DOES THE SEQUENTIAL INFORMATION ARRIVAL AND MIXTURE OF DISTRIBUTION HOLD FOR STOCK FUTURES MARKET IN INDIA?

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ABSTRACT

This article examines the relationship between price volatility, trading volume and open interest for Indian stock futures contract traded on the National Stock Exchange for the period from April 1, 2005 to December 31, 2012 by using Unit Root test, GARCH (Generalized Autoregressive Conditional Heteroskedasticity) and AGARCH (Augmented GARCH) were employed to measure the relationship between these variables by using the method developed by Bessembinder & Seguin (1993). This study is not limited to the determination of relationship between volatility and volume but also considers the likely effect that opens interest, as a proxy for market depth on market volatility. This is achieved by partitioning volume and open interest into expected and unexpected components based on one-step ahead forecast errors. The initial analysis centers upon Karpoff (1986) provide three reasons for this. First, the returns or trading volume relation provides insight into the structure of financial markets. Second, the returns or trading volume relation is important for event studies that use a combination of stock returns and trading volume data to draw inferences. Third, the returns or trading volume relation is critical to the debate over the empirical distribution of speculative prices. Finally, we believe in a dynamic context, an important issue should be whether information about trading volume is useful in improving forecasts of price changes and return volatility.

Key words: Stock Prices, Trading Volume, Open Interest, Volatility, GARCH
JEL Classification : C10, C87, G13, G14.

Introduction

Financial media regularly reports daily trading activities to the stock markets. The information content of this data has long attracted the attention of many researchers, policy makers and investors to examine if there is an asymmetric relationship between these variables. However, trading volume offers useful information for practitioners and investors in investment decisions, as well as for researchers and policy makers in testing the theories of financial economics. The contemporaneous relation between price movements, trading volume and open interest on financial markets has long attracted the attention of many financial economists. Our initial analysis centers on the volume and price change relative are positively related to each other and it was first documented by Ying (1966). Similarly, Karpoff (1987) seminal paper summarizes the importance of this research area by presenting the following argument. First, the returns or trading volume relation provides insight into the structure of financial markets. Second, the returns or trading volume relation is important for event studies that use a combination of stock returns and trading volume data to draw inferences. Third, the returns or trading volume relation is critical to the debate over the empirical distribution of speculative prices.

The primary aim of this paper is to empirically examine the relationship between price volatility, trading volume and market depth for select stock futures contracts. The underlying argument for price-volume relationship relies on the rate of information arrival in the financial market. According to this, it is not clear whether the information arrival is sequential or simultaneous. One of the main limitations of the earlier analyses on the stock return and trading volume relationship is that they are all performed on stock markets. Meanwhile, the results from stock index futures markets will be quite interesting for several reasons. First, price movements can only capture the impact of that 'news' on the average change in investor's expectations. Second, trading volume has the specificity of reflecting the cumulative response of investors. Finally, open interest can prove useful towards the end of the major market moves. Many studies reported a contemporaneous correlation between stock returns and trading volume variables, but the casual relationship between these variables in global markets were quite limited and still it remains like muddy water.

Motivation of the Study

The derivative market serves as a counterpart of security market, which has been accepted worldwide. Even the developing countries have realized the importance of derivatives market. Despite the growing importance of derivative market over the past decades in depth study in derivative market are very few which can throw light on various relationship and on its inherent characteristics etc. Though studies are plenty in stock market, very few studies have been done on derivatives at national and international level. Even within the available researchers at the international level also the studies are mostly confined to U.S and Australia, and there is very little evidence of the existing literature in South Asia. Those few studies also do not throw much light on the in depth understanding of the derivative market characteristics as the results of consensus. The impact of derivative market on the spot market in terms of market volatility, price changes etc., also need careful and consorted analysis. The financial sector reforms, impact of technology, liberalization policy of the government, trend of globalization, etc., are the contributors to the development of derivative markets. Derivatives markets have been outstandingly successful due to reduction of funding costs by borrowers, enhancing the yield on assets, modifying the payment structure of assets. However, the policymakers, practitioners and regulators in these markets are concerned about the impact of derivatives market. One of the reasons for this concern is the belief that derivative trading may attract speculators who then destabilize spot prices. In the flipside, the presence of derivative market helps the speculators to take advantage of booking profit by entering in both the markets and their active presence may also bring a destabilizing effect in the stock market. It is believed that the speculators take advantage of earning profit when the volatility of share increases and as the volatility decreases the investors start investing in the stock market to make profit. The above diversified theoretical arguments create phenomenon of stock return and trading volume an important field for study. The structural changes on the capital market more specifically stock market kindled by the financial reforms has brought the derivative market to a comparable global standard. The introduction of derivative market also was another step in furthering the capital market's development at par with developed market. In the present scenario, there is a need for in depth study of derivatives market and its link with the underlying security market and the price discovery process and forecasting the market volatility. The relationship between the settlement prices, trading volume and open interest in stock futures contract still remains the muddy water in the context of changing scenario and the behaviour of market players.

In empirical finance literature, many empirical papers that provide indirect evidence on the relationship between trading volume and stock returns. Granger and Morgenstern (1963) focused on the positive contemporaneous relationship between asset price volatility and trading volume. Clark (1973) put forward the Mixture of Distributions Hypothesis plays a prominent role in the empirical finance arena. As initially suggested by Morgan (1976) volume is regarded as a major risk factor contributing to the volatility of returns, particularly in less liquid and thin markets including emerging markets. In the mixture model of Epps and Epps (1976), trading volume is used to measure disagreement among traders as investors revise their reservation prices based on the arrival of new information to the market. Similarly, positive contemporaneous relationship between variance of price change and trading volume was linked by Rogalski (1978), Figlewski and Cornell (1981) who studied the basic relationship between the variables. Tauchen and Pitts (1983), and Lastrapes and Lamoureux (1990) alleged that the conditional heteroskedasticity in stock returns can be explained by a serially correlated mixing variable that measures the rate at which information is transmitted to the market. This investigation has also been extended to bond and futures markets Clark (1973), Hanna (1978), Grammatikos and Saunders (1986) Andersen (1996) on examining the cross-country spillovers between trading volume and stock returns Lee and Rui (2002). Bohl and Henke (2003), Ahmed et. al (2005), while Luckey (2005) finds mixed evidence for the mixture of distribution hypothesis in the Irish stock market. These authors have shown that the information arrivals stemming from the existence of exogenous variables can be identified by the mixture of distributions, and these variables exhibit time-varying ARCH effect.

