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Research Article

"Relationship Between The Volume Of Trade And Volatility Spillover Between The Selected Developed And Emerging Asian Markets"

Dr. Charithra C M[1*], Dr. Mukund Sharma[2], Dr. Bhavya Vikas[3]

[1*]Associate Professor, Department of Business Administration, BNM Institute of Technology, Email id: charithra.c.m@gmail.com,
[2]Professor and HoD, Department of Business Administration, BNM Institute of Technology, E-mail: mukund_sharma1@yahoo.co.in,
Associate Professor, Department of Business Administration, BNM Institute of Technology, E-mail: bhavyavikas@gmail.com,

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ABSTRACT

Stock markets serve as the economic barometers. The relationship between the two capital markets can be studied as a proxy to understand the relation between the two economies. The movement of stock market not only reflects the nation's economic condition but also the confidence level the domestic and foreign investors have in an economy. The increase in integration between the global economies has resulted in convergence and co movement. The purpose of this study is to examine relationship between the volume and volatility in the capital markets of Hong Kong, Japan, Singapore, India, China and Philippines. Stratified-convenience sampling technique is used to pick the samples and daily index values are taken from the major index of these countries for a period of seven years. The time series data were tested for stationarity and normality using ADF, PP tests and Jarque-Bera test. Returns, SD, Granger causality test, VAR model and Variance decomposition techniques are used for the analysis. The response of volatility to its own shock is comparatively higher and is found to marginally increase from periods one to ten than the shock due to its trading volume and the impact of Volume is relatively lesser on volatility in majority of the stock markets. The financial stock markets are integrated beyond the geographical borders and the shock in one market impacts the returns from the other market. With a better understanding of the relation between the markets and volatility and volume, the investors can make strategy to trade, by observing the volatility signals in one market, suitable positions can be taken in the other.

Keywords: Volatility, Spillover, Volume of Trade

Introduction

Volatility in the stock market is arguably one of the most misunderstood concepts in investing. Simply put, volatility is the amount of price changes a security experiences over a given period of time. If price stays relatively stable, the security has low volatility. If you toss up the question of whether volatility is good or bad, the experts would probably reply as "It is neither good nor bad". It is very important to understand the right amount of volatility that is good for the market. Volatility is considered bad because it can cause massive loss to the investors. It is also considered good as it can result in massive or pretty good gains. It is just because of the phenomenon of volatility and the consequent gains and losses that it involves that investors are persuaded to trade in securities all the time, in this way keeping the markets perfectly healthy.
It resembles a vital malevolence in the financial markets because without volatility there would be little scope for gains (and losses) from the everyday exchanges. Volatility really ends up being terrible when it all of a sudden increments, rather brutally, causing huge losses across the market.
Each country has one or more stock exchanges where trading of shares takes place in large number. Direction of movement of share prices in a market are captured and represented as a weighted average price of group of representative shares traded in market called as stock market index. Hence the movement of stock market index is good measure of volatility of any stock market.

An Index is a compilation of prices of certain number of representative assets to capture the overall behaviour of the market. The idea of Index was conceived by Charles Dow, who created the Dow Jones Industrial average in 1896. Since then, all the counties have created their own stock market indices.
In the recent decade there is a significant increase in the financial linkage between emerging economies with the global economy which encourage the study of volatility interdependence among the various stock markets.
The purpose of this study is to understand the relationship between the volume of trade and the volatility between the selected six Developed and emerging capital markets in the Asian region for a duration of seven years.

