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Econometric Modelling: Testing of Randomness,Volatility, Casualty and Cointegration of Emerging Stock Market Indices of India and MIST Countries

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Abstract; In general, stock market indices are widely interrelated to the other global markets to detect the impact of diversification opportunities. The present research paper empirically examines randomness and long term equilibrium affiliation amongst the emerging stock market of India and Mexico, Indonesia, South Korea and Turkey from the monthly time series data during February 2008 to October 2019. The researcher employs by the way, Run test, Pearson's correlation test, Johnsen's multivariate cointegration test, VECM and Granger causality test with reference to post-September 2008 Global financial crisis. The test results of the above finds that Nifty 50 and BSE Sensex is significantly cointegrated either among themselves or with MIST countries particularly during the post-September Global financial crisis. No random walk is found during the study period. The ADF (Augmented Dickey-Fuller) and PP (Phillips Pearson) tests evidenced stationarity at the level, but converted into non-stationarity in first difference. Symmetric and asymmetric volatility behaviors are studied using GARCH, EGARCH and TARCH models in order to test which model has the best forecasting ability. Leverage effect was apparent during the study period. So the influx of bad news has a bigger shock or blow on the conditional variance than the influx of good news. The residual diagnostic test (Correlogram-Squared residuals test, ARCH LM test and Jarque-Bera test) confirms GARCH (1,1) as the best suited model for estimating volatility andforecasting stock market index.

Key terms: equilibrium, leverage effects, volatility clustering, asymmetric effect, cointegration, causality, random walk, persistence

1. INTRODUCTION

Mexico, Indonesia, South Korea and Turkey are coined as MIST acronym. They are gaining massive attention among the investment community at the present time because they have a bit more upside potential in terms of favorable demographics and rising productivity, sound fiscal policies, sustainable balance of payments and a contributing financial sector however the total GDP is less than $\frac{1}{3}$ of the BRICS .i.e., \$3.9 trillion, compared with \$14 trillion. So the engine of MIST economies is currently sputtering. MXX are some of the next notable emerging markets in the MIST countries.

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They rise up the global economic ladder and become a much more attractive destination for foreign investors, breaking a new record in the capital market after global financial crisis September 2008.
Over the global MIST stock market are becoming integrated and conform to the international standards.Cramming the bondage of Indian stock market and other global stockmarkets, especiallyMIST county stock markets are a vital one, because it will provide considerable motivation for the Indian investors to look for the new investment opening across the globe for diversifying their portfolio for getting higher returns. For understating of the volatility estimation and forecasting, GARCH, EGARCH and TARCH models are employed to estimate time-varying correlation and leverage effects.In addition, the evidence of cointegration and causality will enable to estimate long term parameters or equilibrium with unit root variables and to check the direction of causality. Hence it is necessitatestudying the rapport between MIST country's emerging stock markets and Indian stock markets to understand the mechanism of comovement, causality, randomness and volatility.

II. THEORETICAL FRAMEWORK OF THE STUDY

A number of studies reviewed the previous literature to know how the proposed research is related to prior research and identify new ways to interpret prior research. It permits us to detect volatility and comovement amongstock markets wherever cointegration occurs and when if the stock market rise with big swings in either direction.
Arshanapalli, Doukas and Lang (1995) investigated a feasible associationof the US and six most emerging Asian stock markets during pre and post period of October 1987. The Asian equity markets were not as much of integrated with the Japanese stock market at that time they were with the US market. Hassan and Naka (1996) also ensuredwell ahead the comovement of the stock market indices of US, Japan, UK and German inshortrun and long run.Masih and Masih (2001) devoted and attention to study the underlying causal relationships of international stock markets using VAR and Vector Error Correction models (VECM). In their subsequentresearch work (Masih and Masih, 2002), they examineand review the degree of globalization using the similarmethod. Naeem (2002) employed the Johansen methodology fortesting non stationary time series and examiningthe correlated or similar movement of daily equity prices among Pakistan,

India and Sri Lanka positioned in South Asia. He failed to proof of the long-run relationship during the study period of 1994-1999.

Darrat and Benkato (2003) studied symmetric and asymmetric volatilitybehaviorof the emerging stock markets of the US, the UK, Japan and Germany and ISE (Istanbul stock Exchange).The two matured markets of the US and the UK under their studyaccepted substantial commitmentto the solidity and financial health of not bigger emerging markets like theISE.

The study of Mukherjee and Mishra (2005) exposed the notion of integration of the Indian stock market with the evolving Asian markets of Indonesia, Malaysia, Philippines, Korea and Thailand. Yet, Bose and Mukherjee (2006) might perhaps not find out the cointegration of the Indian stock market and estimates of all cointegrating vectors with time series data of Japan, Hong Kong, Malaysia, South Korea, Singapore, Taiwan and Thailand and the USA. Although they used the Johansen cointegration test for the Asian group of countries, including India and excluding India. When India was included in the data set, cointegration equation vector (1) was found but then again India was excluded, no cointegration was found. It evidences distinctive role of Indian stock in the integration of Asian markets.

Li (2007) investigated the associations of two developing stock exchanges in mainland China along with the established markets in Hong Kong and in the US. The results of a multivariate GARCH approachconfirm no sign of a progressive relationship between the stock markets in mainland China and the US market, then againmake certain the indication of uni-directional volatility spillovers from the stock markets in Hong Kong to those in Shanghai and Shenzhen.Thus,overseas investors of the Chinese market will benefit from the reduction of diversifiablerisk. More of late, the study of Cerny and Koblas (2008)gavea detail report of stock market cointegration whose linear combination is stationary and the speed of information transmission. They matched Polish, Hungarian, and Czech stock market indices with those from developed markets.

EGARCH and TGARCH modelswere applied by Elasayeda (2011) to prove the presence of asymmetric volatility pattern and the leverage effect for the Egyptian stock market index. The existence of the leverage effect for daily EGX30 indexreturns was finding it. Oskoose and Shamsavari (2011) assessed the magnitude of asymmetric volatility effects on the Iranian stock market. They employed nonlinear autoregressive conditional heteroskedasticity test based on standardized residuals from a fitted GARCH model. No asymmetric effects were found in the dynamic volatility of the Iranian stock market.

Gupta and Guidi (2012) valued the time-varying conditional associationamong the stock markets of India, Hong Kong, Japan and Singapore. No strong long-runrelationship was found from the study.Darrat, Li and Wu (2012) investigated the weekly, monthly and quarterly risk-return relationship during the period of 1973 to 2011. Three different generalized autoregressive conditional heteroskedasticity (GARCH) models were employed besides a plain vanilla time-series approach. The results failed to support a significantly specifications. Emenike and Aleke(2012) examine daily closing prices of the Nigerian stock exchanges (NSE) with the intention to knowing the response of volatility to negative and positive news. Asymmetric effects were explored in the NSE stock returns, but with an absence of leverage effect.As per our literature related to past research cointegration test is acknowledged as an acceptable and suitable method for analysing comovement. Symmetric and asymmetric model like GARCH, EGARCH and TARCH are considered as the best method for finding stock market volatility. In addition to this unit root test and run test are often used for finding random walk. Therefore, the present study is also interesting to test randomness with run test, volatility with ARCH family models and cointegration with Johansen Cointegration analysis, normalized cointegrating coefficient, VECM model and Pair-wise Granger Causality Tests in addition to Karl Pearson’s correlation analysis

III. DATA AND METHODOLOGY

BSE Sensex, Nifty 50, IPC MEXICO (^**MXX**), Jakarta Composite Index (^JKSE) Indonesia (**JCI**), KOSPI 200 Index (^KS200) South Korea–(KOSPI**2)** and BIST 30 (XU030) Turkey (**BIST 30**)- are the emerging stock exchange of India and MIST countries whose data set has been collected from Yahoo finance for in-depth study. The period of the study is from September 2008 to October 2019. The following econometric and statistic tools are used for analyzing data.