An overwhelming number of studies have examined at international level to test the empirical relationship between future return, trading volume and open interest. Bessembinder and Seguin (1992) reported that active futures markets enhance the liquidity and depth of equity markets. In contrast, the results obtained here provide low cost of futures trading attracts additional informed traders, and support for the alternate theory that futures trading leads to price destabilization. Bessembinder and Seguin (1993) investigated the relations between volume, volatility, and market depth in eight physical and financial futures markets and suggested that unexpected volume shocks have a larger effect on volatility, the role of open interest provides information to mitigate volatility and he suggested that the volatility-volume relation in financial markets depends on the type of trader. Ragunathan and Pecker (1997) focused on the relationship between volume and price variability for the Australian futures market and explore positive relationship between volume and volatility by documenting asymmetric volatility response to unexpected shocks in trading volume by using the model developed by Bessembinder and Seguin (1993). Toshiaki Watanabe (2001) examined the relation between price volatility, trading volume and open interest for Nikkei 225 stock index futures and evidenced the relation between price volatility; volume and open interest may vary due to regulatory changes. Whereas, in India the empirical works are quite limited. Pati & Kumar (2006) tested the maturity, volume effects and volatility dynamics for Indian futures market and suggested that time-to-maturity is not a strong determinant for futures price volatility, but rate of information arrival proxies by volume and open interest are the important sources of volatility. Pati and Rajib (2010) examined the contemporaneous and lagged trading volume is related to the current volatility significantly using ARMA-GARCH model. Zwergel and Heiden (2012) observed a positive and contemporaneous relation between volume and volatility in by using MDH and SIA in German market. Finally, they concluded that Samuelson Hypothesis does not provide support for Indian futures market so the investors should not base their investment decision on time-to-maturity. Hence, this paper adds to the growing literature by examining futures markets variables, and makes two contributions. First, the prices changes and trading volume moves together with the market is called Sequential Information Arrival hypothesis (SEQ). Second, the information may be considered as mixing variables are referred as Mixture of Distribution hypothesis (MDH). It is really intricate; to test the non-informational trade by using futures returns data. The basic logic is to use trading activity variable having explanatory power in addition to past returns and price changes. Our study proceeds along the following lines. In the following section deals materials

and methods conducted in this study. Econometric methodological issues concerning to price movements, trading volume and market depth relationship and data used and validity are presented before Concluding Comments.

Materials and Methods

The sample used in this study includes daily closing prices, trading volume and open interest for selected 25 stock futures contracts traded on the National Stock Exchange (NSE) with a vast experience in the equity derivatives. The turnover of derivatives on the NSE increased from 24 billion in 2000–2001 to 313,497 billion in 2011–2012, maintaining a continuous upward trend. India is one of the most successful developing countries in terms of a vibrant market for exchange-traded derivatives. This reiterates the strengths of the modern development in India's securities markets, which are based on nationwide market access, anonymous electronic trading, and a predominantly retail market. There is an increasing sense that the equity derivatives market plays a major role in shaping price discovery. The NSE remained the global leader in the category of stock index options in number of contracts traded as per the Futures Industry Association (FIA) Annual Volume Survey. The NSE also figured among the top 5 stock exchanges globally in different categories of ranking in the derivatives market. The study uses return series of the contracts from 1st April 2005 to 31st December 2012. For each security, three types of contracts are usually traded simultaneously. The first is the expiring contract that is in the delivery month. The second is the nearby contract that has the next nearest delivery dates. The third kind is the more distant contracts. Price changes from all three kinds of contract are highly correlated. Since most trading activities take place in the near-month contract, only near-month contract are examined. As a result, this controls the maturity effect on future prices. Due to monthly maturity effect in futures market will rolls or switching over to the next closest five days prior to maturity. An adjusted return was calculated as $R_t = \log (P_t/P_{t-1})$ where P_t and P_{t-1} are natural logarithms of adjusted return on day t and t-1 respectively. The logarithm of the price relative is used to calculate the price change. The use of logarithmic price changes prevents non-stationarity of the price level of the data from affecting future price variability. As for the trading volume and open interest, the study applies logarithmic procedure on other variables to account for the non – stationarity in the series.

Econometric Methodology

Unit Root Test

The study first test the stationarity of the time series for price changes, trading volume and open interest. Engle and Granger (1982) have shown that many time series variables are non-stationary or order of integration in differences. Since most of time series have unit roots as many studies indicated including, Nelson and Plosser (1982), and as proved by Stock and Watson (1988) that most of the time series are non-stationary, conventional regression techniques based on non-stationary time series produce spurious regression, Granger and Newbold (1974). The Augmented Dickey Fuller (ADF) test and Phillips-Perron (PP) test are employed to infer the stationarity of the series.

Generalized Autoregressive Conditional Heteroskedasticity (GARCH) Model

The Engle (1982) autoregressive conditional heteroskedasticity (ARCH) model was the most extensively used time-series models in the finance literature. The ARCH model suggests that the variance of residuals at time *t* depends on the squared error terms from past periods Engle (1982). The residual term ε_{it} is conditionally normally distributed and serially uncorrelated. The strength of the ARCH techniques is that by using established and well specified models for economic variables, the conditional mean and conditional variance are the two main specifications. A useful generalization of this model is the GARCH parameterization introduced by Bollerslev (1986) extended Engle's ARCH model to the GARCH model and it is based on the assumption that forecasts of time varying variance depend on the lagged variance of the asset. The GARCH model specification is found to be more appropriate than the standard statistical models because it is consistent with return distribution, which is leptokurtic and it allows long-run memory in the variance of the conditional return distributions. As a result, the unexpected increase or decrease in returns at time t will generate an increase in the expected variability in the next period. The GARCH (1,1) model works well in most applied situations Najand and Yung (1991) and Bollerslev (1992). The basic and most widespread model GARCH (1,1) can be expressed as;

$$R_t = a + bR_{t-1} + \varepsilon_t \quad \varepsilon_t \mid I_{t-1} \; N(0, h_t),$$

$$h_{it} = \alpha_0 + \sum_{i=1}^{p} \beta_i h_{t-1} + \sum_{j=1}^{q} \lambda_j u_{t-j}^2$$

Where, R_t denotes the realized return, h_{it} is the conditional variance, which is proxies by R_{t-1}, α, β and λ are the coefficients to be estimated. The sizes of the parameters β and λ measure the short-run dynamics of the resulting volatility time series. The λ scaling parameter h_t now depends both on past values of the shocks, which captured by the lagged squared residual terms, and on past values of itself, which are captured by lagged h_t terms. The β parameter refers to the last periods forecast variance, the larger coefficients value of GARCH term characterize the shocks to conditional variance take a long time to die out. The GARCH is weekly stationery $\Sigma\beta_i + \Sigma\lambda_j < 1$, the latter two quantifying the persistence of shocks to volatility Nelson (1992).

