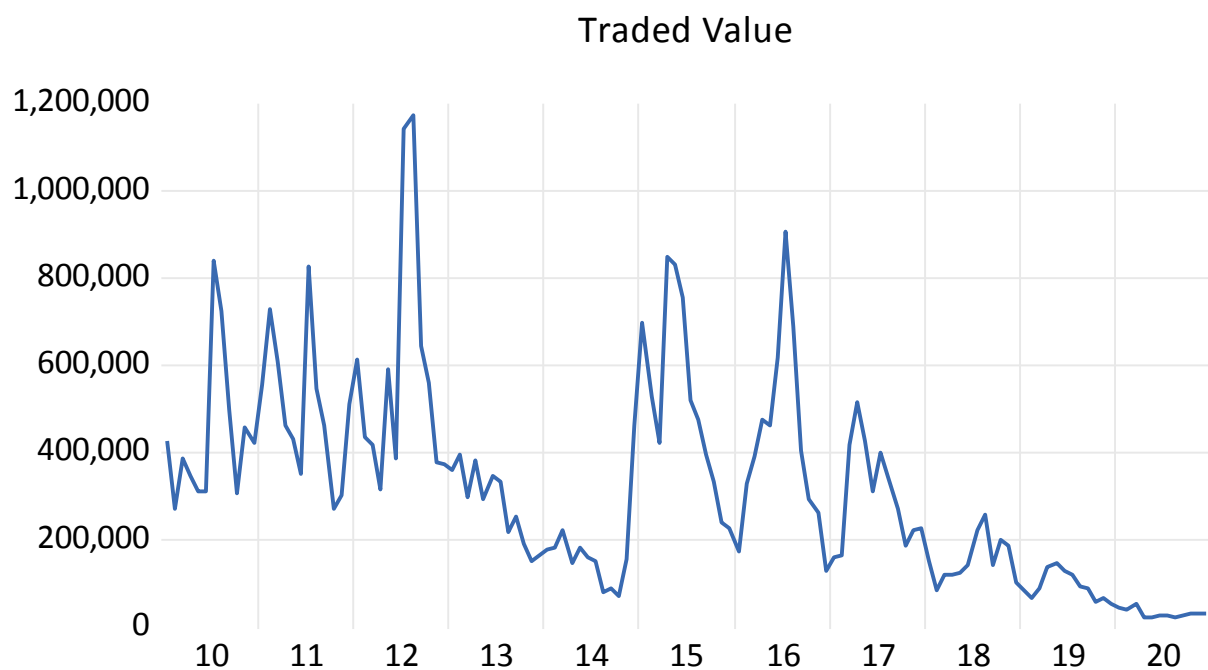


Figure 4.14 shows the jeera price volume of agricultural commodities derivatives trading has also attracted substantial price volume in India. It indicates the price volume of jeera which show the existence of break point or outlier in the series. Based on the above figure we can say that there is no break point or outlier in the jeera price volume.

4. 15. Jeera Traded Value



As seen in figure 4.15. The jeera traded value of agricultural commodities futures trading has also attracted significant price value in India, It shows the traded value of jeera and indicates the presence of a break point or outlier in the series. Based on the following graph, we may conclude that the jeera traded value has no break point or outlier.

4.2. Conclusion of the study

The volume and value of five agricultural commodities were examined in this chapter. The factors that affect agricultural commodity spot prices in India, as well as agricultural commodity futures pricing, seasonality, and the cost of carry model, are discussed in this chapter. The study includes graphical representations of the value and volume of wheat, barley, jeera, crude palm oil, and mentha oil.

CHAPTER – V

The Hedge Ratio and the Effectiveness of Hedging in Indian Commodity Markets

5.1. Introduction

Hedging is the process of lowering risk exposure. As a result, a hedge is any action that decreases the price risk of a certain cash market position. It's worth remembering that futures contracts were created with the sole intention of giving producers and users of various commodities with a mechanism to hedge against price risk. Futures contracts remain a popular way of hedging because they allow market players to mitigate the risks associated with unexpected price changes. When a position in futures is taken that is the inverse of an existing or expected cash position, it acts as a hedge. Hedgers sell futures when they take a long position on a cash asset and purchase futures when they take a small one. A small hedge is when a hedger sells a futures contract with the expectation that prices would decline. In the case of a price drop, losses in the spot position would be sustained. When prices fall, a short hedger who is now long on the cash good or has an obligation to sell at an unknown price in the future will lose money in the cash market, but will win money in the futures market due to the short position. Prices may, of course, increase. In that situation, there will be a gain in the spot market, but a loss in the futures position will be sustained. In a long hedge, on the other hand, a hedger purchases futures contracts when he or she is either currently short the cash good or is obligated to buy the good at the current spot price at a later date. The long hedger is exposed to the possibility of price increases. If a price rise occurs, the long hedger will lose money on the cash good but make money on the long futures position (N D Vohra and B R Bagri).

5.2. Basis Risk

The differential among the futures price and the cash asset that a hedger is long or short on is important to a hedger. The difference between the price of the futures contract and the price of the deliverable asset underlying the futures contract is the basis risk. If you're hedging with Sensex index futures, for example, you'll look at the difference between the prices of the securities in your portfolio on which you've taken long or short positions and the price of the futures. (N D Vohra and B R Bagri).

5.3. Hedge Ratio

We can now proceed to compute the right amount of futures contracts to buy or sell when hedging by using the relationship among changes in futures prices and prices of cash assets. Normally, one would suppose that the futures contract is of a certain size position should be the same as the amount of the cash asset exposure (i.e., for a Rs 10 lac cash market position, the size of the futures contract position should also be Rs 10 lac), and that the hedging ratio should be 1.0. However, as we will show, the ideal hedging ratio is determined by the magnitude and character of relative price changes between futures and cash good prices. The “hedge ratio” refers to the number of futures contracts purchased or selling per unit of a spot good position. The size and character of relative price changes of futures and cash good prices determine the optimal hedge ratio.

“Regressing changes in spot prices (ΔS) on changes in futures prices (ΔF), yields the best hedge ratio, for a risk-minimizing hedger”.

For this, we can use the regression model below.

$$\Delta S = \alpha + \beta \Delta F$$

The slope co-efficient, β , of the regression line so obtained would yield the estimated optimal hedge ratio (N D Vohra and B R Bagri).

Hedging is defined as the acquisition of an asset with the goal of lowering the risk of losses from other assets. “Hedging is a risk management” strategy used in finance to mitigate and reduce the risk of unknowns. It aids in the prevention of financial losses caused by unanticipated market turmoil. “Hedging” acts as a form of protection against any negative market events that might damage your investments. We're not claiming that hedging would keep the bad thing from happening. However, if you're appropriately hedged as it happens, the effect will be lessened. All around us, people are hedging their bets. When you purchase auto insurance, for example, you're protecting yourself against robbery, collateral injury, and other unexpected disasters.

The twin roles of the commodity futures market i.e., price discovery and risk management. Risk control will be carried out by hedging. By establishing a specific position on the futures market, cash market participants can mitigate price risk. As commodities shift together in the futures and financial markets, where gains are primarily attributed to unfavorable price fluctuations on the real market are either completely or slightly compensated by potential

stocks. Therefore, hedging is one of the risk control strategies in potential. The effective hedging can be accomplished by requiring significant uncertainty in potential stocks. Hedges may be bought and sold as needed with the use of both brokers and speculators in trades, as well as the purchase of derivatives. The key goal and benefit of potential business shelter is to reduce likely reductions in sales correlated with unfavorable cash price shifts. A hedging strategy can handle the danger of the market fluctuations of the commodity. Hedging helps farm participants to balance the adverse cash market fluctuations with preferred potential price changes in order to minimize overall price risk. Optimal safeguarding methods limit the gap between cash and potential dividends.

Agricultural commodity rates and uncertainty have been significantly modified since the mid-2000s, supply-side factors such as growing and unpredictable extreme weather events are guiding the market. Unanticipated new financial situations, such as droughts, floods, or demand-side developments. Risk management techniques that use monetary tools can mitigate the effects by effective hedging of certain unpredictable price fluctuations. Derivatives are used as useful tools for the battle against business threats such as competitive risk, price risk and counterpart risk. The hedging scheme will handle the product possibility of market volatility. The most cost-effective method of defending against price danger is called commodity derivatives. Traders can use futures and forwards as advanced hedging products to protect themselves from price swings in the spot market. The sustainability in every potential business depends on future deals being successful. The hedge shall be called successful if market fluctuations compensate for price adjustments in the underlying assets in the potential deal. As a result, hedges can avoid prospective transactions that take a long position in the underlying asset or vice versa. The best hedging ratio will vary substantially depending on the methodology used to calculate it. Several researchers predicted this risk to return ratio using the usual model.

The standardized method is defined as such an ordinary least square model whereby the dependent variable is the unhedged value of the place (or the return value of the commodity on the money market), in contrast to the descriptive variable is the value (or return price) of the hedging instrument. This paradigm is being questioned for three factors. First of all, long-term evidence and short-term trends are disregarded. In other terms, second OLS effects are partial if there is a co-integration of future and spot return. Second, the assumption that spot and future values are spread simultaneously over the years is not regarded as a constant hedge factor.

Thirdly, the assumption is based on a continuous and mutual distribute of the position and potential costs. [Kroner and Sultan \(1993\)](#) reported and proposed the appropriate formula for calculating the hedge ratio and cointegration for locations and potential markets to use as a vector error correction. However, for two factors, the VECM model was often attacked. Finally, the VECM hedge ratio obtained by unconditional variance is centred on the conditional variances of the true minimum hedge. As a consequence of underestimating the hedge ratios obtained from these equations, “Ghosh (1993) and Hsiang (1996)” emphasized the constant equations of “hedge-ratio viz., OLS, VECM and VAR”. In this sense, most experiments are reported and validated by the [Bollerslev \(1986\)](#) “GARCH” model, to evaluate the optimum hedge ratio. More complex econometric time series strategies including multivariate GARCH models are often used to forecast time-varying hedge relationships that taken into consideration the location's conditions and covariance and potential returns. Several observational studies carried out a contrast with the “time-varying hedge ratio of the constant hedge” relation for the perpetuation of yield as well as the decline in variances. The hedge estimation system consists of two methods the “static hedge ratio and the dynamic hedge ratio”. There are two versions. The OLS, VAR, VECM are included in the static strategy and dynamic evaluation of the VECM-MGARCH model.

The prices of commodity depend on the factors like, seasons, consumption levels, government policies, inventory levels and supply and demand balance and these prices cause both manufacturing and market related risks. The revenue of the producers depends on the yield of the crop and their income is affected by the changes in the prices. These carrying costs can be avoided by entering into financial markets. The association among “spot price and the futures price” is reasonable because of holding of commodities in inventories to face the shortage in the future in the commodity economy. The impact of pricing changes on the real economy is significant. Since the variations in the prices of the commodity affect every element in the society, the risk management plays a significant role. The Individuals manage risks to cover their personal incomes, the organisations by protecting their bottom lines and competitive strength, and the economy to protect its macroeconomic stability. Besides price risk management, there are many positives related to hedging. The commodity trading is performed with standardization in sizes and in qualities for improving efficiency of their extractions, distributions and consumption processes.

5.4. Motivation of the study

The present research took into account the fact that there had been work on the Indian commodity futures globally in past studies and that various studies centered on agriculture, energy and metals in India, the present study empirically investigated on five most highly liquid agricultural commodities spot and future markets. First, the research used the key commercial commodities in Indian, five farming commodities, such as cumin, mentha oil, barley, crude palm oil and wheat and hence the analysis also limited it to a few agricultural commodities since there are very large numbers of agricultural commodities. Second, the report revised and protected data sets for review from 1st December 2010 to 31st May 2019. Third, the analyses of market uncertainty, hedging and performance of commodity futures in India have gained substantial attention from researchers and academics. While extensive literature on product stocks is available, furthest of these studies focus on farming commodity production and the main connection of the Indian spot and future marketplaces, while the cointegration of Johansen, the Ordinary Least Square and Vector Auto Regressive models are used to assess the hedge ratios and hedge performance. In India, however, few studies have centred on assessing the market uncertainty, hedging and efficiency of agricultural commodity futures. Finally, the purpose of the present analysis is to analyse the five potential trade in extremely liquid farm commodities. The present objective therefore used these items to fill the analysis gap. Several research were conducted to determine the effectiveness of hedging., but it is necessary to reexamine the hedging efficiency of the Indian commodity sector in light of recent events such as large and regular swings in uncertainty, further financial downturns in the substantial changes in government policies, as well as the financial market.

5.5. Review of literature

[Acharya et al. \(2015\)](#) in order to approximate the ongoing dynamically hedging ratios in agricultural and non-agricultural commodity contracts, employed a “Standard Least Squares and a Vector Error Correction Model”. In the analysis, the growth cycles of the nearby month and next to nearby month were listed. Authors find that the next to near month's maturity contract outcomes are stronger than next month relative to “coriander, jeera, pepper, gold and silver”. In copper the findings indicate that in both maturities the hedge and hedger ratios are poor. Finally, the report showed that non-agricultural commodity hedges should not hedge potential prices in conjunction with agricultural futures contracts to protect risk on the spot market. [Bhaduri and Sethu \(2008\)](#) during the time span between 4 September 2000 and 4 August 2005, examined the relation between optimized hedge ratio and hedge performance in

India. The authors used the ordinary least square, M-GARCH models and vector error corrections. The analytical findings have shown that a hedge utility to test the GARCH model tests stronger output over the long term while OLS tests good performance over the short term. [Choudhry \(2009\)](#) through using the “GARCH” family models for the estimation of time-divergent distribution efficiencies in the potential markets of specific agricultural commodities uses the seven commodities, namely soya, coffee, maize, rice, wheat, pork and live animals, for the period from August 1980 to July 2004. Empirical findings from the author reported that the approximate hedge ratio of GARCH-X technique is higher portfolio efficiency. Das and [Chakraborty \(2015\)](#) on the hedging of agricultural commodities (such as turmeric, potatoes, gum, chilly and mentha oil) were analysed in by the implementation of an ordinary least squares system during the time from April 2008 to March 2014. Authors' observations also recorded that hedging results are more acceptable in most agricultural commodities. With the use of econometric models “ordinary least square and error correction mechanism” and the percent of reduced return variants. [Giulio and Paladino \(2015\)](#) investigated dynamic relations among “spot and futures returns” of commodity markets, use the non-linear means of a “Constant Conditional Correlation- Generalized Autoregressive Conditional Heteroscedasticity” (CCC-GARCH) model. For the duration from 3 January 1990 to 26 January 2010, the analysis employed many resources, including copper, soybeans, gasoline, cotton and silver. Authors' studies have shown that future prices rely on time interactions between financial traders and hedgers that are risk-averse. [Gupta and Poornima \(2016\)](#) analysed the relationship between market discovery and uncertainty impact on spot and future markets, utilizing econometric methods such as cointegration, error correction and granger causality tests. In India, for the period from 15 March 2003 to 18 February 2012. The authors find that knowledge flows from potential markets to local markets are higher, but they also claimed that price discovery would take place tomorrow and find two-way causality in the two markets between uncertainty spills. [Gupta et al. \(2017\)](#) by using econometric techniques including OLS, VAR, VECM and VAR-MGARCH conditions of self-reliance techniques, calculated the “constant hedge ratio and time variance hedge ratio efficiencies for Indian commodity futures markets” by considering both the agricultural sector and the non-agriculture it has been observed that, relative to industrial commodities and energy commodities, the future demand has greater textile productivity in specific metals. Finally, the findings indicated that hedging was the best in VECM and VAR-MGARCH and hedge was the best in the VECM model.

[Haq and Rao \(2013\)](#) by calculating the error correction mechanism and Ederington model for the optimum “hedge ratio and the hedging” efficiency of Indian agricultural commodities, have examined 10 commodities namely such as “soybeans, pepper, guar gum, barley, chili, soy oil, guar seeds, pepper, turmeric and chana” from 2006 January to 2011 December period. The research findings have shown that the optimum hedge ratio has increased dramatically and the model steps by Ederington have demonstrated how the portfolio volatility comprising potential values can be minimized. Finally, the analysis reported in significant measure the decline in variance. [Hussain and Kamaiah \(2012\)](#) by using two econometric models, namely, ordinary less square and error corrector models, analysed hedging efficiency in commodity futures contracts for spices and base metal commodities in the Indian context. They find that in the nearby month deal, the future demand dominates price discovery. Their findings suggested, however, that in the far-month market there are no long-term relationships in turmeric prices with futures prices. The analysis also showed that hedging performance is more efficient across further months and months of expiration contracts. They also indicated, ultimately, that the potential demand belongs to the base metal contract business.

[Kaur and Dhiman \(2019\)](#) to calculate agricultural commodities such as barley, cottonseed, guar gum, gur, crude palm oil, gur gum, jeera, pepper, mustard seed, rubber, turmeric, RBD palm oil, soybean oil, wheat, soybean, yellow peas and the FMCG stock index of over the period from 2007 January to 2017 December using econometric techniques such as Autoregressive Distributive Lag (ARDL). The ARDL bound test verified that there was no long-term co-integration of agricultural commodities with the “NSE FMCG index”. The “Toda and Yamamoto” tests confirmed that there is no causal relationship between “barley, cottonseed, jeera, mustard seed wheat, and the NSE FMCG index”.

[Kumar and Lagesh \(2011\)](#) used bivariate methods “GARCH, DVECH-GARCH, BEKK-GARCH and CCC-GARCH” to calculate market uncertainty, hedge ratio and efficiency of the hedge method. Furthermore, the research studied the interpretation of the sample results of the “hedge ratios using the GARCH model for the hedge return and reduction of variances”. The success appraisal analytical findings were mixed. In a hedged return study, DVECH-GARCH was used and strong returns were obtained in all markets. Results of the variance reduction method showed that for both AGRI and COMDX markets full variance reductions are needed. [Kumar et al. \(2008\)](#) the hedging effectiveness and time gap hedge ratios for product markets and bonds in India, by have been studied using different quantitative econometric strategies for

the analytical study of VAR, VECM, OLS and VAR-MGARCH. The analysis further measures model and control results and indicates that portfolio exposure is substantially decreased. Owing to the period volatility of the hedge ratio, high variance relative to the constant hedge ratios was greatly decreased.

[Lee and Yoder \(2007\)](#) during the duration 2nd January 1991 to 29th December 2004, investigated the time changing hedge ratios of nickel and maize for both spot and future prices by implementing the bivariate Markov regime switching system model (RS-BEKK-GARCH). The results of this study have shown that the optimal hedge ratios for futures contracts for maize and nickel have been marginally improved compared to BEKK or naive approaches. [Li Ming-Yuan Leon \(2010\)](#) studied the effectiveness of the hedging using the vector threshold correction technique. Empirical findings show that arbitrage activity decreases co-operation among futures and spot markets and improves both futures and spot markets' volatility. [Lien Donald et al. \(2002\)](#) the findings of commodities futures contracts on agricultural products' hedging ratios, including maize, wheat, cotton, soybean and currency futures of Japanese Yen (JY), UK Pound (BP) and German Mark (GM) and the S&P 500 (SP) and NYSE composite (YX) stock index future contracts, spanning the months of January 1988 to June 1998. To their analyses, these authors OLS and VGARCH models. The analysis revealed that the OLS hedging ratio is more efficient than the VGARCH hedging ratio.

[Malhotra \(2015\)](#) estimating the “hedging” performance of “oil and oilseeds” futures in the context of India. By using the econometric models of “ordinary least square and error correction mechanism” for the estimating hedge ratio and hedging effectiveness of particularly oil commodities namely such as “mustard seed, refined soya oil, crude palm oil and mentha oil”. The empirical findings showed that the hedging output of the “refined soya oil and crude palm oil futures is strong and mustard oil and menthe oil futures rank low in terms of risk reduction”.

[Mandeep and Gupta \(2018\)](#) analysed in the context of the hedge ratio model for three predictor indexes NIFTYIT, BANKNIFTY and NIFTY traded on the national stock exchange from June 2000 to March 2017. The authors find that BANKNIFTY, NIFTY but NIFTYIT, is the most successful to defend the variation reduction mechanism and the hedge ratio. Once again, the findings of the VECM model indicated that hedge productivity was the best. Lastly, the authors find the lowest hedging efficiency of the Naïve hedge ratios.

[Manogna and Mishra \(2020\)](#) examine the relationship between nine commodity spot prices namely “chana, jeera, guar seed, cottonseed, soybean seed, castor seed, mustard seed rape, turmeric, coriander and the fast-moving consumer goods stock index”. The research employed econometric techniques, namely the cointegration technique of the “Autoregressive Distributive Lag (ARDL) bound test and the causality test of Toda and Yamamoto”. Finally, the authors find that the lead lag association among the “index of agricultural commodities and the stock market index” is not proven. [Nair \(2018\)](#) a study using the co-integration model of Engle-Granger on the hedging capacity of prospective rubber markets in India for 2004-2007. Efficient hedging of rubber future has also been shown in the analytical evidence to reduce the danger over the duration before and after the crisis. The hedge effectiveness mechanisms for risk return and variance elimination.

[Park and Lorne \(1995\)](#) in order to study time fluctuations in hedge market and spot hedge rates, used the bivariate GARCH model. The data revealed there exists a long-term relationship among the spot and potential stock indices, as well as that the bivariate GARCH hedging technique may be more effective than other standard strategies. [Radha and Balakrishnan \(2017\)](#) investigate the link among “spot and future prices” for agricultural commodities, namely “wheat, castor seed, coriander and soybean”. The “Johansen, cointegration test, VECM and Granger causality test” are used to explain the association among spot and future prices. Using “VECM, optimum hedge ratio and hedging efficacy” are measured. The findings show co-integration among spot and future prices for all four items analysed in near-month and next to near-month contracts. For near-month contracts, both markets often respond simultaneously and lead to “price discovery” but the futures market plays a dominant position for near-month contracts.

[Ripple and Imad \(2007\)](#) the relationship between future and spots of crude oil prices for the duration of 2 January 1998 to 29 April 2005. Authors find that hedging is more successful in the next month and also reveals that the hedging levels are smaller than hedging for the first month. [Srinivasan \(2010\)](#) in the case of India using econometric models OLS, VECM and for the period from 27 May 2005 to 26 March 2009, it explores hedging utility. In particular, 21 market-traded commodities are used for commercial banking (National Stock Exchange). The author finds that the hedging method is the best way of reducing the conditional volatility of the hedging portfolio. [Yang and Awokuse \(2003\)](#) researched, by the GARCH bivariate model from 1 January 1997 to 31 December 2001, storable, non-storable agricultural futures such as

“Maize, wheat, soya, cotton, cattle feed, lean hogs and live cattle”. The empirical data showed that the hedging utility of all storable goods is high and that the hedging value of non-storable goods is also poor.

5.6. Source of Data

The research uses a selection of five most fluid potential goods exchanged on NCDEX and MCX agricultural commodities. In this study the prices of five commodities such as “jeera, wheat, barley, mentha oil, and crude palm oil” and the correlation among both “spot and future markets” is investigated. The length of the analysis is from 1 December 2010 to 31 May 2019.

5.7. Empirical Methodology

The study employed ADF unit root tests to determine the order of integration of variables in the analysis. To estimate long-term relationship, author applied Johansen cointegration tests. The ordinary least-square (OLS) estimated to know the association between the variable and to examine hedge ratio. Finally, the bivariate autoregressive vector (VAR) approach was used to find the correlations between the variables under study. Using Four distinct hedge ratio calculation approaches are the subject of this study.