Table 1: Econometric and Statistic tools are used in the present study

Sl. No	Tools for analysis	Description
1.	Skewness $\widehat{S}\,(x)$	$\widehat{S}\ (x) = \frac{1}{(T-1)\hat{\sigma}x^3}\sum_{t=1}^{T}(xt - \hat{\mu}x)^3$ (1) Where $x_1, x_2, \ldots x_T$ is a random sample of X with T observations $\hat{\mu}x$ is the mean and $\hat{\sigma}x$ is the standard deviation. Data sets with low value have heavy tails whereas Data sets with high value have light tails
2.	Kurtosis $\widehat{K}\ (x)$	$\widehat{K}\ (x) = \frac{1}{(T-1)\hat{\sigma}x^4}\sum_{t=1}^{T}(xt - \hat{\mu}x)^4$ (2)

3.	Jarque-Bara Test	JB= $\frac{\hat{S}^2(r)}{6/T} + \frac{[\hat{K}(r)-3]^2}{24/T}$ (3) H_0 accepted if p-value> 0.05(Data set is normally distributed)
4.	GARCH(1,1)	$\sigma_t^2 = \alpha_0 + \alpha_1\epsilon_{t-1}^2 + \beta_1\sigma_{t-1}^2$ (4) where $\alpha_0 > 0, \alpha_i \geq 0, \beta_j \geq 0. \alpha_i = ARCH\ parameters, \beta_j = GARCH\ parameters$
5	EGARCH(1,1)	$\log\sigma_t^2 = a + \sum_{i=1}^{p}\sigma_i\, g(Z_{t-i}) + \sum_{j=1}^{q}\beta_j log\sigma^2{}_{t-j}$ (5) where α,β… are parameters
6	TARCH (1,1)	$\sigma_t^2 = \alpha_0 + (\alpha_1+\gamma_1 N_{t-1})\alpha_{t-1}^2 + \beta_1\sigma_{t-1}^2$ (6)
7	Unit Root Test	$\Delta y_t = \alpha + \pi + \delta y_{t-1} + \sum_{i=1}^{m}\beta_i\, \Delta y_{t-1} + \epsilon_t$ (7) It is applied to examine the stationarity
8.	Pearson's Correlation Coefficient test	$\frac{n(\sum(xy)-(\sum x)(\sum y)}{\sqrt{(n\sum x^2-\sum(x)^2)-(n\sum y^2-\sum(y)^2)}}$ (8) It is employed to find the significant linear relationship
9.	Johnsen's Cointegration test	Trace test statistics : $\lambda_{trace}(r) = -T\sum_{i=r+1}^{n} 1n(1-\lambda_1)$ (9) Max.Eigen test statistics: $\lambda_{max}(r,r+1) = -T\sum_{i=r+1}^{n} 1n(1-\lambda_{r+1})$ (10)
10.	Granger causality test	$y_t = \alpha_0 + \sum_{i=1}^{m} a_i\, y_{t-1} + + \sum_{j=1}^{n}\beta_i\, x_{t-1} + \epsilon_t$ (11) $x_t = \omega_0 + \sum_{i=1}^{m} y_i\, y_{t-1} + + \sum_{j=1}^{n}\theta_j\, x_{t-1} + \epsilon_t$ (12) It is used to observe the direction of causality and short term relationship

All the test was conducted using SPSS 13 version and Eviews 10.0 statistical softwares.

IV. RESULTS AND DISCUSSION

4.1. Descriptive statistics and Testing Normality of Observations

The descriptive statistics narrate the characteristics of the data as the summary of descriptive statistics of monthly market indices, of emerging stock markets of India and MIST country which is presented in Table 2.

Skewness and kurtosis measures offer understandings about the fundamental statistical distribution of stock market indices. The negative skewness explains that the distribution of MIST country's stock market indices has a long left tail (mean < median < mode) and its distribution is negatively skewed to the normal distribution. At this point a negative skewness highlights the risk of left tail events (Black swan events). The positive skewness of BSE Sensex and Nifty 50 indices describes the tail on the right side of the distribution is longer and fatter. Generally positive skewness with positive mean isgood.

The kurtosis of more than 3 in MXX and KOPSI2 stock market specifies that the distribution is peaked (leptokurtic) comparative to kurtosis 3. But distributions of remaining stock markets with kurtosis less than 3 are said to beplatykurtic.

The Jarque-Bera statistic is used to check the goodness of fit of whether monthly stock indices have the skewness and kurtosis matching normaldistribution.

Hypothesis: 1

Null hypothesis H0: The monthly data are normally distributed

Alternative hypothesis H1: The monthly data are not normally distributed

Table 2: Summary of Descriptive statistics of Indian stock markets and MIST countries' markets

	Indian stock markets		MIST country's markets			
	NIFTY_50	BSE_SEN...	MXX	JCI	KOSPI2	BIST_30
Mean	7139.578	23603.96	39612.80	4381.820	251.7474	89494.44
Median	6276.950	21120.12	41640.27	4592.872	255.7200	91600.76
Maximum	11922.80	39714.20	51210.48	6605.631	333.5700	146553.9
Minimum	2755.100	8891.610	17752.18	1241.504	138.0700	30691.34
Std. Dev.	2423.849	7940.551	7728.878	1408.085	38.23300	26915.29
Skewness	0.326957	0.347775	-0.903200	-0.471323	-0.630384	-0.132903
Kurtosis	2.030547	2.142111	3.162951	2.360396	4.111762	2.505939
Jarque-Bera	8.033732	7.166107	19.32659	7.623841	16.60011	1.849148
Probability	0.018009	0.027791	0.000064	0.022106	0.000249	0.396700
Sum	1006680.	3328158.	5585404.	617836.6	35496.39	12618716
Sum Sq. Dev.	8.23E+08	8.83E+09	8.36E+09	2.78E+08	204646.8	1.01E+11
Observations	141	141	141	141	141	141

The probability value of the computed Jarque-Bera is less than 0.05 ($p < 0.05$) in all stock markets except BIST 30. It implies that the distributed population of the market indices is not normally distributed. The stock indices diverge significantly from the normal distribution in each stock market. It opens a phenomenal chance and openings for investors to benefit from abnormal returns.

4.2. Run Test forRandomness

The Random Walk Theory or the Random Walk Hypothesis assumes that the prices of securities listed in the stock market evolve according to a random walk and the movement in the price of one security is independent of the movement in the price of another security. These assumptions are tested and verified with monthly time series data of nifty 50, the BSE Sensex and MIST country's stock market by Run test named after Abraham Wald and variance ratio test.

4.2.1. Run test with the Median as a Base for finding random walkbehaviour

Once normality checked, run test of randomness is applied to know whether the stock market indices are behaving randomly, or if there is any pattern. Run test assumes that the mean and variance are constant or same over a period of time and the probability is not dependent.

Hypothesis: 2

H_0: The market indices are formed in a random fashion (i.e. H_0: market indices follow the Random Walk)

H_1: The market indices are not formed in a random fashion (i.e.H_1: The market indices do not follow the Random Walk)

The Runs Test results from the SPSS statistical analysis, which has taken the Median as a base for finding random walkbehaviour are tabulated in Table 3.

Table 3: result of run test for randomness check

	Indian stock markets		MIST countries' markets			
	NIFTY50	BSESENSEX	MXX	JCI	KOSPI2	MIST30
Test Value[a]	6276.95	21120.12	41640.27	4592.87	255.72	91600.76
Cases < Test Value	70	70	70	70	70	70
Cases >= Test Value	71	71	71	71	71	71
Total Cases	141	141	141	141	141	141
Number of Runs	6	6	10	6	20	12
Z	-11.072	-11.072	-10.396	-11.072	-8.705	-10.058
Asymp. Sig. (2-tailed)	.000	.000	.000	.000	.000	.000

a. Median

Since the p-values of run test are less than 5 per cent for all indices, an alternative hypothesis is accepted. So that the sequence of the market index data formed in a non-random fashion and there is a relationship between successive prices in a sequence. In short the past movement or trend of these stock markets can be used to predict its future movement and the day-to-day market index is dependent on each other

4.4 Volatility modelling

4.4.1 Time Series Graph

The random walk theorist crafts a paradox by defining risk as volatility. The presence of volatility (time-varying variance) in the Indian stock market indices (Nifty50 index and BSE Sensex) and emerging MIST country's stock market indies time series data are first checked by plotting time series graphs, which is presented in the Figure 1 and 2.