Augmented GARCH Model

To capture the types of persistence in conditional variance can be picked up by estimating a GARCH model. The Augmented GARCH model was developed by Duan (1997) nests most of the popular univariate parameterization and allows us to add explanatory variables in the GARCH specification of the conditional variance equation. Engle (1982) and Bollerslev (1986)

emphasized the inclusion of exogenous variables in the conditional variance. Volume and open interest series are included to evaluate their incremental significance in return prediction. The Augmented GARCH model may be expressed as;

$$R_t = a + bR_{t-1} + \varepsilon_t \quad \varepsilon_t \mid I_{t-1} \; N(0, h_t),$$
$$h_{it} = \alpha_0 + \sum_{i=1}^{p} \beta_i h_{t-1} + \sum_{j=1}^{q} \lambda_j u_{t-j}^2 + \sum_{k=1}^{m} \psi_k X_k$$

Where, R_t is the realized return, h_{it} is the conditional variance, λ is the lag of squared residuals from the mean equation and provides news about volatility clustering, β is the last period's forecast variance and ψ is a set of explanatory variables that might help to explain the variance of the equation.

Expected Components of Trading Volume and Open Interest

The trading activity and open interest variables are introduce in the conditional variance equation to investigate their effects on volatility. Specifically, to evaluate their incremental significance in return prediction on volume, volume prediction on return, return prediction on open interest and open interest prediction on return for volatility estimation are given below by utilizing Augmented GARCH model in the following equation;

Return Prediction on Trading Volume:

$$R_t = a + bR_{t-1} + \varepsilon_t$$
$$h_{it} = \alpha_0 + \sum_{i=1}^{p} \beta_i h_{t-1} + \sum_{j=1}^{q} \lambda_j u_{t-j}^2 + \sum_{k=1}^{m} \psi_k V_k$$

Returns Prediction on Open Interest:

$$R_t = a + bR_{t-1} + \varepsilon_t$$
$$h_{it} = \alpha_0 + \sum_{i=1}^{p} \beta_i h_{t-1} + \sum_{j=1}^{q} \lambda_j u_{t-j}^2 + \sum_{k=1}^{m} \psi_k O_k$$

Where, R_k, V_k and O_k represent the future returns, trading volume and open interest for the stock index futures. Engle (1982) and Bollerslev (1986) emphasized inclusion of exogenous variables in the conditional variance will facilitate to explain the incremental significance in the equation.

Unexpected Components of Trading Volume and Open Interest

Initially, the univariate Box-Jenkins methods are employed to partition trading volume and open interest series into expected and unexpected components Bessembinder and Seguin (1993). Partitioning the series into expected and unexpected components separates out information shocks that might otherwise enter the market. An ARIMA model was estimated for trading volume and open interest series to decompose futures trading volume into forecastable (expected) and unexpected components. The uncorrelated residuals of the conditional mean equation are the unexpected innovations of trading volume and open interest, which are then squared and included in the Augmented GARCH conditional variance specification. Bessembinder and Seguin (1992) provide evidence consistent with the reasoning that expected and unexpected trading volume conveys different information to market participants. The unexpected trading activity and unexpected open interest variables are introduce in the conditional variance equation to investigate their effects on volatility. Specifically, to evaluate their incremental significance in return prediction on unexpected trading volume, unexpected trading volume prediction on return, return prediction on unexpected open interest and unexpected open interest prediction on return for volatility estimation are given below by utilizing Augmented GARCH model in the following equation;

Return Prediction on Unexpected Trading Volume:

$$R_t = a + bR_{t-1} + \varepsilon_t$$
$$h_{it} = \alpha_0 + \sum_{i=1}^{p} \beta_i h_{t-1} + \sum_{j=1}^{q} \lambda_j u_{t-j}^2 + \sum_{k=1}^{m} \psi_k UV_k$$

Returns Prediction on Unexpected Open Interest:

$$R_t = a + bR_{t-1} + \varepsilon_t$$
$$h_{it} = \alpha_0 + \sum_{i=1}^{p} \beta_i h_{t-1} + \sum_{j=1}^{q} \lambda_j u_{t-j}^2 + \sum_{k=1}^{m} \psi_k UO_k$$

Where, UV_k and UO_k are the trading volume and open interest for the stock index futures. Engle (1982) and Bollerslev (1986) emphasized inclusion of exogenous variables in the conditional variance will facilitate to explain the incremental significance in the equation.

Results and Discussion

To set the stage for the distributional properties of price volatility, trading volume and open interest, the order of integration of the variables was initially determined and presented in Table 1. One of the main concerns of the time series data is to check,

whether the series is stationary of nature. So we conducted Augmented Dickey Fuller (ADF) test and Phillip-Perron test of the time series, whether the multivariate series contain unit root. The results allow us to reject the null hypothesis that price volatility, trading volume and open interest have unit root in favour of alternative hypothesis of stationary even at 1 per cent level at Mac Kinnon critical value.

