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DO FUTURES TRADING ACTIVITIES AFFECT THE SPOT MARKET VOLATILITY SPILLOVER? EVIDENCE FROM INDIA

Keywords: commodity futures market, futures trading activity, spot market volatility, GARCH.

JEL Classification: C1, G12, G130.

Abstract: The present study verifies the effect of futures trading activities on spot market volatility spillover in actively traded commodities on the Multi-Commodity Exchange in India. We employ the Generalised Autoregressive Conditional Heteroscedasticity (GARCH 1, 1) and Granger Causality models. The Granger causality results show that futures trading volume leads spot market volatility in all commodities except mentha oil and natural gas. On the other hand, futures open interest affects spot market volatility only for cotton. Furthermore, the study emphasises that futures trading activities significantly affect the volatility of commodity spot markets. Moreover, futures trading volumes and spot market volatility persistently show a positive, statistically

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significant association, highlighting the role of speculative activity in driving short-term price fluctuations. Furthermore, the influence of futures open interest is mixed, both positively and negatively affecting spot market volatility. It suggests that it can be used as both a speculative and a hedging technique, depending on the nature of the commodity. The significant ARCH effect in the GARCH model estimates indicates that new market shocks are the primary source of volatility for most commodities.

■■■ INTRODUCTION

The influence of futures trading on the prices of the underlying spot market has attracted considerable attention. Since the 1980s, farmers and other agricultural stakeholders have asserted that futures trading destabilises spot prices, resulting in losses for producers and consumers (Cox, 1976). Furthermore, it is frequently stated that the introduction of derivatives trading could destabilise the related spot market, thereby increasing the volatility of spot prices (Debasish, 2009). On the other hand, Corgel and Gay (1984), Moriarty and Tosini (1985), and Simpson and Ireland (1982) argue that the introduction of futures trading does not increase the spot volatility. Through arbitrage, price changes are transferred to the same underlying spot market, increasing volatility. Similarly, uninformed speculators cause herd behaviour in markets, thereby increasing volatility (Malhotra & Sharma, 2016).

Next, volatility is another key area of research for policymakers, market participants, and other stakeholders, who are also interested in managing their price risk. It provides substantial information and serves as a gauge of the degree to which the asset's current price diverges from its average historical price. In fact, volatility indicates confidence or strength behind a price movement (Sehgal, Rajput & Deisting, 2013). Thus, volatility spillover between two markets occurs when the volatility of returns in one market significantly influences the other, and vice versa (Edward & Rao, 2013). Besides, the commodity market's trading volume increased significantly compared to earlier levels (Schulmeister, 2012). Prior studies find a strong relationship between trading volume and market liquidity (Ding, Cui, Zheng & Du, 2021; Pagano, 1989). Bessembinder and Seguin (1993) state that trading volume strongly influences price volatility. A handful of studies have examined commodity market volatility in depth and reported mixed results (Ahmed & Huo, 2021; Ding et al., 2021). The seminal work experiment by Bollerslev (1986), Engle (1982), and Urbain (1992) is remarkable for its econometric modelling of volatility spillover.

Moreover, Indian futures markets have been accused of destabilising the physical market, particularly between 2006 and 2007, when food grain inflation rose, leading to the suspension of futures trading for several agricultural commodities, including rice, wheat, urad, and tur. This study has empirically examined the following difficulties, as futures trading has been held accountable for increasing spot price volatility. First, does the volatility spillover from futures to spot or vice versa? Second, how do futures trading activities affect the spillover of spot market volatility? Hence, it is important to examine volatility spillovers from time to time to assess the effects of commodity derivatives on spot and futures markets.

