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EFFECTIVENESS OF CROSS-HEDGING IN INDIAN COMMODITY FUTURES MARKET

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Abstract *Futures markets play a vital role in managing risk and improving price stability in the commodity market. While few commodities have futures contracts that promote direct hedging, the majority of them rely on alternative strategies like cross-hedging for risk reduction. Whether these strategies promote meaningful risk reduction, particularly in an emerging market like India, is still unclear. The present study examines the effectiveness of cross-hedging for selected agricultural commodities by assessing whether spot price variances are mitigated by commodity futures or commodity futures of related and unrelated commodities. The study uses a Diagonal BEKK GARCH framework to analyse weekly data from 2016 to 2021 collected from MCX, NCDEX, and NSE to estimate optimal hedge ratios and hedging effectiveness. The findings show that the cross-hedging strategy mostly involves low hedging costs, but its ability to reduce risk is limited across cross-hedging alternatives. Futures contracts on related commodities do not outperform commodity index futures in most cases because the co-movement of price between spot and futures markets is unstable and weak. The results suggest that the cross-hedging strategy cannot be considered a close substitute for direct hedging in the Indian market under normal conditions. The study extends the literature on commodity risk management and suggests useful insights for investors, hedgers, and policymakers who seek practical alternatives when direct commodity futures contracts are unavailable.*

Keywords: *Risk Management, Hedging, Commodity Derivatives, Commodity Markets, Cross-Hedging*

INTRODUCTION

Risk is an inevitable part of every business and investment decision due to changing economic conditions, fluctuations in market prices, and unexpected external events that are difficult to predict (Burt, 2001). Commodity markets, which have long been among the most volatile parts of the global financial system, are also exposed to these risks. The prices of commodities are influenced by many factors, including weather conditions, geopolitical events, supply disruptions, and changes in demand, but commodity markets continue to play an important role by enabling the trade of raw materials that support industries, agriculture, and daily life. Commodities are generally divided into hard (gold and crude oil) and soft (wheat and coffee) categories, with a system of trading developed over centuries both in spot and derivative markets through standardised contracts that play a key role in the modern economy (Periasamy & Satish, 2016).

The global economy heavily depends on commodity markets as they facilitate the exchange of essential raw materials, informed decision-making, resource allocation, and international trade with transparent trading mechanisms. Commodity markets serve as an indicator of economic conditions as movements in commodity prices show changes in demand and supply, shifts in market sentiment, and macroeconomic developments, providing valuable signals for policymakers and central banks in designing monetary strategies (Bauer & Rudebusch, 2014). These price fluctuations create investment opportunities in commodities, which allow individuals and institutions to diversify their portfolios and be protected against inflation. However, the price volatility that makes these markets attractive also exposes participants to considerable financial risk. The sharp and unexpected price movements make effective risk management indispensable can be triggered by weather shocks, geopolitical tensions, policy interventions, and

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supply chain disruptions. Hedging remains one of the most widely used techniques among the various risk management alternatives, involving taking an offsetting position in a related market to reduce potential losses arising from adverse price changes (Hardy & Lyon, 1923). Derivative markets enable market participants to lock in prices and manage uncertainty more effectively than is possible in spot markets and play a central role in this process by offering standardised contracts for future delivery. The interaction of hedgers, speculators, arbitrageurs, and institutional investors in derivative markets leads to market liquidity, price discovery, and overall trading efficiency (Hull, 2017). Existing literature on Indian commodity derivatives, such as Garg and Narwal (2024), indicates strong price discovery and volatility interactions in agricultural commodity markets, while Sethy & Tripathy (2024) report that commodity and equity relationships are time-varying under structural breaks, reflecting the dynamic nature of risk transmission.

Hedging is widely regarded as one of the most effective ways to manage commodity price risk, while the success of a hedging strategy is not uniform across markets. Recent evidence points to only moderate hedging effectiveness in the highly liquid gold futures market (Khindri, 2024), while other studies report noticeable differences in hedging performance across equity and currency derivatives due to basis risk and the strength of price correlation as key determinants of effectiveness (Kaur & Gupta, 2020). These studies suggest that hedging success is highly market-specific and context-dependent (Buyukkara, Kucukozmen & Uysal, 2022; Shahzad, Bouri, Rehman & Saeed, 2022) and the challenge becomes even greater when no suitable futures contract exists for the commodity being traded, making conventional hedging impossible. Here, market participants often consider cross-hedging as a practical alternative that involves using futures contracts on a different but related asset, which exhibits strong and stable price co-movement (Anderson & Danthine, 1981).

Empirical research on cross-hedging is still relatively limited, and the evidence available is scattered across different asset classes and market settings. Most studies have concentrated on the estimation of optimal hedge ratios and the effectiveness of cross-hedges between specific pairs of assets. Some studies examine cross-hedging between commodities and equity index futures by highlighting the role of volatility spillovers and dynamic correlations in determining hedge effectiveness (Boubaker & Managi, 2013; Sadorsky, 2014). Movafaghi (2014) conducted a study in agricultural and livestock markets and analysed the cross-hedging performance between bison prices and live cattle futures and reported limited risk reduction due to weak price co-movement. Studies on precious metals like gold show mixed results, confirming that risk can only be partially cross-hedged using stock index futures, with effectiveness varying across market conditions and volatility regimes (Fakhfekh, Jeribi, Ghorbel & Hachicha, 2023). Evidence from industrial metals markets using metal spot and futures markets suggests that cross-hedging effectiveness depends on the degree of integration among related commodities (Chen & Tongurai, 2021). Research on energy markets indicates similar outcomes, suggesting that energy price risk can be cross-hedged to some extent using equity futures, with results sensitive to market structure and crisis periods (Olson, Vivian & Wohar, 2019; Batten, Maddox & Young, 2021). These studies suggest that cross-hedging can serve as an alternative when direct hedging instruments are unavailable, but its success depends on many factors, like the strength and stability of price correlations, the extent of basis risk, and market conditions. These observations motivate the present study, which examines whether cross-hedging strategies can offer a practical means of managing price risk for agricultural commodities in situations where direct futures contracts are unavailable.