5.7.1. ADF unit root model

In order to validate integration and time-series outcomes in order of stationarity, Augmented Dickey-Fuller, Dickey and Fuller, 1981, experiments have been used. The intercept and intercept and trend were used for these stationary testing, since the data span a long period of time. The ADF research lags have been calculated and the vital values in the Dickey and Fuller studies (1981) have been taken into account, depending on the “Akaike information Criterion (AIC)”. In the use of the time series data, first step significantly needs to verify the stationary properties of the data. In doing this, the study uses the “Augmented Dickey Fuller (ADF) test”. The first and only step in every time series approximation. In this study, the Augmented Dickey Fuller (ADF) was used to validate defined properties.

$$\Delta y_t = \mu + \lambda t + \phi y_{t-1} + \sum_{i=1}^p \alpha_i \Delta y_{t-1} + \varepsilon_t$$

“Where $y, \mu, \lambda t, p$ and ε Denotes, intercept, linear cycle, statement order and error word are. Denotes, intercept”.

5.7.2. Johansen cointegration

The cointegration study is performed using [Johansen's \(1991\)](#) criteria of highest probability.

$$\Delta Y_t = C + \sum_{i=1}^k \Gamma_i \Delta Y_{t-1} + \Pi_{t-1} + \eta_t$$

Where Y_t, Γ, Π, k and C are indicates vector of non-stationary variables, the coefficient matrices, the lag length and constant.

5.7.3. The Regression Method

The linear regression model that follows is an example is a common methodology used by plain, ordinary least-square (OLS) estimation to determine an optimum hedge ratio.

$$r_{st} = \alpha + \beta r_{ft} + \varepsilon_t$$

Where r_{st} and r_{ft} the spot and the future is the first relation among the logarithmic position and the futures graph for the time t measured. The value of β offers the optimum hedge ratio estimate.

5.7.4. The Bivariate VAR method

The possibility of autocorrelated residuals is a big downside of the above-noted simple regression methodology. This was overcome by a bivariate autoregressive vector (VAR) model. For each lag, n agreed to iterate before the self-relation in the residuals had been fully eliminated from the process. The optimal location and potential lags duration m .

$$r_{st} = \alpha_s + \sum_{i=1}^m \beta_{si} r_{st-i} + \sum_{j=1}^n \gamma_{sj} r_{ft-j} + \varepsilon_{st}$$

$$r_{ft} = \alpha_f + \sum_{i=1}^m \beta_{fi} r_{st-i} + \sum_{j=1}^n \gamma_{fj} r_{ft-j} + \varepsilon_{ft}$$

The remaining series is produced after the estimation of the equation system to calculate the hedge ratio. Let $\text{VAR}(\varepsilon_{st}) = \sigma_s$, $\text{VAR}(\varepsilon_{ft}) = \sigma_f$ and $\text{COV}(\varepsilon_{st}, \varepsilon_{ft}) = \sigma_{sf}$, then, the minimum hedge percentage of variance is $h^* = \sigma_{sf} / \sigma_f$.

5.8. Results and Discussion

Table 1: Unit root test results

Variables	Levels	First difference
Crude Palm Oil future	0.394 (0.797)	-47.752 (0.000) ***
Crude Palm Oil spot	0.564 (0.838)	-48.145 (0.000) ***
Mentha Oil future	0.0719 (0.705)	-44.422(0.000) ***
Mentha Oil spot	-0.788 (0.374)	-46.412 (0.000) ***
Wheat future	0.599 (0.845)	-51.230 (0.000) ***
Wheat spot	0.432 (0.807)	-14.273 (0.000) ***
Barley future	0.156 (0.731)	-45.669 (0.000) ***
Barley spot	0.254 (0.759)	-10.672 (0.000) ***
Jeera future	-0.136 (0.636)	-19.772 (0.000) ***
Jeera spot	-0.046 (0.667)	-10.934 (0.000) ***

Note: ***, indicates significance at 1% level.

To understand the stationary features of the data series and to meet the study's goal. First, it is significant to avoid the problem of spurious and invalid result because these are mainly depending on non-stationary data series. To estimate the “unit root results” the study adopts “Augmented Dickey Fuller” test to know the order of integration. The “ADF unit root test” required significant lag length, therefore, the study selected based on optimal lags which is determination of the SCI criteria. The results of time series “unit root tests” are displayed in Table 1. The findings of “Augmented Dickey Fuller” demonstration that “crude palm oil future, crude palm oil spot, mentha oil future, mentha oil spot, wheat future, wheat spot, barley future, barley spot, jeera future and jeera spot” commodities are non-stationary at level. Therefore, it converted into first order of integration then all of the variables are stationary at their first order of integration. These results show that “crude palm oil future, crude palm oil spot, mentha oil future, mentha oil spot, wheat future, wheat spot, barley future, barley spot, jeera future and jeera spot” commodities are integrated order of one, i.e. I(1).

Table 2: Bivariate Cointegration Results

Hypothesized: No. of CE(s)	trace test	critical values	λ -max test	critical values
Crude Palm Oil				
None	138.378	15.494***	138.375	14.264***
At most 1	0.002	3.841	0.002	3.841
Mentha Oil				
None	36.292	15.494***	31.461	14.264***
At most 1	4.8306	3.841**	4.830	3.841**
Jeera				
None	137.085	15.494***	132.750	14.264***
At most 1	4.335	3.841**	4.335	3.841**
Barley				
None	65.769	15.494***	62.369	14.264***
At most 1	3.400	3.841*	3.400	3.841*
Wheat				
None	70.596	15.494***	68.635	14.264***
At most 1	1.961	3.841	1.961	3.841

“Note: ***, **, * indicates significance at 1% 5% and 10% level”.

Table 3: Multivariate Cointegration Results

Hypothesized: No. of CE(s)	trace test	critical values	Prob.	λ -max test	critical values	Prob.
None	899.862	239.235	0.000***	441.375	64.504	0.000***
At most 1	458.486	197.370	0.000***	164.655	58.433	0.000***
At most 2	293.831	159.529	0.000***	85.740	52.362	0.000***
At most 3	208.091	125.615	0.000***	83.418	46.231	0.000***
At most 4	124.672	95.753	0.000***	62.643	40.077	0.000***
At most 5	62.028	69.818	0.178	26.441	33.876	0.294
At most 6	35.587	47.856	0.417	19.474	27.584	0.378
At most 7	16.112	29.797	0.704	9.780	21.131	0.764
At most 8	6.331	15.494	0.656	4.157	14.264	0.842
At most 9	2.174	3.841	0.140	2.174	3.841	0.140

Note: ***, indicates significance at 1% level.

In this section, this study provides empirical results of cointegration, to estimate this the present research apply both bivariate and multivariate cointegration. In order to use lag lengths criteria, the research has adopted automatics lags under study. The estimated results of both bivariate and multivariate long-run cointegration are reported in Table 2 and Table 3. Those bivariate and multivariate cointegration methods have two test statistics to confirm the present of long-term link between factors namely trade and maximum eigen statistics. Existence of a long-term strategy link between the commodities is confirmed by these statistics. In the model, the long-run equilibrium vector association with respect to “spot commodities of crude palm oil spot,

mentha oil spot, wheat spot, barley spot and jeera spot” shows that these are cointegrating coefficients with respect to “future prices of crude palm oil future, mentha oil future, wheat future, barley future and jeera future” are statistics significant at 1% level.

Table 4: Least squares method results

Variable	Coefficient	t-Statistic	Prob.
Barley	0.184	14.290	0.000***
Crude Palm Oil	0.993	393.286	0.000***
Jeera	0.217	26.261	0.000***
Wheat	0.058	3.676	0.000***
Mentha Oil	0.014	0.503	0.614

Note: *** donates significance at 1% and 5% levels.

Before estimating the optimal hedge ratio, the study needs to estimate the OLS regression. In doing this, the estimated OLS regression (1) with five study commodities such as “barley, crude palm oil, jeera, wheat and mentha oil”. The empirical results of ordinary least square regression are reported in Table 4.

Table 5: Optimal hedge ratio from the bivariate VAR model.

Variable	h^*
Crude Palm Oil	0.992
Jeera	0.213
Barley	0.179
Wheat	0.070
Mentha Oil	0.010

Table 6: Optimal hedge ratio from the bivariate VEC model.

Variable	h^*
Crude Palm Oil	1.007
Jeera	0.247
Barley	0.246
Wheat	0.154
Mentha Oil	0.159

To estimate the hedge ratio, the present study selected using both the VAR and VEC models. The hedge ratio is estimated as $h^* = \alpha_{sf} / \alpha_f$. the results of hedge ratio are reported in Table 5 and 6. The present research were used α_{sf} is variance in the model $(\varepsilon_s \varepsilon_f)$. α_f is variance (ε_f) with ε_s and ε_f .

5.9. Conclusion of the study

The chapter covered the efficiency of hedging for the agricultural commodities studied, which included “barley, wheat, cumin, crude palm oil, and mentha oil”. To justify the goal of this chapter, the findings were derived from the numerous tests mentioned above. In the international market all transactions are made via both the spot and future market arguments. It is particularly essential for agriculture future markets to minimize the need for an effective hedging approach. The study used ADF unit root test, both bivariate and multivariate cointegration tests, VAR and VECM approaches to know the hedge ratio under the study. The study confirmed that all of the variables are stationary at integrated order of one and also confirms implies there is a long-term link between the commodities. Finally, the present research attempts to offer a summary of present competing techniques when determining the optimum hedge ratio. As a result, the efficacy of such strategies is measured in terms of average returns and average variance reductions in the revealed scenario.

Participants should find it easier to take positions suitable for hedging price risk on commodity derivative markets. To identify the suitable “hedge ratio” which is the number of futures contracts to sell to hedge per unit of spot asset held, as well as hedging efficiency, which measures how efficiently concurrent gains or losses in physical markets are offset by losses or gains in futures markets. When it comes to derivatives, hedging is an important topic. If the derivative sector is efficient and effective, price risk management is conceivable. Producers that want to resolve price fluctuations in the spot or cash market utilize derivatives as a strategy to protect their in a spot market position. Hedging is the technique of using futures contracts to manage price risk, i.e. critical change in prices in the physical market. Hedging's benefits have also been demonstrated by pragmatic research. Researchers studied the ideal “hedge ratio and hedging efficacy” in order to better understand the major emphasis of hedging. Price behavior and condition influence both the appropriate hedge ratio and the hedging effectiveness Garcia et al (2004). The ideal hedge ratio was previously determined to be one, which suggests that one must take the same position in the futures market as in the spot market. However, due to the fact that presence of basis risk (when futures and spot prices are in equilibrium), the best hedge ratio might potentially be less than one Mathew and Holthausen, (1991).

The relationship among "Spot" and "Futures Price" is called "Basis." A study by Pindyck (2001), the relationship among "Spot Price" and "Futures Price" provides a direct estimate of the "Marginal Value of Storage"; alternatively, we call it "Marginal Convenience Yield" (MCY). The price of the spot is higher than the price of the futures when MCY is significant,

and vice versa. The level of inventories in the spot market will be decided by basis, which will provide useful information regarding private storage, resulting in a smoother price pattern in the spot market and lowering volatility Netz, (1995) & Morgan, (1999). Hedging reduces price risk in exchange for a lower base risk. Cash and futures prices should gather on maturity month, and the basis should approach zero, excluding delivery expenses, according to the hypothetical sketch. The derivatives market's primary function is hedging, which is also the primary cause for the development of derivative products. Hedging effectiveness is the percentage of volatility in returns on hedged positions that can be reduced by hedging (Malhotra, 2015).

5.10. Policy Implications

1. Other factors, such as output seasonal variation, rainy season vagaries, storage availability, inventory availability, consumption seasonality, export-import policies, government interventions such as minimum support prices, and so on, all have an effect on the prices of agricultural commodities.
2. The commodity futures contract is a common market-based tool used in India to mitigate price risk by farmers, traders and other users of farming produces. When futures markets are used as a risk reduction tool, spot price risk is replaced by simple risk.
3. The future market is considered to be an efficient tool for reducing price risk if the baseline uncertainty is smaller than the spot price variability. If the basis is less volatile than the spot price, by taking the opposite position on the futures market, futures traders can hedge their spot position and reduce the risk associated with their final transaction.

CHAPTER- VI

The Effect of Volatility Spillovers in Indian Commodity Markets

6.1. Introduction

Commodities are considered from an investment point of view to be distinct assets in the domain of all asset groups. Commodities markets are known to be unpredictable. Therefore, the uncertainty of prices fuels demand for risk hedging in the commodity market. Producers and buyers are also searching for ways to hedge risk and exchange risk, [Mahalik & Acharya and Babu \(2014\)](#). Commodity trading has evolved rapidly internationally as an external investment category to traditional bond and equity portfolios both on line and on futures markets in the last two decades. Commodity prices are volatile and this variance has evolved with time, and thus knowing the essence of price fluctuations in commodity markets is essential since commodity markets are interdependent with each other. As product price fluctuations fluctuated continuously (both for market players as well as policy-makers, the price change per se is not a predictability and danger to stock values but its own unpredictability) the traders (financial firms and retail investors). Agricultural market volatility is largely attributed to supply fluctuations. Agricultural product volumes and values are always volatile. Normal market variations occur in the long, medium or short term. Volatility is typically a significant supply risk factor for agricultural commodities. Agricultural and development variable rates differ considerably relative to any other assets. The high price of agricultural goods in particular is largely a result of supply shocks. These disturbances contribute to severe market swings between short-term demand and supply elastics. Goods markets demonstrate that production statistics, hedging and betting statistics and the physical supply of goods are the main factors impacting price fluctuations. More and more volatility has rendered betting on food markets a popular spot in values that involve primary agricultural products. Price variance is closely connected to the knowledge flow of an environment free of arbitration. The market of spot commodities could expose the level of uncertainty on the future market if the future market improves knowledge flow through the implementation of new technologies.

Volatility is a significant risk factor and an essential issue for decision makers in agriculture. The volatility level is calculated by variances in the supply shock and the coefficients of the demand and supply function. The enhanced shock variance and lower elastic coefficients are responsible for high market fluctuations. Fluctuations of values are usually popular of farm

commodities. The idea that market instability causes confusion and risks that threaten sustainable agricultural production and adversely impact farm returns is of great concern to lawmakers and economists. The exchange in agricultural resources in the future is considered one of the successful methods to tackle volatility in agricultural prices. Futures sector has many financial functions such as hedging, exploration of rates, investing, liquidity and price stability. Goods are known as different property groups. Derivative goods are a valuable method for economic exposure to mineral capital. Commodity futures are a prospect, a trade or an option. Future contracts may contribute to exposure of these to energy prices. A terminal arrangement shall be a deal for the procurement and selling of a pre-determined quantity of certain products at a pre-determined future rate. A variety of economic roles are fulfilled by potential economies. Which involves hedging, exploration of rates, borrowing, liquidity and market stabilization. This tremendous significance is apparent from the fact that they have been used as main tools for investment decisions, asset selection, asset valuation, diversification and risk management, and are critical for understanding financial asset correlation and dynamics. The utility of each variance is calculated by the frequency with which variance can be estimated.

The analysis of volatility and stylized information clearly helps to explain the connection between dissemination of awareness and volatility, as any change in market access level will impact volatility. In the developing world, some aspects of a sequence of financial cycles have been well-researched and acknowledged, as have the prevalence of volatility and leverage. But the volatility details on the Indian commodity sector have scarcely been studied. Volatility linkages and transmissions are also critical for understanding the integration of the commodity market, boom and bust price cycles, and market crisis analysis. Portfolio managers also require multivariate volatility research because they are looking for correlations between multiple markets to successfully hedge their speculative positions [Musunuru, N. \(2014\)](#).

For the majority of commodity market participants, understanding and analysing agricultural commodity price volatility is essential. Volatility analysis applications include the detection of optimum portfolio combinations, the discovery of values, value at risk, option premiums and the design of efficient “hedging strategies”. Farmers and agribusinesses face increased commodity price volatility, which poses a financial risk to their operations in the foreseeable future. In terms of public policy, volatility in commodity prices is also significant, the world's poor, who rely on their purchasing power to buy food, as well as international relief organisations that distribute food, are particularly sensitive to changes in agricultural

commodity prices. It is also crucial for consumers to understand price volatility as they constantly explore when faced with the situation of shifting food prices, there are ways to locate cheaper alternatives. Lastly, for policy making, volatility analysis is also essential, [Musunuru, N. \(2016\)](#).

6.2. Motivation of the study

Volatility is a measure of a stock's randomness in terms of price. The dynamic volatility phenomenon is linked to market relationships. Spillover of volatility implies the returns of volatility of single market often has an influence on the other market's volatility returns. Uncertainty still exists as a result of the news, whether good or bad, and if there is some relationship between the two markets, this effect is always channeled to another market. The Capital markets, product markets, and money markets are examples of financial markets, etc., are extremely unpredictable because they are continuously affected by financial, economic and other factors. The entire world has become a single market with the introduction of globalization, which has led to expanded investment opportunities. Today, one market's data influences other markets or marketplaces throughout the world, increasing volatility. Policymakers, portfolio managers, researchers, and other stakeholders will benefit from this agreement then it becomes a debatable subject of concern for any potential stakeholder as this extends to other economic sectors as well as other global economies.

The core problem of the analysis was to examine India's most frequently traded spot and future markets in terms of the framework for volatility spillover. India's push to pursue an agricultural commodity sector is attributed to its strong output and demand position in the global economy. Inherently chaotic, non-stated and leptokurtic, agricultural market data are also challenging to capture consumer behaviour. In this analysis, market activity has been studied and the uncertainty spillover consequences related to potential exchange have been examined. Many research papers were identified and discussed with the preliminary research into the literature, but most of them were linked to stock market volatility. The key aim of the present research is to analyse volatility spillovers effect of “spot and futures commodity markets in India”.

6.3. Review of Literature

[Kumar and Shollapur \(2015\)](#) the “price discovery and volatility spillover” on India's agricultural commodity market is analysed by four key agricultural commodities, namely” soy oil, soy bean, chana and mustard seed” were used in this research. The study finds that the supply of both markets and spot rates had a long-term connection. For soya oil, soybeans, chana and the mustard-oil, the volatility spillover from “future markets to spot markets” is higher. The impact is greater in future markets. [Apergis and Rezitis \(2003\)](#) by utilizing the GARCH model, studied the impact of uncertainty spillovers on “agricultural input, output prices and retail food prices” in the context of Greece. It has shown that both farm input and retail food prices fluctuations have important and beneficial impacts on agricultural production prices fluctuations. It reported an important positive effect on its fluctuations in the fluctuations of agricultural production prices. In contrast with agricultural production costs, the input and retail food prices showed to be more unpredictable.

[Arora and Chander \(2018\)](#) by using the Johansen cointegration test, VECM, GARCH and EGARCH models to measure the predictions between the two markets, the “spot and future prices of agricultural commodities, namely mustard seed, chana, soy oil and guar seed” were investigated for the months of April 2012 and April 2017. The authors have documented the long-term equilibrium connection exists among spot and future commodity prices. The research also demonstrates that commodity futures demand efficiently functions as a forum for underlying spot market price discovery. Data spillovers from futures to spot markets are validated. [Bhattacharya and Gupta \(2016\)](#) the uncertainty of the future returns of aluminium, copper and zinc for a broad sample from November 11, 2010 to December 4, 2015, the study consider the regular potential closing prices for future contracts. After eliminating the autocorrelation, the GARCH, EGARCH, GJR-GARCH and APARC parameters were used to capture the heteroskedastic behaviour of the sequence. In conclusion, long memory is a significant function of aluminium, volatility in copper and zinc is returning and should be taken into consideration when addressing investment decisions.

[Chakraborty and Das \(2013\)](#) the study explores the connection between trading in commodity futures and volatility in spot prices agricultural commodities namely such as pepper, maize, barley and mustard seed over a period from 8th June 2005 to 31st May 2010 by employing econometrics techniques like “Granger causality test and GARCH model” to measure the both the markets behavior. The study shows that for most commodities, unpredictable trading volumes trigger spot price instability. Since the causality test of bivariate granger causality

indicates information flow from the spot for a few commodities, market instability to unpredictable trading rate, no such proof is found in the results of the forecast error variance decomposition.

[Gözüör and Memiş \(2015\)](#) examined the spillovers in price fluctuations between commodity markets for energy and agriculture. In the global commodity crisis. The study has considered daily data from January 1, 2006 to November 29, 2013. The study focuses on spillovers of volatility in future “crude oil, soybeans, corn, wheat and sugar markets”. The empirical results from the granger causality test procedures suggest that there is a spillover of price volatility from crude oil to maize markets. There is also a bidirectional link among the “corn and soybean markets”. Finally, the effects of spillovers of price volatility from both the soybean and maize markets to the wheat markets were reported by the authors.

[Mahalik et al. \(2014\)](#) by using “Cointegration, VECM and bivariate EGARCH model” for spillover fluctuations on the futures and spot commodity markets. Four MCX futures and spot indices were included. The VECM findings showed that aggregate commodity index, agricultural future price indexes and energy future price indexes and efficiently support the “price discovery function in the on-the-spot market” suggesting a knowledge transfer from future commodity markets to spot commodity markets, but no reverse causality exists. The bivariate EGARCH model has already demonstrated developments in a system that can forecast volatility in a particular sector and that volatility spillovers have driven spot markets.

[Maitra \(2018\)](#) Analyzed the transmission of uncertainty between spot and futures, the asymmetric essence of the co-movement, seasonal factors, spillover fluctuations and uncertainty impact on foodstuffs and non-food commodities in India. Crop resources in the non-food and food group, including “cumin, soy oil, pepper and guar seed”. This study revealed that all markets are influenced by seasonality on volatility. In future and “spot markets, cumin, soy oil and guar seed” have systemic disturbances.

[Mukherjee and Goswami \(2017\)](#) the volatility calculation is taken into account by on the four chosen “commodity futures, potato, crude oil, gold and mentha oil” and the volatility study recognizes all three forms of contract intervals. Their findings suggest that there is a declining trend of potato potential volatility and a growing pattern of uncertainty across all contract periods for gold.

[Musunuru \(2014\)](#) the price volatility among agricultural commodities, namely corn and wheat, was empirically investigated using the multivariate model of GARCH-BEKK. Evidence of bilateral links between corn and wheat in terms of returns and volatility was discovered. A one-way transmission of volatility from corn to wheat is shown by multivariate conditional student's-t distribution performance.

[Rout et al. \(2019\)](#) examined the spillover mechanism for instability in India's energy and agricultural commodity markets. The agricultural commodities "chana, chilli, jeera, soybean and turmeric and aluminium, copper, lead, nickel and zinc" metal products. From the research period from January 2010 to December 2015. The outcome indicates that metal commodities are more popular than agricultural commodities and deserving of investment. The findings demonstrate the spillover of bidirectional volatility of both metal and Commodity markets for agriculture and the transmission of uncertainty is targeted at spotting futures in agriculture and spotting futures in metal commodities.

[Sendhil et al. \(2014\)](#) the volatility of agricultural commodities futures markets was investigated In India. Twenty agricultural products exchanged in NCDEX are the extremely liquid spot prices of this report. GARCH Model was used to catch fluctuations related to futures exchange at local rates. Empirical findings indicate that during peak inflation (2009-10), low prices of maize, soybean, castor seed, palm, cumin and chilli were observed, while the volatility of potato, cotton seed oil cake and cumin was comparable from the beginning of trading. Finally, this report suggests that the outlook for the future tends to decrease price uncertainty of almost all consumer goods.