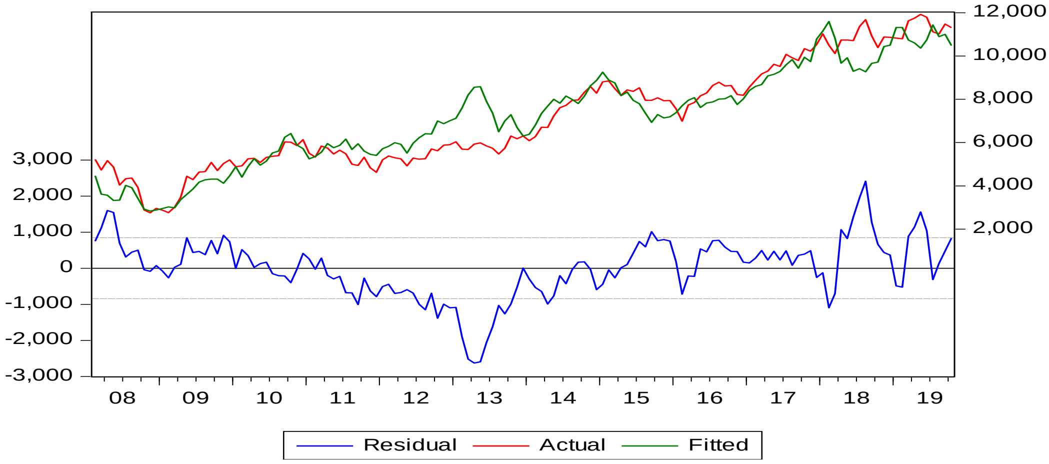


Figure 1: Time series graph for Nifty 50

The Figure 1and 2 represents that time series of stock market indices are highly volatile and wide range of swings for some months and calm in others. It is showing an unequal variance of residual. Months of low volatility are followed by months of low volatility for a prolonged period. Months of high volatility are followed by months of high volatility for a prolonged period. In short, higher impulsiveness or unpredictability corresponds to a higher probability of a declining market, while lower impulsiveness or unpredictability corresponds to a higher probability of a rising market. Equity Investors can make use of the monthly index for long term stock market volatility to line up their portfolio with associated expected returns.

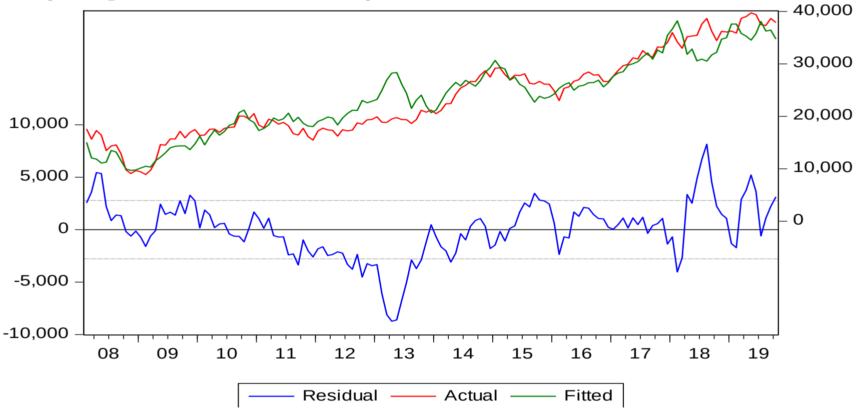


Figure 2:Time series graph for BSE Sensex

As a result, the ARCH family model is employed so that further investigate the symmetric and asymmetric unpredictable behaviour of the targeted stock market and also to determine effectiveness of each model. The Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model, EGARCH and TARCH models are run after testing the presence of ARCHeffect.

4.4.2. Testing for Autoregressive Conditional Heteroscedasticity (ARCH) effects using Heteroscedasticity: Arch test

Arch effect is concerned with a relationship within the heteroskedasticity (Engle 1982). As the first step of checking the symmetric and asymmetric volatility behaviour of the targeted stock market, Arch test is used to analyse the error term or effects left unexplained by econometric models and to check the relationship in residuals. In short the present study is interested in analysing the volatility of monthly index of Nifty 50, BSE Sensex and MIST country. The null hypothesis of this model is that ARCH effect is not present. It assumes that the variance of the error term will be uniform orhomoskedasticity.

Hypothesis: 3

H_0: No ARCH effect is present in the residual series

H_1: ARCH effect is present in the residual series

The results of Heteroskedasticity-Arch test are accessible in Table 4. F-Statistics from the Eviews results is significantly high (273.7203 and 259.2569) when Nifty 50 and BSE Sensex is assumed as dependent. Probability-chi-square is also equal to 0.000. (Prob- chi-square ≤ 0.05). It is suggested the rejection of the null hypothesis. Hence, no ARCH effect is existed in Indian stock market indices and emerging MIST country's stock market Indices time series data. Conditional variance is also time-varying. In this circumstance the variance is not uniform or heteroskedasticity. Heteroskedasticity is present in this monthly time series data because the size of the error term differs across values of independent variables. Since there is ARCH effect, both symmetric and asymmetric models are proceeding to model the change in variance over time in a monthly time series data of Nifty 50, BSE Sensex and MIST country's stock market that is time dependent such as increasing or decreasingvolatility.

Table 4: Results ofHeteroskedasticity: ARCH test

Heteroskedasticity Test: ARCH

F-statistic	273.7203	Prob. F(1,138)	0.0000
Obs*R-squared	93.07495	Prob. Chi-Square(1)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 10/12/19 Time: 00:05
Sample (adjusted): 2008M03 2019M10
Included observations: 140 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	127625.3	69703.64	1.830970	0.0693
RESID^2(-1)	0.815338	0.049282	16.54450	0.0000

R-squared	0.664821	Mean dependent var	686882.5
Adjusted R-squared	0.662392	S.D. dependent var	1241344.
S.E. of regression	721270.8	Akaike info criterion	29.82960
Sum squared resid	7.18E+13	Schwarz criterion	29.87162
Log likelihood	-2086.072	Hannan-Quinn criter.	29.84668
F-statistic	273.7203	Durbin-Watson stat	1.566471
Prob(F-statistic)	0.000000		

Heteroskedasticity Test: ARCH

F-statistic	259.2569	Prob. F(1,138)	0.0000
Obs*R-squared	91.36648	Prob. Chi-Square(1)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 10/12/19 Time: 01:28
Sample (adjusted): 2008M03 2019M10
Included observations: 140 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1449939.	777143.0	1.865730	0.0642
RESID^2(-1)	0.807922	0.050177	16.10146	0.0000

R-squared	0.652618	Mean dependent var	7448192.
Adjusted R-squared	0.650100	S.D. dependent var	13642687
S.E. of regression	8069964.	Akaike info criterion	34.65938
Sum squared resid	8.99E+15	Schwarz criterion	34.70140
Log likelihood	-2424.157	Hannan-Quinn criter.	34.67646
F-statistic	259.2569	Durbin-Watson stat	1.479280
Prob(F-statistic)	0.000000		

4.3.3. Symmetric volatility of Nifty 50, BSE Sensex and MIST country's stock markets (GARCH (1,1))

ARCH family modelsare explicitly designed to model and estimate conditional variance. It helps to examine methodologically and in detail the risk of holding the shares listed in the stock market of Nifty 50, BSE Sensex and MIST country. Here the variance of the dependent or outcome variable is modelled as a function of past values of dependent or outcome variables and independent or predictor variables. In this study monthly time series data of Nifty 50, BSE Sensex is taken as the dependent variable. The Eviews results of the variance equation are reported in the Table. The variance of the error terms is predicted by forminga constant (a weighted average of a long term average), the GARCH term (the forecasted variance from the last month), and the ARCH term (information about volatility observed in the previous month)in GARCH (1,1) model(Bollerslev 1986).

Hypothesis: 4

H_0: ARCH or GARCH errors do not find in conditional variance

H_1: ARCH or GARCH errors exist in conditional variance

The Eviews result of GARCH (1,1) estimation is reported in Table 5. The upper part of GARCH estimation provides mean equation and lower part provides variance equation. ARCH parameters (α) correspond to RESID(-1)^2 and GARCH parameters(β) correspond to GARCH(-1).