The relevance of this issue has become more noticeable in India following the Securities and Exchange Board of India's (SEBI's) decision to extend the suspension of futures trading until December 2024 for major agricultural commodities like wheat, non-basmati paddy, chana, mustard, soybean, crude palm oil, and moong, which account for a substantial share of trading activity in the agricultural derivatives market before their suspension. The suspension of these agricultural derivatives has significantly reduced the availability of direct hedging instruments for farmers, traders, and investors, making risk management considerably challenging. In this context of a derivatives ban, it is important to explore alternative approaches such as cross-hedging; this is not merely an academic exercise but a practical necessity. The present study investigates whether price risk in selected Indian agricultural commodities can be effectively managed through cross-hedging using commodity index futures and futures contracts on related and unrelated commodities. It compares the performance of index-based and commodity-based strategies to assess which cross-hedging alternative offers superior risk reduction. The study also seeks to identify potential substitute instruments that could provide meaningful protection when direct agricultural futures are unavailable. The study contributes to the broader discussion on agricultural risk management in India and offers fresh evidence on the extent to which commodity index futures and related commodity futures can function as viable alternatives within the Indian commodity derivatives market, a topic that has immediate policy relevance.

REVIEW OF LITERATURE

The empirical literature suggests that cross-hedging is a practical alternative when hedged assets are devoid of futures. The theoretical foundation argues that cross-hedging can reduce price risk when the hedged asset and the hedging instrument exhibit strong and stable price co-movement and minimum basis risk (Anderson & Danthine, 1981). Empirical research demonstrates that cross-hedging effectiveness is highly dependent on correlation dynamics, volatility behaviour, and market maturity (Lien & Tse, 2002). Studies in equity markets document effective cross-hedging between the UK FTSE 100 and global stock index futures, indicating that financial integration enhances cross-market hedging opportunities (Zainudin & Mohamad, 2021). Similar results appear in liquid and well-developed markets, where market index futures can improve hedging efficiency relative to single stock futures (Brooks, Davies & Kim, 2007). These studies highlight the importance of liquidity, integration, and structural depth in determining cross-hedging outcomes.

Cross-hedging has also been examined extensively in commodity and energy markets and it is found that Indian aviation turbine fuel price risk can be effectively hedged using Brent crude oil futures and composite hedging strategies (Kar & Khandelwal, 2020). Some studies report limited hedging effectiveness when bison prices are cross-hedged using live cattle futures, indicating the impact of weak correlation structures (Movafaghi, 2014). Empirical evidence from global energy and commodity markets also suggests that volatility spillovers and asymmetric price movements play a critical role in determining hedging success (Batten, Maddox & Young, 2021; Wu, Guan & Myers, 2011).

Indian literature on the derivatives market provides insights into market linkages, volatility transmission, and hedging efficiency. Some studies demonstrate spot price discovery and volatility spillovers in the Indian cardamom market and show that commodity–equity correlations in India are time-varying and increase during periods of market stress (Garg & Narwal, 2024). Studies further demonstrate that crude oil price shocks significantly affect sectoral stock returns, confirming the interconnectedness of commodity and financial markets (Pathak & Kumar, 2024). Literature on hedging performance in Indian derivatives indicates substantial variation across different asset classes. Some report only moderate hedging effectiveness in gold futures despite high liquidity, while others find very high hedging effectiveness for equity index futures but considerably lower effectiveness for currency futures due to basis risk and unstable correlations (Khindri, 2024; Kaur & Gupta, 2020). Earlier evidence on Indian agricultural derivatives shows persistent inefficiencies in hedging effectiveness across commodities and models and also report inconsistent price discovery in agricultural futures markets (Srinivasan, 2012; Inani, 2018). Some show that financialisation has altered commodity correlation dynamics and often reduced diversification and hedging benefits. From a broader perspective, a few studies confirm that hedging effectiveness deteriorates under asymmetric volatility conditions in emerging markets like India (Silvennoinen & Thorp, 2013; Cotter & Hanly, 2012).

The existing literature points to three broad conclusions. Successful cross-hedging depends fundamentally on strong price co-movement between the hedged asset and the selected hedging instrument. Hedging effectiveness is highly context-specific and shaped by factors like basis risk, liquidity, market integration, and structural characteristics. Finally, a substantial body of research has examined conventional hedging strategies, but relatively little attention has been given to the effectiveness of cross-hedging in agricultural commodities in India using commodity index futures and alternative commodity futures during periods of regulatory intervention. The present study addresses this gap by evaluating the effectiveness of these alternative cross-hedging strategies for selected agricultural commodities in India across multiple investment horizons using a multivariate Diagonal BEKK GARCH framework.

DATA

The present study examines the effectiveness of cross-hedging for selected agricultural commodities using weekly data obtained from three major exchanges in India, namely the Multi Commodity Exchange (MCX), the National Commodity and Derivatives Exchange (NCDEX), and the National Stock Exchange (NSE). The sample includes 245 weekly observations from 1 January 2016 to 8 January 2021. The study focuses on two agricultural commodities chosen because of the absence of active futures contracts for direct hedging, namely wheat and chana, along with mentha oil, which serves as a benchmark commodity with an available futures market. The present study also incorporates the Nifty 50 index and two commodity indices, MCX iCOMDEX Bullion and MCX iCOMDEX Energy, as potential cross-hedging instruments. Commodities and indices like Jeera, Guar Seed, Cotton, Crude Palm Oil (CPO), Barley, and the MCX Base Metal Index with low market activity or inadequate statistical properties are excluded from the study. This combination of agricultural commodities,

financial indices, and commodity indices futures allows for a comprehensive assessment of whether alternative futures instruments can provide meaningful protection against spot price risk when direct hedging opportunities are unavailable.

METHODOLOGY

The study adopts an empirical approach to evaluate the effectiveness of the cross-hedging strategy in the Indian commodity futures market, beginning with descriptive statistics to examine the basic characteristics of the data, including measures of central tendency, dispersion, skewness, and kurtosis. This provides a clear understanding of the underlying variables before applying advanced econometric techniques. The Jarque-Bera test is employed to examine whether the data follow a normal distribution, and when departures from normality are observed, logarithmic transformation was used to improve the statistical properties of the series and ensure the reliability of the analyses. The stationarity of each variable was then tested using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests, as time-series modelling requires stable data, and these tests determine whether the statistical characteristics of the series remain consistent over time, thereby establishing their suitability for econometric modelling.

The analysis further investigates a common feature of financial and commodity price series, in which periods of high volatility tend to be followed by further high volatility, namely the presence of autoregressive conditional heteroscedasticity (ARCH). The ARCH-LM test is employed to detect this behaviour and to justify the use of conditional volatility models. Given the presence of volatility clustering, the study estimates a Diagonal BEKK GARCH model, which is particularly well suited to capture time-varying variances and covariances while allowing volatility shocks in one market to influence another.