Objectives of the Study

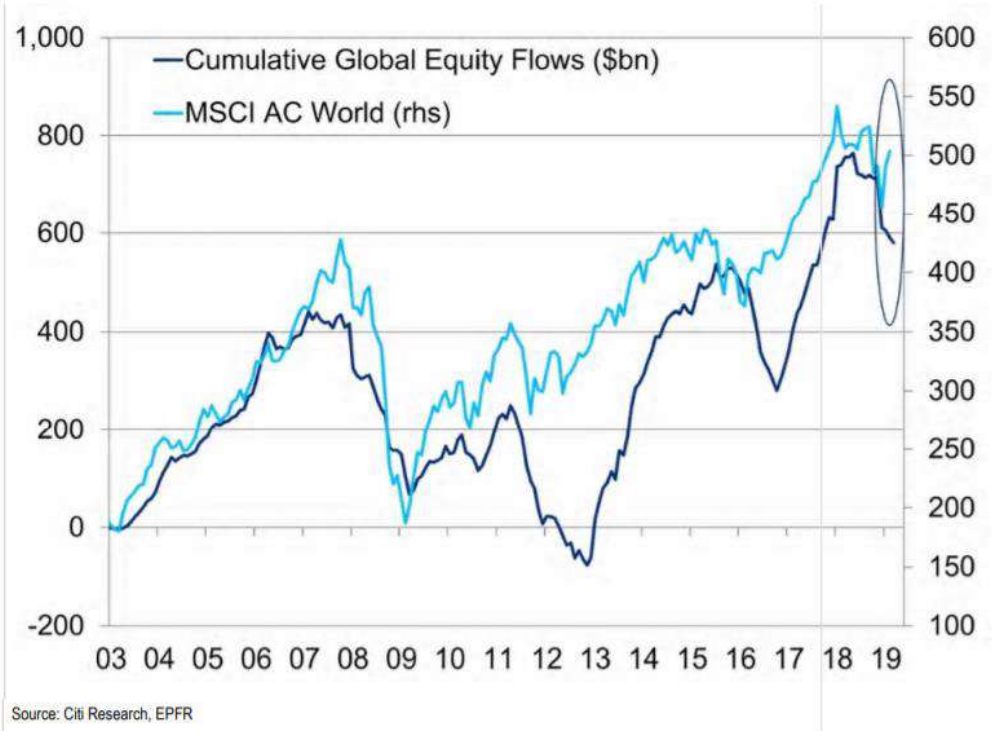
In this direction, the following research objective is posed for the study:
• To find out the relationship between the Volume of trade and Volatility in the selected stock markets

Research Methodology

This study made use of quantitative Research technique where the deductive approach is used to find solutions to the research questions. This study completely depends on numerical data collected from secondary sources. The actual goal of financial quantitative analysis is to apply quantifiable statistics and tools to make better decisions.

The Period of the Study:

