Journal of Commerce & Accounting Research
11 (3) 2022, 10-16
http://publishingindia.com/jcar/

Submitted: 29 July, 2021
Accepted: 23 November, 2021

RELATION BETWEEN OPEN INTEREST AND VOLATILITY IN COMMODITIES MARKETS

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Abstract *The purpose of this paper is to examine the consequence of open interest on volatility of futures markets. This paper emphasises on investigating the relation between open interest and the commodities futures. An effort was made to capture the size and change in speculative behaviour in futures markets by examining the behaviour of futures prices due to open interest. The findings show that the depth of market has an effect on the futures market's volatility, but the direction of this effect depends on the type of contract. The sample includes daily data covering the period 2010-2020 from the Indian commodities futures markets (including crude oil futures). A two-stage methodology was employed by the authors: first, the authors investigate the relation between open interest and volatility. Next, the authors employ the E-GARCH model and considers the asymmetric response of volatility to shocks of different signs. Finally, the authors consider a regression framework to scrutinise the contemporaneous relationships between open interest and futures prices (volatility).*

Keywords: *Futures, Commodities, E-GARCH, Volatility, Open Interest*

JEL Classification: *C32, C58, G15, F65*

INTRODUCTION

Forecasting a financial time series has become a vital issue because of its rewarding implications for assessing and managing risk. Forecasting earnings help manage risk and guide investors to choose quality stock for better returns (Aghazadeh et al., 2014). In recent times, movement classifiers and agent-based modelling techniques have offered directions for investment (Hajek, 2012; Neri, 2012), with a great emphasis given by researchers to forecast the performance of financial markets and assets (Neri, 2012; Neri, 2010). Studying sensitivity of the stock market with volatility helps in risk aversion and increases the confidence of the investors (Chopra, 2019). Volatility dynamics also affect the financial derivatives hedging and valuation (Chang et al., 2012, Chang, 2013).

Open interest has recently received much attention in literature, as an important indicator of trading activity unique to futures and options market. Several ostensibly related views have emerged on the economic role of open interest in literature. Specifically, open interest has been used as a proxy for hedgers' opinions (Kamara, 1993), the hedging demand (Chen et al., 1995), market depth (Bessembinder & Seguin, 1993), and the difference in traders' opinion (Bessembinder et al., 1995).

Open interest represents the number of futures contracts outstanding (i.e., sum of either the outstanding long positions or short positions) at any point in time. In other words, it is the total number of futures contracts that have not been closed. The change in the level of open interest measures the direction of capital flow relative to that contract.

The futures contracts of commodities are used for hedging, speculation, and arbitraging. Although, Mahadevan (2021) studied that hedging can be done without financial instruments as well. Studying volatility may help reduce the risks involved in trading, and therefore, it is considered an important variable in the futures market to measure the time period for the market to include new information, as price fluctuation within a duration is displayed (Desai & Joshi, 2021). Open interest measures the number of outstanding traded contracts at a time factor. Open interest is an essential variable in futures markets, which shows trading activity.

The relationship between open interest and volatility on futures market has always been of experimental attentiveness. A huge number of the evidence is précised in articles by Karpoff (1987) and Sutclifffe (1993). Open interest has been considered a vital parameter for the purpose of market depth (Bessembinder & Seguin, 1993) and hedging (Kamara, 1993; Chen et al., 1995). Findings of past studies show a robust correlation between price volatility and open interest.

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A negative impact of estimated open interest on volatility is reported from a study of this relationship for eight futures market (Bessembinder & Seguin, 1993).

Ragunathan and Peker (1997) concluded that open interest shocks which are positive have a greater impact on volatility than the shocks which are negative. This can be inferred as volatility not being dependent on market depth. Watanabe (2001) shows that in the case of the Nikkei 225 index futures, volatility and open interest had shown a significant negative relationship. Girma and Mougoue (2002) used a GARCH (1, 1) model to show the impact of open interest and trading volume on volatility. The results showed that lagged open interest and trading volume provide an important explanation for futures spreads volatility, when considered jointly in three out of four cases.