(i). C (a constant part) represents kind of an ambient volatility.
(ii). α represents the adjustment of past shocks.
(iii). β represents the adjustment of past volatility

Table 5: Results of GARCH model

Dependent Variable: NIFTY 50
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Sample: 2008M02 2019M10
Included observations: 141
Failure to improve likelihood (non-zero gradients) after 83 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
GARCH = C(6) + C(7)*RESID(-1)^2 + C(8)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	2137.363	186.4501	11.46346	0.0000
MXX	-0.016858	0.000297	-56.70351	0.0000
JCI	1.131793	0.055603	20.35475	0.0000
KOSPI2	-14.25443	1.148861	-12.40744	0.0000
BIST 30	0.050092	0.003376	14.83960	0.0000
Variance Equation				
C	48610.18	21585.01	2.252034	0.0243
RESID(-1)^2	1.468367	0.351714	4.174888	0.0000
GARCH(-1)	-0.063420	0.032976	-1.923241	0.0544

R-squared	0.871400	Mean dependent var	7139.578
Adjusted R-squared	0.867618	S.D. dependent var	2423.849
S.E. of regression	881.9027	Akaike info criterion	15.69743
Sum squared resid	1.06E+08	Schwarz criterion	15.86473
Log likelihood	-1098.669	Hannan-Quinn criter.	15.76541
Durbin-Watson stat	0.238594		

Dependent Variable: BSE SENSEX
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Sample: 2008M02 2019M10
Included observations: 141
Convergence achieved after 47 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
GARCH = C(6) + C(7)*RESID(-1)^2 + C(8)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	7829.363	770.0080	10.16790	0.0000
MXX	-0.202399	0.036475	-5.549029	0.0000
JCI	4.393776	0.326465	13.45866	0.0000
KOSPI2	-26.63349	6.427581	-4.143626	0.0000
BIST 30	0.129563	0.020019	6.471886	0.0000
Variance Equation				
C	507823.1	299048.8	1.698128	0.0895
RESID(-1)^2	0.729545	0.341012	2.139351	0.0324
GARCH(-1)	0.247910	0.213139	1.163139	0.2448

R-squared	0.876935	Mean dependent var	23603.96
Adjusted R-squared	0.873315	S.D. dependent var	7940.551
S.E. of regression	2826.264	Akaike info criterion	18.09891
Sum squared resid	1.09E+09	Schwarz criterion	18.26621
Log likelihood	-1267.973	Hannan-Quinn criter.	18.16690
Durbin-Watson stat	0.233547		

Positive RESID(-1)^2 coefficient(α) in table 4 reveals success to improve likelihood after 83 iterations. The convergence problem is not experienced. It also seems a very strong GARCH effect in residuals.

The first two coefficients c (constant), α (ARCH term) except β (GARCH term) for the GARCH (1,1) model are statistically significant and divulge the expected sign (α>0) for both Indian market and MIST countries' stock market. The significance of α indicates the lagged conditional variance has an impact on the conditional variance, whereas the insignificance of β indicates the lagged conditional variance have no impact on the conditional variance. Hence news about volatility from the previous months has an explanatory power of current volatility.

The sum of persistence coefficient α+β for Nifty 50 (1.468367+ (-0.063420) =1.404947) is larger than 1 (α+β>1) suggesting that the conditional variance is explosive. However, for BSE Sensex The sum of persistence coefficient α+β (0.729545+ 0.247910=0.977455) is close to 1 (α+β<1) signifying volatility shocks are quite persistent but not explosive.

The normal range lies between alpha and beta are 0.05 to 0.1 and 0.85 to 0.98 respectively. But GARCH volatilities with relatively high α (1.468367,0.729545) and relatively low β (-0.063420, 0.247910) of stock markets nifty 50, BSE Sensex and MIST country are more 'spiky'. It produces GARCH volatilities with high volatility of volatility and the volatility can jump around more.

4.3.4. Asymmetric volatility modelling and the leverage effect on Nifty 50, BSE Sensex and MIST country's stock markets

4.3.4.1. Exponential GARCH (EGARCH (1, 1)) asymmetric model:

The univariate EGARCH asymmetric model (1,1) is employed to capture the Asymmetric Behaviour of the volatility of Nifty 50, BSE Sensex and MIST country's stock markets. It benefits from no parameter restrictions.

There are four parameters in the conditional variance equations toEGARCH asymmetric model (1,1).

1. C(6): Constant. It indicates the last period (t-1) volatility.
2. C(7): Impact of a magnitude of a shock(size effect) or ARCH effect or spill over effect. It indicates the impact of long term volatility or explains the volatility clustering.
3. C(8): the impact sign(sing effect) of shock (if C4 is negative, then leverage effect (bad news has more impact than a good news about the same size))
4. C(9): GARCH effect: persistence of past volatility (past volatility explains thecurrent volatility)

The following hypothesis are formulated for EGARCH asymmetric model (1,1) model

Hypothesis for α: 5

H_0: spill over effect is not found.

H_1: There is a spill over effect is found

Hypothesis for γ: 6

H_0: the negative has less impact than the positive shocks on the volatility of the selected stock market when γ is negative

H_1: the negative has more impact than the positive shocks on the volatility of the selected stock market when γ is negative.

Hypothesis for β: 7

H_0: There is no existence of volatility persistence

H_1: There is no existence of volatility persistence

Table 6: Results of EGARCH asymmetric model (1,1)

Dependent Variable: BSE SENSEX
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Sample: 2008M02 2019M10
Included observations: 141
Convergence achieved after 57 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(6) + C(7)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(8)*RESID(-1)/@SQRT(GARCH(-1)) + C(9)*LOG(GARCH(-1))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	6732.435	963.7770	6.985469	0.0000
MXX	-0.159717	0.036709	-4.350948	0.0000
JCI	4.054942	0.320607	12.64771	0.0000
KOSPI2	-29.73411	6.829248	-4.353936	0.0000
BIST 30	0.145055	0.018756	7.733816	0.0000
Variance Equation				
C(6)	3.018198	1.695312	1.780320	0.0750
C(7)	1.143400	0.400833	2.852557	0.0043
C(8)	-0.033989	0.176504	-0.192570	0.8473
C(9)	0.737741	0.123246	5.985913	0.0000

R-squared	0.877849	Mean dependent var	23603.96
Adjusted R-squared	0.874257	S.D. dependent var	7940.551
S.E. of regression	2815.742	Akaike info criterion	18.13020
Sum squared resid	1.08E+09	Schwarz criterion	18.31842
Log likelihood	-1269.179	Hannan-Quinn criter.	18.20669
Durbin-Watson stat	0.239472		

Dependent Variable: NIFTY 50
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Sample: 2008M02 2019M10
Included observations: 141
Convergence achieved after 48 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(6) + C(7)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(8)*RESID(-1)/@SQRT(GARCH(-1)) + C(9)*LOG(GARCH(-1))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	2102.131	307.3872	6.838707	0.0000
MXX	-0.017687	0.011724	-1.508568	0.1314
JCI	1.136400	0.093528	12.15034	0.0000
KOSPI2	-13.70264	2.461286	-5.567269	0.0000
BIST 30	0.048622	0.005386	9.028135	0.0000
Variance Equation				
C(6)	2.142884	1.700701	1.260000	0.2077
C(7)	1.340760	0.367407	3.649246	0.0003
C(8)	-0.075328	0.183386	-0.410763	0.6812
C(9)	0.741634	0.137777	5.382861	0.0000

R-squared	0.874188	Mean dependent var	7139.578
Adjusted R-squared	0.870488	S.D. dependent var	2423.849
S.E. of regression	872.2900	Akaike info criterion	15.71717
Sum squared resid	1.03E+08	Schwarz criterion	15.90539
Log likelihood	-1099.060	Hannan-Quinn criter.	15.79365
Durbin-Watson stat	0.238051		

The parameter values of the asymmetric EGARCH (1,1) model are testifying in Table 6. C7(Alpha α) are positiveand find it significant shows there is a positive relation between the past variance and the current variance in absolute value. It means the spill over is positive. It implies that increase volatility in the country makes other country's volatility not reduced but increased.

C8 (Gamaγ) is negative and significant specifies theexistence of an asymmetric effect or leverage effect. Thisinfers negative shock has a greater influence or effect on volatility rather than the positive shocks of the same magnitude. Bad news will increase or risein volatility in excess of good news of the same size does.