The current framework provides a more realistic representation of the relationship between spot and futures prices than constant variance models. These hedge ratios represent the proportion of the futures position required to minimise the risk associated with spot price fluctuations. The optimal hedge ratios are estimated by relating the covariance between spot and futures returns to the variance of futures returns, based on the estimated conditional covariance and variance matrices. The effectiveness of the cross-hedging strategy is evaluated by comparing the variance of the unhedged portfolio with that of the hedged portfolio. The resulting measure of hedging effectiveness indicates the extent to which price risk can be reduced through alternative futures instruments, providing a comprehensive assessment of the practical viability of cross-hedging in the Indian agricultural commodity market.

ANALYSIS AND INTERPRETATION

The present study evaluates the effectiveness of cross-hedging strategies by examining whether investments in selected agricultural commodities can be effectively hedged using commodity index futures as well as related and unrelated commodity futures. Fig. 1 presents the movement of weekly closing prices for the selected spot commodities, futures contracts, and indices over the period from 31 December 2015 to 8 January 2021, and a visual inspection reveals fluctuations across all series, indicating the volatile nature of commodity markets. These price movements are not surprising, as commodity prices respond to a wide range of influences such as changes in supply and demand, weather conditions, policy interventions, global economic developments, and shifts in investor sentiment. Although the magnitude of these fluctuations varies across commodities, the overall pattern suggests that price dynamics are far from stable over time.

One of the most striking features of Fig. 1 is the sharp decline observed during the early months of the COVID-19 pandemic. The unprecedented disruption to global economic activity, coupled with supply chain bottlenecks, mobility restrictions, and heightened uncertainty, resulted in a broad-based fall in commodity prices. Reduced industrial activity and weaker consumer demand further amplified the downward pressure on several commodities, while financial market uncertainty encouraged investors to reduce exposure to riskier assets. However, the decline was not permanent. Fiscal stimulus packages, accommodative monetary policies, and the gradual reopening of economies restored confidence in many commodities, though the pace and extent of recovery differed across markets. Some commodities rebounded relatively quickly, while others exhibited a more gradual adjustment, reflecting differences in their underlying demand and supply conditions.

Overall, the price movements depicted in Fig. 1 demonstrate the dynamic and often unpredictable nature of commodity markets and reinforce the importance of effective risk management strategies during periods of heightened market uncertainty, while the observed volatility provides a suitable setting for evaluating the performance of cross-hedging strategies as periods of large price swings offer a meaningful test of whether alternative futures instruments can effectively reduce spot market risk.

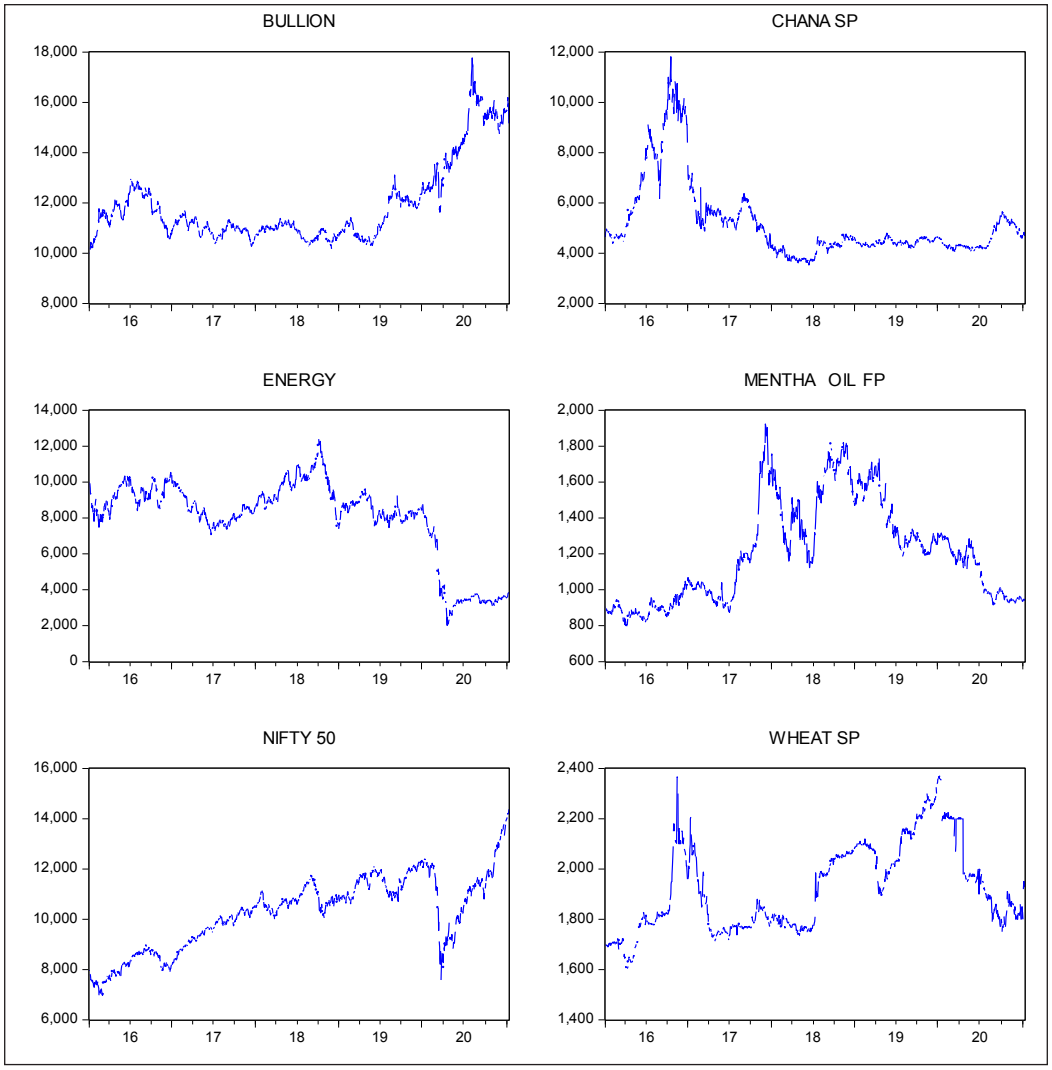


Fig. 1: Commodity Spot, Futures, Nifty 50, and Commodity Indices

Descriptive Statistics

Descriptive statistics provide an initial understanding of the dataset by summarising its key characteristics, including measures of central tendency, dispersion, skewness, and kurtosis. Examining these properties is an important first step because many econometric techniques assume that the underlying data exhibit reasonably well-behaved statistical distributions, so the study employs the Jarque-Bera (JB) test to assess this, where the null hypothesis states that the data are normally distributed, while the alternative hypothesis suggests departures from normality. A p-value below the conventional significance level of 0.05 results in the rejection of the null hypothesis, indicating that the distribution differs significantly from normality.