Ferris et al. (2002) concluded that there is no direct impact on open interest with increase in volatility. Yang et al. (2004) have examined the importance of open interest for the long-run information in futures markets. They concluded that open interest and futures prices (volatility) have a long-run relation between them.

Figlewski (1981) had conducted a study in GNMA futures market and concluded that open interest can give an explanation for volatility. Bessembinder and Seguin (1993) studied the relationship between open interest (market depth) and volatility in eight futures markets, and observed a negative relation. Chang et al. (2000) indicated that open interest, which measures the demand for hedging, increases at the same time as sudden volatility increases.

Autoregressive conditional heteroscedasticity (ARCH) models have been designed for conditional variances. These models had been introduced by Engle (1982) and generalised as GARCH (generalised ARCH) by Bollerslev (1986) and Taylor (1986). GARCH-family models are broadly utilised in various financial studies, especially in time-series evaluation (Bollerslev et al., 1992 and Bollerslev et al., 1994). Even though a GARCH (1, 1) version is widely used in empirical finance, different uneven GARCH procedures (integrated GARCH, threshold GARCH, and exponential GARCH) are selected from preceding research for the reason that they permit negative shocks to behave in another way from positive shocks. This uneven behaviour of volatility is a stylised fact in almost any market, and ignoring it can lead to poor estimates of volatilities.

The returns of financial assets are having characteristics such as volatility clustering, volatility smile, leverage, skewness, leptokurtosis, and so on. To capture these stylised facts, Engle (1982) proposed an ARCH model to capture the changes in variance. This model was introduced to explain the volatility clustering, which varies with time in the time-series data. Bollerslev (1986) extended the ARCH model, which was referred to as GARCH (p, q) model. This model includes past variances, as well as past forecast errors. This model captures the propensity in time-series data for volatility clustering and heteroscedasticity in the process of estimation. GARCH (1, 1) model had been used following the argument from a significant number of research articles that the GARCH (1, 1) model accounts for temporal dependence in variance and excess kurtosis (Ciner, 2002). The GARCH (1, 1) model is found to be ungenerous and laid-back to estimate the parameters and identify them (Bollerslev, 1986; Enders, 1995). Sharma et al. (1996) found that the GARCH (1, 1) model is the best for description of the market indicator returns.

Watanabe (2001) indicated a sizeable negative relationship between open interest and volatility in the Nikkei 225 index futures market. Ferris et al. (2002) documented that implied volatility is linked with open interest due to pricing errors. Yang et al. (2004) investigated the informational role of open interest in the long run, and discovered that open interest explains same information as price for storable commodities futures; however, price forces open interest, and not the other way around. Yen and Chen (2010) studied the interrelationship between volatility and open interest in three of Taiwan's stock index futures market, and concluded that both present day and lagged open interest assist in forecasting futures volatility; both 'sequential information arrival' hypothesis and 'investors with trade time discretion generally tend to trade when market is particularly liquid' hypothesis are confirmed. Kumar and Pandey (2010) find insignificant courting between volatility and open interest for most commodity futures markets in India.

OBJECTIVE

The objective was to observe the GARCH effects in the data pertaining to commodities futures prices and open interest, and test how well open interest explains the GARCH effects. Additionally, the focus was to investigate Granger causality between commodity index futures prices and open interest to know whether the futures prices drive open interest or the other way around.

MATERIALS AND METHODS

The data used are the daily closing prices and open interest between 25/10/2010 and 13/12/2020 closest to expiration (i.e., near month, middle month, and far month contract) for MCX Crude Oil Futures. For example, if the trading month is June, the closing prices (daily) and open interest are collected for the contract that is deliverable on the last Thursday of June. Next day, after the closing date in June, it is rolled over to the July month's contract that are deliverable on the last Thursday of that month. So, the data used in the study is back-adjusted crude oil futures, close-to-close, continuous contract, rolling on open interest. The data was obtained from www.mcxindia.com containing 1,999 observations of open interest and closing price.