[Sendhil et al. \(2013\)](#) the maximum likelihood method of Johansen has been used to analyse the degree integration of spot markets and futures, the framework model of Garbade-Silber was used to describe the degree of price discovery and the GARCH model has been used to calculate the scope of Spot market volatility for food grains after futures trade in India. The study of cointegration shows that for most contracts there is a long-term co-movement among "futures and spot prices". The demand for futures dominates the price discovery process. The study shows the successful performance of trading futures in wheat and maize. The degree of spot price volatility due to futures trading, as calculated by the GARCH model coefficients, has shown that spot market volatility has continued.

[Shihabudheen and Padhi \(2010\)](#) the "price discoveries and volatility" impact on the Indian commodity market were analyzed. Their conclusions were focused on the availability of data and on regular closing futures and spot prices for each product. "Gold, silver and crude oil

futures and spot rates” obtained from MCX and jeera, castor seed and sugar closing prices were collected from NCDDEX. The price of the future shall be taken from the deal nearby contract. The study indicates that potential prices in the case of “gold, silver, crude oil, castor seed and jeera” are a reliable way of exploration. They find that there are uncertainty spillovers in all resources excluding sugar products from future to market.

[Srinivasan \(2012\)](#) the long-term correlation between future prices and their current commodity markets was documented by the results of the “cointegration test” as well as the “VECM” findings indicate that spot markets for commodities play a prominent role and are a significant means of price discovery. This shows that information changes from place to future commodity markets. The bivariate EGARCH model findings indicate that volatile spillovers from the site to prospective markets are overwhelming in all “MCX commodity markets”.

[Živkov et al. \(2020\)](#) investigated the spillover effect of idiosyncratic volatility among the four commodities for agricultural futures, namely rice, soybean maize, and wheat. For the estimation of the volatility spillover, the analysis used the MS-GARCH model. This model offers impartial and reliable measures of uncertainties in farm futures markets. Relatively strong volatility shocks in agricultural commodities due to volatility shocks soybeans and wheat are the agricultural commodities that are witnessing relatively high instability shocks from other markets. All other agricultural futures receive the least amount of volatility shocks, except rice.

[Musunuru \(2016\)](#) study the presence of persistence of uncertainty and news asymmetry in future data for soybeans over a period from January 4, 1993 to May 31, 2013. To assess the situation “volatility effects on soybean returns” the present study employs the GARCH methodology suggested by Bollerslev (1986). The results of this study show that the leverage effect for soybeans was missing, indicating that positive news causes the product to be more volatile than negative news. [Musunuru \(2019\)](#) research of the nature of long-range dependence by applying fractionally integrated “GARCH models” to daily wheat returns. To research the long memory property in wheat, the period between January 2, 1993, and May 16, 2017. This research is limited to modelling only one food commodity's long-range dependency.

[Chen and Weng \(2018\)](#) potential markets knowledge flows examined agricultural product movements from the US to China. From January 2005 to December 2014, the analysis achieved regular commodity futures rates on maize, wheat and soybeans. The analysis used the VAR – BEKK – Skew-t model. Evidence suggests that erratic spillovers from Chinese futures markets have increased in the US sector, particularly in exceedingly marketable commodities like “maize and soybeans”.

[Dahl et al. \(2019\)](#) patterns of “crude oil” and farm product instability outbreaks. The study reports that the stock closing rates of ten agricultural commodities are strong in liquidity and amount of sale every day “sugar, wheat, cotton, soybean, maize, soybean oil, canola, soybean meal, cocoa and crude oil” from the 2nd of July, 1986, until the 3rd of June, 2016. They see signs of bi-directional relationship among in the potential crude oil and agricultural product industries.

[Hamadi et al. \(2017\)](#) analyzed the financialisation of crops and the degree of exchange between major agricultural commodities. Checked in particular in terms of interdependence on the variance of return spillover from maize, wheat, soybeans and soybean oil. Using the ICSS, GARCH (1, 1), and 3 SLS, a bidirectional volatility spillover was identified. It also finds that the variation of agricultural resources is greatly influenced.

[Sehgal et al. \(2013\)](#) the study explores the oil markets linkages among the “spot and futures as well as futures prices” of ICE, NYMEX and MCX markets over a period from 05 February, 2006 to 15 October, 2012 by employing econometrics techniques namely Johansen cointegration, VEC model, Granger causality and BEKK-GARCH. The findings support the long-term relationship that exists among futures and spot prices in each market, with futures prices leading to spot prices in the “price discovery process”. The volatility spillover findings reveal that there is a long-term spillover from “ICE to MCX and MCX to NYMEX”.

[Sehgal et al. \(2012\)](#) the study period is from April 2004 to March 2012 for seven farming produces, namely soy beans, guar seeds, black pepper, maize, turmeric, castor seed and barley. The impact of futures trading on spot price volatility is investigated using empirical evidence. The results of the study documented “guar seed, turmeric, soybean, and Maize and castor seed” and the study reveals that future market liquidity (as measured by trading volume) appears to be driving volatility in the spot market, indicating a destabilizing effect. The lead lag association among spot price fluctuation and futures trading activity shows that in most commodities, spot price volatility is triggered by an unexpected quantity of futures trade. The findings are supported by the “Granger causality test” suggesting that the volatility of the commodity spot is substantially influenced by the unexpected amount of futures exchanged for five agricultural commodities, except pepper and barley, out of a total of 7 taken under analysis.

[Musunuru \(2013\)](#) Checking the existence in agricultural product markets of calendar anomalies empirically investigated fourteen agricultural commodities namely “corn, coffee, cotton, feeder cattle, live cattle, lean hogs, oats, orange juice, rough rice, soybeans, soybean meal, soybean

oil, sugar and wheat”. The analysis considered monthly data for the period from January 1992 to April 2012 by employing econometrics techniques namely OLS, GARCH, TGARCH, and EGARCH models. The present study noticed that positive return shocks caused more volatility for certain agricultural commodities “corn, coffee, rough rice, soybeans and soybean meal” than negative shocks, suggesting no leverage impact.

[Jhunjhunwala and Suresh \(2020\)](#) examines the volatility correlations between asset and commodities markets from December 26th, 2006 to December 26th, 2018 by employing econometric models namely DCC-GARCH and BEKK-GARCH. Gold's safe haven position is clearly illustrated by the growing negative correlation between the two markets, whereas the volatility of crude oil is increasing. For diversification, zinc, nickel and lead have significant benefits. In the current market situation, investors have decreased dramatically since 2013 because of their association with the stock market.

[Seth and Sidhu \(2018\)](#) the “Granger causality test” reveals that bidirectional connection exists among the wheat spot and futures markets. The long-term balance between “wheat spot and wheat futures” prices is approved by the Johansen cointegration test. The VECM illustrates that the “wheat futures market” is leading the “wheat spot market” in the long-term phase of price discovery. It demonstrates that a dominant position is played by the “wheat futures market” and acts as a tool for “price discovery”. The GJR-GARCH model exhibits the spillover of uncertainty from “wheat futures the wheat spot market” and the “wheat spot market” are close to the “wheat futures market” for the next month.

6.4.Data and Methodology

To evaluate the efficacy of “volatility spillover in agricultural spot and futures” commodities in India. The data on daily closing prices has been collected from NCDEX and MCX database from the 1st of December 2010 to the 31st of May 2019 for wheat, barley, jeera, mentha oil and crude palm oil. This study examines the (i) volatility spillover effect from “spot prices to futures prices” (ii) “futures prices to spot prices” of agricultural commodities, employing the VAR (1)-BEKK (1, 1) model. To run VAR, we have selected the lag length through Akaike Information Criterion (AIC). The details of this model are given below.

6.5. VAR BEKK Model

6.5.1. Conditional Mean Model

“To run the BEKK model, we run Vector Auto-Regressive (VAR) model for mean equation (as all our variables are stationary at level), which has been popularized by Sims (1980) and widely used in financial data by Hamilton (1994). This study applies the VAR (1) model to estimate the mean of the returns. The lag order for VAR has been selected by Schwarz Information Criteria (SIC)”. The model is specified as

$$R_t = \Phi_0 + \Phi_1 R_{t-1} + \Phi_2 R_{t-2} + \varepsilon_t \dots \dots \dots (i)$$

“Where R_t is a column vector (length N) with returns of individual assets and $R_{t-1} R_{t-2}$ corresponds to lag 1 and 2 of respectively, and ε_t is also a column vector (length N) with residuals of the mean equations for all the assets. We assume ε_t follows a multivariate normal distribution, i.e., $\varepsilon_t \sim N(0, H_t)$, where H_t denotes the conditional variance-covariance matrix of the residuals”.

6.5.2. Conditional Volatility Model

“To predict the dependency on the asset returns in a portfolio, multivariate GARCH (MGARCH) models have been developed. One of the most popular and acceptable MGARCH models is the BEKK model. To model the conditional volatility H_t , we use a BEKK (1,1) model”. It can be specified as:

$$H_t = C'C + A'\varepsilon_{t-1}\varepsilon'_{t-1}A + B'H_{t-1}B \dots \dots \dots (ii)$$

“where A, B, and C are square matrices of the order N x N. C is usually taken to be a lower triangular matrix, which makes H_t positive definite. The diagonal elements of the matrix A and B give us the impact of past shocks (ARCH effects) and volatility (GARCH effects) of an asset i on the current volatility of the same asset i. The off-diagonal elements show the impact of past cross shocks and cross volatility (i.e., shocks and volatility of all other assets j) on the current volatility of asset i”.

6.5. Empirical Analysis

Table 1: Unit root test results

Variables	Levels	First difference
Crude Palm Oil future	0.394 (0.797)	-47.752 (0.000) ***
Crude Palm Oil spot	0.564 (0.838)	-48.145 (0.000) ***
Mentha Oil future	0.0719 (0.705)	-44.422(0.000) ***
Mentha Oil spot	-0.788 (0.374)	-46.412 (0.000) ***
Wheat future	0.599 (0.845)	-51.230 (0.000) ***
Wheat spot	0.432 (0.807)	-14.273 (0.000) ***
Barley future	0.156 (0.731)	-45.669 (0.000) ***
Barley spot	0.254 (0.759)	-10.672 (0.000) ***
Jeera future	-0.136 (0.636)	-19.772 (0.000) ***
Jeera spot	-0.046 (0.667)	-10.934 (0.000) ***

Note: ***, indicates significance at 1% level.

To know the stationary properties of the data series and in order to meet the study's purpose. First, it is significant to avoid the problem of spurious and invalid result because these are mainly depending on non-stationary data series. To estimate the unit root results, the research makes use of “Augmented Dickey Fuller test” to know the order of integration. The “Augmented Dickey Fuller test” unit root test required significant lag length, therefore, the study selected based on optimal lags which is determination of the SCI criteria. The outcomes of time series unit root tests are displayed in Table 1. The findings of “Augmented Dickey Fuller test” demonstration that “crude palm oil future, crude palm oil spot, mentha oil future, mentha oil spot, wheat future, wheat spot, barley future, barley spot, jeera future and jeera spot” variables are non-stationary at level. Therefore, it converted into first order of integration then all of the variables are stationary at their first order of integration. These results show that “crude palm oil future, crude palm oil spot, mentha oil future, mentha oil spot, wheat future, wheat spot, barley future, barley spot, jeera future and jeera spot” variables are integrated order of one, i.e. $I(1)$.

6.6.1. Volatility Spillovers Results

Table No-2 presents the VAR- GARCH-BEKK between spot and futures of wheat, barley and crude palm oil. We find the ARCH and GARCH coefficient of Wheat spot and futures are significant from spot to futures but the same is insignificant from “futures to spot”. This demonstrates that wheat spot determines the wheat futures volatility as both the short term and long-term volatility spillovers 0.21% and 0.18% respectively and are significant. The own volatility spillovers of both spot and futures are significant which is natural. Looking to the volatility spillovers of barley spot and futures, we find that in short-term the own spillover is significant for the spot only and the same is insignificant for the future. Secondly the long-term spillovers of the “spot and futures” own spillovers are significant in which the spot spillover is more (0.57%) as compared to the future spillovers (0.48%). Interestingly the long-term volatility spillovers from spot to the future is more (0.37%) as compared from future to spot (0.17%). This again indicates that as like wheat, the barley spot is leading the barley future.

If we see the volatility spillovers result of spot and future of crude palm oil, own spillover is significant in both in terms of the short and long term and the own spillovers of spot is more as compared to future. The short-term volatility spillovers are significant from spot to future but the same is not significant from future to spot. The long-term spillovers are significant and is more from spot to future (0.36%) as compared to future to spot (0.34%). Again, the crude palm oil spot is leading to future as like for wheat and barley.

Table No-2: VAR(1)-GARCH BEKK(1,1) Spot and Futures of Wheat, Barley and Crude Palm oil								
Wheat	Coe ff	Std Error	Barley	Coe ff	Std Error	CURDEP ALM	Coe ff	Std Error
VAR(1)-GARCH BEKK(1,1)			VAR(2)-GARCH BEKK(1,1)			VAR(3)-GARCH BEKK(1,1)		
Mean Model(SWHEAT)			Mean Model(SBARLEY)			Mean Model(SPALM)		
1. SWHEAT{ 1}	- 0.10 *	0.03	1. SBARLEY{ 2}	0.10 *	0.04	1. SPALM{3 }	0.26 *	0.02
2. FWHEAT{ 1}	0.05 *	0.02	2. FBARLEY{ 2}	0.02 **	0.01	2. FPALM{3 }	- 0.26 *	0.02
3. Constant	0.02	0.02	3. Constant	0.02	0.01	3. Constant	0.09 *	0.04
Mean Model(FWHEAT)			Mean Model(FBARLEY)			Mean Model(FPALM)		
4. SWHEAT{ 1}	0.06	0.04	4. SBARLEY{ 2}	0.10 **	0.05	4. SPALM{3 }	0.22 *	0.02
5. FWHEAT{ 1}	- 0.03	0.03	5. FBARLEY{ 2}	- 0.01	0.03	5. FPALM{3 }	- 0.22 *	0.02
6. Constant	0.01	0.02	6. Constant	- 0.01	0.04	6. Constant	0.09 **	0.04
7. C(1,1)	0.34 *	0.04	7. C(1,1)	0.08	0.08	7. C(1,1)	9.45 *	3.05
	-			- 1.19 *			9.54 *	
8. C(2,1)	0.46	0.30	8. C(2,1)		0.19	8. C(2,1)		3.13
9. C(2,2)	0.06	0.91	9. C(2,2)	0.00	0.15	9. C(2,2)	0.10	0.19
10. A(1,1)	0.52 *	0.06	10. A(1,1)	0.86 *	0.19	10. A(1,1)	0.36 *	0.10
	0.21 **	0.09		-			- 0.54 *	
11. A(1,2)			11. A(1,2)	0.15	0.20	11. A(1,2)		0.07
12. A(2,1)	0.00	0.03	12. A(2,1)	-	0.04	12. A(2,1)	-	0.05
13. A(2,2)	0.21 *	0.07	13. A(2,2)	0.29	0.18	13. A(2,2)	0.17 *	0.02
14. B(1,1)	0.73 *	0.04	14. B(1,1)	0.57 *	0.12	14. B(1,1)	0.37 *	0.07
15. B(1,2)	0.18 *	0.06	15. B(1,2)	0.37 *	0.13	15. B(1,2)	0.36 *	0.07
16. B(2,1)	0.15	0.11	16. B(2,1)	0.17 *	0.03	16. B(2,1)	0.34 *	0.06
17. B(2,2)	0.85 *	0.10	17. B(2,2)	0.48 *	0.14	17. B(2,2)	0.33 *	0.06

Note: “We use QMLE robust standard errors to estimate the model. The sample variables in the order are Spot (1), and Future (2) respectively for each of the commodities under considerations like- Wheat, Barley and Crude Palm Oil. In the variance equation, 'C'

*represents the constant term, 'A' indicates the ARCH term, and 'B' represents the GARCH term. The ARCH term provides short-term volatility spillovers, and the GARCH term provides long-term Volatility spillovers between two variables under consideration. We select lag one for VAR based on the Schwartz information criterion. After that, we run the VAR-based BEKK model to capture the short-term and long-term volatility spillovers between spot and futures". *, ** and *** indicates significance level at 1%, 5% and 10% respectively.*

Table No-3. Presents the volatility spillovers among “spot and futures” of mentha and jeera using VAR-GARCH BEKK. The result of volatility spillovers among “spot and future” of mentha indicates that own spillovers in both short term and long term are significant for both spot and future and it is more in case of future. If we look into the cross-market spillovers in short term, future to spot is more (0.60%) as compared from spot to future (0.07%). The long-term cross market volatility spillovers are also more from future to spot (0.12%) as compared from spot to future (0.09%). This indicates that the volatility spillovers result between spot and future of mentha is different from wheat, barley and crude palm oil. Because in all the cases spot was leading future but in case of mentha future is leading spot.

The volatility spillovers between spot and future of jeera indicates that own spillovers are present and is more in case of spot both in the long-term and the short term. The cross-market volatility spillovers are more from spot to future in short term and long term. The short-term spillovers from spot to future is more (0.27) as compared from future to spot (0.09%). The long-term spillovers from spot to future is more (0.66%) as compared from future to spot (13%). This indicates that in case of jeera spot is leading the future.

Table No-3: VAR(1)-GARCH BEKK(1,1) Spot and Futures of Mentha and Jeera					
VAR(8)-GARCH BEKK(1,1)			VAR(10)-GARCH BEKK(1,1)		
Mentha oil	Coeff	Std Error	Jeera	Coeff	Std Error
Mean Model(FMENTHA)			Mean Model(SJEERA)		
1. FMENTHA{8}	0.05*	0.02	1. SJEERA{10}	0.05**	0.02
2. SMENTHA{8}	0.09*	0.02	2. FJEERA{10}	0.00	0.01
3. Constant	0.00	0.01	3. Constant	-0.03**	0.01
Mean Model(SMENTHA)			Mean Model(FJEERA)		
4. FMENTHA{8}	-0.03	0.04	4. SJEERA{10}	0.04	0.04
5. SMENTHA{8}	0.00	0.01	5. FJEERA{10}	-0.01	0.02
6. Constant	0.00	0.00	6. Constant	-0.04	0.04
7. C(1,1)	0.09*	0.01	7. C(1,1)	0.11*	0.02
8. C(2,1)	-0.02*	0.01	8. C(2,1)	-1.08*	0.08
9. C(2,2)	0.00	0.00	9. C(2,2)	0.00	0.05
10. A(1,1)	-0.18*	0.05	10. A(1,1)	0.27*	0.04
11. A(1,2)	0.07*	0.02	11. A(1,2)	0.27**	0.14
12. A(2,1)	0.60*	0.19	12. A(2,1)	0.09*	0.03
13. A(2,2)	0.39*	0.06	13. A(2,2)	-0.13**	0.06
14. B(1,1)	0.84*	0.03	14. B(1,1)	0.72*	0.08
15. B(1,2)	0.09**	0.04	15. B(1,2)	0.66*	0.23
16. B(2,1)	-0.12*	0.01	16. B(2,1)	0.13*	0.04
17. B(2,2)	0.94*	0.01	17. B(2,2)	0.51*	0.13

Note: “We use QMLE robust standard errors to estimate the model. The sample variables in the order are Spot (1), and Future (2) respectively for each of the commodities under considerations like- Mentha and Zeera. In the variance equation, 'C' represents the constant term, 'A' indicates the ARCH term, and 'B' represents the GARCH term. The ARCH term provides short-term volatility spillovers, and the GARCH term provides long-term Volatility spillovers between two variables under consideration. We select lag one for VAR based on the Schwartz information criterion. After that, we run the VAR-based BEKK model to capture the short-term and long-term volatility spillovers between spot and futures. *, ** and *** indicates significance level at 1%, 5% and 10% respectively”.

6.6.2. The Post-Estimation Test/Diagnostic Test

One of the essential properties of the time series model is that there should not be any autocorrelation in the residuals. This is called as post estimation test or diagnostic test. The autocorrelation in the residuals is measured using the Ljung-Box Q statistics. The null hypothesis for this test is that the residuals have no autocorrelation. Rejecting the null and accepting the alternative hypothesis depends on the significance level of the probability value. If the probability value of the statistics is significant, we accept the alternative hypothesis i.e.; there is no autocorrelation in the residuals. Serial independence is a stringent requirement of ARCH family models. Similarly, McLeod-Li statistic also checks autocorrelation or serial correlation in the residuals in a stronger movement condition. The null hypothesis is rejected in this test as well, implying that there is no autocorrelation in the residuals. In this study, we have performed both Ljung-Box Q statistic as well as McLeod-Li statistic to test the serial correlation in the residuals. The diagnostic test result is presented in Table No-4.

Table No-4: Diagnostic Tests for Standardized Residuals- MGARCH BEKK					
	BARLEY	WHEAT	JEERA	MENTHA OIL	CRUDE PALM OIL
Ljung-Box Q(20)	78.25*	50.45*	210.77*	17.57	0.04
McLeod-Li(20)	2.04	16.03	21.06	9.27	0.01

6.7. Conclusion of the study

This chapter looked at the volatility spillover among agricultural commodity “spot and futures”. Barley, mentha oil, jeera, crude palm oil, and wheat” are the agricultural produces discussed in this chapter. The MGARCH-BEKK model, which has been proven by several researchers to be the best MGARCH model for measuring volatility and return spillover between spot and future, was used in this study to test both volatility and return spillover between spot and future. Return and volatility are two factors to consider. According to our findings, there are spillovers between spot and futures markets for the commodities under investigation. However, in all five commodities studied, the extent of such spillover is greater from “futures to spot”. This means that the commodity futures market determines the commodity spot's return and volatility.

Prices for agricultural commodities in India have been quite volatile. Not only are agricultural commodity prices affected by the demand-supply scenario, but they are also affected by seasonality, weather conditions, government intervention through export/import restrictions, levying of duties and setting the minimum support price mechanism, [Bodhanwala, S., Purohit, H., & Choudhary, N. \(2020\)](#).

As a result of changes in underlying supply and demand fundamentals, product prices fluctuate constantly throughout the year. Agricultural commodity market prices typically rise before harvest and decline after harvest, causing volatility variations. The study of an agricultural commodity's volatility activity, such as barley, wheat, jeera, crude palm oil and mentha oil has consequences for both farmers and market participants. Farmers can better manage their production risks and make better marketing decisions by understanding uncertainty. This also allows farmers, during times of greater uncertainty, to minimise their market exposure. In creating an efficient buffer against adverse market fluctuations, volatility analysis may also be helpful. These studies may also help market investors in the proper selection and management of their investment portfolio. Agricultural commodities typically have wide volatility intervals as a result of both positive and negative information shocks. Market participants adapt as quickly as possible to the uncertainty generated by new knowledge and seek to benefit from such inefficiencies. Farmers and investors, for example, are better prepared for shifts in market momentum and in managing their market judgments, according to the empirical findings of this study by adequately evaluating the volatility of farm commodities, Musunuru and Larson (2013). To achieve an effective price discovery mechanism, policymakers need to ensure stability in the markets. Furthermore, futures markets must represent all available information while simultaneously setting futures prices, [Sakthivel et al. \(2017\)](#).