The results presented in Table 1 reveal that the JB p-values for almost all variables fall below the 0.05 threshold, indicating that the majority of the series do not follow a normal distribution, while the Nifty 50 index is the only notable exception, with test results suggesting a distribution that is comparatively closer to normal. Such departures from normality are common in financial and commodity price data because extreme observations and asymmetric price movements frequently produce skewed or heavy-tailed distributions, so the variables were transformed into logarithmic form before further analysis to improve the statistical properties of the dataset. Log transformation helps stabilise variance, reduces the influence of extreme values, and brings the distributions closer to normality, thereby enhancing the reliability of the subsequent econometric estimations.

Table 1: Descriptive Statistics of Commodity Spot, Futures Prices, Nifty 50, and Commodity Indices

	BULLION	CHANA_SP	ENERGY	MENTHA OIL_FP	NIFTY_50	WHEAT_SP
Mean	11875.02	5200.690	8027.146	1209.185	10252.39	1932.658
Median	11239.80	4600.000	8502.290	1190.400	10556.90	1900.000
Maximum	17402.49	10900.00	12155.47	1854.500	14370.90	2367.500
Minimum	10011.88	3600.000	2492.390	797.5000	6990.000	1608.300
Std Dev	1567.480	1540.350	2241.005	280.2379	1487.360	177.7881
Skewness	1.545555	1.994244	-1.139856	0.488185	-0.150925	0.431583
Kurtosis	4.561539	6.368151	3.354682	2.054717	2.456924	2.146736
Jarque-Bera	122.4322	278.2024	54.33782	18.85334	3.940871	15.03804
Probability	0.000000	0.000000	0.000000	0.000081	0.139396	0.000543

Source: Computation of author.

The variables were transformed into logarithmic form to correct the departures from normality identified by the JB test, as this transformation stabilises variance and improves the distributional properties of the data, thereby enhancing the accuracy and reliability of statistical inference and econometric modelling. By aligning the dataset more closely with the assumptions underlying many statistical techniques, log transformation ensures that subsequent analyses produce more valid and interpretable results, thereby strengthening the integrity of the study's findings as well as the insights derived from the data.

Stationarity Test

A stationarity test was used to determine if the data are stationary or not, ensuring that results are not spurious. It tests whether the statistical properties of the data, such as mean, variance, and autocorrelation structure, remain constant over time. The ADF and PP tests were employed in the study to check stationarity. The ADF and PP test for the presence of a unit root in the data, where rejection of the null indicates stationarity. If the null hypothesis is rejected, it suggests that the data are stationary, as they do not possess a unit root. The null hypothesis states that the series possesses a unit root and hence is not stationary. If the p-value obtained from the test is greater than 0.05, the study fails to reject the null hypothesis, indicating that the series likely contains a unit root and is non-stationary. If the p-value is less than 0.05, the study rejects the null hypothesis, concluding that the series does not possess a unit root and is stationary. Overall, the ADF and PP tests provide valuable insights into the stationarity of the dataset, aiding in subsequent analyses and modelling efforts.

Table 2: Unit Root Test – Augmented Dickey-Fuller (ADF) Test

Variables	Level		First Difference	
	C	C&T	C	C&T
WHEAT_SP	0.2267	0.5089	0.0000	0.0000
CHANA_SP	0.5618	0.6715	0.0000	0.0000
MENTHA OIL_FP	0.5211	0.9217	0.0001	0.0000
INDEX_ENERGY	0.8347	0.7453	00.000	0.0000
INDEX_BULLION	0.7715	0.8363	0.0000	0.0000
NIFTY 50	0.5542	0.5542	0.0000	0.0001

Source: Computation of the author.

By analysing the ADF test statistic table, several inferences can be drawn. It was observed that all p-values were higher than 0.05, suggesting failure to reject the null hypothesis, indicating the presence of a unit root and thus non-stationarity in the series. When considering the first difference of all the variables, the p-values were below 0.05 for all variables, implying rejection of the null hypothesis for all variables in their first difference form, indicating that these series were stationary after differencing.

Table 3: Unit Root Test – Phillips–Perron (PP) Test

Variables	Level		First Difference	
	C	C&T	C	C&T
WHEAT_SP	0.4546	0.4546	0.0000	0.0000
CHANA_SP	0.425	0.5054	0.0001	0.0000
MENTHA OIL_FP	0.4645	0.8948	0.0001	0.0000
INDEX_ENERGY	0.8267	0.7698	0.0000	0.0000
INDEX_BULLION	0.7846	0.8462	0.0000	0.0000
NIFTY 50	0.776	0.4178	0.0000	0.0000

Source: Computation of author.

The inferences drawn from the chart suggest that in the level form all p-values were higher than 0.05, indicating failure to reject the null hypothesis for all variables in their original form, implying the presence of a unit root and non-stationarity in the series. However, upon considering the first difference of the variables, all p-values were below 0.05. This signifies rejection of the null hypothesis for all variables after differencing, leading to the conclusion that the series became stationary. Overall, these observations highlight the importance of differencing in achieving stationarity, a crucial prerequisite for many time-series analyses and modelling techniques.