REVIEW OF LITERATURE

The extensive literature on futures trading activities and spot price volatility is carried out on developed markets such as the United States, the United Kingdom, and the European Union. For instance, Banerjee and Weaver (1982) document that daily observations reveal that these individual futures prices have a direct impact on, an immediate relationship with, and no effect on the cash price. Admati and Pfleiderer (1988) document a positive association between insider trading and prices. There are studies that have examined the impact of index futures trading on spot volatility and have shown a strong, significant association. For example, Rubinstein (1987) and Harris (1989) show that the introduction of index futures has made the spot market even more volatile. Bessembinder and Seguin (1992) study the relationship between futures trading activities and stock price volatility spillover. The study results show that stock volatility is negatively correlated with forecastable futures trading activity, whereas it is positively associated with unanticipated futures trading volume. Antoniou and Holmes (1995) investigate the effects of FTSE-100 stock index futures on the underlying spot market's volatility and find that futures trading has increased volatility; however, volatility characteristics have remained unchanged. Followed by Darrat and Rahman (1995), who investigated the impact of futures trading activities on stock price volatility. The study argues that stock market volatility is caused by index futures trading. Furthermore, Chatrath et al., (2003) revisit Bessembinder and Seguin's methodology to test the effect of index futures trading on spot volatility. They document strong evidence of a rise in spot volatility. Yang, Balyeat and Leatham (2005) verify the

linkage between futures trading activities and spot price volatility of agricultural commodities. The study results show that an unexpected rise in futures trading volume unidirectionally increases the majority of agricultural commodities and spot price volatility. Nevertheless, the study found a weak linkage between futures open interest and spot volatility. On the contrary, Edwards (1988) tests the relationship between the stock index and interest rate futures on spot market volatility. The study found no significant impact of financial futures trading on spot price volatility. Similarly, some studies report that the emergence of futures trading has not increased the cash price volatility (Corgel & Gay, 1984; Moriarty & Tosini, 1985; Simpson & Ireland, 1982).

Furthermore, Gulen and Mayhew (2000) and Chen, Han, Li and Wu (2012) find that the introduction of index futures substantially reduces the spot price volatility. Whereas Xie and Huang (2014) examine the effect of index futures trading on volatility in the Chinese spot market. The authors document that the introduction of futures trading does not reduce the spot market volatility. However, Bohl and Stephan (2013) and Weaver and Banerjee (1990) find that futures trading does not destabilise spot market volatility. Pawłowski (2013) examines the market risk on KGHM Polska Miedź SA and PGNiG SA. Bag (2019) investigates the information content over time and finds that realised volatility significantly influences the pre-market information content.

In the Indian context, very few studies have verified the effect of futures trading activities on spot price volatility. Studies such as Nagaraj and Kotha (2004) assess the effect of index futures trading on spot market volatility. The authors state that the spot market is more vibrant and assimilates the information into its prices. Debasish (2008) examines the effect of Nifty index futures on the spot market volatility employing dynamic linear regression and the GARCH model. The study documents that since the introduction of futures trading in the NSE Nifty, spot return volatility has been less significant in explaining spot returns. Sehgal, Rajput, and Dua (2012) point out that the destabilising impact of futures trading on spot market volatility has been observed across most commodities, except for pepper and barley. Malhotra and Sharma (2016) study the effect of futures trading activities on spot price volatility. The authors employ augmented GARCH, bivariate GARCH, and the Granger causality test and find that the unanticipated increase in futures trading activities, such as trading volume or open interest, destabilises the spot price volatility of three out of four commodities.

It has been found that there are limited studies examining the commodity markets in India. Next, most studies mainly focus on the individual commodity segments or commodity indices. There is no comprehensive study examining the impact of futures trading activities on the volatility of the Indian commodity spot market. Hence, the present study aims to bridge the research gap by examining the effect of futures trading activities on commodity spot market volatility in the Indian context.

DATA

The present study considers the most actively traded nine non-agricultural and two agricultural commodities, namely two precious metals (Gold and Silver), five base metals (Aluminium, Copper, Lead, Nickel and Zinc), two energy commodities (Crude oil and Natural gas), and two agricultural commodities (Cotton and Mentha Oil). This study uses daily spot closing prices of actively traded commodities in the Multi-Commodity Exchange (MCX). In addition, the study considers the corresponding daily futures open interest and futures trading volume from January 3, 2012, to September 30, 2024. All data was collected from the official website of the Multi-Commodity Exchange. Furthermore, the study utilises the GARCH residual value as a measure of spot market volatility.