This study makes the following recommendations for regulators and traders based on the aforementioned analysis and conclusions. Futures markets are riskier than spot markets due to these aspects of futures pricing. When confronted with this circumstance, we recommend that Indian policymakers refrain from modifying existing regulations or introducing new ones relating to agricultural commodity markets in order to keep them stable. Traders should restrict speculating in futures markets, particularly those with higher risks, and utilise futures as a risk hedging tool. Because some commodity futures prices have a large lead power, it's critical to minimise the risk of abrupt price swings and lower hazards. To minimise the number of private

investors and, as a result, the price volatility produced by excessive speculation, the tripartite cooperation between the government, businesses, and farmers should be increased.

6.8. Policy implications

1. Regulators and traders should pay closer attention to pricing problems when a commodity is about to be harvested or is influenced by positive news and policy. This is especially important for futures with long-term volatility.
2. The agricultural commodities futures market is used by farmers who seek to reduce the price risk associated with their products. Farmers are obliged to sell their crops in distress through market-by-market intermediaries, exposing them to cartelization. Seasonality, participant knowledge, market size, and regulatory oversight are all contributing to the agricultural derivatives market's troubles.
3. This research took a multifaceted strategy to investors and hedgers. Investors may find the insights on market dynamics to be beneficial in making decisions. Regulators must look at issues connected to market inefficiencies and take actions to enhance this area.

6.9. Scope for future research

1. Future research should verify the generalizations suggested in the study by incorporating other commodities and historical periods, as well as utilizing more advanced methodologies.

CHAPTER – VII

An Assessment of the Efficiency of Agricultural Commodity Markets in India

7.1. Introduction

The success of two economically significant positions is focused on commodity derivatives, price exploration and risk management. Numerous entities such as hedge holders, speculators and arbitrators are present on potential stocks, which implies more price seeking. Speculators usually act as equivalents to hedgers, allowing them to handle risks. In order to reap the benefit of the mispricing, referees help in seeking a better market. The commodity exchanges operate as essential locations for purchasers and sellers to perform trades with or without actual goods within a set of specified rules and regulations. Commodity exchanges are projected to lead to consumer development by reduction of transaction costs, improved price recognition and reduction of risks. Since a centralized location helps minimize expenses related to the identification of commodity content and physical examination of counterparts. Market performance is indicated by the rate and consistency at which information of asset values is conveyed.

With the introduction of futures, the same commodity is eligible for sale in both the spot and future. The dilemma here is whether demands learn information more easily. Both markets respond to information in an ideal situation. This includes the presence in commodity markets of different actors, such as growers, manufacturers, intermediaries, wholesalers, consumers, buyers, and so on. However, one market in an imperfect environment can lead another because of variations in features such as expense, liquidity, leverage and so on. The popular opinion is that futures contribute to market discovery because they take futures as a platform for their views and the related low-price advantages, as speculators and other well-known buyers. One of the key problems in India is that growers or farmers are not educated in the organized trades of commodities. Therefore, the stocks are regulated by speculators and brokers. This results in needless speculation, in turn requiring routine government action to enforce a trade embargo. It will help the potential business performance ineffectively. The research in this sense aims to quantify the performance of the commodity futures price discovery market, [Lakshmi \(2017\)](#). Successful promotion of agricultural goods is pursued to safeguard the interests of both producers and customers. The forward markets commission (FMC) has needed over a decade to excel in prospective marketing. Farm production to a large degree relies on the atmosphere

and the monsoon. Future trade is a methodology used for demand discovery and risk assessment in all economic fields, including producers and customers. Future exchange is a method used for demand exploration and all segments of the economy, including producers and customers, are subject to risk management. This is seen as a weapon to avoid steep market fluctuations. Abnormal rates have a detrimental effect, with volatility, on both suppliers and customers. Future investing provides a way to measure demand and supplies over time and space, and to protect from market risks. It also provides farmers and consumers with demand cues and guidance in time.

The process of determining the spot price for a potential firm is known as “price discovery”. For two reasons, this is vital for producers. First of all, they have a clear sense of potential prevailing projected rates for commodities. Second, to maximise profit and minimise risk, they should efficiently disperse their limited wealth. Consumers frequently like becoming aware of items rates ahead of time. It is vital for a farming economy to have a well-functioning transportation system future demand in order to properly carry out the price discovery phase. The purpose of the price discovery phase is to examine if any new information has surfaced can be replicated in the future market or in adjustments in spot prices, or if the transitions between the spot and future markets are greatly delayed, [Manogna and Mishra \(2020\)](#). The economic transition of a developing nation such as India is crucial. It depends on the success of its agricultural sector and of its allies. In terms of rural subsistence, employment, and national food security, this sector is critical. It happens to be India's largest source of livelihood. The proportion of the Indian population directly or indirectly relying on agriculture for employment opportunities is greater than that of any other sector in India ([Economic Survey 2019-20](#)).

Agricultural sector plays a key position in the case of the Indian economy. Farming, actively and indirectly, accounts for nearly two-thirds of the workforce. The central statistics office is projected that almost 16.5 percent of the 2019-20 gross value added at rates are estimated to be in agriculture and their relevant industries (including cultivation, animal husbandry, the forestry industry and fishing). Therefore, the Indian economy is labelled the "monsoon gamble" since the agriculture sector is highly based on monsoon. Against that background, the position of future agricultural goods contracts is much greater in an economy like India. The export of India is a major part of agricultural goods, i.e., tea, tomato, potatoes, spices, jute, cotton, peppers, coffee, sugar cane, wheat and rice. The government intervenes quite strongly in the

pricing of agricultural goods since it establishes minimum rates of assistance. The method of agriculture in India has experienced dramatic changes over many decades thanks to the implementation of green revolution technology and government policy on market subsidies (Chand, 2003). India has thus progressed from a nation with food deficits to a country with a food surplus. The government rules on the production, supply and sale of many agricultural products appear to be affected (Sahadevan, 2002). Indian farmers face every day unpredictable and crucial circumstances in the shape of the output and the price of supply. Farmers are primarily vulnerable to the danger of agricultural output and, secondly, to prices. Therefore, because of varying climatic factors, agriculture development is still full of uncertainty. In the kharif and rabi season, too the prices fluctuate. The uncertainty of markets there by causes instability immediately. In this basis, the instability affects farmers' wages, rendering rural villages poorly safe. Under all these situations, prices will fluctuate if demand decreases similarly. Future markets have two key features, namely, risk control and competition exploration, as is seen in literature (Garbade and Silber 1983).

Farmers and suppliers, though, are rather worried at potential product costs, because their vulnerability must still be mitigated by coverage. Agricultural goods need tremendously to achieve an accessible and liquid futures market in addition to improve and more reliable discovery of values. In literature, the term market discovery has been used in various ways, but the rapid incorporation of fundamental news into market pricing is critical in assessing risk. Hasbrouck (1995) described the price discovery, which is often referred to as the market share of knowledge, as the quantity by which the effective price revolution adjustment may be assigned to such a market.' As the various securities have many trading places, knowing the "price discovery mechanism", i.e. anything's the influence of every business to the "price discovery process" is essential for traders and market participants. Any farmer's primary objective is to increase his income and reduce his risk. Peak season is a big problem, with a catastrophic decline in costs. And during its season, this forces a manufacturer to sell at a lower price. When farmers want to store the selling of farm at a reasonable price for the future, they have to contend with the problems of storage depletion. In comparison, India's long intermediate chain markets are extremely fragmented and locational. Regional companies often play a dominant position and foreign players play a spoil role in these spot markets and the national markets. In the post-globalization era regional and global players on locations and domestic markets play a significant role. These market imperfections betray the aspirations of farmers, since they earn little benefit from sales of output that adversely influence their profits.

7.2. Motivation of the study

The key explanation for the present objective is that comparatively numerous studies have been carried out on this topic. The present research is however, to analyse the problem and to analyse the market behaviour, in particular barley, wheat, crude palm oil, mentha oil and jeera, for the five food items chosen on the spot and for the future. Emerging markets such as India use more commodities than developing countries. The study data collected from the “NCDEX and MCX”. NCDEX is the agricultural commodities is one of the leading commodity exchanges of India. Different econometric models were used in the present analysis to approximate bivariate cointegration, multivariate co-integration, causality checks and processes of error correction, among other things. That is why the analysis initially investigates whether the chosen agricultural commodities are co-integrated between the spot and future markets. The analysis is therefore verified as spot and possible co-integration are validated. We observe the interaction between the spot and future markets, nevertheless the market for few commodities such as “jeera, mentha oil, barley, crude palm oil and wheat” is very strong. Problems including price detection and the performance of potential product prices for commodity markets with an increased emphasis on the financial markets have been thoroughly studied. Business in emerging markets, however, and in India in particular, is restricted to the agricultural commodity markets. In this sense, this study reviews the efficiency debate on the future and spot markets of Indian agricultural commodities. The above-mentioned problems led the authors to research the efficiency of India's agricultural commodity markets.

7.3. Review of literature

[Ali and Gupta \(2011\)](#) the findings show that there is a large difference among spot and futures pricing of sugar, cashew, guar seed, pepper, red lentil, maize, chickpea, black lentil, soy bean and except two commodities wheat and rice. The findings of the “Granger Causality test” indicate that there is a bidirectional connecting among both commodity markets for pepper, black lentil and maize. Finally, this study found that futures market prior information comparatively spot prices. [Arfaoui \(2018\)](#) investigated the relationship among the both market commodities namely heating oil, gasoline propane and crude oil over a period from January 2007 to April 2015. The study employed the ARDL and ECM models to measure the relationship among the commodities. The author discovers that spot and future rates are in equilibrium over the long run. [Arora and Kumar \(2013\)](#) this analysis investigates the discovering costs component of metal commodities namely copper and aluminium over a

period from January 2006 to December 2011. Focused on a cointegration technique, the “Vector Error Correction Model (VECM)” is applied. The authors concluded that order one combines both the spot and future price series and shows a stable long-run balance relationship.

[Chakraborty and Das \(2015\)](#) the efficacy of five agricultural and three non-farming organizations, Commodities were checked by measurement of multiscale entropy, taking single and multivariate sequences. In order to calculate the performance of the Indian commodity future markets, the Multivariate Multiscale Entropy (MMSE) approach is used. The agricultural commodities chosen are barley, corn, chickpea, cumin, mustard seed and aluminium, gold, Brent crude oil are the non-agricultural commodities. The duration from 1 January 2004 to 31 December 2012 will be included. The findings show a partial performance of the Indian commodity sector. In the case of agricultural resources, productivity variations are higher. The study therefore concludes that the Indian market for products is partly efficient and that time and time scales differ in quality. [Dimpfl et al. \(2017\)](#) investigated the empirical relationship among the commodities prices of eight separate farm commodities such as wheat, corn, live cattle, lean hogs, feeder, soybeans, soybean meal and soybean oil. They found that both goods were special on the spot market while future markets led to price discovery by less than 10 percent.

[Inani \(2016\)](#) investigated the common factor models price discovery association among commodity indexes for spot markets and futures namely agriculture index, energy index, combined commodity index and metal index, The spanning period from Oct 21, 2005 to May 29, 2015, the sample includes daily closing prices. Except for the farming index, it is observed because all indices' spot and future prices are co-integrated, they are excluded from the market discovery study. The findings show that for the combined commodity index and metal index, the discovery of prices takes place in the “spot market” while the discovery of prices for the energy index takes place in the futures market. [Inani \(2018\)](#) has been investigating, by applying Johannsen's cointegration and VECM techniques, the relation between productivity and discovery of prices in Indian agriculture products futures markets, from 1 January 2009 to 20 October 2015. The empirical results demonstrated that there is a long-term connection among “spot and future” agricultural commodity prices, and the pricing findings revealed that six commodities have a long-term association., including cotton seed oil cake, coriander, sugar, castor seed, turmeric, soy oil have a future demand and lead a spot market. [Irafan and Hooda \(2017\)](#) analyse the long-run equilibrium among the both agricultural commodities of spot and

future. This research documented that there is a cointegration relationship among the whole selected farm commodities. While the “Granger causality test” it has been established that there is still a unidirectional flow among all agricultural commodities. Iyer and Pillai (2010) examined if a dominant position is played by futures markets method for price discovery. Two-regime autoregression threshold for calculation of chana, copper, gold, nickel, rubber and silver commodities. This study finds proof of the phase of the discovery of prices for five out of six commodities in the futures market.

Joseph et al. (2014) employed frequency domain analysis, they investigated the causative relationship among the both market prices of Indian commodity markets. Their findings indicate that frequency domain analysis indicates that a clear unidirectional causation exists between both markets’ commodities. Joseph et al. (2015) utilizing the wavelet study, examines the Indian futures from 2 January 2006 to 31 December 2014 on eight agricultural commodities such as “gold, chana, silver, crude oil, soybean natural gas, aluminium, copper”. Their findings revealed the unidirectional causative association of all chosen goods in this analysis from future markets to spot. In addition, its analytical findings indicate a strong price discovery feature on future markets and an effective future demand for Indian commodity products. Joseph et al. (2015) employed the asymmetric causality test to analyses the asymmetric causative association among the spot and future prices of farming commodities in the Indian commodity market. From January 2008 to March 2014, the data was compiled. The regular closing prices of spot and future agricultural commodities were considered to be wheat, jeera, soybean, pepper, castor seed, soy oil, coriander, cotton oilcake, chana, mustard seed and turmeric. Their results indicate that the price discovery function is the powerful mechanism in agriculture commodity futures prices and implies the effectiveness of the potential prices of agricultural commodities in India.

Lakshmi et al. (2015) the analysis explores the connection among spot returns and contracts for the future of “crude oil and gold” exchanged in India for during the months of January 2005 and May 2012. The study employed the “vector auto-regressive model (VAR), the Granger causality test, variance decomposition and impulse response functions” were used. The results have shown that the possible trading volume for both “crude oil and gold” is defined by its own background. Bidirectional causality takes place from gold spot to gold future selling rate. The results suggest that the rate of trade in gold goods reacts to information more easily and helps predict the return of gold in the Indian commodity markets than the return of crude oil. Lakshmi (2017) examines the long-term causal connection and path among the “spot and futures” markets. The cointegration test results documented that the futures causing spot in

case of “barley, cotton seed oilcake, Gur, mustard seed, castor seed and refined soya oil” commodities. Granger causality test results documented that the bidirectional relationship in case of coriander, jeera, soya bean, sugar M grade and wheat. The study also found that there is efficiency in futures market in “price discovery”.

[Lakshmi and Joshi \(2019\)](#) the research discusses the shift in the “price discovery” mechanism among “spot and future markets” for chosen inventories from the time before the crisis to the post-crisis period between November 9, 2001 and December 31, 2018. The price discovery process was studied by taking spot prices and future prices into consideration. This research uses the Johansen co-integration and the Vector Error Correction Model (VECM) in order to measure the price discovery impact since it adds to the market survey (spot or future) to minimize the possible value of knowledge. The study also extends the approach taken by Hasbrouck to exchanging information to assess the share of the “price discovery” contribution of each sector. The findings indicate that in the pre-crisis period there is proof of a leading potential business position. However, during the depression period, the leading role of the future disappeared. [Lagesh et al. \(2014\)](#) examined the potential for the advantages of portfolio diversification using estimated “Dynamic Conditional Correlations” in the Indian context. Empirical findings indicate that there is a very low “DCC” among returns from commodity futures indices and returns from conventional asset indices, which indicates the potential benefits of commodity futures for portfolio diversification.

[Malhotra and Kumar \(2013\)](#) in the present analysis, its efficiency and price discovery are tested using robust models such as Johansen's cointegration, Vector Error Correction process, Impulse Response and Variance Decomposition to analyse the output of the Guar seed futures market. The temporal connection among spot prices and futures prices between 2004 and 2011. Long-run co-movement is observed by spot and futures rates, and futures contracts may also work as a valuable hedging mechanism. In the short term, that there is a unidirectional flow of data from the future to the “spot market i.e., the futures market” is leading Guar seed to the spot market. [Nair \(2019\)](#) investigated the recession results in business performance of Indian-traded natural rubber futures contracts. Research reveals that the demand for rubber futures is informatively useful in discovering prices. The cointegration among the spot and future prices of natural rubber. The effect of the recession on the market effectiveness of contracts for rubber futures are evident from the rise in the “optimal hedge ratios” calculated using the technique of cointegration. [Narsimhulu and Satyanarayana, \(2016\)](#) according to the findings of this research, spot and future commodity prices have a long-term link. The outcomes of the VECM

have been documented for a long-term causality ranging from future prices to spot prices. Chilli and turmeric commodity returns have unidirectional causality, whereas chana commodity futures and spot returns have bidirectional causality. [Pavabutr and Chaihetphon \(2010\)](#) the data collection consisting of the regular closing futures price and the exchange size between November 2003 and December 2007 of standard gold futures contracts and mini gold futures contracts is obtained from the MCX. The research used vector error correction models to explain the association among future and spot. The study finds the price of futures corresponds to spot prices, which implies that the discovery of prices takes place in the futures market.

[Prasanna \(2014\)](#) investigate the output of the “futures market” for Indian agricultural commodities over a period from March 2007 to May 2012. Study employed the Johansen Cointegration, Granger causality and Vector error correction (VEC) models. Author observational studies have shown that spot and potential values are mixed in the long term, whereas the causality path follows twofold, unidirectional and has no reason for 11 commodities. [Raghavendra et al. \(2016\)](#) investigated the productivity in the commodities markets for the agriculture and future, namely turmeric, channel, soybean, corn and jeera. The study period from January 2010 to March 2015. Authors found that a long-term balance between the five spot and futures items plays a crucial role both on the spot and potential markets in the “price discovery” phase. Lastly, the authors indicated that all economies are informationally productive and that markets are immediately collectively accountable.

[Sehgal et al. \(2012\)](#) the “price discovery” in Indian agricultural commodity marketplaces was documented. This study has selected 10 farming products are like castor seeds, barley, soya bean, chana, maize, potato, guar seeds, kapas, pepper, and turmeric. The findings of the Johansen Cointegration Test indicate that nine out of ten commodities have a long-term balance relationship. The “Granger causality test” There appears to be a bidirectional relationship, according to the research spot-to-future causality for nine out of ten commodities. Overall results documented that there is no cointegration and causality relationship existed in turmeric. [Shakeel and Purankar \(2014\)](#) the association of prices contained in agricultural commodities would be, soya bean, castor seed and chana. The required regular data on position and commodity prices obtained from NCDEX was collected for the duration from 1 January 2009 to 31 March 2014. The findings of cointegration reveal that castor seed, chana and soya bean spot and future prices have long-term association existed. The model confirmed that the bi directionality of castor seed, chana and soya bean spot and its future sequence has led the way

in India through the phase of discovery of prices, indicating the location and the chosen agricultural commodity's future markets play an important role. [Sharma and Sharma \(2018\)](#) the performance of Indian chilli futures markets was examined for between 2006 and 2016. The study established that chilli long-term correlation of the future and spot prices illustrated the two-way trigger of spot-future price. The findings show that both markets and errors are co-integrated. In both sectors, corrections are taking place. The outcome of the Granger causality test also supports this. Wald test results, however, show short-term causality that flows from “futures to chilli spot prices”. The study observes a long-run distribution among “spot and futures prices”, suggesting that futures contracts will serve as a helpful hedging method.

[Soni \(2014\)](#) analysed market performance of agricultural futures contracts in India. In the time between January 2004 and September 2010. The two frameworks for study were the Johansen co-integration and the VECM. Authors report that the future of agricultural crops is linked to their spot prices. [Surobhi \(2017\)](#) examined whether developments in the financialisation of agricultural commodities are evident in the Indian futures markets. During the period from July 2011 to September 2014, this study included four crops such as castor seed, guar seed, chana and soybean oil. Markets display considerably high volumes and exchange prices in the domestic product market. The current study results show that while castor seed and soya oil undergo financialisation, Chana and guar seed tend to lend themselves to old-style speculation. [Vimal Shubhendu \(2015\)](#) to investigate future-to-spot prices in seven foodstuffs such as “wheat, mustard seed, chilly, jeera, pepper, castor seed and soybean”. The study employed cointegration model and the “Granger causality” model. The study observational findings show the connection between future and “spot prices” and unidirectional from future market prices to “spot prices for wheat, castor seed and jeera” whereas the association among future market prices and spot-prices for “chilli, pepper, mustard seed and soya bean” is bidirectional. [Goyari and Kumar \(2011\)](#) investigated the link between the “spot and futures commodities of gold, crude oil and guar seed” in the context of India the time span of 2005 to 2009 by employing econometric models namely Engle-Granger Cointegration, Johansen Cointegration test, ARIMA, RW, VAR and VEC. This study discovered that the selected commodities' futures and spot markets are both short and long-term effective.

[Jena and Goyari \(2016\)](#) this study explored the relationship in India between the price of goods, the yield of bonds and stock prices. For three alternative asset groups from June 10, 2005 to June 30, 2011, this analysis utilises secondary data on daily returns. The analysis shows that

commodity and stock prices are positively correlated, while the price of goods and the yield of bonds are negatively correlated. The conditional correlation between product prices and stock prices suggests that there is a negative correlation between both variables. If there is an elevated risk in the stock market, the conditional relationship between commodity prices and stock prices decreases, which is beneficial for investors to allocate assets to the commodity market and vice versa.

7.4. Source of Data

This study relies on secondary data to evaluate the effectiveness of agricultural commodity futures in India. The data on daily closing prices has been collected from NCDEX and MCX. In this study the prices of five commodities such as “jeera, wheat, barley, mentha oil, and crude palm oil” and the association among spot and future markets are analyzed. The data covering the period from 1 December 2010 to 31 May 2019.

7.5. Empirical Methodology

7.5.1 ADF Unit root

In order to validate integration and time-series outcomes in order of stationarity, “Augmented Dickey-Fuller (ADF), (Dickey and Fuller, 1981)” experiments have been used. The intercept and intercept and trend were used for these stationary testing, since the data span a long period of time. The ADF research lags have been calculated and the vital values in the [Dickey and Fuller \(1981\)](#) studies have been taken into account, depending on the “Akaike Information Criterion (AIC)”. In the use of the time series data, first step significantly needs to verify the stationary properties of the data. The study employs the “Augmented Dickey Fuller (ADF)” test to do this. In the literature, there is a good number studies also used this model for analysis. The empirical equation is as follows

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \sum_{i=1}^p \varpi_i \Delta y_{t-1} + \varepsilon_t$$

“Where y, β, γ, p are dependent variable, intercept in the model, linear trend in the model and integrated order of augmentation. ε is the error term in the model”.

7.5.2. Johansen Cointegration test

To know the cointegration association among the variables, the present study applies Johansen cointegration model. The selected technique also extensively used in the previous empirical literature. This method works under the main assumption of vector autoregressive basis.

$$\Delta Y_t = C + \sum_{i=1}^k \Gamma_i \Delta Y_{t-1} + \Pi Y_{t-1} + \eta_t$$

Where Y_t is the variables, C is the constant in the model, k is the lag lengths in the model and Γ is the coefficients of the model. Π denotes coefficient matrix of the model and it has disintegrated as $\Pi = \alpha\beta$ are both the coefficient matrix for adjustment in the model and cointegrating vectors matrix in the model. The present method can significantly determine the number of vectors cointegrating of the model and in any given number of non-stationary data series. This technique also has another advantage is that the model can allow feedback effect among non-stationary data series. The present model is works based on likelihood ration tests that can display the number pf cointegrating vectors in the model. In addition, to determine the relationship Johansen proposed two different statistics namely trace and maximum eigen statistics in the model.