Table: 1 Unit Root Test

Sl. No:	Company	Returns		Volume		Open Interest	
		ADF	PP	ADF	PP	ADF	PP
1	ACC	-14.58	-566.12	-12.12	-12.12	-11.37	-11.37
2	BEL	-17.21	-388.46	-14.61	-14.61	-12.32	-12.32
3	BHEL	-12.98	-451.41	-12.23	-12.23	-12.39	-12.39
4	BPCL	-12.38	-265.56	-12.07	-12.07	-13.28	-13.28
5	CIPLA	-12.99	-474.17	-14.06	-14.06	-10.84	-10.84
6	Dr. REDDY	-14.05	-479.75	-13.99	-13.99	-11.27	-11.27
7	GRASIM	-12.34	-409.73	-12.51	-12.51	-11.27	-11.27
8	HCLTECH	-13.36	-462.60	-13.13	-13.13	-12.13	-12.13
9	HDFC	-14.26	-416.94	-14.13	-14.13	-12.33	-12.33
10	HEROHONDA	-14.26	-393.36	-12.83	-12.83	-12.91	-12.91
11	HINDPETRO	-12.41	-316.56	-11.03	-11.03	-12.98	-12.98
12	ICICIBANK	-13.53	-272.35	-14.25	-14.25	-11.48	-11.48
13	INFOSYSTCH	-12.98	-445.29	-13.48	-13.48	-12.09	-12.09
14	ITC	-12.67	-1034.70	-12.99	-12.99	-10.02	-10.02
15	M & M	-12.55	-544.70	-15.14	-15.14	-12.54	-12.54
16	MTNL	-12.43	-554.11	-9.90	-9.90	-11.83	-11.83
17	NATIONALUM	-13.29	-352.55	-11.46	-11.46	-11.87	-11.87
18	ONGC	-12.54	-417.23	-9.44	-9.44	-11.29	-11.29
19	POLARIS	-12.89	-341.83	-11.11	-11.11	-14.61	-14.61
20	RANBAXY	-14.33	-443.28	-10.99	-10.99	-10.19	-10.19
21	RELIANCE	-12.93	-399.25	-13.15	-13.15	-12.87	-12.87
22	SBIN	-12.79	-313.23	-11.93	-11.93	-12.87	-12.87
23	TATAPOWER	-13.06	-499.38	-11.05	-11.05	-12.00	-12.00
24	TATATEA	-14.03	-429.07	-12.67	-12.67	-11.01	-11.01
25	WIPRO	-13.90	-500.37	-13.95	-13.95	-13.49	-13.49

Note: The significant value at 1 per cent level for Augmented Dickey Fuller test Phillips-Perron test is – 2.5665.

An autoregressive model of AR (p) was estimated for each of the stationary series and an ARIMA model was estimated for trading volume and open interest series to obtain residuals as a dependent variable in Table 2. Partitioning the series into expected and unexpected components separates out information shocks that might otherwise enter the market. Trading volume and open interest are used to explain the lag length required to produce uncorrelated residuals for stock index futures without over fitting the model. The residuals from ARIMA model are then used as the unexpected components. The Ljung Box Q-Statistics for unstandardized residual, over 6 and 12 lags do not reject the null hypothesis of no autocorrelation at any standard level for the unexpected components of trading volume and open interest in each period for stock index futures.

Table: 2 Autoregressive Model for Trading Volume and Open Interest

Sl. No:	Company Name	Futures Volume			Futures Open Interest		
		AR (p)	LB (6)	LB (12)	AR (p)	LB (6)	LB (12)
1	ACC	2	7.12	12.73	4	7.81	25.63
2	BEL	3	17.53	19.61	4	6.68	24.24
3	BHEL	2	11.82	15.80	4	6.24	21.68
4	BPCL	4	11.50	20.38	4	5.69	21.00
5	CIPLA	3	16.62	18.66	6	5.43	19.13
6	Dr. REDDY	3	8.22	12.14	4	6.51	21.00
7	GRASIM	5	11.78	13.59	5	6.17	19.83
8	HCLTECH	6	10.92	13.08	6	4.49	15.89
9	HDFC	2	5.28	5.52	2	0.64	1.47
10	HEROHONDA	4	8.95	14.30	4	4.11	15.55
11	HINDPETRO	4	16.62	21.29	4	6.43	23.63
12	ICICIBANK	3	9.12	12.40	4	6.60	19.02
13	INFOSYSTCH	2	5.63	8.99	3	8.67	20.80
14	ITC	2	14.93	20.38	2	12.34	25.76
15	M & M	2	10.51	16.34	5	7.50	25.39
16	MTNL	3	14.74	16.42	4	6.95	17.60
17	NATIONALUM	3	16.95	20.58	4	6.18	17.80

18	ONGC	6	19.64	22.82	3	9.62	15.13
19	POLARIS	2	5.39	17.22	5	5.25	22.24
20	RANBAXY	2	12.09	22.31	5	6.98	23.97
21	RELIANCE	2	9.38	15.43	4	9.77	31.26
22	SBIN	2	12.56	20.06	5	5.68	19.38
23	TATAPOWER	2	14.35	18.65	4	5.87	18.82
24	TATATEA	2	8.15	12.90	4	8.16	27.00
25	WIPRO	2	9.47	12.35	5	4.93	17.08

Note: LB (6) & LB (12) refers Ljung- Box Portmanteau statistic for uncorrelated residuals, over 6 and 12 lags, respectively

The parameter estimates of the GARCH (1,1) model with the inclusion of expected and unexpected volume in the conditional variance are revealed in Table: 3. In the following models, an iterative procedure is used based upon the method of Bernd-Hall-Hall Hausman algorithm to maximize the log-likelihood function. Panel A shows the results for expected trading variable and Panel B shows the corresponding results for unexpected trading variables. The log likelihood function statistics are large, which indicates that the AGARCH formulation is an appropriate presentation of daily stock future behaviour that captures the temporal dependence of return volatility. The F-statistics is significant at 1 per cent for all the stock index futures.

In Panel A, the AGARCH model allows us to add expected trading activity variable in the specification of the conditional variance equation. The expected trading activity variables are statistically significant at 1 per cent level. The coefficients of β_2 indicates that shocks to conditional variance take long time to die out for BPCL, GRASIM and M & M and identified with statistically significant at 1 per cent level except Dr. REDDY and RANBAXY at 5 per cent level. Alternatively, large error coefficients α_1 mean that volatility reacts quite intensely to market movements for BHEL, Dr. REDDY and WIPRO. Finally, the sum of $\alpha_1 + \beta_1$ should be less than one, but for BHEL, Dr. REDDY, HCLTECH and WIPRO it envisaged with greater than one. In Panel B, the coefficients of β_2 identifies with significant at one per cent level for all the stock futures except Dr. REDDY and the volatility shocks to conditional variance take a long time to die out in ACC and BPCL. In α_1, the coefficients parameter estimates was higher for WIPRO at 1 per cent level BHEL, HCLTECH, MTNL, RELIANCE, TATATEA and WIPRO have estimated greater than one. Moreover, the unexpected trading activity variable observed with statistically significant at 1 per cent level for all the stock futures but Dr. REDDY identified with negatively significant value of 7.700. So we can conclude the unexpected trading volume has a greater impact on Dr. REDDY.