METHODOLOGY

Unit Root Test

The present study conducts necessary tests to verify the nature and quantity of the data. To test for stationarity, the study employs the Augmented Dickey-Fuller (ADF) test, proposed in 1979. The ADF test verifies the presence of unit roots (if any) in each price series. Furthermore, it is a parametric model for controlling higher-order autocorrelation, assuming that the price series follow an autoregressive (AR) p process (Dickey & Fuller, 1979). The null hypothesis of the ADF test is that the series contains a unit root.

Granger Causality Model

Additionally, Granger's (1969) causality test is used to determine whether futures trading activities (X) can be used to anticipate the spot market volatility of eleven commodities and to calculate the short-term causality relationship between spot market volatility and futures trading activities.

$$\Delta Y_t = \alpha_0 + \sum_{i=1}^k \alpha_1 \Delta Y_{t-i} + \sum_{i=1}^k \alpha_2 \Delta X_{t-i} + \varepsilon_{1t} \quad (1)$$

$$\Delta X_t = \beta_0 + \sum_{i=1}^k \beta_1 \Delta Y_{t-i} + \sum_{i=1}^k \beta_2 \Delta X_{t-i} + \varepsilon_{2t} \quad (2)$$

Where Y_t and X_t are commodity spot prices and futures trading activities (futures trading volume, and futures open interest) data, Y_{t-i} and X_{t-i} indicate variables, vectors, and matrices alpha and beta are to be calculated, and ε_t is uncorrelated with white-noise error terms. Whereas employing Granger causality, the study assumes that Y and X are not cointegrated. If the α_2 is statistically different from zero for different lags, then it rejects the non-existence of Granger causality and implies that X Granger causes Y. If the β_2 is statistically significant that the direction of causality is from Y to X. If both terms are significant, then it can be inferred that there exists bidirectional causality between the commodity spot returns and futures trading activities.

Generalised Autoregressive Conditional Heteroscedasticity (GARCH 1, 1) Model

Finally, the study employs the most widely used Generalised Autoregressive Conditional Heteroskedasticity (GARCH 1, 1) model, proposed by Bollerslev (1986), to investigate the association between spot market volatility and futures trading activities. This model is more popular when examining and predicting volatility. The first number in the conventional notation (1,1) in parentheses indicates the number of autoregressive lags or ARCH terms that are present in the equation. The second number indicates the number of moving average lags

specified, commonly referred to as the number of GARCH terms. The following equation refers to the GARCH (1,1) model:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^p \alpha_i \varepsilon_{t-1}^2 + \sum_{j=1}^q \beta_j \sigma_{t-1}^2 + \psi FTV_t + \varphi FTOI_t \tag{3}$$

Where σ_t^2 refers to conditional variance (one-period-ahead forecast variance based on past information), $\alpha_i \varepsilon_{t-1}^2$ and $\beta_j \sigma_{t-1}^2$ indicate ARCH and GARCH term, ψ , and φ denote the coefficient parameters, FTV_t presents the futures trading volume at a time t , $FTOI_t$ denotes future trading open interest at a time t .

EMPIRICAL RESULTS

Table 1 presents summary statistics for the commodity’s daily spot returns, futures trading volume, futures trading open interest, and spot market volatility. The table presents the means and standard deviations for study variables. All commodities show positive returns, except mentha oil, which shows a negative return (-0.0001). Natural gas has the highest standard deviation (0.085). Furthermore, futures trading volume and open interest for crude oil (11,461) and silver (9,680) have the highest means. The futures trading volume and open interest of mentha oil have the highest standard deviations of 1.67 and 1.30, respectively. Spot market volatility of natural gas has the highest mean (2.392) and standard deviation (1.69).