C9 (Beta β) is significant indicates volatility persistence. β are all positive and relatively large (0.737741, 0.741634). After September 2008 global financial crisis, volatility takes long time to collapse or die out. It also takes long time for investors to recover their confidence in themarket.

4.3.4.2. The Threshold ARCH (TARCH (1, 1))asymmetric model:

TARCH (1, 1) model is used to know the influence of positive and negative innovations on the volatility. The null hypothesis (γ_t> 0)checks the manifestation of leverage effect.

Hypothesis:8

H_0: (γ_t> 0), Bad news increase volatility.

H_1: ($\gamma_t \neq$ 0), news impact is asymmetric.

Table 7: Results of TARCH model

Dependent Variable: NIFTY 50
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Sample: 2008M02 2019M10
Included observations: 141
Convergence achieved after 55 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
GARCH = C(6) + C(7)*RESID(-1)^2 + C(8)*RESID(-1)^2*(RESID(-1)<0) + C(9)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	2181.002	304.7677	7.156277	0.0000
MXX	-0.008321	0.010170	-0.818115	0.4133
JCI	1.077842	0.085990	12.53448	0.0000
KOSPI2	-15.68137	1.989255	-7.883039	0.0000
BIST 30	0.052366	0.004762	10.99738	0.0000
Variance Equation				
C	57815.53	25545.66	2.263223	0.0236
RESID(-1)^2	0.903894	0.420708	2.148505	0.0317
RESID(-1)^2*(RESID(-1)<0)	0.361167	0.533013	0.677596	0.4980
GARCH(-1)	0.004002	0.081807	0.048919	0.9610

R-squared	0.870563	Mean dependent var	7139.578
Adjusted R-squared	0.866756	S.D. dependent var	2423.849
S.E. of regression	884.7689	Akaike info criterion	15.71882
Sum squared resid	1.06E+08	Schwarz criterion	15.90704
Log likelihood	-1099.177	Hannan-Quinn criter.	15.79530
Durbin-Watson stat	0.243252		

Dependent Variable: BSE SENSEX
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Sample: 2008M02 2019M10
Included observations: 141
Convergence achieved after 46 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
GARCH = C(6) + C(7)*RESID(-1)^2 + C(8)*RESID(-1)^2*(RESID(-1)<0) + C(9)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	7848.638	774.1062	10.13897	0.0000
MXX	-0.204185	0.035942	-5.680998	0.0000
JCI	4.394503	0.325905	13.48400	0.0000
KOSPI2	-26.64328	6.436430	-4.139449	0.0000
BIST 30	0.130034	0.019964	6.513335	0.0000
Variance Equation				
C	503241.8	315035.2	1.597415	0.1102
RESID(-1)^2	0.682831	0.372189	1.834638	0.0666
RESID(-1)^2*(RESID(-1)<0)	0.089343	0.418293	0.213590	0.8309
GARCH(-1)	0.248694	0.215322	1.154987	0.2481

R-squared	0.877096	Mean dependent var	23603.96
Adjusted R-squared	0.873481	S.D. dependent var	7940.551
S.E. of regression	2824.410	Akaike info criterion	18.11218
Sum squared resid	1.08E+09	Schwarz criterion	18.30040
Log likelihood	-1267.909	Hannan-Quinn criter.	18.18867
Durbin-Watson stat	0.234579		

TARCH (1, 1) must satisfy a positive condition. From the estimation result of this model reported in a Table 7, it is understood that the (γ) estimates are positive as expected by the TARCH (1,1) model, but they are not statistically significant when Nifty 50 and BSE Sensex is considered as dependent and MIST country's stock indies as independent variables. It means that there exists leverage effect for i, but it is not statistically significant. The leverage effect denotes a negative shock to the conditional variance which tends to cause volatility to increase by too much positive shock of the same magnitude

4.3.5. Model selection and testing:
All the four models are compared to find out which one is the best to capture symmetric and asymmetric volatility effect as per AIC and SIC criterion. The values of AIC and SIC criterion are enumerated from the Table 8. The best fitted model both in symmetric as well as asymmetric effect are chosenon the basis of minimum AIC and SIC Value. The Likewise, the AIC and SIC value (15.69743, 15.89473 in case of Nifty 50,18.09891, 18.26621 in case of BSE Sensex) is low and Log likelihood is high for GARCH (1,1) when compared to its alternative symmetric and asymmetric models, called ARCH, TARCH (1,1), EGARCH (1,1). Hence GARCH (1,1) asymmetric model is found to be the best fitted volatility estimation model.

Table 8: Results of Akaike info criterion and Schwarz criterion of ARCH family models

ARCH Models	Nifty 50		BSE Sensex	
	Akaike info criterion (AIC)	Schwarz criterion (AIC)	Akaike info criterion	Schwarz criterion
ARCH	29.8296	29.87162	34.65938	34.70140
GARCH(1,1)	15.69743	15.89473	18.09891	18.26621
TARCH(1,1)	15.71882	15.90704	18.11218	18.30040
EGARCH(1,1)	15.71717	15.90539	18.13020	18.31842

4.3.6. Diagnostics checking of GARCH model
With help of Correlogram-Squared residuals, Histogram – Normality test and ARCH LM test, Residual Diagnostics are made to check further whether really the GARCH (1,1) model is best fitted model or not. Results of Correlogram-Squared residuals, ARCH LM test and Histogram – Normality test and are as follows.

4.3.6.1. Residual serial correlation test:
Correlogram-Squared residual test is employed to examine the serial correlation in residuals.

Correlogram –Q-statistics are specifically computed to test for serial correlation in the mean equation and to examine the specification of the mean equation,whereas autocorrelations(AC) and partial autocorrelations(PAC) of the squared residuals is specifically used to test for serial correlation in the variance equation.

Hypothesis:9

H_0: No the serial correlation is present in residuals

H_1: The serial correlation is present in residuals

The serial correlation test results are put on view in Table 9. It reports AC and PAC of the squared standardized residuals, the Ljung-BoxQ-statistics and the probabilities with lag 1 to 32 for GARCH (1, 1) residuals. P-values from lag 1 to 32 are greater than 0.05 or 5%. Hence serial correlation does not exist in the residuals of Nifty 50 and BSE Sense while regressing the MISTcountries' market monthly indices.