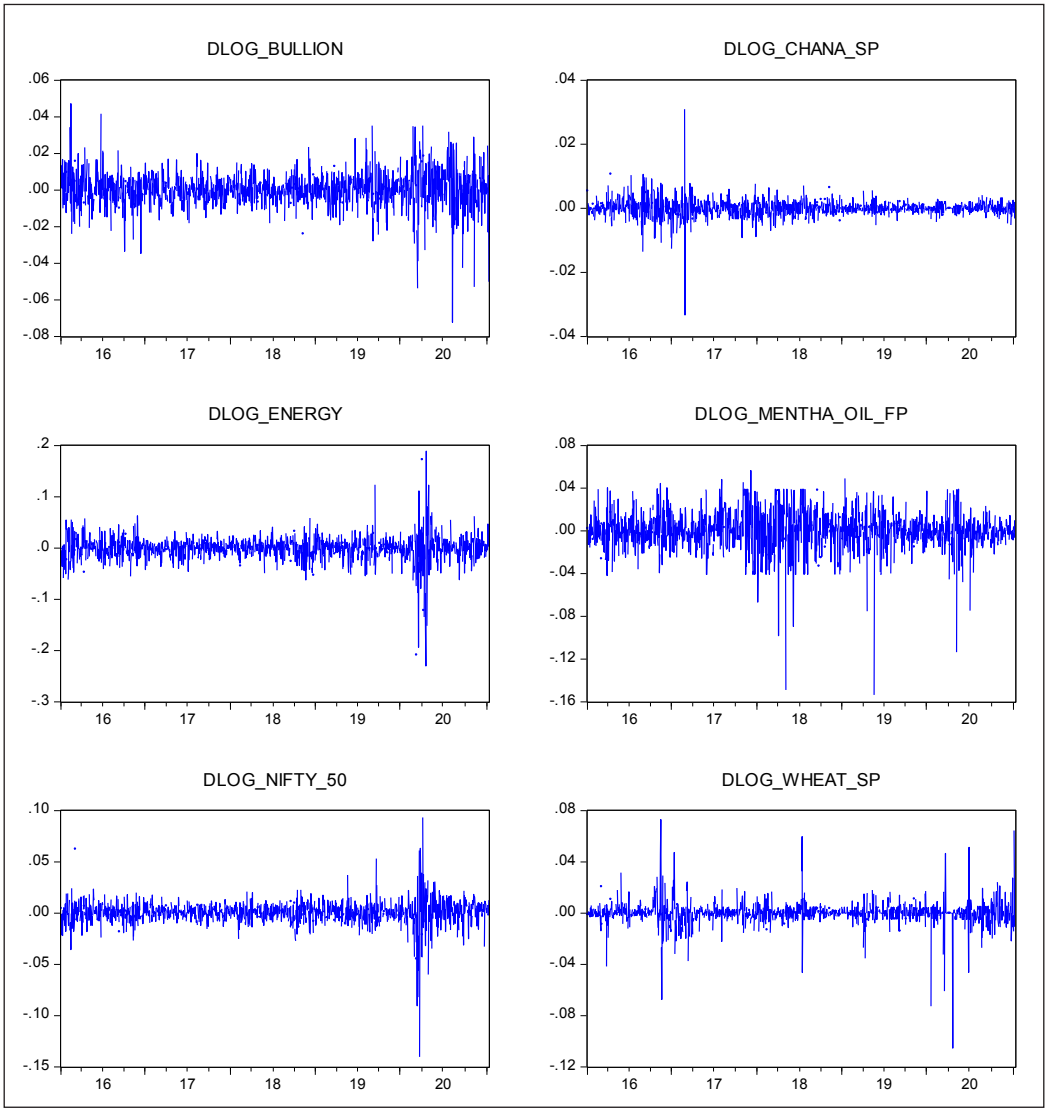


Fig. 2: Returns of Commodity Spot, Futures Prices, and Indices in Futures Market

ARCH (Autoregressive Conditional Heteroscedasticity) Effect

Volatility in financial and commodity markets is rarely constant over time because periods of high volatility are often followed by further episodes of high volatility, while relatively calm periods also tend to persist. This phenomenon, known as the ARCH effect or volatility clustering, is a well-established characteristic of financial time series with important implications for risk measurement and forecasting. Ignoring this behaviour can lead to inefficient parameter estimates and unreliable inferences, so the study employs the ARCH-LM test to determine whether the dataset exhibits conditional heteroscedasticity. The null hypothesis assumes the absence of ARCH effects, while the alternative hypothesis indicates that the variance of the error terms depends on past information. A p-value below the conventional significance level of 0.05 results in the rejection of the null hypothesis, thereby confirming the presence of conditional heteroscedasticity and justifying the use of volatility models that allow the conditional variance to evolve over time.

Detecting ARCH effects is a crucial step because it provides the statistical basis for applying more advanced econometric models such as the Diagonal BEKK GARCH model, which explicitly captures time-varying volatility and the transmission of volatility shocks across related markets, unlike conventional regression models that assume constant variance. This is particularly relevant in the context of cross-hedging because the effectiveness of a hedge depends not only on average price relationships but also on the dynamic interaction between spot and futures market volatility. By accounting for these changing volatility patterns, the model generates more reliable estimates of conditional variances, covariances, and optimal hedge ratios, thereby enhancing the accuracy of risk assessment and providing a stronger empirical foundation for evaluating the effectiveness of alternative hedging strategies in the Indian commodity market.

Table 4: Results of ARCH-LM Test

Index	Statistic	P Value
WHEAT SP	17.27125	0.0001
CHANA SP	43.02168	0.0000
BULLION	9.258931	0.0027
ENERGY	126.2923	0.0000
NIFTY50	20.15497	0.0000
MENTHA OIL FP	4.804708	0.0293

Source: Computation of author.

The findings presented in Table 4 highlight the results of the ARCH-LM test conducted on the selected variables for the study, where each variable exhibits a p-value below the threshold of 0.05, indicating statistical significance and leading to the rejection of the null hypothesis of no conditional heteroscedasticity for all variables. This confirms the presence of conditional heteroscedasticity in the dataset and emphasises the importance of accounting for time-varying volatility when conducting further analyses and modelling to ensure a more accurate representation of the underlying dynamics of the financial markets.

Diagonal BEKK GARCH Model

The Diagonal BEKK GARCH model serves as a powerful tool for capturing the dynamics of volatility spillovers and clustering within multivariate time series data. Its primary objective is to elucidate how shocks in one series influence the volatility of other series within the system. By incorporating conditional covariance, this model provides valuable insights into the interdependencies among various variables and their respective volatilities over time.

The model equation is represented as follows:

$$H_{t} = \Omega + \alpha_1 e_t - 1 e'_{t-1} + \beta_1 H_{t-1}$$

Here, Ht denotes the conditional covariance matrix at time t, e_{t-1} represents the vector of standardised residuals at time t-1, Ω is a constant matrix, α_1 and β_1 are coefficient matrices that capture the impact of past residuals and conditional covariances, respectively. This equation highlights how past shocks and conditional covariances contribute to the current volatility dynamics within the multivariate time series. Overall, the Diagonal BEKK GARCH model offers a comprehensive framework for analysing and understanding the complex interactions and dependencies among variables in a multivariate time series context, thereby facilitating more accurate volatility forecasting and risk management strategies.