Table 1. Summary Statistics for Commodities Spot Returns, Futures Trading Volume, Futures Open Interest and Spot Market Volatility

Commodities	Commodities Spot Returns		Futures Trading Volume	
	Mean	Standard Deviation	Mean	Standard Deviation
Gold	0.0003	0.008	9.388	0.71
Silver	0.0002	0.015	9.952	0.68
Aluminium	0.0003	0.014	8.638	0.70
Copper	0.0002	0.013	10.086	0.93
Lead	0.0002	0.015	8.679	1.47

Table 1. Summary...

Commodities	Commodities Spot Returns		Futures Trading Volume	
	Mean	Standard Deviation	Mean	Standard Deviation
Nickel	0.0003	0.022	10.061	1.45
Zinc	0.0003	0.016	9.294	1.38
Cotton	0.0003	0.007	7.655	0.82
Mentha Oil	-0.0001	0.016	6.987	1.67
Crude Oil	0.0000	0.029	11.461	0.94
Natural Gas	0.0001	0.085	11.157	0.79
Commodities	Futures Trading Open Interest		Spot Market Volatility	
	Mean		Mean	Standard Deviation
Gold	9.544	0.36	0.774	0.24
Silver	9.680	0.37	1.388	0.58
Aluminium	8.231	0.57	1.374	0.39
Copper	9.401	0.73	1.280	0.29
Lead	7.621	1.05	1.497	0.31
Nickel	8.998	1.29	1.802	1.05
Zinc	8.293	0.89	1.665	0.77
Cotton	8.906	0.67	0.714	0.28
Mentha Oil	7.749	1.30	1.462	0.74
Crude Oil	9.522	0.80	2.392	1.68
Natural Gas	9.541	0.74	2.392	1.69

Source: author's own calculation.

The Augmented Dickey-Fuller (ADF) unit root test results for all commodities, futures trading volume, futures open interest and spot market volatility are presented in table 2. The results clearly show that all variables are stationary at level.

Table 2. Unit Root Test Results

Commodities	Particulars	Spot returns	Futures Trading Volume	Futures Open Interest	Spot Market Volatility
Gold	T statistics	-52.479***	-4.573***	-3.743***	-11.275***
	Prob.*	(0.000)	(0.000)	(0.003)	(0.000)
Silver	T statistics	-52.014***	-6.144***	-5.637***	-9.785***
	Prob.*	(0.000)	(0.000)	(0.000)	(0.000)
Aluminium	T statistics	-63.797***	-3.576***	-6.170***	-10.018***
	Prob.*	(0.000)	(0.000)	(0.000)	(0.000)
Copper	T statistics	-60.948***	-3.641***	-3.856***	-10.320***
	Prob.*	(0.000)	(0.005)	(0.002)	(0.000)
Lead	T statistics	-62.771***	-2.600**	-4.643***	-13.354***
	Prob.*	(0.000)	(0.093)	(0.000)	(0.000)
Nickel	T statistics	-16.537***	-3.502***	-4.406***	-10.833***
	Prob.*	(0.000)	(0.008)	(0.000)	(0.000)
Zinc	T statistics	-54.212***	-2.819**	-6.387***	-8.371***
	Prob.*	(0.000)	(0.056)	(0.000)	(0.000)
Cotton	T statistics	-14.652***	-4.379***	-3.173***	-10.070***
	Prob.*	(0.000)	(0.000)	(0.022)	(0.000)
Mentha Oil	T statistics	-56.078***	-4.368***	-7.625***	-10.226***
	Prob.*	(0.000)	(0.000)	(0.000)	(0.000)
Crude Oil	T statistics	-20.424***	-2.677**	-5.120***	-6.546***
	Prob.*	(0.000)	(0.078)	(0.000)	(0.000)
Natural Gas	T statistics	-37.338***	-3.440***	-5.014***	-6.546***
	Prob.*	(0.000)	(0.000)	(0.000)	(0.000)

Note: Prob.* refers to Probability; *** and ** indicate significant at 1% and 5% level.