The trace statistics (test) is following as

$$\lambda_{trace} = -T \sum_{i=r+1}^n \log(1 - \hat{\lambda}_i)$$

Where T stand for number of observations of the model, $\hat{\lambda}$ donates for statistics of eigen values, n is the number of individual series of the model. Therefore, the null hypothesis is the of long-run equilibrium cointegration vectors is $\leq r$ and where $r = 0, 1, \text{ or } 2$ against the alternative hypothesis of number of long-run equilibrium cointegration of the model with vectors $= r$

The maximum eigen test statistics is defined as

$$\lambda_{max} = -T \log(1 - \hat{\lambda}_{r+1})$$

“Here the null hypothesis is the number of long-run equilibrium cointegrating vectors $= r$ and the alternative hypothesis is the number of long-run equilibrium cointegration vectors $r + 1$. $r = 0$ is the value that tested against the alternative hypothesis which $r = 1$ and $r = 0$ is the

tested against the alternative hypothesis which $r = 2$. The λ_{MAX} test statistics has the sharper alternative hypothesis”.

7.5.3. The Error Correction Method

In order to verify the causality in the long-run, if the both future and spot index level data series are stationary and non-stationary. Therefore, vector error correction technique can be used. To estimate this, the study used ECM model.

$$r_{st} = \alpha_s + \sum_{i=1}^m \beta_{si} r_{st-i} + \sum_{j=1}^m \gamma_{sj} r_{ft-j} + \lambda_s Z_{t-1} + \varepsilon_{st}$$

$$r_{ft} = \alpha_f + \sum_{i=1}^m \beta_{fi} r_{st-i} + \sum_{j=1}^m \gamma_{fi} r_{ft-j} + \lambda_f Z_{t-1} + \varepsilon_{ft}$$

“In the model $Z_{t-1} S_{t-1} - \delta F_{t-1}$ is the error correction in the model with the $1 - \delta$ as long-run cointegration vectors of the model. λ_s and λ_f both are the adjustment parameters of the model”.

7.6. Results and Discussion

Table 1: Unit root test results

Variables	Levels	First difference
Crude Palm Oil future	0.394 (0.797)	-47.752 (0.000) ***
Crude Palm Oil spot	0.564 (0.838)	-48.145 (0.000) ***
Mentha Oil future	0.0719 (0.705)	-44.422(0.000) ***
Mentha Oil spot	-0.788 (0.374)	-46.412 (0.000) ***
Wheat future	0.599 (0.845)	-51.230 (0.000) ***
Wheat spot	0.432 (0.807)	-14.273 (0.000) ***
Barley future	0.156 (0.731)	-45.669 (0.000) ***
Barley spot	0.254 (0.759)	-10.672 (0.000) ***
Jeera future	-0.136 (0.636)	-19.772 (0.000) ***
Jeera spot	-0.046 (0.667)	-10.934 (0.000) ***

Note: ***, indicates significance at 1% level.

To know the stationary properties of the data series and in order to achieve the study's goal. First, it is significant to avoid the problem of spurious and invalid result because these are mainly depending on non-stationary data series. To estimate the unit root results, the study adopts “Augmented Dickey Fuller” test to know the order of integration. The Augmented Dickey Fuller unit root test required significant lag length, therefore, the study selected based on optimal lags which is determination of the SCI criteria. The results of time series unit root tests are displayed in Table 1. The findings of “Augmented Dickey Fuller” demonstration that “crude palm oil future, crude palm oil spot, mentha oil future, mentha oil spot, wheat future, wheat spot, barley future, barley spot, jeera future and jeera spot” variables are non-stationary at level. Therefore, it converted into first order of integration then all of the variables are stationary at their first order of integration. These results show that “crude palm oil future, crude palm oil spot, mentha oil future, mentha oil spot, wheat future, wheat spot, barley future, barley spot, jeera future and jeera spot” variables are integrated order of one, i.e. I(1).

Table 2: Bivariate Cointegration Results

Hypothesized: No. of CE(s)	trace test	critical values	λ -max test	critical values
Crude Palm Oil				
None	138.378	15.494***	138.375	14.264***
At most 1	0.002	3.841	0.002	3.841
Mentha Oil				
None	36.292	15.494***	31.461	14.264***
At most 1	4.8306	3.841**	4.830	3.841**
JEERA				
None	137.085	15.494***	132.750	14.264***
At most 1	4.335	3.841**	4.335	3.841**
BARLEY				
None	65.769	15.494***	62.369	14.264***
At most 1	3.400	3.841*	3.400	3.841*
WHEAT				
None	70.596	15.494***	68.635	14.264***
At most 1	1.961	3.841	1.961	3.841

“Note: ***, **, * indicates significance at 1% 5% and 10% level”.

Table 3: Multivariate Cointegration Results

Hypothesized: No. of CE(s)	trace test	critical values	Prob.	λ -max test	critical values	Prob.
None	899.862	239.235	0.000***	441.375	64.504	0.000***
At most 1	458.486	197.370	0.000***	164.655	58.433	0.000***
At most 2	293.831	159.529	0.000***	85.740	52.362	0.000***
At most 3	208.091	125.615	0.000***	83.418	46.231	0.000***
At most 4	124.672	95.753	0.000***	62.643	40.077	0.000***
At most 5	62.028	69.818	0.178	26.441	33.876	0.294
At most 6	35.587	47.856	0.417	19.474	27.584	0.378
At most 7	16.112	29.797	0.704	9.780	21.131	0.764
At most 8	6.331	15.494	0.656	4.157	14.264	0.842
At most 9	2.174	3.841	0.140	2.174	3.841	0.140

Note: ***, indicates significance at 1% level.

In this section, the study analyses the long-run relationship among the variables. To estimates this, the study uses both bivariate and multivariate cointegration tests. The results of bivariate “cointegration tests” are reported in Table 2. The findings show that there is a long-run equilibrium association among “crude palm oil futures, crude palm oil spots, mentha oil futures, mentha oil spots, wheat futures, wheat spots, barley futures, barley spots, jeera futures, and jeera spots”. It means that these variables are cointegrating in the long-run. The results of multivariate “cointegration tests” are show in Table 3. The investigation also confirmed that there is a long-term link among the variables. All the variables are moving towards the equilibrium position and it will reach same level in the long-run. Finally, the research shows that the “crude palm oil future, crude palm oil spot, mentha oil future, mentha oil spot, wheat future, wheat spot, barley future, barley spot, jeera future, and jeera spot” have a long-run equilibrium relationship.

Table 4: Causality and ECM Results

Hypothesis	F-statistic	Prob.	Direction
CPOS →CPOF CPOF →CPOS	0.056 0.247	0.944 0.780	No Causality
MOS →MOF MOF →MOS	14.366 3.571	6.000 0.028**	Unidirectional causality
JEERA-S →JEERA-F JEERA-F →JEERA-S	4.591 198.086	0.010*** 4.008	Unidirectional causality
BARLEY-S →BARLEY-F BARLEY-F →BARLEY-S	5.752 57.199	0.003*** 6.E-2	Unidirectional causality
WHEAT-S →WHEAT-F WHEAT-F →WHEAT-S	14.746 47.854	4.000 4.002	No Causality
Hypothesis	t-statistic	Prob.	Direction
CPOS →CPOF CPOF →CPOS	-3.344 -6.023	0.000*** 0.000***	Bidirectional causality
MOS →MOF MOF →MOS	-2.938 -9.171	0.003*** 0.000***	Bidirectional causality
JEERA-S →JEERA-F JEERA-F →JEERA-S	-5.576 -1.701	0.000*** 0.088*	Bidirectional causality
BARLEY-S →BARLEY-F BARLEY-F →BARLEY-S	-0.235 -0.712	0.814 0.475	No Causality Relation
WHEAT-S →WHEAT-F WHEAT-F →WHEAT-S	-2.672 -8.326	0.007*** 0.000***	Bidirectional causality

“Note: ***, **, * indicates significance at 1% 5% and 10% level”.

In this section, the explore the direction of causality between “crude palm oil future, crude palm oil spot, mentha oil future, mentha oil spot, wheat future, wheat spot, barley future, barley spot, jeera future and jeera spot”. The result of both causality and ECM tests are reported in Table 4. In short-run, the study finds unidirectional causality from mentha oil spot to mentha oil future. The results confirmed that jeera spot Granger causes jeera future and there is a unidirectional causality from barley spot to barley future. In the long-run, there is a bidirectional relationship between “crude palm oil spot and crude palm oil future, mentha oil spot and mentha oil future, jeera spot and jeera future, wheat spot and wheat future”.

7.7. Conclusion of the study

Furthermore, Indian agriculture responded to all the advantages in an age of globalization and liberalization. The FMC (Forward market Commission), After a lengthy embargo and rigorous laws, the “Ministry of Consumer Affairs, Food, and Public Distribution” has been closely

supervising the government in compliance with the Future Contracts Act 1952. Offset trading in agricultural products has been an effective forum for a variety of commodity market players in a relatively a seven-year period of time. Government played a major role in stabilizing both farmers and customers with respect to trade in agricultural goods in order to sustain the economy by minimum subsidy rates, national insurance and public distribution programmes. However, with government actions lowering demand for agricultural commodities, the futures market's role in “price discovery and price management” has become increasingly important. The feasibility of potential markets for farm crops depends on price exploration honesty and performance, agile communication demands, unjust speculation, price risk control, supply and delivery of products, infrastructure assistance etc. This study examines empirically, using the Johanssen cointegration technique, the efficiency of five key agricultural commodities that are regularly traded on NCDEX and MCX exchanges' futures markets. As evidence of empirical proof, all 5 agricultural commodities chosen “barley, jeera, crude palm oil, mentha oil, and wheat, have a long-term balance between future and spot prices”.

Across the globe, day by day increasing the importance of commodity future market. It is significant for trade transactions in particularly both future and spot market. There is more problem in uncertainty to certainty. Given this background, the study considered major trading commodities for analysis. The present study examines the relationship between “crude palm oil future, crude palm oil spot, mentha oil future, mentha oil spot, wheat future, wheat spot, barley future, barley spot, jeera future and jeera spot” variables covering day data period from 1-12-2010 to 31-05-2019. The study applies several time series econometric methods such as “unit root tests, bivariate and multivariate cointegration tests, causality and error-correction model (ECM) test”. The investigation demonstrates that the variables have a long-run connection existed. The results confirmed that “jeera spot granger causes jeera future” and there is a unidirectional causality from “barley spot to barley future”. In the long-run, there is a bidirectional connection among “crude palm oil spot and crude palm oil future, mentha oil spot and mentha oil future, jeera spot and jeera future, wheat spot and wheat future”.

The purpose of this research is to see how efficient these agricultural “commodity futures markets” in India are. A well-functioning commodities “futures market” can provide useful signals for “spot market prices” while also removing the prospect of profit as part of the trading process. The equilibrium value for market suppliers and purchasers is reflected in this futures price. The government, as well as producers and purchasers in India, are interested in studying

efficiency in “agricultural commodity futures markets”. An effective market is a better option for the government than intervening in the market through policies. It gives processors and marketers with a solid projection of future spot pricing, allowing them to successfully manage market risks. This research can help them to get a better idea of what's going on current state of the Indian agricultural commodity futures and cash markets ([H. Holly Wang and Bingfan Ke](#)). In India, a variety of agricultural commodities are traded on many national and regional commodity exchanges, but “NCDEX” is the major agricultural commodity exchange. For better and more effective price discovery, an agricultural economy needs a well-functioning and for agricultural commodities, there is a liquid futures market. Despite the futures market's major role in price discovery, it can be concluded based on these findings. Furthermore, the data illustrate the amount to which “spot and futures markets contribute to price discovery” for all of the commodities studied.

For all of the commodities analyzed, the results of the stationarity and cointegration tests reveal that “spot and futures prices” are integrated and cointegrated at a 5% level of significance. It signifies that in its current state, the Indian commodities market is efficient, and that “spot and futures prices” have a long-term association. These findings also provide new insights into “price discovery” or the lead-lag association among spot and futures prices, based on relatively recent data. The findings of this study reveal that for the vast majority of commodities analysed, the futures market had a greater influence on price discovery. The current study's findings show that the futures market is more influential in the price discovery process. As a result, governments should stimulate the creation of futures markets for more agricultural commodities by enacting rules and regulations that favour the growth of futures markets ([Sarveshwar Kumar Inani, 2017](#)). India's agriculture is adapting to the era of globalization and liberalizations in order to reap the benefits. In a relatively short period of time, probably a couple of years, future trading in agricultural commodities has become an essential platform for several stakeholders in the commodity markets. The government has played a crucial role in market stabilisation in agricultural commodity markets, safeguarding both farmers and consumers through minimum support prices, market guarantee schemes, and public distribution systems. The importance of the futures market in price discovery and price management has become increasingly important as government engagement in the agricultural commodities market declines. The viability of agricultural commodity futures markets is dependent on their transparency and efficiency of operation for price discovery, price risk

management, flexible contract specification, controlling unfair speculation, commodity delivery system and coverage, infrastructural support, and other aspects.

7.8. Policy Implications

1. SEBI, commodities exchanges, farmers, producers, makers, brokers, and other middlemen are all interested in investigating the effectiveness of commodity futures. Based on actual evidence, SEBI and exchanges can implement improved regulatory systems and take other steps to guarantee that farmers and other beneficiaries participate actively. Setting up sophisticated infrastructure, such as good storage or warehousing facilities, standardization of norms, and so on, may entice a large number of companies to participate. (Lakshmi VDMV, 2017).
2. The “price discovery” association has an impact on market efficiency, policy formulation, “risk management” and trading tactics. The agricultural commodity futures contracts have made a substantial contribution to market information efficiency. As a result, policymakers and regulators should focus on measures that make the futures market more liquid and efficient while minimizing the impact of speculative trading.
3. Overall, the findings can assist market participants, manufacturers, dealers, wholesalers, lawmakers, regulators, and researchers in determining the efficiency of agricultural commodity futures contracts. The findings would help market participants by allowing them to develop effective trading methods that would eventually lead to arbitrage and hedging are two methods for reducing financial risk.

7.9. Limitations of the study

1. The study's first limitation is the small sample size of only five commodities. It's because we've just looked at the top five most liquid commodities. Because of data limitations, only the Indian agricultural commodity market was considered.
2. Daily closing prices, both spot and futures, were used in the study, however intra-day data might be used to obtain more precise results. The study focused on only five agricultural commodities, while NCDEX trades a wide range of agricultural goods.

7.10. Future research or scope of research

1. Analyzing the factors that influence agricultural commodity price discovery in various nations could be a valuable study topic in the near future.

2. Rainfall, seasons, and government assistance in the form of subsidies and support prices are all important factors in agricultural commodities.
3. It's also possible to do similar study and evaluate the results on other national commodities markets including the MCX, NMCE, ICEX, and UCEA variety of natural elements, such as harvest-dependent seasonal cycles, monsoons, depressions, and weather-related events, which is another area that requires further investigation.

CHAPTER – VIII

Summary, Conclusion and Findings

8.1. Introduction

This chapter highlights the primary findings based on the findings and debates of the empirical investigation, and then offers recommendations. The findings are presented on objective wise and commodities are considered this study “jeera, wheat, barley, crude palm oil and mentha oil”. The Indian economy places a strong focus regarding agriculture, with ongoing attempts to improve the country's agribusiness situation. Agriculture provides a living for almost two-thirds of the population. To protect the interests of both producers and consumers, efficient agricultural commodity marketing has been implemented. “NCDEX is a leading commodity exchange in India” that primarily trades agricultural commodities. Agricultural commodity exchanges provide as a centralized platform for market players and farmers to transfer commodity price risk and acquire pricing data. Price swings in agriculture's sector play a significant role in hedging risk for those involved in investing in agriculture futures. The risk associated with these commodities has grown as a result of price volatility in agriculture ([Manogna and Mishra, 2021](#)).

All industrialized, emergent, and developing countries rely heavily on commodities for their economic development. About 60 percent of the population is also in India, based on subsistence agriculture. A physical product is sold or bought in a spot market at a price agreed upon by the purchaser and wholesaler. The spot market is a cash-based market where goods are bought and sold with same-day shipping. Individual customers and the business-to-business segment both have spot markets. A commodity, on the other hand, can be purchased or sold via a derivatives contract. A futures contract is a standardised agreement to buy or sell commodities at a predetermined price and on a predetermined future date.

One of the major issues with commodities is the sharp upward or downward trend of prices. Price fluctuations can be caused by erratic as well as manufacturing and harvesting demand and supply swings. Both producers and customers face risks as a result of volatility. Volatile prices have the potential to devastate economies. Price changes in agricultural commodities excite farmers, the government, industry, and even financial market participants. Price

forecasting is an essential aspect of commodity markets and price research. Prices are also unpredictable and affected by natural disasters such as droughts, storms, and pest and disease attacks, which contributes to the difficulty of predicting and modelling prices. Since rainfall influences the majority of agricultural output, excessive or low rainfall can reduce income for small farmers who do not have enough buffer to cope with such disruptions.

In future markets where the agriculture industry is highly reliant upon weather conditions and the volatility of future prices and prices discovery, the impact of the climate shock on agricultural industries has a crucial position. In the course of the years, the weather would have a different influence on different crops such as mentha oil, jeera, palm oil, barley and wheat. Agriculture in India relies primarily on precipitation. Price variability is one of the most serious problems affecting farmers. There are many factors confronting agricultural producers, along with market fluctuations such as heavy or low precipitation, crop diseases, seed destruction, weather conditions, which have contributed to higher input prices and to a high decline in revenue and adverse effect on agriculture. The key explanation behind this analysis is the fact that there have been comparatively numerous trials. The present research, however is intended to revisit the problem and analyse the price action of agricultural commodities in India on a spot and in the future. Emerging markets such as India consume relative to developing countries more commodities. This has contributed to great demand for storable as well as non-storable goods. But there is immense demand for just a few farm crops, such as herbs, pulse, cereal, and oil & pulse plants. Issues such as price exploration and quality of product potential markets for commodity business with a stronger emphasis on capital markets have been widely discussed. The work in emerging markets, particularly in India, is limited to agricultural product markets.

Hedge ratio and hedging success in the prospective sector are not novel phenomenon. Several experiments have been carried out in developing countries on the problem of hedging productivity of futures. However, in developing countries such as India the literature on hedging effectiveness is not complete. This research explores the hedge ratio and hedge efficacy of agricultural commodity products in Indian futures markets. The main question in this analysis will be to examine India's most actively traded place and potential demand of agricultural goods with respect to the process of spillovers of volatility. The rationale for India's preference for the agricultural commodity industry is because of its dominant output and demand position in the global economy. Inherently noisy, non-stationary, and leptokurtic,

agricultural market data are thus hard to catch the price actions of farmers. In this analysis, the price activity was analysed and the uncertainty impact of spot market spillovers on the basis of potential exchange was investigated. In this background, this study examines the debate on the hedge ratio and hedge quality, unpredictable spills and productivity of potential markets for indigenous agricultural commodities. As a consequence of historical weather and climate change the world demand for farm goods is still seeing sudden ups and downs. Price shifts in environment, access to goods, use of materials and market price stability have mainly influenced all facets of commodities (Porter et al., 2014). The environment influence was known as the primary cause of agricultural product price shifts (Gilbert and Morgan 2010). The number of precipitations continues to differ from year to year, causing farm productivity to vary with changing rainfall. With output fluctuations agricultural commodity prices still see significant fluctuations since Indian agriculture still mainly follows the principle of "plough to plate" Few rigidities therefore preclude the presentation of real market situations of some product prices. The government regulates several goods' prices with different steps, including minimum subsidy rates, buffer inventory policies etc. Markets are far from active in terms of knowledge absorption. With the consequence of development and prices in agriculture farmers are facing a daily, unpredictable critical condition. The agricultural producers in the first case face risks and the second is costs. In agricultural development, however there are still difficulties owing to various climates. Likewise, in the kharif and Rabi season prices are fluctuating. Price variance thereby generates confusion immediately. All these risks adversely influence farmers' wages and leave rural citizens poorer by the welfare thesis. Under all these cases, output declines as prices fluctuate.

Any farmer's primary objective is to increase income and reduce risk. High season is an important problem and declining rates contribute to sales pressure. This implies that even in their season, a producer has to sell at lower rates. If farmers want to store the selling of their farms at the future, they would have to face up to the issue of storage depletion, more markets in India consisting of a very fractured and location-specific long intermediate chain. In addition to all of those regional competitors, the foreign actors play a dominant position and influence in these domestic markets and locations. In post-globalization era, regional and global players in the palace of local and domestic markets played a major role. These demand defects contribute to demands from farmers and thus don't benefit from the sales of output that have detrimental consequences on their revenues.

8.2. Findings of the study

Across the globe, day by day increasing the importance of commodity future market. It is significant for trade transactions in particularly both future and spot market. There is more problem in uncertainty to certainty. Given this background, the study considered major trading commodities for analysis. The present study examines the relationship between spot and futures of agricultural commodities covering day data period from 1-12-2010 to 31-05-2019. “ADF unit root tests, bivariate and multivariate cointegration tests, causality, and the error-correction model (ECM) test” are among the time series econometric approaches used in this work. The study confirms cointegration between commodities. Results confirmed that “jeera spot granger causes jeera future and there is a single-way causality from barley spot to barley future”. In the long-run, bidirectional relationship among “crude palm oil spot and crude palm oil future, mentha oil spot and mentha oil future, jeera spot and jeera future, wheat spot and wheat future”. It is particularly essential for agriculture future markets to minimize the need for an effective hedging approach. The study used ADF unit root test, both bivariate and multivariate cointegration tests, VAR and VECM approaches to know the hedge ratio under the study. The analysis found that all of the variables are stationary at an integrated order of one and that there is a long-term link between them. Finally, present research attempts to offer a summary of present competing techniques when determining the optimum hedge ratio. Therefore, the efficiency of such methods is associated through average returns and average variance decreases in the exposed case. The causality test, also known as the influential direction analysis, determines whether spot prices influence futures prices and, if so, in which direction. In order to determine the cause and link of variables such as “spot and futures” prices, the study used the “Granger Causality Test”. The results are sufficient to comprehend the price discovery mechanism.

The “Vector Error Correction Model (VECM)” is a constrained “VAR (Vector Auto Regression)”. On one hand, the model is used to verify the lead-lag association among variables in order to conduct the price discovery process, and on the other hand, it is used to verify the lead-lag association among variables in order to perform the price discovery process. It gives a technical picture of how quickly pricing fluctuations adjust to reach equilibrium. The “Johannsen’s Cointegration Test” reveals the long-term relationship between variables. With a speed-of-adjustment technique, VECM mobilizes the data. As a result, the “Johansen Cointegration test” is required to determine whether the next level analysis should be unrestricted VAR or restricted VAR (VECM).

This study looked at the “return and volatility spillover” between agricultural commodity spot and futures. Barley, mentha oil, cumin, crude palm oil, and wheat are the agricultural products discussed in this chapter. The MGARCH-BEKK model, which has been proven by several researchers to be the best MGARCH model for measuring volatility and return spillover between spot and future, was used in this study to test both volatility and return spillover between spot and future. Volatility and return spillovers occur when commodities are traded on the spot market and in futures markets under consideration, according to our findings. However, in all five commodities studied, the extent of such spillover is greater from futures to spot. This means that the commodity futures market determines the commodity spot's return and volatility.