Table 9: Results of Residual serial correlation test

Nifty 50: Sample: 2008M02 2019M10; Included observations: 141

BSE Sensex: Sample: 2008M02 2019M10; Included observations: 141

Nifty 50					BSE Sensex				
Lag	AC	PAC	Q-Stat	Prob*	Lag	AC	PAC	Q-Stat	Prob*
1	-0.022	-0.022	0.0723	0.788	1	-0.022	-0.022	0.0723	0.788
2	0.048	0.047	0.4031	0.817	2	0.048	0.047	0.4031	0.817
3	-0.012	-0.010	0.4228	0.935	3	-0.012	-0.010	0.4228	0.935
4	-0.001	-0.004	0.4229	0.981	4	-0.001	-0.004	0.4229	0.981
5	-0.024	-0.023	0.5083	0.992	5	-0.024	-0.023	0.5083	0.992
6	0.041	0.041	0.7628	0.993	6	0.041	0.041	0.7628	0.993
7	0.014	0.018	0.7934	0.998	7	0.014	0.018	0.7934	0.998
8	-0.041	-0.045	1.0494	0.998	8	-0.041	-0.045	1.0494	0.998
9	0.008	0.005	1.0593	0.999	9	0.008	0.005	1.0593	0.999
10	-0.090	-0.086	2.3076	0.993	10	-0.090	-0.086	2.3076	0.993
11	-0.067	-0.071	2.9960	0.991	11	-0.067	-0.071	2.9960	0.991
12	-0.139	-0.137	5.9950	0.916	12	-0.139	-0.137	5.9950	0.916
13	0.147	0.145	9.3813	0.744	13	0.147	0.145	9.3813	0.744
14	0.012	0.034	9.4030	0.804	14	0.012	0.034	9.4030	0.804
15	-0.004	-0.023	9.4055	0.855	15	-0.004	-0.023	9.4055	0.855
16	-0.103	-0.110	11.129	0.801	16	-0.103	-0.110	11.129	0.801
17	-0.043	-0.044	11.429	0.833	17	-0.043	-0.044	11.429	0.833
18	-0.100	-0.084	13.052	0.788	18	-0.100	-0.084	13.052	0.788
19	0.069	0.062	13.838	0.793	19	0.069	0.062	13.838	0.793
20	-0.033	-0.049	14.024	0.829	20	-0.033	-0.049	14.024	0.829
21	-0.058	-0.073	14.596	0.843	21	-0.058	-0.073	14.596	0.843
22	0.047	0.023	14.969	0.864	22	0.047	0.023	14.969	0.864
23	-0.070	-0.062	15.812	0.863	23	-0.070	-0.062	15.812	0.863
24	0.121	0.135	18.319	0.787	24	0.121	0.135	18.319	0.787
25	-0.117	-0.084	20.709	0.709	25	-0.117	-0.084	20.709	0.709
26	0.022	-0.035	20.797	0.752	26	0.022	-0.035	20.797	0.752
27	-0.071	-0.102	21.697	0.753	27	-0.071	-0.102	21.697	0.753
28	0.005	-0.052	21.701	0.795	28	0.005	-0.052	21.701	0.795
29	0.079	0.120	22.816	0.785	29	0.079	0.120	22.816	0.785
30	-0.027	-0.036	22.949	0.817	30	-0.027	-0.036	22.949	0.817
31	0.035	0.058	23.180	0.843	31	0.035	0.058	23.180	0.843
32	0.015	-0.032	23.220	0.871	32	0.015	-0.032	23.220	0.871
33	-0.052	-0.098	23.718	0.882	33	-0.052	-0.098	23.718	0.882
34	-0.055	-0.031	24.290	0.891	34	-0.055	-0.031	24.290	0.891
35	0.006	-0.019	24.297	0.913	35	0.006	-0.019	24.297	0.913
36	-0.014	0.019	24.336	0.930	36	-0.014	0.019	24.336	0.930

*Probabilities may not be valid for this equation specification.

*Probabilities may not be valid for this equation specification.

4.3.6.2. **Heteroskedasticity-ARCHLM test**

The ARCH LM test is performed to infer the existence of an ARCH effect in residuals and the results are presented in Table 10.

Hypothesis: 10

H_0: No ARCH effect is found in residuals

H_1: ARCH effect is found in residuals

F-Statistics is significantly low (3.058879in case of Nifty 50 and 0.069505 in case of BSE Sensex) when Nifty 50 and BSE Sensex is assumed as dependent. Probability chi-square are also equal to 0.0814in case of Nifty 50 and 0.07906 in case of BSE Sensex) (Prob- chi-square ≥ 0.05). It is suggested that the acceptation of the null hypothesis that no ARCH effect is found in residuals.

Table 10: Results of Heteroskedasticity-ARCHLM test

Nifty 50

Heteroskedasticity Test: ARCH

F-statistic	3.058879	Prob. F(1,138)	0.0825
Obs*R-squared	3.035917	Prob. Chi-Square(1)	0.0814

Test Equation:
Dependent Variable: WGT_RESID^2
Method: Least Squares
Date: 10/12/19 Time: 01:48
Sample (adjusted): 2008M03 2019M10
Included observations: 140 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.147641	0.143448	8.000374	0.0000
WGT_RESID^2(-1)	-0.147396	0.084276	-1.748965	0.0825

R-squared	0.021685	Mean dependent var	1.001568
Adjusted R-squared	0.014596	S.D. dependent var	1.390134
S.E. of regression	1.379951	Akaike info criterion	3.496156
Sum squared resid	262.7886	Schwarz criterion	3.538180
Log likelihood	-242.7309	Hannan-Quinn criter.	3.513233
F-statistic	3.058879	Durbin-Watson stat	1.998990
Prob(F-statistic)	0.082520		

BSE Sensex

Heteroskedasticity Test: ARCH

F-statistic	0.069505	Prob. F(1,138)	0.7925
Obs*R-squared	0.070477	Prob. Chi-Square(1)	0.7906

Test Equation:
Dependent Variable: WGT_RESID^2
Method: Least Squares
Date: 10/12/19 Time: 01:51
Sample (adjusted): 2008M03 2019M10
Included observations: 140 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.025099	0.137485	7.456086	0.0000
WGT_RESID^2(-1)	-0.022455	0.085174	-0.263639	0.7925

R-squared	0.000503	Mean dependent var	1.002773
Adjusted R-squared	-0.006739	S.D. dependent var	1.277235
S.E. of regression	1.281532	Akaike info criterion	3.348172
Sum squared resid	226.6408	Schwarz criterion	3.390196
Log likelihood	-232.3721	Hannan-Quinn criter.	3.365249
F-statistic	0.069505	Durbin-Watson stat	1.994000
Prob(F-statistic)	0.792452		

3. Jarque-Bera test normality test

The histogram – Normality test is done using Eviews to check the residuals whether normally distributed or not. Table 11 puts on show mean, median, standard deviation, skewness, kurtosis, Jarque-Bera test statistics and probability value, and a histogram of the standardized residuals. If the probability value reflects the probability of accepting the null hypothesis, then the standardized residuals are normally distributed.

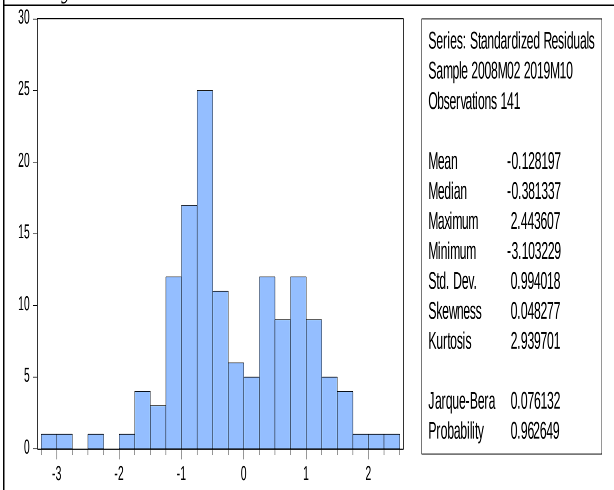
Hypothesis: 11

H_0: The standardized residuals are normally distributed.

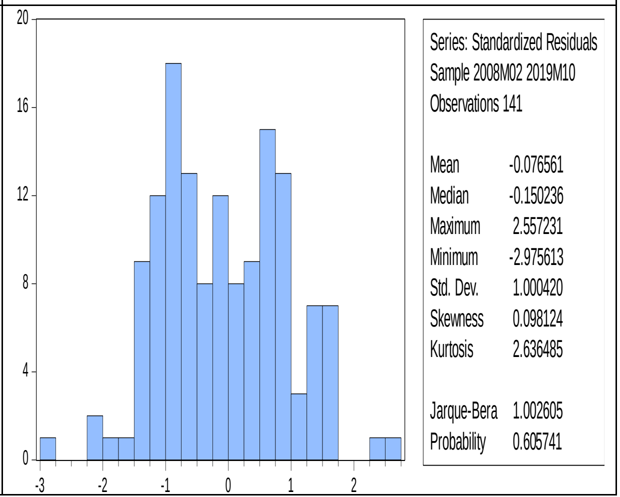
H_1: The standardized residuals are not normally distributed.

Table 11: results of Jarque-Bera test normality test

Nifty 50



BSE Sensex



Jarque-Bera test statistics conforms nonnegative. The P-values of the Jarque-Bera test are also greater than 0.05. The p-value reflects the possibility of accepting the null hypothesis. So residual data of Nifty 50 and BSE Sense are normally distributed. Further the standardized residuals (2.939701, 2.636485) are platykurtic (k<3). The Positive skewness (0.048277, 0.098124) describe the tail of the distribution of residuals is on the right. Thus the residual diagnostic test of Correlogram-Squared residual test, ARCH LM test and Jarque-Bera test indicates that undoubtedly GARCH (1,1) symmetric model is the supreme model to predict volatility behaviour of Indian stock market and MIST countries' stock market indies and model estimates are good for policy formulation.