Source: author's own calculation.

Table 3 presents the Granger causality test results between spot market volatility (SV), futures trading volume and open interest. The study results show that futures trading volume leads spot market volatility in all commodities except mentha oil and natural gas. It also documents that the majority of commodities exhibit a bidirectional relationship with futures trading volume, except for zinc, mentha oil, crude oil, and natural gas. It implies that futures trading volume impacts the spot market volatility. On the other hand, futures open interest affects spot market volatility only for cotton. Commodities such as gold and crude oil show a unidirectional relationship between futures open interest and spot market volatility (SV). The results are consistent with Biswas and Rajib, 2011; Kumar and Pandey, 2010; Laubsch, Smales and Vo, 2024; Lethesh and Reddy, 2023; Mukherjee and Goswami, 2017; Pani, Gherghina, Mata, Ferrão and Mata, 2022; Rout, Das and Rao, 2021; and Zhan, 2019.

Table 3. Granger Causality Test Results

Commodities	Spot Market Volatility and Futures Trading Activities							
	Futures Trading Volume				Futures Open Interest			
	F statistics	Prob.*	F statistics	Prob.*	F statistics	Prob.*	F statistics	Prob.*
	SV → TV		TV → SV		SV → OI		OI → SV	
Gold	5.534	0.004	32.130	0.000	1.353	0.258	3.488	0.030
Silver	2.548	0.078	37.099	0.000	1.961	0.140	0.525	0.591
Aluminium	6.041	0.002	31.189	0.000	1.278	0.278	0.339	0.711
Copper	2.164	0.115	8.059	0.000	0.037	0.964	1.880	0.152
Lead	3.877	0.020	4.736	0.008	0.129	0.878	0.901	0.406
Nickel	9.116	0.000	15.141	0.000	0.626	0.534	0.477	0.620
Zinc	0.449	0.638	12.062	0.000	0.374	0.688	1.096	0.334
Cotton	7.866	0.000	39.476	0.000	2.922	0.054	3.483	0.030
Mentha Oil	3.316	0.036	0.878	0.416	0.197	0.821	0.783	0.457
Crude Oil	0.262	0.769	16.558	0.000	1.774	0.169	3.248	0.039
Natural Gas	1.045	0.351	2.407	0.090	0.137	0.874	0.872	0.417

Source: author's own calculation.

Table 4 presents the GARCH (1,1) results for futures trading volume, open interest, and spot market volatility. The results reveal a positive and significant relationship between futures trading volume and spot market volatility across all commodities. It implies that higher futures trading volume tends to increase the spot market volatility. On the other hand, futures open interest has a positive and significant association with the volatility of the spot markets for gold, copper, lead, and nickel. More interestingly, futures open interest shows mixed results and plays a dual role, serving both as a speculative and a hedging tool, depending on the commodity's characteristics. It indicates that the positive association suggests higher speculative open interest. Whereas silver, aluminium, zinc, cotton, mentha oil, and natural gas exhibit a significant adverse linkage between futures open interest and spot market volatility. It suggests stabilising effects due to long-term positions. Next, the ARCH effect (α) indicates a positive and significant impact, signifying that recent shocks (events/news) are the major contributors to spot market volatility. Further, commodities like gold, zinc and nickel exhibit a high magnitude in volatility ($\alpha + \beta > 1$). The results of the GARCH effect (β) indicate mixed results, with all commodities showing positive and significant effects. It suggests persistent spot market volatility. However, the ARCH-LM test of the residuals confirms that the model is well-specified and shows no ARCH effects. The study concludes that the rise in the ARCH component indicates greater informational efficiency in spot market volatility, driven by the informational content of futures trading. The findings are aligned with Biswas and Rajib, 2011; Kumar and Pandey, 2010; Lethesh and Reddy, 2023; and Mukherjee and Goswami, 2017.