Table: 3 GARCH (1,1) Model prediction for Returns on Trading Volume

Panel A: Futures Returns on Expected Trading Volume

Sl. No:	Company	Coefficients						F - Statistic	Log Likelihood
		Ø	R_{t-1}	α_0	α_1	β_2	ψ_3		
1	ACC	-0.000(-0.30)	-0.468(-16.86)*	4.92E-0 (5.77)*	0.153(7.92)*	0.792(31.54)*	0.000(8.10)*	56.27	2769.54
2	BEL	-0.001(-1.96)	-0.423(-15.12)*	0.000(7.59)*	0.260(11.06)*	0.556(14.06)*	0.000(21.96)*	71.83	2711.35
3	BHEL	1.77E-0(0.03)	-0.289(-9.88)*	0.000(7.99)*	1.043(18.20)*	0.292(10.32)*	0.000(7.15)*	48.99	2653.47
4	BPCL	-0.000(-0.63)	-0.503(-19.69)*	2.6E-0(3.65)*	0.114(9.27)*	0.860(55.99)*	0.000(8.44)*	68.67	2709.33
5	CIPLA	0.000(0.20)	-0.371(-7.94)*	0.002(12.46)*	0.075(3.48)*	0.272(4.86)*	-0.001(45.44)*	73.22	1853.45
6	Dr. REDDY	0.003(7.10)*	-0.424(-16.45)*	0.000(16.09)*	1.658(14.58)*	0.028(2.04)#	1.24E-0(0.99)	74.69	2530.77
7	GRASIM	-0.000(-0.66)	-0.479(-16.93)*	3.10E-0(4.86)*	0.160(8.26)*	0.802(36.61)*	0.000(11.73)*	72.08	2875.11
8	HCLTECH	0.003(2.61)*	-0.592(-11.33)*	0.000(70.85)*	0.643(13.79)*	0.430(12.92)*	0.000(13.10)*	81.22	2367.65
9	HDFC	-0.000(-0.80)	-0.467(-16.94)*	8.25E-0(5.07)*	0.226(10.25)*	0.675(21.15)*	0.000(7.40)*	55.17	2804.91
10	HEROHONDA	-0.000(-1.28)	-0.470(-17.68)*	7.07E-0(5.20)*	0.216(7.59)*	0.693(19.71)*	0.000(10.87)*	55.96	2853.02
11	HINDPETRO	0.000(0.62)	-0.530(-17.43)*	-0.000(-4.63)*	0.244(8.44)*	0.670(18.24)*	5.86E-0(5.45)*	72.05	2675.97
12	ICICIBANK	-0.001(-1.40)	-0.414(-15.14)*	0.000(6.69)*	0.198(7.06)*	0.427(6.33)*	0.000(19.48)*	54.56	2738.47
13	INFOSYSTCH	-0.001(-0.21)	-0.465(-6.01)*	0.003(3.04)*	0.092(1.74)	0.587(4.60)*	0.001(30.29)*	82.69	1665.96
14	ITC	-0.009(-0.59)	-0.322(-2.71)*	0.004(3.58)*	0.049(2.24)#	0.719(10.59)*	0.004(36.65)*	63.42	1247.55
15	M & M	-0.004(-1.90)	-0.543(-11.38)*	0.000(23.95)*	0.059(3.46)*	0.822(92.23)*	0.000(5.70)*	59.88	2333.10
16	MTNL	-0.000(-0.33)	-0.418(-16.83)*	6.30E-0(3.97)*	0.177(10.53)*	0.758(26.17)*	0.000(96.80)*	52.08	2612.71
17	NATIONALUM	-0.000(-0.19)	-0.481(-17.90)*	4.82E-0(5.98)*	0.186(11.47)*	0.784(51.79)*	0.000(6.83)*	71.63	2536.30
18	ONGC	-0.005(-3.71)*	-0.469(-13.53)*	0.000(22.22)*	0.060(4.50)*	0.600(85.17)*	0.000(2.35) #	56.12	2516.20
19	POLARIS	-0.000(-0.56)	-0.429(-17.90)*	0.000(6.57)*	0.313(11.25)*	0.581(15.13)*	0.000(13.13)*	72.15	2331.50
20	RANBAXY	-0.000(-0.65)	-0.450(-13.57)*	0.000(3.62)*	0.068(3.15)*	0.406(2.48)#	0.000(12.01)*	78.40	2535.05
21	RELIANCE	-7.26E-0(0.14)	-0.516(-16.03)*	7.30E-0(5.90)*	0.316(19.51)*	0.608(21.18)*	9.50E-0(5.68)*	87.31	2914.26
22	SBIN	0.000(0.39)	-0.483(-17.87)*	9.48E-0(4.19)*	0.200(8.51)*	0.691(15.98)*	0.000(5.58)*	57.90	2750.44
23	TATAPOWER	-0.000(-0.47)	-0.442(-15.09)*	6.28E-0(5.84)*	0.232(11.01)*	0.722(34.20)*	8.67E-0(3.91)*	38.14	2667.29
24	TATATEA	-0.000(-0.83)	-0.459(-17.40)*	7.90E-0(6.30)*	0.327(8.53)*	0.594(14.13)*	0.000(12.74)*	45.37	2887.12
25	WIPRO	-0.001(-1.52)	-0.335(-7.70)*	0.000(24.96)*	1.340(21.78)*	0.040(1.95)	-0.000(17.77)*	79.59	2175.91

Note: Figures in the parenthesis report z-Statistics. * & # significance at the 0.01 & 0.05 per cent level respectively.