In this study, an extension of the simple GARCH (1, 1) model, the E-GARCH version of Nelson's (1991) is employed. The advantage of this model is that rather than modelling the variance in stages, this model uses its logarithm. In this way, the implicit assumption is made that the variance is positive at any point of time. Another advantage is that there is no restriction at the coefficients, which simplifies the optimisation process. For a lot of these reasons, the E-GARCH model offers a realistic choice to model the conditional volatility of futures contracts.

We employ the subsequent AR (1)-EGARCH (1, 1) in equation (1) to measure the conditional volatility in the futures returns. We measured returns using an AR (1) mean equation to capture the non-synchronous buying and selling impact (Xekalaki & Degiannakis, 2010). Futures returns are computed as the normal logarithm of price modifications:

$$RET_t = \frac{\ln(P_t)}{\ln(P_{t-1})} = RET_t = \alpha_0 + \alpha_1 RET_{t-1} + \varepsilon_t, \varepsilon_t \sim N(0, \sigma_t) \quad (1)$$

$$\sigma_t^2 = \omega + \alpha\varepsilon_{(t-1)}^2 + \beta\sigma_{(t-1)}^2 \quad (2)$$

$$\sigma_t^2 = \omega + \alpha\varepsilon_{(t-1)}^2 + \beta\sigma_{(t-1)}^2 + \gamma OI_t \quad (3)$$

The returns is given by $R_t = \ln(P_t) - \ln(p_{t-1})$, where, P_t is the closing futures price daily and P_{t-1} is the closing futures price of the previous day. OI_t is the daily open interest at time t, which can be used as market depth proxy (Bessembinder & Seguin, 1993). If open interest is positive (negative) and significant, then positive (negative) effect on return is expected. Since R_t is return, it was expected that their mean value (which will be given by μ) to be positive and small and the value of □ (average level of volatility) again to be small.

$$OI_t = \alpha_0 + \alpha_1 OI_{t-1} + \beta_1 RET_{t-1} + \varepsilon_t \quad (4)$$

$$RET_t = \alpha_0 + \alpha_1 RET_{t-1} + \beta_1 OI_{t-1} + \mu_t \quad (5)$$

The Granger (1969) approach to the question of whether x causes y is to see how much of the current y can be explained by past values of y and then to see whether adding lagged values of x can improve the explanation; y is said to be Granger-caused by x if x helps in the prediction of y, or equivalently, if the coefficients on the lagged x's are statistically significant. In equation (4), the null hypothesis is that RET_t does not Granger-cause OI_t; and OI_t does not Granger-cause RET_t in equation (5). The long-run information role of open interest in the futures market can be found if causality between futures prices and open interest is found.

Empirical Results

The empirical analysis is shown by first studying the descriptive statistics of returns and open interest. The results presented in Table 1 show that the returns and open interest series of the crude oil futures has a positive skewness and high kurtosis relative to a normal distribution.

Table 1: Descriptive Statistics of Returns, Open Interest, and Open Interest (Log)

Summary Statistics	Returns	Open Interest
Mean	3.23E−05	20530.96
Median	0.000335	18206.00
Maximum	0.137403	76202.00
Minimum	−0.071575	1018.000
Std. Dev.	0.018530	11224.28
Skewness	0.417352	1.193394
Kurtosis	6.668036	4.889418
Jarque-Bera	1178.679	772.2214
Probability	0.000000	0.000000
Sum	0.064556	41061922
Sum Sq. Dev.	0.686019	2.52E+11
Observations	1999	2000

Source: Author's Calculation.