Hedge Ratio and Cross-Hedging Effectiveness

The study endeavours to assess the efficacy of cross-hedging within the Indian commodity futures market, aiming to pinpoint the optimal hedge ratio. This ratio plays a pivotal role in mitigating the risks associated with price fluctuations in assets. Calculated from the residuals of the Diagonal BEKK GARCH model, the hedge ratio represents the covariance of futures and spot prices divided by the variance of futures.

The optimal hedge ratio is determined as the average ratio, with a lower ratio implying reduced hedging costs.

$$\text{Hedge Ratio} = \frac{covariance\ of\ futures\ and\ spot}{variance\ of\ \ futures}$$

Furthermore, the hedging effectiveness ratio serves as a crucial metric for evaluating the performance of a hedge in minimising asset or portfolio risk exposure. Computed as the difference between the variance of unhedged (Var(U)) and hedged (Var(H)) positions divided by the variance of unhedged positions, this ratio quantifies the extent to which hedging has reduced risk exposure. A hedging effectiveness ratio of 100% indicates complete effectiveness, with higher percentages signifying greater hedging effectiveness. This measure serves as a valuable tool for assessing the success of hedging strategies in managing risk within the Indian commodity futures market.

$$\text{Hedging Effectiveness} = \frac{Var(u)-Var(H)}{Var(u)}$$

Hedge Ratio and Cross-Hedging Effectiveness of Chana

The hedge ratio and hedging effectiveness of commodities, chana and wheat, regarding various futures alternatives such as Mentha oil, Nifty 50, bullion index, and energy index, are demonstrated graphically. Analysis of the hedge ratio reveals that the expense of hedging spot prices of commodities with futures of other commodities and index futures is comparatively lower. Notably, the optimal hedge ratio, which signifies the associated cost, occasionally dips into negative territory, particularly evident in cross-hedging chana with the bullion index and mentha oil.



Fig. 3: Graphical Representation of the Hedge Ratio of Chana with Commodity Futures and Indices

Table 5: Optimal Hedge Ratio – Chana

Cross-Hedging Portfolio	Optimal Hedge Ratio
CHANA SP_BULLION INDEX	-0.10
CHANA SP_ENERGY INDEX	0.04
CHANA SP_MENTHA OIL FP	-0.02
CHANA SP_NIFTY50	0.01

Source: Computation of author.

From these observations, it can be inferred that the overall cost of hedging involved in cross-hedging diminishes. This indicates that employing futures contracts on other commodities or index futures to hedge against price fluctuations in chana entails lower expenses compared with traditional hedging methods. Consequently, cross-hedging emerges as a cost-effective strategy for managing risk exposure in the Indian commodity futures market, offering potential benefits in terms of reduced hedging costs.

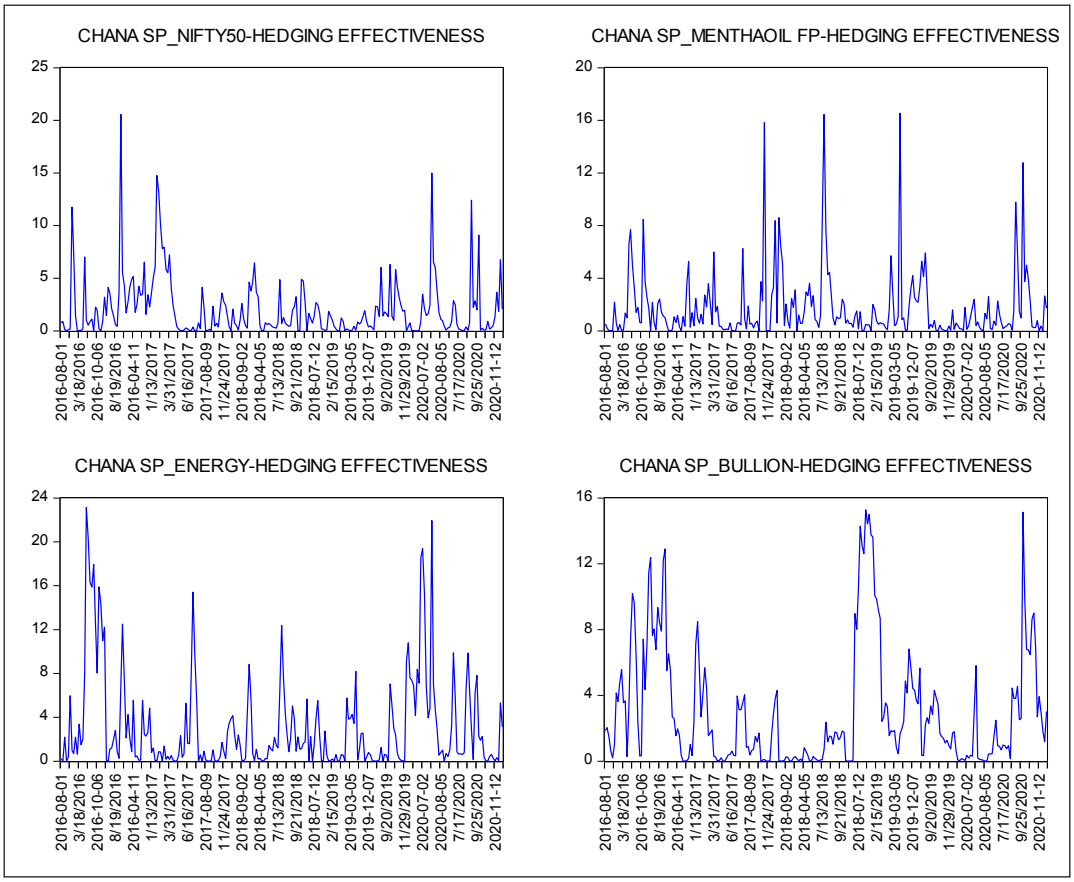


Fig. 4: Graphical Representation of Cross-Hedging Effectiveness in Chana

Table 6: Cross-Hedging Effectiveness in Chana

Cross-Hedging Portfolio	Hedging Effectiveness
CHANA SP_BULLION INDEX	3.03
CHANA SP_ENERGY INDEX	3.14
CHANA SP_MENTHA OIL FP	1.73
CHANA SP_NIFTY50	2.07

Source: Computation of author.