Panel B: Futures Returns on Unexpected Trading Volume

Sl. No:	Company	Coefficients						F - Statistic	Log Likelihood
		Ø	R_{t-1}	α_0	α_1	β_2	ψ_3		
1	ACC	-8.6E-0(-0.14)	-0.464(-16.86)*	4.110(5.27)*	0.135(7.88)*	0.819(35.61)*	0.000(8.73)*	56.38	2770.33
2	BEL	-0.000(-1.15)	-0.423(-15.05)*	0.000(7.20)*	0.251(10.19)*	0.555(12.78)*	0.000(13.25)*	71.78	2710.03
3	BHEL	-0.001(-1.28)	-0.202(-3.58)*	0.000(5.98)*	0.707(9.05)*	0.438(7.66)*	0.000(29.96)*	37.57	2489.53
4	BPCL	0.000(0.27)	-0.505(-18.94)*	2.96E-0(4.08)*	0.131(8.05)*	0.840(46.11)*	0.000(10.37)*	68.52	2714.78
5	CIPLA	0.000(0.30)	-0.288(-7.60)*	0.003(33.70)*	0.132(2.69)*	-0.102(-3.29)*	-0.001(-38.3)*	62.45	1862.35
6	Dr. REDDY	0.001(1.72)	-0.442(-10.68)*	0.000(11.84)*	0.409(5.24)*	0.059(0.85)	-7.700(-9.84)*	78.54	2528.06
7	GRASIM	5.83E-0(0.10)	-0.474(-16.46)*	5.110(11.07)*	0.175(12.96)*	0.755(241.76)*	0.000(7.72)*	72.01	2871.38
8	HCLTECH	0.000(0.39)	-0.520(-17.16)*	0.000(9.36)*	0.766(35.31)*	0.330(11.59)*	0.000(12.91)*	86.45	2513.70
9	HDFC	-0.000(-0.78)	-0.467(-16.92)*	8.46E-0(5.28)*	0.233(10.37)*	0.666(21.48)*	0.000(7.62)*	55.18	2808.04
10	HEROHONDA	-0.000(-0.84)	-0.46(-17.44)*	8.640(12.01)*	0.193(10.25)*	0.675(184.64)*	0.000(7.50)*	56.29	2856.93
11	HINDPETRO	0.000(0.21)	-0.529(-18.29)*	9.79E-0(5.77)*	0.222(8.76)*	0.682(19.36)*	0.000(9.97)*	72.03	2688.74
12	ICICIBANK	-0.000(-1.20)	-0.419(-15.22)*	0.000(7.14)*	0.164(6.38)*	0.397(5.45)*	0.000(21.13)*	54.63	2725.73
13	INFOSYSTCH	-0.001(-0.19)	-0.488(-8.61)*	0.003(3.28)*	0.064(2.26)#	0.578(4.90)*	0.001(30.38)*	83.22	1695.83
14	ITC	-0.008(-0.49)	-0.339(-2.50)#	0.007(3.99)*	0.071(1.74)	0.533(5.48)*	0.004(49.27)*	66.17	1232.23
15	M & M	-0.004(-2.73)*	-0.506(-9.98)*	0.000(6.18)*	0.121(5.69)*	0.741(21.95)*	0.000(17.08)*	60.54	2377.93
16	MTNL	0.000(1.02)	-0.423(-20.04)*	5.11E-0(3.72)*	0.172(10.48)*	0.781(31.15)*	0.000(15.40)*	51.84	2620.21
17	NATIONALUM	-0.001(-1.14)	-0.465(-15.55)*	0.000(11.50)*	0.202(6.21)*	0.435(9.18)*	0.000(7.61)*	71.31	2462.09
18	ONGC	-0.001(-1.19)	-0.460(-13.46)*	0.000(3.95)*	0.082(3.67)*	0.471(3.49)*	0.000(4.43)*	65.00	2548.83
19	POLARIS	-0.000(-0.33)	-0.419(-17.09)*	0.000(6.22)*	0.309(11.47)*	0.604(16.90)*	0.000(15.83)*	71.74	2334.18
20	RANBAXY	-0.000(-0.52)	-0.441(-13.08)*	0.000(3.86)*	0.070(3.24)*	0.410(2.69)*	0.000(11.53)*	78.11	2534.41
21	RELIANCE	-7.890(-0.15)	-0.515(-15.99)*	7.09E-0(6.03)*	0.314(19.12)*	0.614(21.99)*	9.48E-0(5.17)*	87.32	2914.08
22	SBIN	0.000(0.40)	-0.483(-17.96)*	9.55E-0(4.13)*	0.199(8.48)*	0.691(15.72)*	0.000(5.61)*	57.91	2750.46
23	TATAPOWER	-0.000(-0.31)	-0.441(-15.07)*	6.15E-0(5.88)*	0.230(11.24)*	0.725(35.40)*	8.79E-0(4.07)*	38.21	2667.82
24	TATATEA	-0.000(-0.33)	-0.457(-17.44)*	8.45E-0(6.90)*	0.346(8.35)*	0.573(13.31)*	0.000(14.09)*	45.50	2884.38
25	WIPRO	-0.005(-4.39)*	-0.221(-15.22)*	0.002(38.60)*	1.289(18.39)*	-0.052(-4.60)*	-0.001(-31.7)*	53.66	2037.03

Note: Figures in the parenthesis report z-Statistics. * & # significance at the 0.01 & 0.05 per cent level respectively.

Table: 4 presents the results of selected parameters for estimating return prediction on expected open interest and return prediction on unexpected open interest are envisaged in Panel A and Panel B. First, the log likelihood statistics are very large. This implies that the AGARCH model is an attractive representation of daily return behaviour that successfully captures the temporal dependence of return volatility. Second, the F-statistics are significant at 1 per cent level for all the stock index futures in Panel A and Panel B.

In Panel A the estimated coefficients for α1 are statistically significant for all the futures contracts at 1 per cent level, except INFOSYSIS and ITC at 5 per cent level. The coefficients of β_2 envisaged with 1 per cent level of significance for all the stock index futures contracts, except WIPRO with insignificant effect. The expected open interests are statistically significant at 1 per cent level for BHEL, CIPLA, Dr. REDDY, HCLTECH, INFOSYSTCH, ITC, ONGC, POLARIS, RANBAXY, RELIANCE, TATATEA and WIPRO. The average value of $\alpha_1 + \beta_2$ should be less than one except in the case of BHEL, HCLTECH and WIPRO. This indicates a greater persistence of shocks to volatility. In Panel B, the coefficients estimates for α_1 and β_2 are statistically significant at 1 per cent level for all the stock index future contracts. On one hand, the value of α_1 analyzed with 5 per cent level INFOSYSTCH, ITC. On the other, the β_2 for Dr. REDDY revealed with 5 per cent level of significant. The coefficient results of unexpected open interest observed with 1 per cent level for BHEL, CIPLA, Dr. REDDY, HCLTECH, INFOSYSTCH, ITC, M & M, ONGC, POLARIS, RANBAXY, RELIANCE, TATATEA and WIPRO but for other stock futures envisaged with insignificant effect. A high value of $\alpha_1 + \beta_2$ therefore implies a long memory and shock will lead to a permanent changes in all future values for BHEL, HCLTECH, M & M, NATIONALUM, TATAPOWER and WIPRO. Hence, shock to the conditional variance is 'persistent'.