The Indian economy places a strong focus regarding agriculture, with ongoing attempts to improve the country's agribusiness situation. Agriculture provides a living for almost two-thirds of the population. To protect the interests of both producers and consumers, efficient agricultural commodity marketing has been implemented. “National Commodity and Derivative Exchange is a leading commodity exchange in India” that primarily trades agricultural commodities. Agricultural commodity exchanges act as a centralised platform for market players and farmers to transfer commodity price risk and acquire pricing data. Price swings in agriculture's sector play a significant role in hedging risk for those involved in investing in agriculture futures. The risk associated with these commodities has grown as a result of price volatility in agriculture ([Manogna and Mishra, 2021](#)).

All industrialized, emergent, and developing countries rely heavily on commodities for their economic development. About 60 percent of the population is also in India, based on subsistence agriculture. A physical product is sold or bought in a spot market at a price agreed upon by the buyer and seller. The “spot market” is a cash-based market where goods are buying and selling with same-day shipping. Individual customers and the business-to-business segment both have spot markets. A commodity, on the other hand, can be purchased or sold via a derivatives contract. A futures contract is a pre-determined and standardized agreement to buy or sell commodities at a specific price and on a specific future date.

One of the major issues with commodities is the sharp upward or downward trend of prices. Price fluctuations can be caused by erratic as well as manufacturing and harvesting demand and supply swings. Both producers and customers face risks as a result of volatility. Volatile prices have the potential to devastate economies. Price changes in agricultural commodities excite farmers, the government, industry, and even financial market participants. Price forecasting is an essential aspect of commodity markets and price research. Prices are also unpredictable and affected by natural disasters such as droughts, storms, and pest and disease attacks, which contributes to the difficulty of predicting and modelling prices. Since rainfall influences the majority of agricultural output, excessive or low rainfall can reduce income for small farmers who do not have enough buffer to cope with such disruptions.

In future markets where the agriculture industry is highly reliant upon weather conditions and the volatility of future prices and prices discovery, the impact of the climate shock on agricultural industries has a crucial position. In the course of the years, the weather would have a different influence on different crops such as mentha oil, jeera, palm oil, barley and wheat. Agriculture in India relies primarily on precipitation. Price variability is one of the most serious problems affecting farmers. There are many factors confronting agricultural producers, along with market fluctuations such as heavy or low precipitation, crop diseases, seed destruction, weather conditions, which have contributed to higher input prices and to a high decline in revenue and adverse effect on agriculture. The key explanation behind this analysis is the fact that there have been comparatively numerous trials. The present research, however is intended to revisit the problem and analyse the price action of farming produces in India on a spot and in the future. Emerging markets such as India consume relative to developing countries more commodities. This has contributed to great demand for storable as well as non-storable goods. But there is immense demand for just a few farm crops, such as herbs, pulse, cereal, and oil & pulse plants. Issues such as price exploration and quality of product potential markets for commodity business with a stronger emphasis on capital markets have been widely discussed. The work in emerging markets, particularly in India, is limited to agricultural product markets.

8.3.Suggestions of the study

The following suggestions are made to improve the Indian agricultural commodity markets' market efficiency, volatility and hedging efficiency.

1. Problems with contract parameters, such as lot size and margin money, must be addressed in order to attract large, medium, and even small traders to the futures market.

2. The regulatory authority will hold regular training sessions for market participants to raise awareness of the agricultural commodity futures market.
3. A single regulatory authority will oversee both the spot and futures markets.
4. To develop a unified national market for agricultural commodities, the electronic National Agricultural Market (eNAM) proposal must be implemented. It will simplify the regulatory process and eliminate speculation.
5. Agri-commodity options contracts must be approved for trading. Because losses are restricted to the premium paid by buyers to sellers of a call option or a put option, it helps to improve commodity market efficiency.
6. To expand farmers' participation in the futures market, banks, NGOs, co-operatives, and other institutions act as an aggregator on their behalf, bringing additional liquidity to the market.

8.4.Direction of the future research

There are numerous concerns that require empirical investigation, and future research investigations will most likely address the issues raised by this study.

1. Comparing the Indian and international agricultural commodities futures markets can be used to perform research.
2. The regulatory architecture of Indian agricultural commodity markets should also be investigated.
3. After incorporating intra-day data for the sample period, the study could be repeated in the future. There are still several aspects that need to be investigated, such as pricing and forecasting.
4. The lack of a link between open interest and futures volatility raises the question of why people trade in the first place.
5. If the sample of respondents is increased to include all Indian brokers and the questionnaire covers more specific particular commodities, the poll may yield more useful results.

References

- Acharya, S., Rath, S. S., & Panchal, B. (2015). Commodity Futures Market in India: Hedging Efficiency.
- Ajoy Kumar, M., & Shollapur, M. R. (2015). Price Discovery and Volatility Spillover in the Agricultural Commodity Futures Market in India. *IUP Journal of Applied Finance*, 21(1).
- Ali, J., & Gupta, K. B. (2011). Efficiency in agricultural commodity futures markets in India. *Agricultural Finance Review*.
- Apergis, N., & Reztis, A. (2003). Agricultural price volatility spillover effects: the case of Greece. *European Review of Agricultural Economics*, 30(3), 389-406.
- Arfaoui, M. (2018). On the spot-futures relationship in crude-refined petroleum prices: New evidence from an ARDL bounds testing approach. *Journal of Commodity Markets*, 11, 48-58.
- Arora, M., & Chander, R. (2018) Volatility Transmission between Futures and Cash Markets of Indian Agri Commodities: An Empirical Study. *IUP Journal of Financial Risk Management*, 15(4), 23-48.
- Arora, S., & Kumar, N. (2013). Role of futures market in price discovery. *Decision*, 40(3), 165-179.
- Baldi, L., Peri, M., & Vandone, D. (2016). Stock markets' bubbles burst and volatility spillovers in agricultural commodity markets. *Research in International Business and Finance*, 38, 277-285.
- Beckmann, J., & Czudaj, R. (2014). Volatility transmission in agricultural futures markets. *Economic Modelling*, 36, 541-546.
- Bhaduri, S. N., & Sethu Durai, S. R. (2008). Optimal hedge ratio and hedging effectiveness of stock index futures: evidence from India. *Macroeconomics and Finance in Emerging Market Economies*, 1(1), 121-134.
- Bhattacharya, S., & Gupta, P. (2016) Modelling Time-Varying Volatility in Indian Commodity Futures Return: Some Empirical Evidence. *IUP Journal of Financial Risk Management*, 13(4), 28.
- Bhanumurthy, N. R., Dua, P., & Kumawat, L. (2013). Weather shocks and agricultural commodity prices in India. *Climate Change Economics*, 4(03), 1350011.
- Bodhanwala, S., Purohit, H., & Choudhary, N. (2020). The causal dynamics in Indian agriculture commodity prices and macro-economic variables in the presence of a structural break. *Global Business Review*, 21(1), 241-261.

- Boonyanuphong, P., & Sriboonchitta, S. (2014). The impact of trading activity on volatility transmission and interdependence among agricultural commodity markets. *Thai Journal of Mathematics*, 211-227.
- Booth, G. G., So, R. W. and Tse, Y. (1999): 'Price Discovery in the German Equity Index Derivatives Markets', *The Journal of Futures Markets*, Vol.19, pp.619-643.
- Bose S., "Commodity futures market in India: a study of trends in the notional multi-commodity indices", *Money and Finance, ICRA Bulletin*, vol. 3, no.3, pp. 125-158, 2007.
- Buyukkara, G., Kucukozmen, C. C., & Uysal, E. T. (2021). Optimal hedge ratios and hedging effectiveness: An analysis of the Turkish futures market. *Borsa Istanbul Review*.
- Cecchetti S. G., Cumby R. E. and Figlewski S., "Estimation of optimal hedge", *Review of Economics and Statistics*, vol. 70, no. 6, pp. 623- 630, 1988
- Chakrabarty, R., & Das, R. (2010). Effect of Futures Trading on the Volatility of Spot Market in the Context of Indian Agricultural Commodity Market. *GITAM Review of International Business*, 3(1), 41.
- Chakrabarty, R., & Das, R. (2010). Effect of Futures Trading on the Volatility of Spot Market in the Context of Indian Agricultural Commodity Market. *GITAM Review of International Business*, 3(1), 41.
- Chakrabarty, R., & Sarkar, A. (2010). Efficiency of the Indian commodity and stock market with focus on some agricultural product. *Paradigm*, 14(1), 85-96.
- Chakraborty, R., & Das, R. (2013) Dynamic relationship between futures trading and spot price volatility: evidence from Indian commodity market. *IUP Journal of Applied Finance*, 19(4), 5.
- Chakraborty, R., & Das, R. (2015). A Multivariate Multiscale Entropy Approach to Testing Commodity Market Efficiency. *IUP Journal of Financial Risk Management*, 12(3).
- Chauhan, A. K., Singh, S., & Arora, A. (2013). Market efficiency and volatility spillovers in futures and spot commodity market: The agricultural sector perspective. *Samvad*, 6(2), 61-84.
- Chen, Q., & Weng, X. (2018). Information Flows between the US and China's Agricultural Commodity Futures Markets—Based on VAR-BEKK-Skew-t Model. *Emerging Markets Finance and Trade*, 54(1), 71-87.
- Choudhry, T. (2009). Short-run deviations and time-varying hedge ratios: evidence from agricultural futures markets. *International Review of Financial Analysis*, 18(1-2), 58-65.
- Cifarelli, G., & Paladino, G. (2015). A dynamic model of hedging and speculation in the commodity futures markets. *Journal of Financial Markets*, 25, 1-15.

- Cont R., “Empirical properties of asset returns: stylized facts and statistical issues”, *Quantitative Finance*, vol.1, no.3 pp. 223-236, 2001.
- Dahl, R. E., Oglend, A., & Yahya, M. (2019). Dynamics of volatility spillover in commodity markets: Linking crude oil to agriculture. *Journal of Commodity Markets*, 100111.
- Darekar, A., & Reddy, A. A. (2018). Forecasting wheat prices in India. *Wheat and Barley Research*, 10(1), 33-39.
- Das, J. K., & Chakraborty, G. (2015). The hedging performance of commodity futures in India: an empirical study on some agricultural commodities. *International Journal of Information, Business and Management*, 7(3), 162.
- Dimpfl, T., Flad, M., & Jung, R. C. (2017). Price discovery in agricultural commodity markets in the presence of futures speculation. *Journal of Commodity Markets*, 5, 50-62. Pavabutr, Pantisa, and
- Dummu, T. R. (2009). Commodity futures markets in India: its impact on production and prices. *Indian Journal of Agricultural Economics*, 64(902-2016-67871).
- Easwaran, R. S., & Ramasundaram, P. (2008). Whether commodity futures market in agriculture is efficient in price discovery?-An econometric analysis. *Agricultural Economics Research Review*, 21(347-2016-16671), 337-344.
- Ederington L.H., “The hedging performance of the new futures markets”, *Journal of Finance*, vol. 34, no.1, pp. 157-170, 1979.
- Fama, E. (1970): ‘Efficient Capital Markets: A Review of Theory and Empirical Work’, *The Journal of Finance*, Vol. 25, pp. 383-417.
- Fama, E. (1970): ‘Efficient Capital Markets: A Review of Theory and Empirical Work’, *the Journal of Finance*, Vol. 25, pp. 383-417.
- Figlewski S., “Hedging performance and basis risk in stock index futures”, *Journal of Finance*, vol. 39, no.3, pp. 657-669, 1984.
- Floro C., and Vougas D. V., “Hedging effectiveness in Greek stock index futures market 1999-2001”, *International Research Journal of Finance and Economics*, vol. 5, no.1, pp. 7-18, 2006. Assessed: wolfweb.unr.edu/~zal/STAT758/Engle82.pdf, 12 June, 2014
- Goyari, P., & Kumar Jena, P. (2011). Commodity Futures Market in India: An Econometric Analysis. *Indian Journal of Economics*, 91(363), 699.
- Gözüör, G., & Memiş, C. (2015). Price volatility spillovers among agricultural commodity and crude oil markets: Evidence from the range-based estimator.

- Gozgor, G., and C. Memis. "Price volatility spillovers among agricultural commodity and crude oil markets: Evidence from the range-based estimator." *Agricultural Economics* 61.5 (2015): 214-221.
- Gupta, S., Choudhary, H., & Agarwal, D. R. (2017). Hedging efficiency of Indian commodity futures: An empirical analysis. *Paradigm*, 21(1), 1-20.
- Hamadi, H., Bassil, C., & Nehme, T. (2017). News surprises and volatility spillover among agricultural commodities: The case of corn, wheat, soybean and soybean oil. *Research in International Business and Finance*, 41, 148-157.
- Haq, I. U., & Chandrasekhara Rao, K. (2013). Optimal Hedge Ratio and Hedging Effectiveness of Indian Agricultural Commodities. *IUP Journal of Financial Risk Management*, 10(2).
- Howard C. T., and D'Antonio L. J., "A risk-return measure of hedging effectiveness", *Journal of Financial and Quantitative Analysis*, vol. 19, no.1, pp. 101–112, 1984
- Hsin C. W., Kuo J., and Lee C. F., "A new measure to compare the hedging effectiveness of foreign currency futures versus options", *Journal of Futures Markets*, vol. 14, no. 6, pp. 685–707, 1994.
- Hussain Yaganti, C., & Kamaiah, B. (2012). Hedging Efficiency of Commodity Futures Markets in India. *IUP Journal of Financial Risk Management*, 9(2).
- Inani, S. K. (2016). Price discovery in Indian commodity market. *International Journal of Business and Emerging Markets*, 8(4), 361-382.
- Inani, S. K. (2016). Price discovery in Indian commodity market. *International Journal of Business and Emerging Markets*, 8(4), 361-382.
- Inani, S. K. (2016). Price discovery in Indian commodity market. *International Journal of Business and Emerging Markets*, 8(4), 361-382.
- Inani, S. K. (2018). Price discovery and efficiency of indian agricultural commodity futures market: an empirical investigation. *Journal of Quantitative Economics*, 16(1), 129-154.
- Inoue, T., & Hamori, S. (2014). Market efficiency of commodity futures in India. *Applied Economics Letters*, 21(8), 522-527.
- Irafan M and Hooda J (2017) An Empirical Study of Price Discovery in Commodities Futures Market, *Indian Journal of Finance*, 11, (13), 41-57.
- Iyer, V., & Pillai, A. (2010). Price discovery and convergence in the Indian commodities market. *Indian Growth and Development Review*.
- Jena, P. K., & Goyari, P. (2016). Empirical Relationship between Commodity, Stock and Bond Prices in India: A DCC Model Analysis. *IUP Journal of Applied Finance*, 22(1), 37.

- Jhunjhunwala, S., & Suresh, S. (2020). Commodity and Stock Market Interlinkages: Opportunities and Challenges for Investors in Indian Market. *Global Business Review*, 0972150920946413. *Journal of Indian Business Research*, Vol. 5, No. 2, pp.101–121.
- Johnson L., “The theory of hedging and speculation in commodity futures”, *Review of Economic Studies*, vol. 27, no.1, pp.139-151, 1960.
- Joseph, A., Sisodia, G., & Tiwari, A. K. (2014). A frequency domain causality investigation between futures and spot prices of Indian commodity markets. *Economic Modelling*, 40, 250-258.
- Joseph, A., Sisodia, G., & Tiwari, A. K. (2015). The inter-temporal causal nexus between Indian commodity futures and spot prices: A wavelet analysis. *Theoretical Economics Letters*, 5(02), 312.
- Joseph, A., Suresh, K. G., & Sisodia, G. (2015). Is the causal nexus between agricultural commodity futures and spot prices asymmetric? Evidence from India. *Theoretical Economics Letters*, 5(02), 285.
- Kaminsky, G. and Kumar, M. S. (1989): ‘Efficiency in Commodity Futures Markets’ Working papers, International Monetary Fund.
- Kaur, G., & Dhiman, B. (2019). Agricultural Commodities and FMCG Stock Prices in India: Evidence from the ARDL Bound Test and the Toda and Yamamoto Causality Analysis. *Global Business Review*, 0972150919830803.
- Kaur, G., & Dhiman, B. (2019). Agricultural Commodities and FMCG Stock Prices in India: Evidence from the ARDL Bound Test and the Toda and Yamamoto Causality Analysis. *Global Business Review*, 0972150919830803.
- Kaur, M., & Gupta, K. (2018). Estimation of Hedging Effectiveness Using Variance Reduction and Risk-Return Approaches: Evidence from National Stock Exchange of India. *International Journal of Business Analytics and Intelligence*, 6(1), 35.
- Kumar B., Singh P. and Pandey A., “Hedging effectiveness of constant and time varying hedge ratio in Indian stock and commodity futures markets”, IIMA Working Paper No. 2008-06-01, pp. 1-35, 2008.
- Kumar, B. and Pandey, A. (2010) Price volatility, Trading Volume and Open Interest: Evidence from Indian Commodity Futures Markets [online] https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1658844 (accessed 20 January 2017).
- Kumar, B., Singh, P., & Pandey, A. (2008). Hedging effectiveness of constant and time varying hedge ratio in Indian stock and commodity futures markets. Available at SSRN 1206555.

- Kumar, S., & Lagesh, M. A. (2011) Spot Return Volatility and Hedging with Futures Contract: Empirical Evidence from the Notional Commodity Futures Indices of India. *IUP Journal of Behavioural Finance*, 8(2), 70.
- Lagesh, M. A., Kasim C, M., & Paul, S. (2014). Commodity futures indices and traditional asset markets in India: DCC evidence for portfolio diversification benefits. *Global Business Review*, 15(4), 777-793.
- Lakshmi, P., S. Visalakshmi, and S. Padmavathy. "Exploring the nexus between futures contracts and spot returns in the Indian commodity market." *International Journal of Indian Culture and Business Management* 10.3 (2015): 306-317.
- Lakshmi, P., Visalakshmi, S., & Padmavathy, S. (2015). Exploring the nexus between futures contracts and spot returns in the Indian commodity market. *International Journal of Indian Culture and Business Management*, 10(3), 306-317.
- Lakshmi, V. D. M. V. (2017). Efficiency of Futures Market in India: Evidence from Agricultural Commodities. *IUP Journal of Applied Economics*, 16(3).
- Lakshmi, V. D. M. V., & Joshi, M. (2019). Price Discovery Behaviour of Spot and Futures: Evidence from Pre-and Post-Crisis Periods. *IUP Journal of Applied Economics*, 18(4).
- Liu, K., Koike, A., & Mu, Y. (2020). Price Risks and the Lead-Lag Relationship between the Futures and Spot Prices of Soybean, Wheat and Corn. *Asian Journal of Economic Modelling*, 8(1), 76-88.
- Mahalik, M. K., Acharya, D., & Babu, M. S. (2014). Price discovery and volatility spillovers in futures and spot commodity markets. *Journal of Advances in Management Research*.
- Mahalik, M. K., Acharya, D., & Babu, M. S. (2014). Price discovery and volatility spillovers in futures and spot commodity markets. *Journal of Advances in Management Research*.
- Maitra, D. (2018). Do seasonality, break and spillover effects explain commodity price volatility? *Journal of Agribusiness in Developing and Emerging Economies*.
- Maitra, D., & Dawar, V. (2019). Return and volatility spillover among commodity futures, stock market and exchange rate: Evidence from India. *Global Business Review*, 20(1), 214-237.
- Malhotra, M. (2015). Evaluating the hedging performance of oil and oilseeds futures in India. *Paradigm*, 19(2), 184-196.
- Malhotra, M., & Kumar Sharma, D. (2013). Efficiency of Guar Seed Futures Market in India: An Empirical Study. *IUP Journal of Applied Finance*, 19(2).

- Manogna, R. L., & Mishra, A. K. (2020) Can the FMCG Stock Market Investors Hedge the Risk in Agricultural Commodity Markets? Empirical Evidence from India. In *The Financial Landscape of Emerging Economies* (pp. 55-69). Springer, Cham.
- Manogna, R. L., & Mishra, A. K. (2020). Price discovery and volatility spillover: an empirical evidence from spot and futures agricultural commodity markets in India. *Journal of Agribusiness in Developing and Emerging Economies*.
- Meher, B. K., Hawaldar, I. T., Mohapatra, L., & Sarea, A. (2020). The Impact of COVID-19 on Price Volatility of Crude Oil and Natural Gas Listed on Multi Commodity Exchange of India. *International Journal of Energy Economics and Policy*, 10(5), 422-431.
- Mohanty, S. K., & Mishra, S. (2020). Regulatory reform and market efficiency: The case of Indian agricultural commodity futures markets. *Research in International Business and Finance*, 52, 101145.
- Mukherjee, I., & Goswami, B. (2017). The volatility of returns from commodity futures: evidence from India. *Financial Innovation*, 3(1), 15.
- Musunuru, N. (2013). Testing the presence of calendar anomalies in agricultural commodity markets. *Regional Business*, 32, 32-48.
- Musunuru, N. (2014). Modelling price volatility linkages between corn and wheat: a multivariate GARCH estimation. *International Advances in Economic Research*, 20(3), 269-280.
- Musunuru, N. (2016). Examining volatility persistence and news asymmetry in soybeans futures returns. *Atlantic Economic Journal*, 44(4), 487-500.
- Musunuru, N. (2019). Modelling long range dependence in wheat food price returns. *International Journal of Economics and Finance*, 11(9), 1-46.
- Musunuru, N., Yu, M., & Larson, A. (2013). Forecasting volatility of returns for corn using GARCH Models. *Texas Journal of Agriculture and Natural Resources*, 26, 42-55.
- Myers R. J., "Estimating time-varying optimal hedge ratios on futures markets", *Journal of Futures Markets*, vol.11, no. 1, pp.139–153, 1991
- Myers R. J., and Thompson S. R., "Generalized optimal hedge ratio estimation", *American Journal of Agricultural Economics*, vol. 71, no. 4, pp.858-868, 1989
- Nair, S. T. G. (2018) The Effects of Financial Crisis on Hedging Efficiency of Indian Rubber Future Markets. *Financial Statistical Journal*, 1(3).
- Nair, S. T. G. (2019). Recession effect in pricing efficiency of rubber futures: the emerging market's experience. *Journal of Agribusiness in Developing and Emerging Economies*.