When the hedging effectiveness reaches 100%, it signifies that the hedge has eliminated the risk associated with price fluctuations, indicating perfect effectiveness. Moreover, higher percentages indicate greater success in reducing risk exposure. Upon analysing the hedging effectiveness of chana with other commodity futures and index futures, it becomes apparent that the values obtained do not exceed double digits. In other words, the effectiveness of cross-hedging between chana and other futures fails to reach even a modest level. Consequently, it can be concluded that there are no discernible benefits associated with cross-hedging spot prices with futures in this scenario.

The outcomes highlight the necessity of proper evaluation and analysis when adopting cross-hedging strategies. While the advantages of cost reduction and risk diversification make cross-hedging strategies attractive, the true effectiveness relies on varying market situations and specific assets

involved. In the study outlined, it becomes evident that investors should seek alternative options apart from cross-hedging in chana and other related assets to reduce price uncertainty, as hedging effectiveness is limited.

Hedge Ratio and Cross-Hedging Effectiveness of Wheat

The probable cost reduction benefits associated with cross-hedging strategies are outlined by analysing the hedge ratio of wheat with commodity futures. The lower optimal hedge ratio, analysing the cost of hedging the spot market price of wheat with index and commodity futures, concludes that the hedging cost associated with spot prices of commodities with futures of other commodities and index futures is lower in cross-hedging compared with alternative hedging methods. Thus, adopting appropriate cross-hedging techniques facilitates market participants in minimising hedging expenses while mitigating risk exposure to achieve a balance between risk and reward. Investors may utilise commodity futures as a substitute when direct hedging options are comparatively expensive for offsetting price risks.

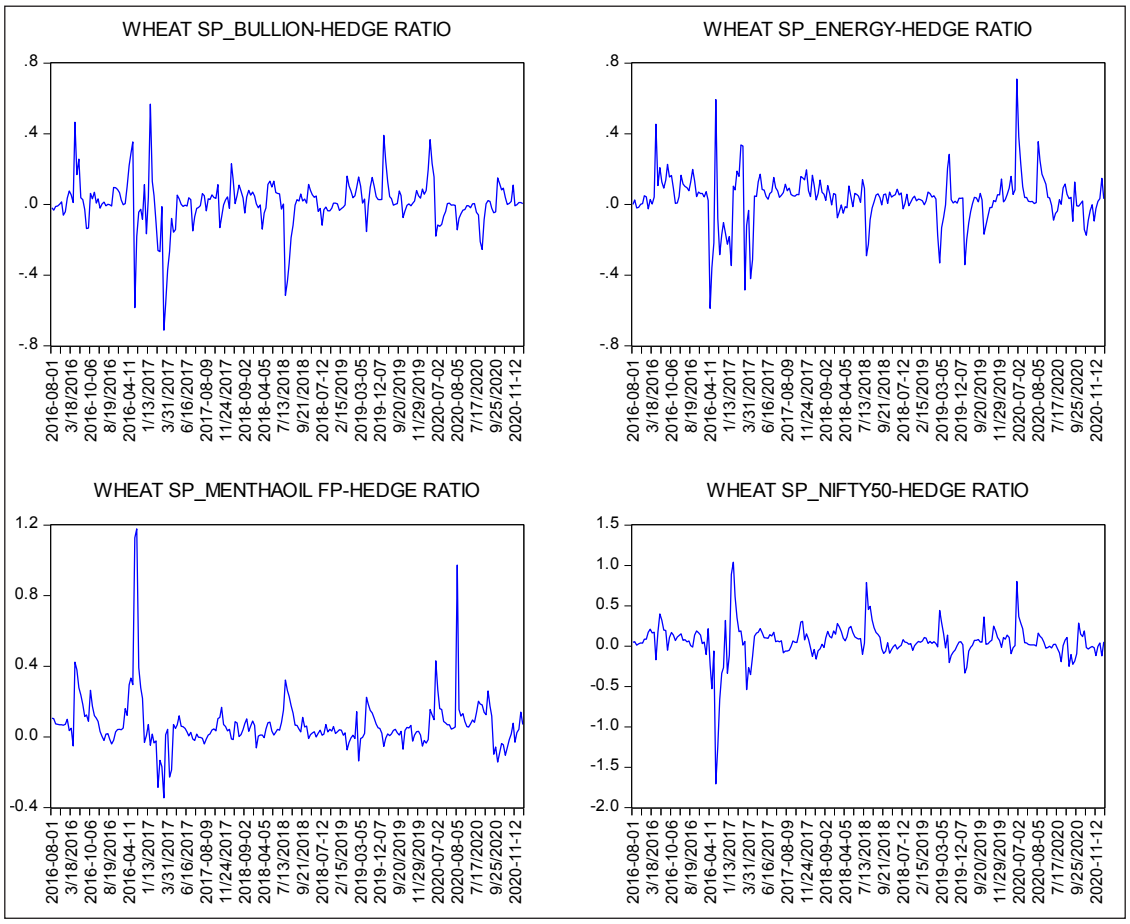


Fig. 5: Graphical Representation of the Hedge Ratio of Wheat with Commodity Futures

Table 7: Optimal Hedge Ratio – Wheat

Cross-Hedging Portfolio	Optimal Hedge Ratio
WHEAT SP_BULLION INDEX	0.001
WHEAT SP_ENERGY INDEX	0.030
WHEAT SP_MENTHA OIL FP	0.07
WHEAT SP_NIFTY50	0.05

Source: Computation of author.