Augmented Dickey-Fuller (ADF) test had been applied to test the stationarity of price and open interest series on their level form. The results are presented in Table 2, which show that the null hypothesis that futures price and open interest series are stationary is rejected for Crude Oil Futures. The results cannot reject the null hypothesis that both the series are stationary.

Table 2: Test of Unit Root for Stationarity

Test of unit root of returns and open interest

Null Hypothesis: RET has a Unit Root			
		T-Statistic	**Prob.***
Augmented Dickey-Fuller Test Statistic		−44.70284	0.0001
Test critical values:	1% level	−3.433424	
	5% level	−2.862784	
	10% level	−2.567479	

Null Hypothesis: OI has a Unit Root			
		T-Statistic	**Prob.***
Augmented Dickey-Fuller Test Statistic		−7.994113	0.0000
Test critical values:	1% level	−3.433425	
	5% level	−2.862785	
	10% level	−2.567479	

Source: Author's Calculation.

The null hypothesis that futures price series and open interest series are stationary is not rejected at 1%, 5%, and 10% level.

The relation between log returns and open interest for crude oil futures market was investigated using the E-GARCH model. Table 3 presents the estimates of model for crude oil futures and with current open interest. For the mean equation, log returns was taken as the dependent variable, and open interest was the explanatory variable in the conditional variance function.

The results of the E-GARCH (1, 1) model [equation (2)] parameter estimates of crude oil futures returns are presented in Table 3. The findings show that current open interest has a marginal explanatory power for the crude oil futures returns volatility.

Table 3: Results of E-GARCH

Dependent Variable: RET				
Method: ML – ARCH (Marquardt) – Normal distribution				
Included observations: 1999				
Convergence achieved after 20 iterations				
Pre-sample variance: back-cast (parameter = 0.7)				
LOG(GARCH) = C(3) + C(4)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(5)				
*RESID(-1)/@SQRT(GARCH(-1)) + C(6)*LOG(GARCH(-1))				
Variable	**Coefficient**	**Std. Error**	**Z-Statistic**	**Prob.**
OI	9.52E−08	1.93E-08	4.938109	0.0000
C	−0.001973	0.000547	−3.605355	0.0003
	Variance Equation			
C(3)	−0.179177	0.028771	−6.227674	0.0000
C(4)	0.102341	0.013784	7.424701	0.0000
C(5)	−0.070635	0.007710	−9.161793	0.0000
C(6)	0.987551	0.002596	380.3481	0.0000
R-squared	−0.007245	Mean dependent var.		3.23E−05
Adjusted R-squared	−0.007749	S.D. dependent var.		0.018530
S.E. of regression	0.018601	Akaike info criterion		−5.375680
Sum squared resid.	0.690989	Schwarz criterion		−5.358871
Log likelihood	5378.993	Hannan-Quinn criter.		−5.369508
Durbin-Watson stat.	1.988555			

Source: Author's Calculation.

The coexistent relation between open interest and volatility is investigated through the E-GARCH model in which the volatility equation is improved with open interest. As suggested by Bessembinder and Seguin (1993), we divide the open interest into expected and unexpected components. The results indicate that all measures of volatility and open interest are highly autoregressive. The results of the contemporaneous relationship between volatility and open interest indicate that open interest (expected or unexpected) positively affects volatility. This result is consistent with the findings of Bessembinder and Seguin (1993) and Karpoff (1987).

Furthermore, the results of Granger causality tests [equations (4) and (5)] for crude oil futures price and open interest are presented in Table 4. The findings show that the hypothesis that open interest does not Granger-cause futures price cannot be rejected; however, the hypothesis that futures price does not Granger-cause open interest is rejected. Therefore, the findings suggest that Granger causality runs one-way, from open interest to futures price. The findings show that open interest Granger-causes futures prices (returns). Before performing the Granger causality test, Johansen system co-integration test was performed between log returns of daily closing price and open interest. The results show that there is an existence of co-integration between log returns and open interest. The results are shown in Table 4.