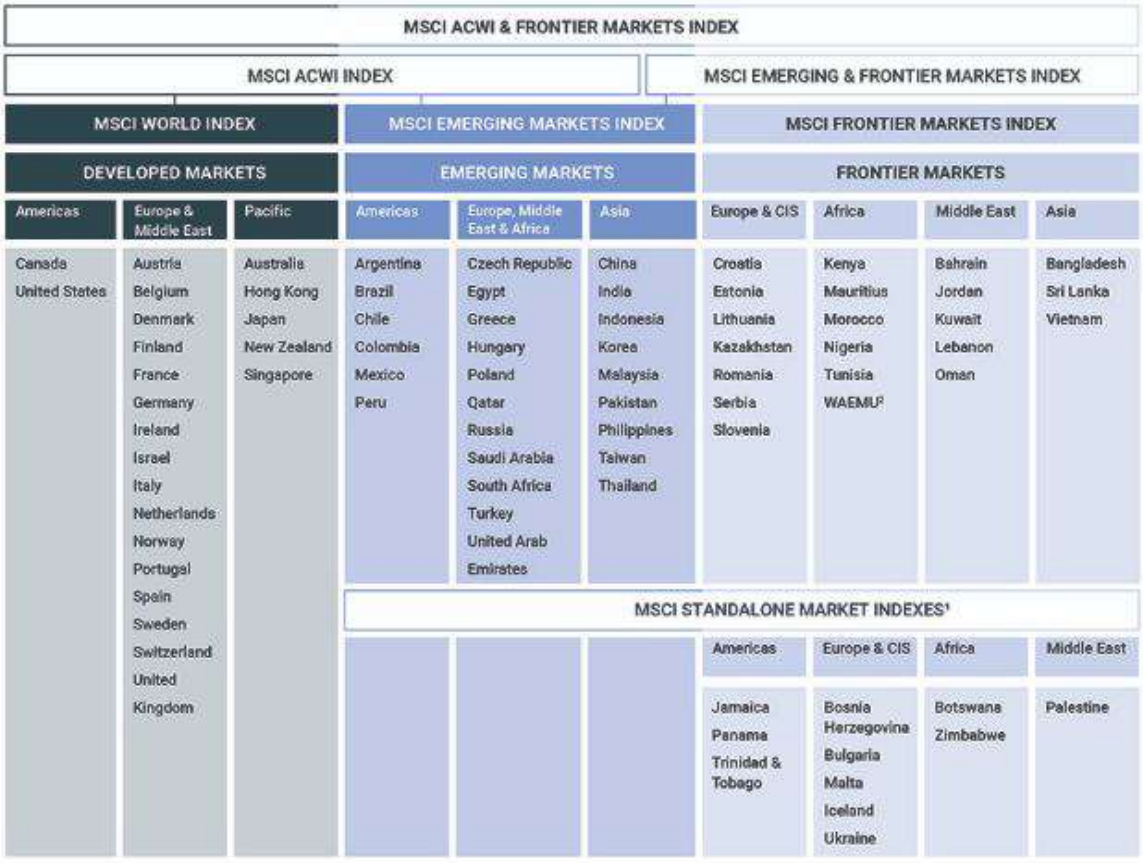
The Study measures and compares volatility of different Stock Exchanges for a period of 7 Years. The Data will be tabulated and analyzed on daily basis from January 2015 to December 2021. At least seven years of data is required for an appropriate GARCH estimation Engle and Mezrich (1995), this is a significant time period as it includes both upward and downward movements in the Index.
This period coincided with the longest bull period during which majority of the markets reached a new high. In its report CNBC stated, that in the year 2018 the major markets like the US suffered the worst after the Great depression. This resulted in the investors pulling back their investments from the markets. The S&P 500 fell by more than 19% in September 2018 which recovered and recorded a new high in April 2019 within a span of eight months.
The graph below shows the cumulative flow of equity across the globe for the last 15 years. From the graph it can be seen that the period of study includes both upward and downward trend in the global stock market.



Sample Selection:

The China, Russia, Singapore and Indian economies are predicted to be the powerful economies in the world within the next 50 years (Goldman Sachs (2003)) and United States and the Japan are the only two out of the six biggest world economies expected to be developed in terms of US dollars by 2050.

As per the IMF report in a list of 36 developed countries the capital markets of Australia, Hong Kong Japan, USA, UK and Singapore have made place.
The Morgan Stanley Capital International (MSCI) in its 2020 annual global market classification, divided the major economies of the world as presented in the diagram below,



So, India, China and Philippines countries as emerging and Japan, Singapore, and Hong Kong as developed economies are considered to understand their behaviour.
Given, an importance in choosing Index for investment management process, an index is expected to be representative, replicable, transparent (Arnott, Hsu and West (2008) broad, investable (Kamp 2008) and efficient (Amenc, Goltz and Sourd(2006)). Index can be considered as a representative of the overall stock market performance of any nation. Hence daily closing values from the major index of the countries Japan, Singapore, Hong Kong, India, China and Philippines is taken for the period of the study.
Different regions experience different levels of economic development. The status of economic development is bound to be persuaded by the activities of the capital market. To study the inter region variations the developed and emerging stock markets are chosen using convenience - stratified sampling technique, where the economies of Asia are divided into strata called developed, Emerging and Frontier markets as per Morgan Stanley Capital International (MSCI) in its 2020 annual global market classification and are chosen based on convenience of data availability and are tabulated in the below table.