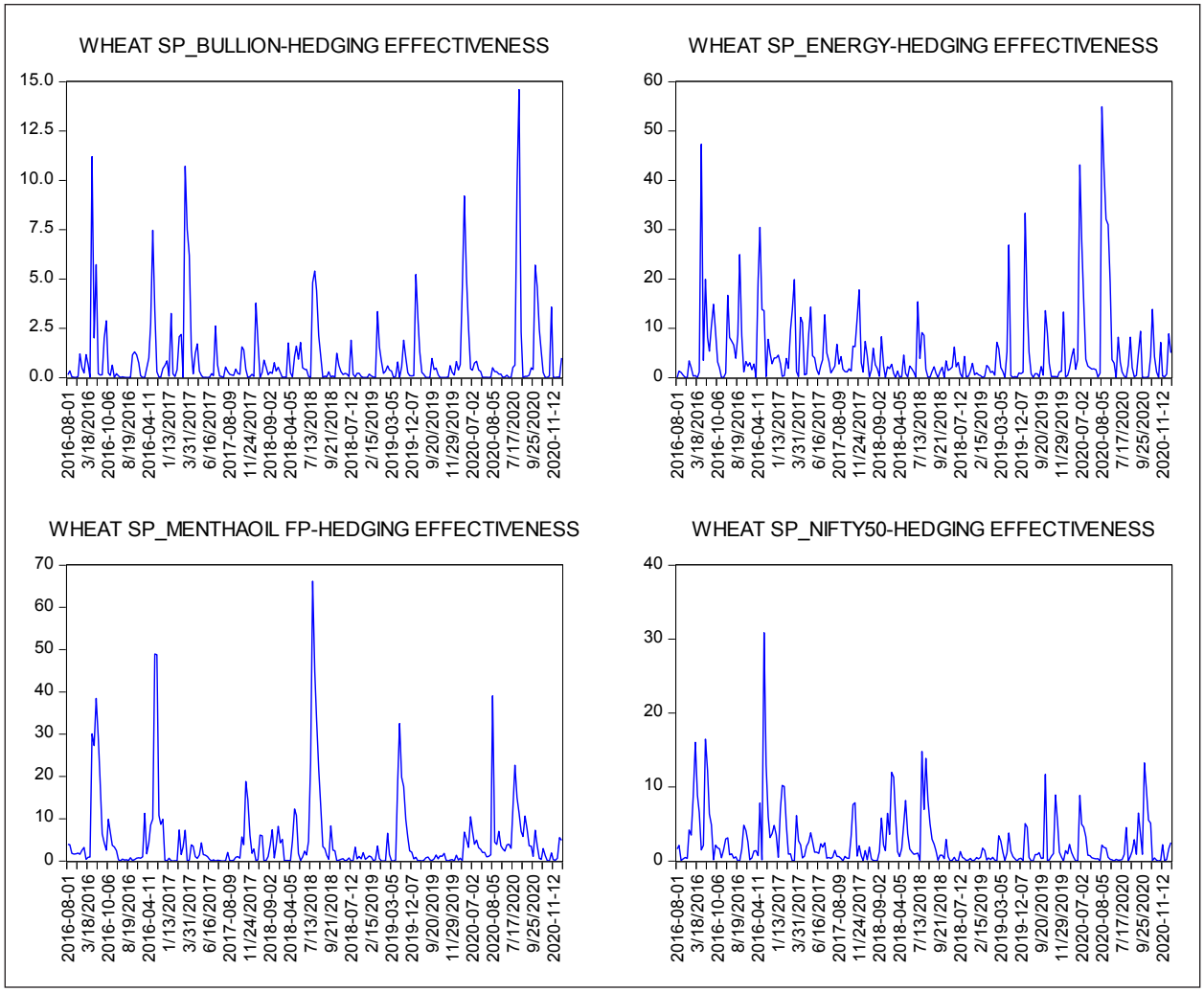


Fig. 6: Graphical Representation of Cross-Hedging Effectiveness in Wheat

Table 8: Cross-Hedging Effectiveness in Wheat

Cross-Hedging Portfolio	Hedging Effectiveness
WHEAT SP_BULLION INDEX	0.99
WHEAT SP_ENERGY INDEX	5.05
WHEAT SP_MENTHA OIL FP	4.88
WHEAT SP_NIFTY50	2.49

Source: Computation of author.

While examining the hedging effectiveness of wheat with other commodity futures and index futures, it becomes evident that the values obtained remain below double digits. This leads to the conclusion that cross-hedging between wheat and other futures fails to achieve even a modest level of effectiveness. This shows that cross-hedging spot prices with futures does not yield noticeable benefits in the case of wheat, highlighting the necessity of proper analysis and evaluation when considering cross-hedging strategies. While the advantages of cost reduction and risk diversification make cross-hedging strategies attractive, the true effectiveness relies on the varying market situations and specific assets involved. The lack of hedging effectiveness suggests that market participants should adopt alternative risk mitigation strategies apart from cross-hedging to minimise price fluctuations in the case of wheat and related assets.

CONCLUSION

The role of commodity futures is crucial in mitigating risk and stabilising prices in fluctuating commodity markets. The absence of actively traded derivative instruments makes direct hedging difficult for certain commodities, making cross-hedging an alternative strategy for market participants, employing different yet related futures contracts to absorb price shocks. Cross-hedging in commodity markets has gained significance owing to regulatory constraints imposed

by SEBI on futures trading. An ample opportunity was created for cross-hedging in commodity markets due to the recent ban on futures trading for seven major agricultural commodities by SEBI, substantially affecting the futures market. The aim of this study was to assess the effectiveness of cross-hedging strategies when commodities were hedged with index futures and other related or unrelated commodity futures.

The study calculated the optimal hedge ratio and measured hedging effectiveness for wheat and chana across different trading horizons, utilising the Diagonal BEKK GARCH framework and data spanning from December 31, 2015 to January 8, 2021. An examination of the data highlights highly fluctuating price movements across variables during the specified period, with even related commodities exhibiting non-uniform price movements.

The findings suggest that benefits derived from cross-hedging are minimal, even when the hedging cost was lower when spot prices were hedged with index and commodity futures. This was concluded from the similar results obtained for both chana and wheat spot prices when applying the Diagonal BEKK GARCH model, as hedging effectiveness was found to be minimal. The primary reason for this negative outcome was basis risk, arising from significant disparities in price movements between commodities in the spot and futures markets. Thus, it became challenging for investors to identify an optimal cross-hedging asset in commodities. Overall, neither related commodity futures nor index futures consistently delivered meaningful cross-hedging benefits for the agricultural commodities examined.

In conclusion, the study found that under normal market conditions cross-hedging was not a preferable alternative for direct hedging in Indian agricultural commodity markets. Futures of related commodities do not outperform index futures in terms of cross-hedging performance, making it difficult to identify an optimal cross-hedging asset for investors. Therefore, investors were not advised to pursue such hedging alternatives for risk reduction purposes. The study also observed that cross-hedging may be effective during extreme market situations, such as the COVID-19 pandemic, suggesting its viability as a short-term alternative under such circumstances.

The study contributes to the literature by providing evidence on the limitations of cross hedging in an emerging agricultural market setting under regulatory constraints. Future research could expand this study by using high-frequency data, alternative assets, or regime-switching models to further investigate the specific conditions that optimise cross-hedging effectiveness.

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