Table 4: Co-Integration Test between Returns and Open Interest

Series: RET OI				
Unrestricted Co-integration Rank Test (Trace)				
Hypothesised		Trace	0.05	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
None*	0.178959	445.2344	15.49471	0.0001
At most 1*	0.025767	52.05214	3.841466	0.0000
Unrestricted Co-integration Rank Test (Maximum Eigenvalue)				
Hypothesised		Max-Eigen	0.05	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
None*	0.178959	393.1823	14.26460	0.0001
At most 1*	0.025767	52.05214	3.841466	0.0000

Source: Author's Calculation.

Table 5: Causality between Returns and Open Interest

Lags: 2			
Null Hypothesis:	**Obs.**	**F-Statistic**	**Prob.**
OI does not Granger-cause RET	1997	6.81941	0.0011
RET does not Granger-cause OI		1.42835	0.2400

Source: Author's Calculation.

The dynamic relationship between volatility and open interest is investigated by means of the Granger causality test. The Granger causality test results of the dynamic relationship between volatility and open interest indicate that for crude oil futures, there exists a unidirectional causality between volatility and open interest. The result shows that open interest Granger-causes volatility. In very few cases we find significant lead-lag relationship between open interest and volatility. This is consistent with the results of Schwert (1990) and Gallant et al. (1992).

The Granger causality test results are in conformity with the results of Yang et al. (2004), which shows that returns cause volume and open interest. This indicates that the decisions made by investors are according to price fluctuation. The findings of the study are consistent with Copeland (1976). Findings show market inefficiency for the crude oil futures contracts.

PRACTICAL IMPLICATIONS

Investors emphasise on the information of open interest for various objectives and motives. It had been observed that an increasing or upwards trend is confirmed when open interest increases with increase in price. Moreover, open interest is a crucial parameter in technical analysis. Open interest measures market depth. The observed findings of E-GARCH model conclude in support of the results of Yen and Chen (2010), that is, open interest leads to increase in volatility persistence. An increase in volatility takes place when the market is active.

As far as source(s) of uncertainty (volatility) for crude oil futures returns is concerned, the empirical results show that open interest is significantly related to the volatility of the commodity returns.

This study can be implicated by hedgers, arbitrageurs, and speculators. These findings provide solutions for speculative and hedging activities, which depend on the prediction of price movements. The findings indicate that prediction of futures prices movements can be made by the use of the variables as open interest.

This improvement of short-term futures price predictability should lead to the construction of more accurate hedge ratios and different investment and trading strategies.

LIMITATIONS OF THE STUDY AND SCOPE FOR FURTHER RESEARCH

The study is mainly based on secondary data and is restricted to the crude oil futures data (close-to-close) from 2010 to 2020. The study does not take into consideration the impact of trading volumes on volatility. Another major limitation of the study is that it involves the study of close-to-close prices. This study ignores the unexpected values of open interest. A further limitation of this study is that it has not considered the relation between spot prices and futures prices.

This study can be extended by taking the data of other commodity indices to check whether the results are consistent or not. This study can be extended further to remove the limitations of the present study.

There are a number of potential extensions of this study. These findings can be used by the policy makers for investors to utilise open interest as a proxy of flow of information. New information can be observed in unexpected open interests and trading volumes. Future research can be focused on such unexpected components by the investors. Finally, transaction-level data might be employed to determine whether the above results are robust to the measurement interval.

CONCLUSION

In this paper, first, the focus was to study the GARCH effects in the data and verify how much and how well open interest explains the GARCH effects. The results conclude that the GARCH effects are explained marginally by the current open interest. In other words, volatility persists in the futures prices. In addition, the Granger causality tests are consistent with previous studies, that is, open interest causes futures prices for crude oil futures. Open interest relies on futures price movements that have taken all information regarding speculators and hedges. It is found that any trader or investor can utilise such information and evidence of open interest to forecast futures prices for commodities futures.

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