Sources of Data

The Study is designed to measure and study the volatility in Stock exchanges in different parts of Asia. The Most important Stock market Index of the country considered are selected to record the index value. The study depends on Secondary data that are collected from the websites of respective Stock exchanges, websources like allstocks and yahoofinance. Microsoft Excel, R Software and E- views package is used for the purpose of analysis.
Two classes of models are extensively used to study volatility. The first model devises the conditional variance directly as a function of observations that is ARCH and GARCH. While the second one devises volatility models that are not pure functions of observation, these are called stochastic volatility (SV) models or latent volatility.
Bollerslev and Taylor in the year 1986 independently developed the GARCH model which states that the conditional variance is dependent on its own previous lags whereas in case of ARCH model, which is non linear model the variance component, is assumed to be non constant it also explains the development of variance of errors. ARCH models are mostly preferred in the analysis of multiple financial time series data in the presence of volatility clustering or volatility pooling. Volatility clustering is a characteristic of time series

where the large changes (in both directions) in the price or value are followed by large changes and small ones by small changes. The autocorrelation in volatility is modelled after considering the conditional variance of errors terms in the ARCH model.

Literature review

The volatility spillover concept for returns from the assets can be understood from the findings of Engle et al., (1990), they set out the hypothetical finding for the internal and cross type of spillovers. The "heat wave" hypothesis states that the volatility in one market can be predicted by the past values of the same market and the “meteor shower” hypothesis states that the intraday volatility spillover from one market to the other (Termed as volatility transmission).

There are a few studies done to investigate the relationship between the volatility and trading volume, especially when there is an unusually high volatility. There is an increase in the studies testing the relationship between the price change and volume traded due to the accessibility to the high frequency data. There exist a significantly strong relation between the volatility and volume traded (Admati and Pfleiderer (1988); Foster and Viswanathan (1994); Andersen (1996) and O'Hara (1996))

In a research, Karpoff (1987), he states that the examination of relation between price and volume is vital as it assists to recognize the structure of the financial market, improve the accuracy of event studies, find the increase in quality of event studies, find distribution of price changes and explains the implication of trading in the future market. Additionally, he argues that it is the volume that brings in changes in the price of the stock, meaning changes in price is seen when there is a positive change in demand for the stocks.

Kumar, S. (2019)The linear and nonlinear relationship between volatility in return and that trading volume in the Indian currency futures marketwasexamined using generalized method of moment estimator andGranger (1969) bivariate vector autoregression model. The findings revealed a negative contemporaneous relation between returns volatility and trading volume.A significant bidirectional relationship was seen between the trading volume and volatility in linear and nonlinear Granger causality test.

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Naik, Pramod, Gupta, Rangan, Padhi, Puja. (2017) considered the volume of trade as a representation to the information rate in the volatility study.The theoretical justification for the study of relationship between trading volume and market volatility is given in mixture of distribution hypothesis (MDH) and the sequential information hypothesis (SIAH).Using EGARCH and granger causality model volume-volatility relationship for Johannesburg Stock Exchange (JSE) of South Africa was studied. The results reveal that JSE exhibited a asymmetric volatility and relationship between trading volume and market volatility is found to be positive and contemporaneous supporting the MDH. There is a positive contemporaneous relationship between volume & volatility and also that trading volumes cannot calm the level of volatility persistence.

Samman, Hazem. Al-Jafari, Mohamed. (2015)For the four industrial firms listed on Muscat securities market, relationship between the volume traded and volatility in the stock return were analyzed using Brailsford model, vector autoregressive model (VAR), and the Granger causality test (pair wise). The analysis shows a significant and positive effect of volatility in return on the trading volume.

Lin, Jung-Chu and Sum, Vichet (2014)the contemporaneous relationship between trading volume and returns in the ETF market was examined. The past results showed a that a linear regression model developed using Correlation and OLS method grasp an average relation between trading volume and return. The empirical results using quantile regression analysis revealed a symmetric volume-return relationship is in the ETF market and in the stock market an asymmetric volume-return relationship was seen. The restriction in short sale and the transaction cost were found to be the important factors affecting the relationship between volume and return.