4.4Testing the relationship among MIST country and regional Indian Stock Markets-Karl Pearson's correlation analysis

Precede to econometric analysis, a correlation test is carried out between India, MIST country Stock Market indices, as this providesearliest insight into the actuality and the existence of cointegration after September 2008 Global Financial Crisis

The following hypothesis are formulated for testing Pearson's correlation

Hypothesis: 12

H_0: There is no statistically significant linear correlation between stock markets of Nifty 50, BSE Sensex and MIST countries

H_1: There is a statistically significant linear correlation between stock markets of Nifty 50, BSE Sensex and MIST country

Correlation coefficient(r), the test statistic and probability values are presented in this Table. Sensex and Nifty are statistically significantly associated with MIST country's Stock Market indices sincethe p-value =0.000 in all indices with a very high positive association (r values are near to 1), which point out that all markets are following more or less the same trend over the applicable period.

Table 12: Results of Karl Pearson's correlation analysis

Sample: 2008M02 2019M10
Included observations: 141

Correlation t-Statistic Probability	BIST_30	KOSPI2	JCI	MXX	BSE_SENSEX	NIFTY_50
BIST_30	1.000000 ----- -----					
KOSPI2	0.866371 20.45323 0.0000	1.000000 ----- -----				
JCI	0.955330 38.11029 0.0000	0.853626 19.32112 0.0000	1.000000 ----- -----			
MXX	0.889475 22.94776 0.0000	0.863580 20.19281 0.0000	0.923016 28.28297 0.0000	1.000000 ----- -----		
BSE_SENSEX	0.910313 25.92876 0.0000	0.743536 13.10935 0.0000	0.918184 27.32580 0.0000	0.795886 15.49824 0.0000	1.000000 ----- -----	
NIFTY_50	0.914881 26.71710 0.0000	0.749922 13.36522 0.0000	0.920545 27.78295 0.0000	0.805610 16.03185 0.0000	0.999052 270.5771 0.0000	1.000000 ----- -----

4.5. Testing for the existence of long term equilibrium relationship

After identifying a positive association via Karl Pearson's correlation analysis the cointegration test was used to check whether they have extensively a long time equilibrium relationship between the Indian stock markets and MIST country's Stock Market. Because of Market indices are discovered to have stationaryfrom the ADF (Augmented Dickey-Fuller) and PP (Phillips Pearson) tests (Walter ,2004) connoting that they are non-stationary at the first level, but become a stationery after the first difference I (1), cointegration test was madewith the intention of testing whether the markets were cointegrated or not. Four ladders were carried out (i) Johansen Co-integration analysis, (ii) Normalized cointegrating coefficient (iii) VECM (Vector Error Correction Model) and (iv) Pair-wise Granger Causality Test.

4.5.1. Johansen Co-integration analysis

Cointegration test is considered as a suitable mode for properly testing hypotheses relating to the long-term relationship between

1. Nifty 50 and MIST countries' Stock Markets
2. BSE Sensex and MIST country's Stock Markets

The Johansen Cointegration test(Johansen, S. 1991)examines a set of null hypothesis that there exist no cointegrating equations among variables. Two likelihood ratios of the Maximum Eigen statistics and the trace statistics have been taken into account. These statistics are used to determine the number of cointegrating vectors. A co-integration exists among stock market indices when the trace statistics value is more than the critical value and the probability is significant. The results for Johansen co-integration was presented in the Table Cointegration results depicts that Null hypothesis of trace statistic and Max Eigen statistic is rejected r+1 cointegrating vector at the 0.05 level up to at most 1 with lag interval of 1to 8. It reveals that long term relationship is exsisted between Indian stock market and MISTcountries' Stock Markets after the September 2008global financial crisis.

Table 13: Result of Johansen system co-integration test

BSE Sensex

Sample (adjusted): 2008M11 2019M10
Included observations: 132 after adjustments
Trend assumption: Linear deterministic trend
Series: BSE_SENSEX MXX JCI KOSPI2 BIST_30 NIFTY_50
Lags interval (in first differences): 1 to 8

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.291450	98.24901	95.75366	0.0333
At most 1	0.141070	52.77038	69.81889	0.5153
At most 2	0.129160	32.69746	47.85613	0.5736
At most 3	0.062782	14.44227	29.79707	0.8149
At most 4	0.033613	5.883399	15.49471	0.7093
At most 5	0.010327	1.370244	3.841466	0.2418

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.291450	45.47863	40.07757	0.0112
At most 1	0.141070	20.07292	33.87687	0.7516
At most 2	0.129160	18.25520	27.58434	0.4740
At most 3	0.062782	8.558867	21.13162	0.8663
At most 4	0.033613	4.513155	14.26460	0.8016
At most 5	0.010327	1.370244	3.841466	0.2418

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Nifty 50

Sample (adjusted): 2008M11 2019M10
Included observations: 132 after adjustments
Trend assumption: Linear deterministic trend
Series: NIFTY_50 MXX JCI KOSPI2 BIST_30 BSE_SENSEX
Lags interval (in first differences): 1 to 8

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.291450	98.24901	95.75366	0.0333
At most 1	0.141070	52.77038	69.81889	0.5153
At most 2	0.129160	32.69746	47.85613	0.5736
At most 3	0.062782	14.44227	29.79707	0.8149
At most 4	0.033613	5.883399	15.49471	0.7093
At most 5	0.010327	1.370244	3.841466	0.2418

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.291450	45.47863	40.07757	0.0112
At most 1	0.141070	20.07292	33.87687	0.7516
At most 2	0.129160	18.25520	27.58434	0.4740
At most 3	0.062782	8.558867	21.13162	0.8663
At most 4	0.033613	4.513155	14.26460	0.8016
At most 5	0.010327	1.370244	3.841466	0.2418

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

4.5.2. Normalized cointegrating coefficient

The results are normalized on the Nifty 50 and BSE Sensex as a dependent variable individually. Normalized cointegrating parameters are accessible in Table 14. The Johansen's Cointegration Test indicates one cointegrating equation with the log likelihood of -5319.932. Therefore, we look at the first normalized coefficient table from Eviews software results which present the normalized beta of the Indian stock market and MIST countries'stock Markets.

Table 14: Summary of normalized cointegrating coefficient (Nifty 50 as a regressor)

1 Cointegrating Equation(s): Log likelihood -5319.932

Normalized cointegrating coefficients (standard error in parentheses)

NIFTY_50	MXX	JCI	KOSPI2	BIST_30	BSE_SENSEX
1.000000	-0.072789	0.284890	-5.252640	0.029659	-0.359923
	(0.01460)	(0.10007)	(1.58811)	(0.00546)	(0.01082)

The cointegration equation for Nifty 50 is derived from the table. The signs of the variables are reversed to make possible correct interpretation due to normalization process

Nifty 50 market index =-0.072789 × MXX+ 0.284890 × JCI–5.252640 × KOSPI2+0.029659 × MIST 30-0.359923×BSE Sensex (13)

This long time cointegrating equation undoubtedly confirms that Nifty 50, JCI and MIST 30 clearly are moving in the same direction over the long time while MXX, KOSPI2 and BSE Sensex in the opposite direction against Nifty market movement. KOSPI2 is more negatively sensitive to change in the Nifty 50 market index

Right now the results are normalized on the BSE Sensex as a dependent variable.

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Table 15: Summary of normalized cointegrating coefficient (BSE Sensex as a regressor)

1 Cointegrating Equation(s): Log likelihood -5319.932

Normalized cointegrating coefficients (standard error in parentheses)

BSE SENSEX	MXX	JCI	KOSPI2	BIST 30	NIFTY 50
1.000000	0.202234	-0.791532	14.59379	-0.082404	-2.778373
	(0.03859)	(0.26566)	(4.32516)	(0.01486)	(0.09284)

The cointegration equation is derived from the Table.

BSE Sensex market index = 0.202234 × MXX - 0.791532 × JCI + 14.59379 × KOSPI2 -0.082404 × MIST 30 -2.778373 × Nifty 50 market index (14)

This long run cointegrating equation undoubtedly confirms that BSE Sensex, MXX, KOSPI2 except Nifty 50, JCI and MIST 30 clearly move in the same direction over the long time period against Sensex market movement. KOSPI2 is more positively sensitive to change in the BSE Sensex market index.