Table: 4 GARCH (1,1) Model predictions for Return on Open Interest

Panel A: Futures Returns on Expected Open Interest

Sl. No:	Company	Coefficients						F - Statistic	Log Likelihood
		Ø	R_{t-1}	α_0	α_1	β_2	ψ_3		
1	ACC	0.000(0.26)	-0.464(-16.82)*	6.03E-0(6.53)*	0.189(8.26)*	0.752(28.63)*	-0.000(-1.55)	56.36	2757.92
2	BEL	-6.210(-0.08)	-0.428(-14.75)*	0.000(7.08)*	0.286(9.27)*	0.499(9.66)*	-1.18E-0(-0.22)	72.44	2685.84
3	BHEL	0.000(1.40)	-0.269(-8.93)*	0.000(18.15)*	0.924(16.98)*	0.155(6.55)*	0.000(7.07)*	46.68	2621.31
4	BPCL	0.000(0.23)	-0.498(-19.23)*	3.05E-0(4.26)*	0.103(8.52)*	0.867(63.53)*	-3.62E-0(-0.77)	68.82	2683.77
5	CIPLA	-0.000(-0.17)	-0.299(-27.03)*	0.003(15.65)*	0.119(3.12)*	-0.23(-2.92)*	0.001(11.12)*	64.23	1915.95
6	Dr. REDDY	0.000(0.57)	-0.488(-11.36)*	0.000(8.68)*	0.249(6.21)*	0.283(3.81)*	-0.00(-52.45)*	80.47	2579.38
7	GRASIM	5.33E-0(0.09)	-0.475(-16.69)*	4.10E-0(5.53)*	0.190(8.49)*	0.767(33.45)*	4.64E-0(1.18)	72.12	2849.92
8	HCLTECH	0.000(1.46)	-0.540(-17.97)*	0.000(10.75)*	0.798(34.71)*	0.310(11.29)*	0.000(3.33)*	86.39	2502.31
9	HDFC	0.000(0.22)	-0.462(-16.54)*	8.38E-0(5.25)*	0.232(10.30)*	0.675(22.10)*	5.86E-0(1.46)	55.36	2791.34
10	HEROHONDA	-0.000(-0.20)	-0.477(-16.93)*	8.01E-0(6.02)*	0.231(7.08)*	0.674(19.38)*	4.78E-0(0.13)	55.90	2833.01
11	HINDPETRO	0.000(0.30)	-0.517(-18.25)*	7.10E-0(5.18)*	0.205(8.99)*	0.736(25.22)*	3.92E-0(0.84)	72.61	2665.07
12	ICICIBANK	4.38E-0(0.06)	-0.427(-14.95)*	9.81E-0(5.27)*	0.221(8.27)*	0.675(19.19)*	4.96E-0(0.97)	54.89	2740.82
13	INFOSYSTCH	-0.000(-0.10)	-0.496(-9.38)*	0.002(2.87)*	0.068(2.26)#	0.506(3.07)*	0.002(29.94)*	83.47	1853.71
14	ITC	-0.001(-0.14)	0.020(0.11)	0.004(4.18)*	0.129(2.19)#	0.527(4.82)*	0.003(27.12)*	72.83	1466.61
15	M & M	0.000(0.49)	-0.521(-9.25)*	0.000(28.45)*	0.216(16.79)*	0.616(50.62)*	0.000(17.48)*	64.79	2402.42
16	MTNL	0.000(0.94)	-0.429(-16.17)*	8.70E-0(5.12)*	0.213(10.17)*	0.720(23.81)*	9.15E-0(1.44)	51.89	2586.22
17	NATIONALUM	0.000(0.37)	-0.480(-17.41)*	6.60E-0(5.76)*	0.210(10.79)*	0.756(38.26)*	3.44E-0(0.43)	71.61	2511.14
18	ONGC	-9.450(-0.11)	-0.447(-15.95)*	0.000(6.14)*	0.165(5.80)*	0.540(7.51)*	0.000(14.76)*	66.09	2642.41
19	POLARIS	0.000(0.26)	-0.446(-17.79)*	0.000(7.31)*	0.352(11.40)*	0.521(12.64)*	0.000(6.79)*	72.72	2298.09
20	RANBAXY	-0.000(-0.62)	-0.462(-16.52)*	0.000(7.64)*	0.033(4.82)*	0.414(4.86)*	-0.001(-39.1)*	78.72	2605.70
21	RELIANCE	0.000(0.28)	-0.521(-16.14)*	8.91E-0(6.43)*	0.301(14.80)*	0.594(18.92)*	-0.000(-3.44)*	87.26	2907.78
22	SBIN	0.000(0.48)	-0.492(-17.93)*	9.95E-0(4.45)*	0.204(8.18)*	0.686(15.88)*	-6.99E-0(-0.80)	57.58	2740.42
23	TATAPOWER	0.000(0.18)	-0.443(-14.95)*	6.42E-0(5.74)*	0.242(10.17)*	0.715(30.80)*	-2.69E-0(-0.42)	38.11	2662.24
24	TATATEA	0.000(0.68)	-0.468(-16.23)*	0.000(7.12)*	0.323(7.81)*	0.551(11.34)*	8.61E-0(6.93)*	44.96	2857.18
25	WIPRO	-0.004(3.60)*	-0.153(-4.68)*	0.001(37.61)*	1.661(20.71)*	-0.014(-1.36)	-0.001(-44.9)*	38.99	2169.61

Note: Figures in the parenthesis report z-Statistics. * & # significance at the 0.01 & 0.05 per cent level respectively.