- Naliniprava, T. (2011). Hedge Ratio and Hedging Efficiency: Evidence from Indian Derivative Market. *Journal of Applied Research in Finance (JARF)*, 3(05), 62-75.
- Narsimhulu, S., & Satyanarayana, S. V. (2016). Efficiency of Commodity Futures in Price Discovery and Risk Management: An Empirical Study of Agricultural Commodities in India. *Indian Journal of Finance*, 10(10), 7-26.
- Park T., and Switzer L., "Bivariate GARCH estimation of the optimal hedge ratios for stock index futures: a note", *Journal of Futures Markets*, vol. 15, no. 1, pp. 61-67, 1995
- Pavabutr, P., & Chaihetphon, P. (2010). Price discovery in the Indian gold futures market. *Journal of Economics and Finance*, 34(4), 455-467.
- Pavabutr, Pantisa, and Piyamas Chaihetphon. "Price discovery in the Indian gold futures market." *Journal of Economics and Finance* 34.4 (2010): 455-467.
- Prasanna, G. S. (2014). Performance Evaluation of Agricultural Commodity Futures Market in India. *IUP Journal of Applied Finance*, 20(1), 34.
- Radha, K., & Balakrishnan, S. (2017) The Role of Commodity Futures in Risk Management: A Study of Select Agricultural Commodities. *IUP Journal of Financial Risk Management*, 14(4).
- Raghavendra, R. H., Velmurugan, P. S., & Saravanan, A. (2016). Relationship between spot and futures markets of selected agricultural commodities in India: an efficiency and causation analysis. *Journal of Business & Financial Affairs*, 5(1), 2167-0234.
- Ranganathan, T., & Ananthakumar, U. (2014). Does hedging in futures market benefit Indian farmers? *Studies in Economics and Finance*.
- Rout, B. S., Das, N. M., & Rao, K. C. (2021). Competence and efficacy of commodity futures market: Dissection of price discovery, volatility, and hedging. *IIMB Management Review*.
- Rout, B. S., Das, N. M., & Rao, K. C. (2019). Volatility Spillover Effect in Commodity Derivatives Market: Empirical Evidence through Generalized Impulse Response Function. *Vision*, 23(4), 374-396.
- Sadefo Kamdem, J., & Moumouni, Z. (2020) Comparison of Some Static Hedging Models of Agricultural Commodities Price Uncertainty. *Journal of Quantitative Economics*, 18, 631-655.
- Sahoo, P., & Kumar, R. (2009). Efficiency and futures trading-price nexus in Indian commodity futures markets. *Global Business Review*, 10(2), 187-201.

- Sakthivel, P., Chittedi, K. R., & Sakyi, D. (2017). Price discovery and volatility transmission in currency spot and futures markets in India: An empirical analysis. *Global Business Review*, 20(4), 931-945.
- Sehgal, S., Berlia, N., & Ahmad, W. (2013). An examination of price discovery and volatility spillovers of crude oil in globally linked commodity markets. *International Journal of Economics and Finance*, 5(5), 15-34.
- Sehgal, S., Rajput, N., & Deisting, F. (2013). Price discovery and volatility spillover: Evidence from Indian commodity markets. *The International Journal of Business and Finance Research*, 7(3), 57-75.
- Sehgal, S., Rajput, N., & Dua, R. K. (2012). Futures trading and spot market volatility: evidence from Indian commodity markets. *Asian Journal of Finance & Accounting*, 4(2).
- Sehgal, S., Rajput, N., & Dua, R. K. (2012). Price discovery in Indian agricultural commodity markets. *International Journal of Accounting and Financial Reporting*, 2(2), 34.
- Sendhil, R., Amit, K., Mathur, V. C., & Jha, G. K. (2014). Price volatility in agricultural commodity futures-an application of GARCH model. *Journal of the Indian Society of Agricultural Statistics*, 68(3), 365-375.
- Sendhil, R., Kar, A., Mathur, V. C., & Jha, G. K. (2013). Price Discovery, Transmission and Volatility: Evidence from Agricultural Commodity Futures §. *Agricultural Economics Research Review*, 26(1), 41-54.
- Seth, N., & Sidhu, A. (2018). Price Discovery and Volatility Spillovers in Indian Wheat Market: An Empirical Analysis. *IUP Journal of Applied Finance*, 24(2), 5-20.
- Shakeel, M., & Purankar, S. (2014). Price discovery mechanism of spot and futures market in India: A case of selected agri-commodities. *International Research Journal of Business and Management*, 8(8), 50-61.
- Shakeel, Moonis, and Shriram Purankar. "Price discovery mechanism of spot and futures market in India: A case of selected agri-commodities." *International Research Journal of Business and Management* 8.8 (2014): 50-61.
- Sharma, D. K., & Malhotra, M. (2015). Impact of Futures Trading on Volatility of spot market- A case of Guar Seed. *Agricultural Finance Review*.
- Sharma, P., & Sharma, T. (2018). A Study of the Efficiency of Chili Futures Market in India. *IUP Journal of Financial Risk Management*, 15(3), 32-43.
- Sharma, T. (2016). The Impact of Future Trading on Volatility in Agriculture Commodity: A Case of Pepper. *IUP Journal of Financial Risk Management*, 13(4), 47.

- Shihabudheen, M. T., & Padhi, P. (2010). Price discovery and volatility spillover effect in Indian commodity market. *Indian Journal of Agricultural Economics*, 65(902-2016-67367).
- Soni, T. K. (2014). Cointegration, linear and nonlinear causality. *Journal of Agribusiness in Developing and Emerging Economies*.
- Srinivasan, P. (2012). Price Discovery and Volatility Spillovers in Indian Spot-Futures Commodity Market. *IUP Journal of behavioural finance*.
- Srinivasan, P., & Ibrahim, P. (2012). Price discovery and asymmetric volatility spillovers in Indian spot-futures gold markets. *International Journal of Economic Sciences and Applied Research*, 5(3), 65-80.
- Surobhi, M. (2017). Futures markets-old style speculation or financialisation? *Economic and Political Weekly*, 52(35).
- Tse, Y.(1999): ‘Price Discovery and Volatility Spillovers in the DJIA Index and Futures Markets’, *The Journal of Futures Markets*, Vol. 19, pp.911–930.
- Vimal Shubhendu (2015) Testing Efficiency in Agricultural Commodity Futures Market in India Using Cointegration and Causality Tests, *Indian Journal of Finance*, 9,(12), 51-62.
- Yang J., Bessler D.A., and Leatham D. J., “Asset storability and price discovery in commodity futures markets: A new look”, *Journal of Futures Markets*, vol. 21, no.1, pp. 279-300, 2001.
- Yang, J., & Awokuse, T. O. (2003) Asset storability and hedging effectiveness in commodity futures markets. *Applied Economics Letters*, 10(8), 487-491.
- Zhang, Y., & Choudhry, T. (2015) forecasting the daily dynamic hedge ratios by GARCH models: evidence from the agricultural futures markets. *The European Journal of Finance*, 21(4), 376-399.
- Živkov, D., Kuzman, B., & Subić, J. (2020). What Bayesian quantiles can tell about volatility transmission between the major agricultural futures? *Agricultural Economics*, 66(5), 215-225.

Stock prices, inflation, and output in India: An empirical analysis

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This study focusses on the negative relationship between inflation and stock returns (the puzzle of Fisher hypothesis). Fama hypothesis examined the relationship between macroeconomic variable and stock return and found the strong relationship between the real output and stock prices. This study revisits Fama's hypothesis from the period 1990M1 to 2016M6 for emerging country perspective. The results documented that there is a significant negative relationship between inflation and output whereas positive between stock price and output.

1 | INTRODUCTION

1.1 | Background

According to Fama's (1981) hypothesis, inflation was negatively related with output and stock prices were positively related with output. This idea was loosely based on the Fisher (1930) hypothesis that stock market returns are independent of inflationary expectations. The popular Fisherian hypothesis shows real returns as a function of expected inflation whereas nominal returns to be a function of unexpected inflation. There are similar studies, such as Bodie (1976), Peel and Pope (1988), and Li, Narayan, and Zheng (2010). Fama (1981) highlighted that there is a positive and negative relationship between stock returns, inflation, and their impact on real output. First, this empirical study tests two hypotheses, a positive association between real stock returns and real output. Second, there is a negative relationship between real output and inflation.

However, over the last few decades, several studies have examined the dynamic relationship among stock prices, inflation, and output growth in the stock returns and inflation. Large part of literature has empirically verified negative association between inflation and stock returns (Adams, McQueen, & Wood, 2004; Bodie, 1976; Fama, 1981). On the other hand, several studies showed positive relationship between stock prices and output (Fama, 1981; Chatrath et al., 1996; Durai & Bhaduri, 2009).

There are numerous studies that have used the U.S. and European countries' data, which consistently rejected the Fisherian

hypothesis (Asprem, 1989; Fama, 1981; Geske & Roll, 1983; Lintner, 1975). Those studies have explored negative and significant relationship between the real stock returns and inflation and failed to justify this paradoxical relationship as an alternative. This paradox in financial literature is assembled as "stock return–inflation puzzle." This puzzle has been explored as emerging economies.

Chatrath, Sanjay, and Song (1996) examined the relationship among stock returns, inflation, and output for India. It is evident from their study that there is partial support for Fama hypothesis and also indicated a negative relationship between stock returns and inflation for unexpected component of inflation. As a perfect hedge, when the expected inflation and stock returns are negatively related. It has significantly understood the relationship between output stock prices and rate of inflation for a better outlook.

1.2 | Motivation

The objective of this study is to analyse Indian stock prices, inflation, and output nexus. There are two facts. First, there is lack of empirical as well as theoretical consensus on linkages between stock prices, inflation, and output. Hence, examining this empirical relationship through extended datasets can provide new and significant insights. Towards this end, the present study uses both updated and extended datasets compared with the extent literature of India.

Second, there are few studies in India, such as Chatrath et al. (1996) and Durai and Bhaduri (2009). The main aim of this study is to

- analyse the negative (inverse) relationship between inflation and real output, contrary to the association represented in the Philips curve, and
- examine the positive association between stock prices and real output in the stock returns–inflation literature.

According to the current world financial crisis or meltdown with unparalleled inflation and stock market, there is every chance of understanding the linkages between three macroeconomic variables in India.

1.3 | Contributions

This study focuses on three issues. First, it analyses inflation and output nexus and we also look at the relationship between stock returns and inflation (unexpected and expected inflation). The motivation for doing is that change in inflation how effect on stock returns and in order to verify which is effectively (unexpected and expected inflation) impact on stock returns.

Second, it examines the relationship between stock market returns and inflation. Some studies suggest that the relationship between stock market returns and inflation across various inflation countries is negative for low inflation but positive for high inflation (see Barnes, Boyd, & Smith, 1999). Therefore, empirical findings display that there is a negative relationship between inflation and stock returns, according to Barnes et al. (1999). India maintained low inflation in this framework by using stock returns as a hedge against rate of inflation.

Third, the study used a database of announcement dates from January 1990 to June 2016. The period considered covers a study period much longer than previous studies, such as Chatrath et al. (1996), who used the announcement data from April 1984 to December 1992, and Durai and Bhaduri (2009), who used the announcement data from November 1995 to July 2006. Announcement dates are taken from papers in this study (see Section 2.1 for details).

The rest of the paper is organized as follows. Section 2 presents the data and methodology. Section 3 documents the empirical results. Finally, Section 4 provides the conclusion.

2 | DATA AND METHODOLOGY

2.1 | Source of data

This study uses monthly data for the spanning period from 1990M1 to 2016M6. The Index of Industrial Production (*IIP*) is used as a proxy for output growth, producer price index for inflation rate (*INF*), and Bombay Stock Exchange for stock prices (*SP*). The selection of the required data is obtained from the International Financial Statistics online published by the International Monetary Fund and Bloomberg. All the selected data converted into natural logarithm; this technique

has been used in the literature such as Raghutla, Sampath, et al. (2018), Raghutla, Sakthivel, et al. (2018), and Ummalla and Raghutla (2015).

2.2 | Methodology

2.2.1 | Testing Fama's hypothesis

This study aims to explore the relationship between stock prices, inflation, and real output, with variables. First, it analyses the negative association between inflation and real output, contrary to the association represented in the Philips curve. Second, it examines the positive association between stock prices and real output. Chatrath et al. (1996) and Durai and Bhaduri (2009) analysed the Fama hypothesis. The relationship between real stock return and inflation is tested below in the form of equations:

$$R_t - INF_t = \alpha + \beta E(INF_t | \varphi_{t-1}) + \varepsilon_t, \quad (1)$$

$$R_t - INF_t = \alpha + \beta_1 (INF_t | \varphi_{t-1}) + \beta_2 (INF_t - E(INF_t | \varphi_{t-1})) + v_t, \quad (2)$$

where R_t is the nominal stock returns and I_t is the rate of inflation. The difference $R_t - INF$ represents (inflation adjusted) the real stock market return. Furthermore, inflation (*I*) was decomposed into two parts, that is, expected inflation [$E(INF)$] and unexpected inflation [$UE(INF)$]. The results confirm a strong negative association with the return of stocks. ε_t and v_t are randomly distributed error terms. To estimate the empirical relationship between variables, we used individual equations is as follows:

$$INF_t = \delta + \sum_{i=-k}^k \alpha_i IIP_{t-1-i} + \varepsilon_t, \quad (3)$$

$$R_t - INF_t = \tau + \sum_{i=-k}^k \beta_i IIP_{t+1} + \varphi_t, \quad (4)$$

where IIP_t is the *IIP* that is proxy of economic growth; both lead and lag values of *IIP* are incorporated because of the lack theory and prior empirical evidence pertaining the relationship of output with stock returns and rate of inflation in India. ε_t is the random error term. Equation (3) tests the negative relationship between inflation (*INF*) and output (*IIP*) and implies that some α_i are significantly negative. Equation (4) tests the positive association between stock prices and output (*IIP*) and implies that some β_i are significantly positive.

However, the proxy effect hypothesis explanation is based on Equations (1) and (2); those equations have inverse relationship between stock returns and inflation. Two equations are treated as single equation (see Johnston, 1987). Accordingly, the two-step ordinary least squares procedure is adapted to this study, the relationship between stock return and the actual as expected and residual as unexpected components of inflation. Regression equation is as follows:

$$INF_t = \mu + \sum_{i=-k}^k \beta_i IIP_{t+1} + \varepsilon_t, \quad (5)$$

$$R_t - INF_t = \alpha + \beta_1 \varepsilon_t + \sum_{i=-k}^k IIP_{t+1} + \nu_t, \quad (6)$$

where $R_t - INF_t$ are lagged values of stock returns and leading value of IIP , the empirical estimated residual from Equation (6), ε_t , indicates the inflation variable that is purged of the association between rate of inflation and output. Coefficient of $\beta_1 = 0$ in Equation (6) would confirm the assumption that stock returns are independent of inflation. Both expected inflation ($E(INF_t)$) and unexpected inflation ($UE(INF_t)$) components are estimated.

2.3 | Correlation

Table 1 shows simple correlations that are estimated among variables considered in this study. The findings clearly indicate that inflation (INF) and output (IIP) have positive correlation with stock prices (SP).

3 | EMPIRICAL RESULTS

3.1 | Order of integration of variables

In empirical analysis, variables are considered, and the order of integration needs to be identified. In this regard, augmented Dickey-Fuller unit root test has been employed. The appropriate lag length criterion is automatic, and Schwarz information criterion has been used. The results of the time series unit root test are reported in Table 2. The empirical results display that the null hypothesis is

cannot reject at level, the variables such as SP , IIP and INF . However, when the augmented Dickey-Fuller test is applied to the first differential data series, the null hypothesis is strongly rejected at 1% significance level for SP , IIP , and INF . This suggests that the SP , IIP , and INF are stationary at the first-order difference.

3.2 | Inflation versus output

The estimated results are clearly shown in Table 3. The coefficient has significant negative relationship between inflation (INF) and output growth (IIP). Similar results are also documented by Chatrath et al. (1997) and Durai and Bhaduri (2009).

3.3 | Stock returns versus inflation

The estimated real stock returns ($R_t - INF_t$) and output growth (IIP ; $R_t - INF_t$) are positively related with the real output growth (IIP). The first study, Chatrath et al. (1997), explored the real stock returns and output. Similarly, the second study, Durai and Bhaduri (2009), examined the real stock returns and output. Overall, their findings established that there is positive association between stock returns and output. The estimated results are shown in Table 4.

3.4 | Stock market returns versus inflationary trends

$$R_t - INF_T = a + \beta_1 E(INF)_T + u_t, \quad (7)$$

$$R_t - INF_t = b + \beta_1 E(INF)_t + \beta_2 UE(INF)_t + \nu_t, \quad (8)$$

$$R_t - INF_t = c + \beta_1 INF_t + \varepsilon_t. \quad (9)$$

Table 5 displayed the relationship between stock returns and expected inflation (Equation (7)), stock returns and expected and

TABLE 1 Correlation matrix

Variable	SP	INF	IIP
SP	1.000		
INF	0.944	1.000	
IIP	0.936	0.981	1.000

Note. Estimated variables are natural logarithms.

TABLE 2 Unit root test results (augmented Dickey-Fuller unit root test results [monthly data series])

Variable	Level	First difference (t value)
SP	-1.908	-15.640***
INF	6.589	-12.415***
IIP	-0.677	-3.558**

**Unit root test stationary at first difference with 5% significant level.

***Unit root test stationary at first difference with 1% significant level.

TABLE 3 Inflation versus output (estimation results from Equation (3))

Variable	Coefficient	Probability
IIP	-0.001	.737
AR	0.356***	.000
SIGMASQ	4.340***	.000
R^2	.129	
Adjusted R^2	.121	
Durbin-Watson statistic	2.048	

***Significant at 1% level.

TABLE 4 Stock returns versus inflation (estimation results from Equation (4))

Variable	Coefficient	Probability
<i>IIP</i>	0.044	.368
<i>AR</i> (1)	0.123	.012
<i>SIGMASQ</i>	0.006***	.000
R^2	.016	
Adjusted R^2	.007	
Durbin–Watson statistic	2.000	

***Significant at 1% level.

unexpected inflation (Equation (8)), and stock returns and inflation (Equation (9)). The coefficient is negative but statistically insignificant. Thus, results indicate no support for Fisherman hypothesis. Hypothesis has three components: The relationship is independent of stock returns and expected inflation, stock returns and expected and unexpected inflation, and stock returns and inflation. To sum up, the hypothesis of the three components lacks the relationship between variables, which are rejected by data.

3.5 | Inflationary trends versus real activity

Table 6 shows that the relationship between inflation and real output is based on proxy effect hypothesis. The regression results of inflation (INF_t) are on lagged values, whereas that of IIP_t are on leading values. The inflation and output coefficient pertain to the model, both incorporate lead-lag values of 1, 3, 6, 9, and 12 months. The estimated results indicate negative relationship between inflation (INF) and output (IIP). Furthermore, the first objective is fulfilled with Fama (1981) proxy effect framework. The coefficients are empirically significant of lagged values of IIP alone; in other words, IIP coefficients seem to lead values declining in inflation (INF) rather than vice versa.

3.6 | Stock returns versus real activities

Table 7 shows that the relationship between stock prices and real output is based on proxy effect hypothesis. The estimated regression results of stock prices are on lagged values, whereas that of IIP are on leading values. The output coefficients pertain to the model and incorporate both lag and lead values of IIP , $IIP(1)$, and $IIP(6)$ coefficients, which are empirically significant, and leading values of IIP coefficients

TABLE 6 Inflationary trends versus real activity (estimation results from Equation (3))

Variable	Coefficient	Probability
<i>C</i>	0.005***	.000
<i>IIP</i>	−0.015	.086
<i>IIP</i> (1)	−0.017**	.037
<i>IIP</i> (3)	−0.007	.238
<i>IIP</i> (6)	0.013*	.055
<i>IIP</i> (9)	0.000	.910
<i>IIP</i> (12)	−0.020**	.031
<i>AR</i> (12)	0.188***	.001
<i>AR</i> (9)	−0.028	.639
<i>AR</i> (6)	0.036	.517
<i>AR</i> (3)	0.081	.121

*Significant at 10% level.

**Significant at 5% level.

***Significant at 1% level.

TABLE 7 Stock returns versus real activities (estimation results from Equation (4))

Variable	Coefficient	Probability
<i>C</i>	0.004	.289
<i>IIP</i>	0.274**	.030
<i>IIP</i> (1)	0.152**	.024
<i>IIP</i> (3)	−0.000	.991
<i>IIP</i> (6)	0.185**	.029
<i>IIP</i> (9)	−0.066	.318
<i>IIP</i> (12)	−0.107	.431
<i>AR</i> (12)	−0.032	.553
<i>AR</i> (9)	−0.036	.540
<i>AR</i> (6)	0.056	.355
<i>AR</i> (3)	−0.055	.327
<i>SIGMASQ</i>	0.006***	.000

**Significant at 5% level.

***Significant at 1% level.

are generally positive, although Table 7 shows that $IIP(3)$, $IIP(9)$, $IIP(12)$, and $AR(12)$ values are negative and statistically insignificant. However, the second objective is fulfilled with Fama (1981) hypothesis proxy effect framework. The coefficients are empirically significant of lagged values of IIP . In other words, there is positive association between stock prices and IIP .

TABLE 5 Stock market returns versus inflationary trends (estimation results from Equations (1)–(3))

Equation	Constant	INF_t	$E(INF)_t$	$UE(INF)_t$	Adjusted R^2
(1)	0.006	—	−0.844	—	.001
(2)	0.013	—	−0.841	−1.394	.006
(3)	0.011	−0.914	—	—	.006

Note. Estimated using natural logarithms data.

4 | CONCLUSION

Global attention to rising inflation, high volatile stock markets, and slow growth momentum understand the relationship between stock prices, inflation, and output significantly. The aim of this study is to analyse the negative association between rate of inflation and output growth and also explore the positive association between stock prices and output in India over the period from 1990M1 to 2016M6. The results documented that there is negative relationship between inflation and output whereas positive relationship between stock prices and output. These results are supported by Chatrath et al. (1997) and Durai and Bhaduri (2009). Moreover, the present study indicates that the stock market accurately reflects future output in India.

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REFERENCES

- Adams, G., McQueen, G., & Wood, R. (2004). The effects of inflation news on high frequency stock returns. *Journal of Business*, 77, 547–574.
- Asprem, M. (1989). Stock prices, asset portfolios and macroeconomic variables in ten European countries. *Journal of Banking and Finance*, 13, 589–612.
- Barnes, M., Boyd, J. H., & Smith, B. D. (1999). Theories of money, credit and aggregate economic activity, inflation and asset returns. *European Economic Review*, 43, 737–754.
- Bodie, Z. (1976). Common stocks as a hedge against inflation. *Journal of Finance*, 31, 459–470.
- Chatrath, A., Sanjay, R., & Song, F. (1996). Stock prices, inflation and output: Evidence from India. *Journal of Asian Economics*, 7(2), 237–245.
- Durai, S. R., & Bhaduri, S. N. (2009). Stock prices, inflation and output: Evidence from wavelet analysis. *Economic Modelling*, 26, 1089–1092.
- Fama, E. F. (1981). Stock returns, real activity, inflation and money. *American Economic Review*, 71(4), 545–564.
- Fisher, I. (1930). *The theory of interest*. New York: Macmillan.
- Geske, R., & Roll, R. (1983). The fiscal and monetary linkage between stock returns and inflation. *Journal of Finance*, 38, 1–33.
- Johnston, J. (1987). *Econometric methods*. New York: McGraw Hill.
- Li, L., Narayan, P. K., & Zheng, X. (2010). An analysis of inflation and stock returns for the UK. *Journal of International Financial Markets, Institutions & Money*, 20, 519–532.
- Lintner, J. (1975). Inflation and security returns. *Journal of Finance*, 30, 259–280.
- Peel, D. A., & Pope, P. F. (1988). Stock returns and expected inflation in the UK: Some new evidence. *Journal of Business Finance and Accounting*, 15(4), 459–467.
- Raghutla, C., Sakthivel, P., Sampath, T., & Chittedi, K. R. (2018). Macroeconomic variables and stock prices in emerging economies: A panel analysis. *Theoretical and Applied Economics*, 225, 91–100.
- Raghutla, C., Sampath, T., & Chittedi, K. R. (2018). Financial development, trade openness and growth in India. *Theoretical and Applied Economics*, 1(614), 113–124.