4.5.3. VECM (Vector Error Correction Model)

VECM is a generally accepted framework taken into account to elucidate the dynamic interrelationship between stationary variables. As stated by Granger representation theorem, when Indian stock market indices and MIST country's Stock Market indices are cointegrated, VECM can be run in Eviews with the endeavour of describing the short run dynamics towards their equilibrium values. The error correction specification has need of monthly time series data of Indian stock market indices and MIST country's Stock Markets is I (1) and cointegrated. The first part of Table 16 of Vector Error Correction estimates presents the estimates of the cointegrating equation and the first row of the second part of the Table 16 presents the estimates of the speed of adjustment coefficient (ECM coefficient), their standard errors and the t-statistics.

Table 16: Vector Error Correction estimates

Vector Error Correction Estimates
Sample (adjusted): 2008M05 2019M10
Included observations: 138 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Vector Error Correction Estimates
Sample (adjusted): 2008M05 2019M10
Included observations: 138 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1	Cointegrating Eq:	CointEq1
NIFTY 50(-1)	1.000000	BSE SENSEX(-1)	1.000000
MXX(-1)	0.196101 (0.07214) [2.71844]	MXX(-1)	0.749644 (0.22329) [3.35729]
JCI(-1)	-1.095584 (0.58421) [-1.87533]	JCI(-1)	-4.518126 (1.80183) [-2.50752]
KOSPI2(-1)	37.10091 (11.2592) [3.29516]	KOSPI2(-1)	112.7583 (34.6741) [3.25195]
BIST 30(-1)	-0.140476 (0.02756) [-5.09630]	BIST 30(-1)	-0.431225 (0.08492) [-5.07782]
C	-6854.653	C	-23228.00
Error Correction:	D(NIFTY_50)	Error Correction:	D(BSE_SE...
CointEq1	-0.057147 (0.02696) [-2.11963]	CointEq1	-0.066506 (0.02715) [-2.44966]

The long run cointegrating equation is extracted from VECM results from the first part of the table using Eviews software. The long run equation would be

Nifty 50 market index = -6854.653+0.196101 × MXX – 1.095584 × JCI + 37.10091 × KOSPI2 -0.140478 × MIST 30 + u_t (15)

BSE Sensex market index = -23228+0. 749644 × MXX – 4.518126 × JCI + 112.7583 × KOSPI2 -0.431225 × MIST 30 + u_t (16)

Here all signs have been reversed. Variables here are all long run variables. The rules of thumb for analysing VECM are: the VCEM (error correction coint equ1) is obliged to lie between 0 to 1, its value is required to be negative and t-statistics ought to be significant. The speed of adjustment coefficient for NSE Nifty 50 market index and BSE Sensex market index are -0.057147 and 0.066505 respectively. The coefficient confirms expected norms. It says that this model is having the capacity to correct errors in the immediate or subsequent month and about5.71% errors occurred in the Nifty 50 market index and 6.6505% in the BSE Sensex market index between each month are corrected in the subsequent month. Therefore, the errors made are short lived and long term relationship found has the ability to be sustained and be not failed.

4.5.3.Pair-wise Granger Causality Test

The Pair-wise Granger Causality Test (Granger, 1969) is a statistical hypothesis test which is used to finding out whether one-time series is helpful in estimating future trend or movement of another. Subsequent to estimating VECM (Vector Error Correction Model), Pair-wise Granger causality test is performed for Indian stock indices and MIST countries stock indices by using lag length 2 to investigate the causality rapport between emerging stock indices of India and MIST countries. The Eviews results are reported in Table 17.

The null hypothesis "MXX, JCI, KOSPI2, BIST 30 does not granger cause Nifty 50 market index" are accepted. It points out that MIST countries' stock indices will not be used to anticipate or predict the index of Nifty 50 with its own lags. In this case granger causality runs one way and the other way.

The null hypothesis "MXX, JCI, KOSPI2, BIST 30 does not granger cause BSE Sensex market index" are accepted. It points out that MIST countries' stock indices can be not used to forecast BSE Sensex market index with its own lags. In this case granger causality runs one way and the other way

Table 17: Results of Pair-wise Granger Causality

Sample: 2008M02 2019M10
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.	Decision on H_0
MXX does not Granger Cause NIFTY 50	139	0.06430	0.9377	Accepted
NIFTY 50 does not Granger Cause MXX		2.04304	0.1337	Accepted
JCI does not Granger Cause NIFTY 50	139	1.33945	0.2655	Accepted
NIFTY 50 does not Granger Cause JCI		1.19293	0.3065	Accepted
KOSPI2 does not Granger Cause NIFTY 50	139	0.85914	0.4258	Accepted
NIFTY 50 does not Granger Cause KOSPI2		1.67268	0.1916	Accepted
BIST 30 does not Granger Cause NIFTY 50	139	0.93739	0.3942	Accepted
NIFTY 50 does not Granger Cause BIST 30		2.15906	0.1194	Accepted
BSE SENSEX does not Granger Cause NIFTY 50	139	0.20198	0.8174	Accepted
NIFTY 50 does not Granger Cause BSE SENSEX		0.34908	0.7060	Accepted
JCI does not Granger Cause MXX	139	0.75612	0.4715	Accepted
MXX does not Granger Cause JCI		0.71885	0.4892	Accepted
KOSPI2 does not Granger Cause MXX	139	0.24652	0.7819	Accepted
MXX does not Granger Cause KOSPI2		2.49584	0.0863	Accepted
BIST 30 does not Granger Cause MXX	139	0.43427	0.6486	Accepted
MXX does not Granger Cause BIST 30		2.24479	0.1099	Accepted
BSE SENSEX does not Granger Cause MXX	139	2.33172	0.1011	Accepted
MXX does not Granger Cause BSE SENSEX		0.04550	0.9555	Accepted
KOSPI2 does not Granger Cause JCI	139	0.07380	0.9289	Accepted
JCI does not Granger Cause KOSPI2		1.50222	0.2264	Accepted
BIST 30 does not Granger Cause JCI	139	0.14508	0.8651	Accepted
JCI does not Granger Cause BIST 30		6.28729	0.0025	Rejected
BSE SENSEX does not Granger Cause JCI	139	1.25040	0.2897	Accepted
JCI does not Granger Cause BSE SENSEX		1.46283	0.2353	Accepted
BIST 30 does not Granger Cause KOSPI2	139	2.07564	0.1295	Accepted
KOSPI2 does not Granger Cause BIST 30		0.05619	0.9454	Accepted
BSE SENSEX does not Granger Cause KOSPI2	139	1.53755	0.2187	Accepted
KOSPI2 does not Granger Cause BSE SENSEX		0.85447	0.4278	Accepted
BSE SENSEX does not Granger Cause BIST 30	139	2.00488	0.1387	Accepted
BIST 30 does not Granger Cause BSE SENSEX		1.01143	0.3665	Accepted

V. CONCLUSION

This research work was principally focus on random walk, volatility, cointegration of the stock markets of India and MIST countries. Time series data confirms no random walk during the period of February 2008 to October 2019. It suggests that the past movement of the market can be used to assess its future movement however the monthly time series data are not normally distributed. MIST countries highlighted the risk of left tail events (Black swan events). GARCH (1, 1) volatility forecasting model is found as the most excellent model in terms of AIC and BIC. Although the volatility might have changed during the long time horizon, EGARCH (1, 1) and TARCH (1, 1) models confirms the asymmetric effect. The evidence of volatility exhibits the clustering and persistence. The monthly indices may react to the bad news and good news asymmetrically. Cointegration test demonstrate the truth of interdependence of the stock markets of India and MIST countries. Since all stock indices do not have random behaviour pattern and weak form of market efficiency, they could be cointegrated in long run. The short term dynamics were known from VECM and then how many deviations from long term are corrected. The hypothesis results of Granger causality clearly evidenced that no one market time series is useful for predicting or forecasting other which indicates Indian stock market and MIST countries stock market can not affect each other. Hence Granger causality is working in all directions rather than in only one direction between the monthly time series. Long run cointegrating equation justified the positive movement of Nifty 50, JCI and BIST 30 while MXX, KOSPI2 and BSE Sensex were moving in inverse direction against each other. KOSPI2 is more negatively sensitive to change in the Nifty 50 market index. As a whole the inference of the present study would be more helpful to know the investor about the level of volatility prevailed and get better insight about the comovement and the presence of leverage effect between regional market and international market.

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