Table 4. GARCH (1,1) Model Results

Commodities	Gold	Silver	Aluminium	Copper	Lead	Nickel	Zinc
Mean equation							
Constant (μ)	0.582***	1.429***	1.327***	1.134***	1.360***	1.454***	1.345***
FTV	2.61E-06***	1.09E-06***	1.02E-05***	7.69E-07***	3.15E-06***	5.30E-06***	2.82E-05***
FOI	7.25E-06***	-1.40E-05***	-2.13E-05***	2.48E-06***	1.39E-05***	4.43E-07***	-3.24E-05***
Variance equation							
Constant (ψ)	0.001***	0.012***	0.012***	0.003***	0.009***	0.014***	0.002***
ARCH Effect (α)	0.796***	0.864***	0.877***	0.748***	0.718***	0.609***	0.496***
GARCH Effect (β)	0.352***	0.027***	-0.125***	0.243***	-0.102***	0.415***	0.662***
(α) + (β)	1.148	0.891	1.002	0.991	0.616	1.024	1.158
Residual diagnostics: ARCH LM test							
Obs [†] R-squared	0.394	0.741	0.006	0.309	0.010	0.033	0.004
Prob. Chi-Square (1)	0.529	0.389	0.935	0.577	0.919	0.855	0.948

Table 4. GARCH...

Commodities	Cotton	Mentha Oil	Crude Oil	Natural Gas
Mean equation				
Constant (μ)	0.567***	1.262***	1.755***	1.796***
FTV	2.88E-05***	3.07E-05***	3.68E-07***	4.34E-07***
FOI	-8.55E-06***	-4.08E-05***	9.37E-08***	-7.21E-07***
Variance equation				
Constant (ψ)	0.004***	0.007***	0.034***	0.037***
ARCH Effect (α)	0.713***	0.929***	0.906***	0.886***
GARCH Effect (β)	0.314***	0.117***	0.082***	0.082***
$(\alpha) + (\beta)$	1.027	1.046	0.988	0.968
Residual diagnostics: ARCH LM test				
Obs ^a R-squared	0.146	0.278	0.023	0.020
Prob. Chi-Square (1)	0.702	0.597	0.877	0.886

Note: FTV refers to futures trading volume; FOI – Futures open interest; *** indicates significant at 1% level.

Source: authors' own calculation.

■■■ CONCLUSION

In this work, the study examines the impact of futures trading on the spot market volatility of commodities traded on the Multi-Commodity Exchange (MCX). The study examines daily commodity spot prices, futures trading volumes, and futures open interest from January 3, 2012, to September 30, 2024. In addition, it uses GARCH model residuals to estimate spot market volatility. The study utilises Granger causality tests and the GARCH (1,1) model. The Granger causality results show that futures trading volume leads spot market volatility in all commodities except mentha oil and natural gas. It also documents that the majority of commodities exhibit a bidirectional relationship with futures trading volume, except for zinc, mentha oil, crude oil, and natural gas. On the other hand, futures open interest affects spot market volatility only for cotton. Commodities such as gold and crude oil show a unidirectional relationship between futures open interest and spot market volatility (SV). Furthermore, the study emphasises that futures trading activities significantly affect the volatility of commodity spot markets. Moreover, futures trading volumes and spot market volatility exhibit a persistent, statistically significant positive association, highlighting the role of speculative activity in driving short-term price fluctuations. What is more, the influence of futures open interest is mixed, both positively and negatively affecting spot market volatility. It suggests that it can be used as both a speculative and a hedging technique, depending on the nature of the commodity. The significant ARCH effect in the GARCH model estimates indicates that new market shocks are the primary source of volatility in most commodities. There are some avenues for future research. For comparative purposes, other commodity exchanges could be included in future studies. Next, to better understand, future research may consider commodity indices from the MCX and NCDEX.

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