Panel B: Futures Returns prediction on Unexpected Open Interest

Sl. No:	Company	Coefficients						F - Statistic	Log Likelihood
		Ø	R_{t-1}	α_0	α_1	β_2	ψ_3		
1	ACC	9.730(0.16)	-0.464(-16.78)*	6.32E-0(6.83)*	0.193(8.27)*	0.745(28.10)*	-5.92E-0(-1.05)	56.26	2751.06
2	BEL	-7.740(-0.11)	-0.425(-14.61)*	0.000(7.06)*	0.286(9.24)*	0.496(9.48)*	-1.42E-0(-0.02)	71.89	2679.98
3	BHEL	0.000(1.05)	-0.323(-11.09)*	0.000(7.52)*	0.781(18.87)*	0.377(13.67)*	9.87E-0(3.46 *	51.80	2642.66
4	BPCL	0.000(0.19)	-0.499(-19.27)*	3.03E-0(4.22)*	0.103(8.57)*	0.867(63.61)*	-1.52E-0(-0.39)	68.70	2677.91
5	CIPLA	0.008(1.26)	-0.425(-8.17)*	0.002(27.68)*	0.052(3.26)*	0.585(31.48)*	0.002(34.69)*	72.47	1692.76
6	Dr. REDDY	0.000(0.84)	-0.483(-11.25)*	0.000(9.31)*	0.300(5.72)*	0.193(2.44)#	-0.000(50.30)*	80.22	2572.89
7	GRASIM	7.93E-0(0.14)	-0.475(-16.69)*	4.12E-0(5.53)*	0.191(8.53)*	0.765(33.42)*	3.37E-0(1.08)	71.96	2840.37
8	HCLTECH	0.000(1.43)	-0.534(-17.76)*	0.000(10.35)*	0.789(35.56)*	0.316(11.35)*	0.000(4.00)*	86.07	2498.68
9	HDFC	0.000(0.24)	-0.462(-16.54)*	8.35E-0(5.23)*	0.232(10.30)*	0.674(22.11)*	5.94E-0(1.57)	55.36	2791.44
10	HEROHONDA	-6.060(-0.10)	-0.477(-16.95)*	7.78E-0(6.01)*	0.219(7.02)*	0.685(19.95)*	-4.72E-0(-1.24)	55.88	2830.19
11	HINDPETRO	0.000(0.31)	-0.518(-18.18)*	7.31E-0(5.14)*	0.208(8.94)*	0.732(24.37)*	4.55E-0(1.02)	72.46	2658.61
12	ICICIBANK	3.13E-0(0.04)	-0.427(-14.95)*	9.65E-0(5.27)*	0.221(8.32)*	0.677(19.55)*	6.84E-0(1.47)	54.83	2735.77
13	INFOSYSTCH	-0.005(-3.1)*	-0.489(-9.37)*	0.002(3.13)*	0.067(2.49)#	0.504(3.37)*	0.002(13.58)*	80.98	1855.98
14	ITC	-0.005(-0.43)	-0.341(-3.65)*	0.006(17.48)*	0.056(2.45)#	0.449(51.61)*	0.003(16.98)*	68.11	1430.64
15	M & M	0.001(1.04)	-0.494(-10.01)*	0.000(5.62)*	0.224(7.61)*	0.740(19.69)*	0.000(33.30)*	65.23	2429.86
16	MTNL	0.000(0.93)	-0.429(-16.16)*	8.83E-0(5.18)*	0.215(10.19)*	0.717(23.64)*	8.80E-0(1.56)	51.91	2582.67
17	NATIONALUM	0.000(0.43)	-0.479(-17.41)*	6.38E-0(5.61)*	0.207(10.81)*	0.761(39.08)*	6.92E-0(1.22)	71.54	2506.40
18	ONGC	-6.060(-0.07)	-0.446(-15.93)*	0.000(6.49)*	0.173(5.76)*	0.515(7.07)*	0.000(15.31)*	65.99	2640.52
19	POLARIS	0.000(0.36)	-0.443(-17.69)*	0.000(7.50)*	0.355(11.75)*	0.517(13.02)*	0.000(6.91)*	72.47	2295.51
20	RANBAXY	8.280(0.10)	-0.447(-14.22)*	0.000(22.00)*	0.141(5.31)*	0.354(10.91)*	-0.001(-79.9)*	78.26	2723.80
21	RELIANCE	0.000(0.33)	-0.522(-16.13)*	8.94E-0(6.45)*	0.310(15.46)*	0.587(18.80)*	-0.000(-2.75)*	87.13	2901.58
22	SBIN	0.000(0.50)	-0.492(-17.75)*	9.90E-0(4.48)*	0.202(8.12)*	0.688(16.11)*	-6.76E-0(-1.01)	57.45	2732.22
23	TATAPOWER	9.390(0.15)	-0.439(-14.78)*	6.28E-0(5.70)*	0.242(10.24)*	0.717(31.14)*	8.13E-0(0.16)	38.13	2658.22
24	TATATEA	0.000(0.70)	-0.466(-16.18)*	0.000(7.31)*	0.328(7.83)*	0.546(11.30)*	8.14E-0(4.97)*	44.94	2848.84
25	WIPRO	-0.012(-7.4)*	-0.218(-10.05)*	0.002(17.20)*	1.372(13.83)*	0.051(-61.3)*	-0.000(-6.23)*	42.35	2044.13

Note: Figures in the parenthesis report z-Statistics. * & # significance at the 0.01 & 0.05 per cent level respectively.

Concluding Comments

The uncertain nature and the relationship between price movements, trading volume and open interest for select stock future contracts are examine over the period from April 1, 2005 to December 31, 2012. The univariate Box-Jenkins methods are employed to partition trading volume and open interest series into expected and unexpected components based on one-step ahead forecast errors. The uncorrelated residuals of conditional mean equation are the unexpected innovations of trading volume and open interest, which are then squared and included in the Augmented GARCH conditional variance specification. The primary findings of the study show significant positive relationship between return volatility, expected trading volume and expected open interest and vice versa. Furthermore, it was found that the return volatility is influencing both expected and unexpected trading volume and open interest respectively. Specifically, the stock futures market in India was more likely to be influenced by lagged volatility, which is consistence with the conclusion of other papers. It was also found that unexpected volume and open interest are more likely to have a greater impact on volatility than the expected trading volume and open interest. Therefore, it can be concluded that market depth does not have any effect on volatility. Our result would be interesting for the researchers, policy makers and market participants. The study suggested that the fluctuations in future return are mainly due to macroeconomic variables and influence in global factors, which will mainly determine the future price movements. But, there is no link between the individual variables like open interest and volatility, whereas trading volume was the variable having meager impact on open interest and volatility. Two of the market participants interested in the results are hedgers and speculators. Hedgers enters the futures market to offset the risk of substantial loss in the future, while speculators take positions based on their expectation of the movements of that contract. Since, open interest does not hold in the Indian futures market, the investors should not base their investment decision according to open interest. Finally, trading volume is an important variable and influencing the futures returns, open interest and volatility in futures markets.

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