Ummalla, M., & Raghutla, C. (2015). Exports, imports and economic growth in India: An empirical analysis. *The Empirical Economics Letters*, 14(7), 689–696.

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Macroeconomic variables and stock prices in emerging economies: A panel analysis

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Abstract. *This study aim to explore the role of the macroeconomic variables and stock prices for emerging economies perspective. Further, the study examines the association between the macroeconomic variable and stock prices across the panel of India and Brazil. The study utilizes monthly data from 2000M1-2016M08. We employ various panel econometric techniques. The findings confirm that the long run relationship between variables and unidirectional causality. The results also reveal that GDP, inflation, exchange rate, interest rate and stock prices play an important role in economic development.*

Keywords: macroeconomic variables, stock prices, panel analysis.

JEL Classification: E00, E44.

1. Introduction

The stock market has become an important indicator of the performance of the emerging economies over the few decades. However, the working of the stock market has become a vital subject for investment professionals, academics, and monetary policymakers. The stock market works with the sentiments of participants, which depend on several factors, making it a very sensitive segment of the economy. Globalization and financial sector reforms have added to the sensitivity by increasing determinants of the stock market movement manifold (Panda, 2008). The framework of economic policies started changing from 1985, with a shift towards market-oriented policies. This has been referred to as the process of economic liberalization. As parts of this initiative, a number of policy changes have been instituted that has gradually shifted control of resources allocation from the government to the markets. These measures, elimination of prices controls and elimination of government control on the exchange rate have had a major impact on the emerging market countries corporate sector and on the evaluation of traded securities. These changes have had the most important effects that have directly affected the stock market.

The present study focus on the association between the stock prices and macroeconomic variables in the prospective of emerging countries. Both variables are depends on present market condition due to the instability of the open economy. This implies that change in aggregate macroeconomic activities will be strongly influence the changes in stock price occurring. In both financial crisis and global economic has stimulated investigation about the relationship between the macro-economy and financial markets. Although, economists would agree that financing decision explore along with the study of the behavior of financial markets are within the sphere of finance. The macroeconomic emphasize of analyzes the behavior of the aggregate or entire economy. While the uncertainty is play a crucial role in each of these areas, Thereby, there is sophisticated empirical evidence in the finance literature that positive uncertainty shocks can predict a slowdown of economic activities. However, the literature does not establish whether this association is stable over time. In this study investigating monthly data from the beginning of 1994: M1 to 2016: M6. We analysis that macroeconomic variables response to changes in stock market prices from our sample period. To investigates this issue especially, we important to explore such unparalleled macroeconomic response pattern.

Given this background, the present paper aims to investigate the impact of stock prices on macroeconomic variables in two emerging economies. More specifically, best of our knowledge, no study so far has examine the relationship between stock prices and macroeconomic variables in two emerging countries. Therefore, the study key findings add to the literature in terms identifying the role of key macroeconomic variables on stock prices. More specifically, it will be important for the policy makers to know to what extent increases output, increases interest rate impact on stock prices and depreciation in exchange rate impact on stock prices. These findings will assist the policy makers to take additional initiatives to promote the key macroeconomic variables to stock market without harming the economic development in those economies.

The remainder of the paper structure is organized as follows. Section 2 discusses the review of the literature. Section 3 documents the data empirical methodology. Section 4 reports results and discussion. Finally, section 5 provides conclusion and remarks of the study.

2. Literature review

Stock market through increases investment may transfer the technology; it leads the innovative production process, increases export and managerial skill to the host economies. Given that, the stock market can have a positive impact on economic output, increases interest rate and depreciation in the exchange rate can have a positive impact on stock prices. Which may then may have a considerable effect on stock market. For instance, Tripathi and Kumar (2016) documented that stock returns and money supply has a positive impact on GDP in BRICS during 1995 Q1 to 2014 Q4. Authors also find interest rate, the rate of exchange rate, and rate of inflation has a negative impact on stock returns. Mohapatra and Rath (2015) examine the relationships between stock prices and key macroeconomic variables in three emerging countries namely such as India, Brazil, and China during from 2000-2012. The results reveal unidirectional causality from interest rate to stock prices; exchange rate to stock prices; exchange rate to inflation; exchange rate to interest rate; inflation to interest rate and long-run unidirectional causality between all the four selected macroeconomic variables and stock prices. However, Tripathi and Kumar (2014) find that inflation has no long-run impact on stock returns in 5 emerging market economies, spanning the period March 2000 to September 2013. Most recently, Riadh El Abed (2017) report that interest rate, inflation rate, and FDI has a positive impact on stock prices in the both short run as well as long run and exchange rate has a significantly negative impact on stock prices in the short run in two emerging countries during 1995:Q1 to 2015:Q1. Further, they document that monetary aggregate has a negative impact on stock prices in the long run.

Similarly, macroeconomic variables may affect negatively or positively stock market via inflation, exchange rate, interest rate and output. Investment increases additional source of funding for economic activities. Therefore, macroeconomic variables may play a major role in the stock market. Tripathi and Kumar (2014) find that unidirectional causality between stock returns and inflation rate, GDP growth rate, exchange rate and money supply in BRICS. Pethe and Karnik (2000) explored the relationship between stock prices and macroeconomic variables in India, during April 1992 to December 1997. Their find no long run relationship between stock prices and macroeconomic variable. Bhattacharya and Mukherjee (2002) investigated the relationship between stock prices and macroeconomic aggregates in India, spanning from April 1990 to March 2001. They find no causal linkage between stock prices and foreign exchange reserves, real effective exchange rate, and trade balance. Sangeeta Chakravarty (2006) examine the causal relationship between macroeconomic variables and stock prices in India during April 1991 to December 2005. Author report that unidirectional causality from money supply to stock prices. Furthermore, document that no unidirectional causality running between stock price and inflation, index of industrial production. Robert (2008) document that exchange rate and the oil price has no significant impact on the stock market in BRIC economies. Further author finds

bidirectional causality stock prices and rate of inflation in India during 1992-1993 to 2000-2001. Ahmed (2008) state that macroeconomic variable has a significant impact on the stock market in India during the period 1995:03 to 2007:03. A very recent study by Jamaludin et al. (2017) investigate the effect of macroeconomic variables and stock market returns in a panel of 3 nations. Authors make use of panel least square regression econometric techniques and monthly data from January 2005 to December 2015. Their findings confirm that the stock market returns has a positive impact on both interest rate and inflation, and stock market returns has an insignificant impact on money supply in Singapore, Malaysia, Indonesia economies, respectively.

Authors suggest that the macroeconomic variables in emerging countries has not reached at the level. Macroeconomic variables where it can effectively impact its adverse effect on the environment. It is clear from the existing literature that there is no research, which investigates the role of the stock market and key macroeconomic variables in major emerging market economies.

3. Data and empirical methodology

Nature of data and measurement

This present study uses monthly data for two emerging nations, spanning the period from 2000M1-2016M08. The selection of data samples are based on the availability; we selected the two emerging nations such as Brazil and India. To meet the study objective, we collect the time series data on stock prices (SP), index of industrial production (IIP) proxy for GDP, consumer price index proxy for rate of inflation (INF), and lending rate (LR) proxy for interest rate, real effective exchange rate (REER) proxy for exchange rate. We obtained data from the World Development Indicators (WDI) online database. We considered variables are converted into natural logarithms (LN) (see Chandrashekar et al., 2018; Ummalla and Chandrashekar, 2015). Because before the empirical investigation begin to avoid the problems related to the selected data measurement.

3.1. Econometric methodology

To examine the interaction between the stock prices, index of industrial production, consumer price index, lending rate, and real effective exchange rate. We frame the following equations:

$$SP_{it} = f(IIP_{it}, INF_{it}, REER_{it}, LR_{it}, e_{it})$$

$$\ln SP_{it} = \beta_{1i} \ln IIP_{it} + \beta_{2i} \ln INF_{it} + \beta_{3i} \ln REER_{it} + \beta_{4i} \ln LR_{it} + e_{it}$$

Where, SP, IIP, CPI, REER, and LR represent for stock prices, index of industrial production, consumer price index, lending rate, and real effective exchange rate, respectively. Similarly, countries which are selected and time period are indicated by the subscripts i ($i = 1, \dots, N$) and t ($t = 1, \dots, T$), respectively. While e_{it} , is denote the residuals which are represent deviations from the long-run equilibrium relationships.

As the given, nature of our panel data first step of the empirical analysis, we make use of the two-panel unit root tests to investigate the order of integration across the variables under study. For instance, we determine selection of econometric models employed the Levin, Lin, and Chu (LLC) (2002) test for common unit root process, while Im, Pesaran, and Shin (IPS) (2003) test for an individual unit root process to investigated. For both LLC and IPS tests, the null hypothesis of a unit root is tested as against the alternative hypothesis of no unit root. If all the sample variables are integrated in the same order, i.e., $I(1)$, then LLC, IPS tests indicates that all the sample variables are nonstationary at levels of data and stationary at their $I(1)$ first-order differentials. Further, this findings suggest that these sample variables, as a group, which may have a positive cointegration equilibrium relationship in the long-run.

Therefore, to employs the long run cointegration relationship between variables of the equation (1), for this purpose, we test the Fisher-type panel cointegration test, the model based on the methodology which is suggested by Maddala and Wu (1999). This model has been developed and using by the Johansen (1991) framework. According to Maddala and Wu (1999), Fisher-type panel cointegration test performs better than the other panel cointegration tests. Because of which are based on the Engle-Granger two-step procedure. Pioneer researchers (e.g., Alam and Paramati, 2015; Alam et al., 2017; Paramati et al., 2017; Kutan et al., 2017). Moreover, these authors suggest that Fisher-type panel cointegration test provides, reliable findings on the long-run association among the variables.

Further, we aim to find out the long run stock price, economic growth, inflation, exchange rate and interest rate; we estimate a single cointegration model based on the equations (1) in the model. For the estimation of long-run elasticities, we are employing dynamic ordinary least squares (DOLS) framework. Finally, we aim, to examine the direction of the short run panel causality among stock price, economic growth, inflation, exchange rate and interest rate are using a model that supports the existence of heterogeneity across the cross-sections variables. We employ this test based on Dumitrescu and Hurlin (2012) approach. This test requires sample variables to be stationary for which propose; we converted all the variables into first differenced. The null hypothesis of no causality in any cross-section is tested against the alternative hypothesis of causality at least for some cross-sections. The suitable lag length criteria for this test is selected based on the Schwarz information criterion (SIC).

3.2. Descriptive statistics

Table 1. Descriptive statistics of the variables, 2000M1-2016M08

variables	SP	INF	IIP	LR	REER
Mean	9.884	4.472	4.414	3.127	4.419
Std. Dev.	0.891	0.324	0.250	0.739	0.181
Skewness	-0.457	0.100	-0.844	0.111	-1.119
Kurtosis	2.342	1.803	2.795	1.213	3.843
Jarque-Bera	21.160	24.540	48.185	53.999	95.379
Sum.	3953.621	1788.860	1765.702	1251.125	1767.738

Note: The growth rates were calculated using natural logarithm data.

Table 1 provides panel descriptive statistics, namely standard deviation, skewness, kurtosis, mean and Jarque-Bera for selected nations. Mean for the most of variables in the panel are positive including stock returns of sample countries. The negative skewness coefficients are the panel of stock returns, industrial production, and real exchange rate indicates that the frequency distribution of real value of these variables is fat-tailed or left skewed. However, positive skewness coefficient for inflation and interest rate implies frequency distribution is right-skewed. The kurtosis value exceeds more than three which the distribution of returns is leptokurtic. Jarque-Bera test statistics show that rejects the null hypothesis of a normal distribution for the most of series.

4. Results and discussion

4.1. Order of integration of the variables

To check stationary process of each variables as follows, Im, Pesaran, and Shin (2003) and Levin, Lin and Chu (2002) panel unit root tests were used. The panel unit root tests helps to combine both time series data as well as cross-sectional data which leads to improve power of test. The result of panel unit root tests is presented in Table 2. The result shows that all log variables of stock prices, inflation, industrial production, real exchange rates and interest rate were nonstationary at the level form. In other words, all variables are panel contain unit root since null hypothesis is accepted in all cases. However, all variables are integrated order of one and have a possible cointegrating relationship to be investigated by Johansen-Fisher panel co-integration test.

Table 2. Panel unit root tests results

Variable	Level				First difference			
	LLC test		IPS test		LLC test		IPS test	
	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.
SP	0.585	0.720	0.737	0.769	-23.688***	0.000	-19.089***	0.000
IIP	4.588	1.000	2.299	0.989	-3.513***	0.000	-2.604***	0.004
INF	0.019	0.508	2.786	0.997	-9.414***	0.000	-11.750***	0.000
REER	0.018	0.507	-0.676	0.249	-24.153***	0.000	-17.871***	0.000
LR	2.512	0.994	0.946	0.828	-23.565***	0.000	-18.909***	0.000

Note: *** indicate the rejection of the null hypothesis of a unit root at the 1% significance levels.

4.2. The Johansen-Fisher panel long-run equilibrium relationship.

The non-stationarity series are used to examine the presence of the long run relationship between stock prices, inflation, industrial production, real exchange rates and interest rate. For this purpose, the study is applied Johansen-Fisher panel co-integration test. The results are reported in Table 3; the results reveal that both trace and maximum-eigen value statistics have rejects null hypothesis no long-run equilibrium relationship among variables. Also panel co-integration test exhibit trace and maximum-eigen value statistics identify two co-integration vectors. It implies that the all variables are co integrated and move together in the long run. In other words presence of long-run equilibrium exists among stock prices, inflation, industrial production, real exchange rates and interest rate in selected countries namely India and Brazil.

Table 3. Johansen-Fisher panel cointegration test

Hypothesized: No. of CE(s)	trace test	Prob.	max-eigen test	Prob.
None	46.23***	0.000	45.26***	0.000
At most 1	12.27	0.015	11.49	0.021
At most 2	4.202	0.379	3.682	0.450
At most 3	2.596	0.627	2.459	0.651
At most 4	2.724	0.605	2.724	0.605

Note: *** indicates the rejection of the null hypothesis of no cointegration at the 1% significance level.

4.3. The long-run elasticities of stock prices

Once cointegration is confirmed, long-run elasticities of stock prices, inflation, industrial production, exchange rates and interest rate are investigated by use of panel dynamic ordinary least squared (DOLS) method. The panel regression results are presented in Table 4. The result reveals that most of the key macroeconomic variables had a positive and significant impact on stock prices when the study conducts analysis those two countries as a group. This shows that industrial production, and exchange rate positivity affecting stock prices. However, inflation and interest rate has no significant impact on stock prices.

Table 4. Panel data analysis of long-run stock prices elasticities

Variable	Coefficient	t-statistics
Dependent variable: Stock Price		
IIP	1.179***	5.687
INF	0.446	2.530
REER	0.633***	3.511
LR	0.070	0.413
R-squared	0.442	

Note: *** indicate the significance level at the 1% level.

4.4. The direction of causality

The heterogeneous panel causality test is used to investigate the short-run relationship between stock prices, inflation, industrial production, real exchange rates and interest rate. Table 5 provides result of panel causality test. Its shows unidirectional causality from stock returns to inflation, industrial production, interest rate and real exchange rates. On the other hand, reverse causality is not found from those variables to stock returns. The existence of short-run relationship among those variables in selected countries namely India and Brazil.

Table 5. *Heterogeneous panel causality test*

Null Hypothesis:	Zbar-Stat.	Prob.
INF does not homogeneously cause SP	0.705	0.480
SP does not homogeneously cause INF	3.432	0.000***
IIP does not homogeneously cause SP	0.227	0.820
SP does not homogeneously cause IIP	8.916	0.000***
LR does not homogeneously cause SP	0.079	0.936
SP does not homogeneously cause LR	3.486	0.000***
REER does not homogeneously cause SP	-0.438	0.661
SP does not homogeneously cause REER	14.402	0.000***

Note: *** indicate the significance levels at the 1%.

5. Concluding remarks

The relationship between stock prices and macroeconomic variables has received high attention from regulators, investors, and academicians because it has wide implications for hedging and speculation. This study empirically investigates the relationship between key macroeconomic variables and stock prices of selected countries namely India and Brazil. We used Monthly data on stock prices, inflation, industrial production, real exchange rates are taken from January 2000 to August 2016. Both short and long-run equilibrium relationship is examined by panel Granger causality test and Johansen-Fisher panel co-integration test. The empirical results suggest that presence of long-run equilibrium among the stock prices, inflation, industrial production, real exchange rates and interest rate of selected countries namely India and Brazil. The result from dynamic ordinary least squared (DOLS) method reveals that most of key macroeconomic such as stocks prices and the exchange rate is positive and statistically significant. This result is emphasize with the result of Mohapatra and Badri (2015). Industrial production positive effect on stocks prices, this empirical result is consistent with the result of Mohapatra and Badri (2015). Other variables had positively impacts on stock prices but statistically insignificant. Moreover, empirical result from panel Granger causality test shows that the existence of unidirectional causality from stock returns to interest rate, this result is consistent with the result of Mohamed et al. (2011). Stock returns to exchange rates; those empirical results is consistent with the results of Abdalla and Murinde (1997), Mohamed et al. (2011), Tripathi and Kumar (2015). Stock returns to industrial production, those empirical result is emphasize with the result of Fama (1981), Tripathi and Kumar (2015). Stock returns to interest rate, this empirical result is underline with the result of Fama (1981). Finally, those variables are follows unidirectional causality stock returns to inflation, industrial production, interest rate and real exchange rates.

Given these findings, we argue that the interaction between index of industrial production, inflation, exchange rate, and interest rate have a significant role in stock prices. Hence, GDP economic growth (index of industrial production (IIP)) positively impact on stock returns, because of stock returns as any increase favorable affects on demand. Increasing inflation rate negatively impact on stocks returns, because of inflation rate as increases input cost. Increasing interest rate many ways to attract the investors to invest in stocks markets, it will give a required rate of returns. Both interest rate and inflation rate are causes raise in financial costs. Moreover, a depreciation (Increasing) in the exchange rate can be favorable for an economy. Thus, the exchange rate can positively impact on stock returns.

References

- Abdalla, I.S.A. and Murinde, V., 1997. Exchange Rate and Stock Price interaction in Emerging Financial Markets: evidence on India, Korea, Pakistan, and Philippines, *Applied Financial Economics*, 7, pp. 25-35.
- Alam, M.S. and Paramati, S.R., 2015. Do oil consumption and economic growth intensify environmental degradation? Evidence from developing economies. *Applied Economics*, 47(48), pp. 5186-5203.
- Alam, M.S. and Paramati, S.R., 2017. The dynamic role of tourism investment on tourism development and CO2 emissions. *Annals of Tourism Research*, available online.
- Ali M. Kutan, Paramati, S.R. and Mallesh U., 2017. Financing renewable energy projects in major emerging market economies: Evidence in the perspective of sustainable economic development, *Emerging Markets Finance and Trade*, available online.
- Bhattacharya, B. and Mukherjee, J., 2002. Causal relationship between stock market and exchange rate, foreign exchange reserves and value of trade balance: a case study for India.
- Chakravarty, S., 2006. Stock Market and macroeconomic behavior in India, <www.iegindia.org>
- Dumitrescu, E.-I. and Hurlin, C., 2012. Testing for Granger non-causality in heterogeneous panels. *Economic Modelling*, 29(4), pp. 1450-1460.
- Fama, E., 1981. Stock returns, real activity, inflation and money. *American Economic Review*, 71, pp. 545-564.
- Im, K.S., Pesaran, M.H. and Shin, Y., 2003. Testing for unit roots in heterogeneous panels. *Journal of Econometrics*, 115(1), pp. 53-74.
- Johansen, S., 1991. Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models. *Econometrica: Journal of the Econometric Society*, pp. 1551-1580.
- Levin, A., Lin, C.-F. and Chu, C.-S.J., 2002. Unit root tests in panel data: asymptotic and finite-sample properties. *Journal of Econometrics*, 108(1), pp. 1-24.
- Maddala, G.S. and Wu, S., 1999. A comparative study of unit root tests with panel data and a new simple test. *Oxford Bulletin of Economics and statistics*, 61(S1), pp. 631-652.
- Mohamed Khaled Al-Jafari, Rashed Mohammed Salameh and Mohammad Rida Habbash, 2011. Investigating the Relationship between Stock Market Returns and Macroeconomic Variables: Evidence from Developed and Emerging Markets, *International Research Journal of Finance and Economics*, Issue 79.
- Mohapatra, M.S. and Rath N.B., 2015. Do Macroeconomic factors matter for stock prices in emerging countries? Evidence from panel cointegration and panel causality, *International Journal of Sustainable Economy*, 7 (2), pp. 140-154.
- Nurasyikin, J, Shahnaz, I. and Syamimi, A.M., 2017. Macroeconomic Variables and Stock Market Returns: Panel Analysis from Selected ASEAN Countries, *International Journal of Economics and Financial Issues*, 7(1), pp. 37-45.
- Paramati, S.R., Shahbaz, M. and Alam, M.S., 2017. Does tourism degrade environmental quality? A comparative study of Eastern and Western European Union. *Transportation Research, Part D: Transport and Environment*, 50, pp. 1-13.

- Pethe, A. and Karnik, A., 2000. Do India Stock Markets Matter Stock Market Indices and Macroeconomic Variables, *Economic and Political Weekly*, Vol. 35, No. 5, pp. 349-356.
- Raghutla Chandrashekar, S. and Krishna, R.C., 2018. Financial development, trade openness and growth in India. *Theoretical and Applied Economics*, Vol. XXV, No. 1(614), pp. 113-124.
- Riadh El Abed, 2017. Exploring the nexus between stock prices and macroeconomic shocks: panel VAR approach, *Economics Bulletin*, 37 (3), pp. 1-15.
- Robert D. Gay, Jr., 2008. Effect of Macroeconomic Variables on Stock Market Returns for Four Emerging Economies: Brazil, Russia, India, and China, *International Business & Economics Research Journal*, Vol. 7, No. 3.
- Shahid A., 2008. Aggregate Economic Variables and Stock Markets in India, *International Research Journal of Finance and Economics*, Issue 14.
- Tripathi, V. and Kumar, A., 2014. Relationship between Inflation and stock returns-evidence from BRICS markets using panel cointegration test, *International Journal of Accounting and financial reporting*, 4 (2), pp. 647-658.
- Tripathi, V. and Kumar, A., 2015a. Do macroeconomic variables affect stock returns in BRICS markets? An ARDL Approach, *Journal of Commerce & Accounting Research*, 4 (2), pp. 1-15.
- Tripathi, V. and Kumar, A., 2015b. Relationship between macroeconomic factors and aggregate stock returns in BRICS stock markets- a panel data analysis, *New age business strategies in emerging global markets*, pp. 104-123.
- Tripathi, V. and Kumar, A., 2016. Impact of financial crisis on the relationship between aggregate stock returns and macroeconomic factors in BRICS stock markets, *Journal of Economic Policy & Research*, 12 (1), pp. 2-18.
- Ummalla, M. and Chandrashekar, R., 2015. Exports, Imports and Economic Growth in India: An Empirical Analysis. *The Empirical Economics Letters*. No. 14. pp. 689-696.



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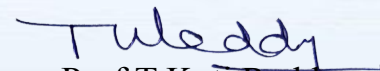
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