Wen-I Chuang, Hsiang-Hsi Liu (2012)A Bi-variate GJR-GARCH was made use of to assess simultaneously the causal and contemporaneous relation between volatility in return and volume on ten Asian markets to found that there was a significant contemporaneous relation between the returns from the stock and the volume of trade. There was a causal relation from stock returns and trading volume in all the selected markets though few markets demonstrated positive the other showed a negative contemporaneous relation. Hence the relation was found to be asymmetric.

Biswas, S. ,Rajib, P. (2011), The price and volume relationship in the Indian commodity futures market was investigated using Mixture of distribution hypothesis which suggested positive contemporaneous relationship and sequential information arrival hypothesis (SIH) which showed a positive intertemporal causal relationship. The results showed that though there existsacontemporaneous correlation between volume and change in price in some of the cases, but in general on the basis of the presence of Granger causality it followed the SIH. David McMillan & Alan Speight (2002) theempirical relationship between the volume and return in the futures market was tested to find that there is not just positive contemporaneous relationship between volume and absolute returns but also bidirectional causality, which supports the sequential arrival of information hypothesis. The investigation of contemporaneous and dynamic relationships between volume and actual returns showed a limited evidence of statistically important relation meaning market inefficiency.

Paul BerhanuGirma , MbodjaMougoué (2002).The relationship between petroleum futures spread variability, trading volume, and open interest was examined in order to find the sources of variation in the future spreads. The results showed that contemporaneous (lagged) volume and open interest explains the volatility in the future spreads. This finding supported the sequential information arrival hypothesis of Copeland (1976). Hence these results suggest a degree of market inefficiency in petroleum futures spreads.
Imad A. Moosa, Param Silvapulle (2000)the relationship between the price and volume in the crude oil futures market was examined to find that there exists a causal relationship between price and volume. However, the causality is uni-directional and runs from volume to price but not the other way.
Daigler and Wiley (1999) examined the volume volatility relation in the futures market. The investors in the market or trading participants drive the volatility and volume relationship. It was also seen that the unexpected, traded volume had greater impact than the expected volume.
Montalvo (1999) using the approach suggested by Lamoureux and Lastrapes (1990), studied the impact of daily volume on the volatility in the Spanish Bond market to find that the greater volume had a positive effect on the volatility.
Bessembinder, H., & Seguin, P. (1993) An investigation of relationship between volatility, market depth and volume in eight futures market was done to find that if volume is divided into components called expected and unexpected, the latter component has a greater impact on the volatility. This relationship is found to be asymmetric as the effect of negative unexpected volume shocks is lesser than the unexpected positive volume shocks.
Campbell et al. (1993) examined and found that the trading volume and volatility have a positive correlation. Price variation signalsthe market traders to act upon it. A stock is purchased by few informed traders based on the inside news due to which the stock price will go up. This will be picked by the others results in increase in the price. The price moves in the same direction due to conjunction; this reduces the volatility. When the volume of trade increases due to such information, it reduced the volatility. This result showed that if the trading is information-driven there exists a negative correlation between volatility and lagged trading volume
There exists a bidirectional relationship between the trading volume and Volatility. The extent of influence varies from one stock market to the other (Wang and Lu (2000); Wen-Cheng Lu and Fang Jun Li (2010)). The relationship was found to be bidirectional but asymmetric in Hong market due to short sales (Henry and McKenzie (2006)). A model was developed by (Wang (1994) and He and Wang (1995)) which shows that the trading volume depends on the information flow in the market. There is no significant effect of trading volume on the reduction of volatility (IzzEddien ,Qasim M, Jdaitawi and Ahmed M Al- Jayonsi(2013)). The investor understanding is seen through trading volume. Though many studies are conducted to determine the volume of trade- volatility relationship very few studies are done in Indian market and the results are found to be inconsistent.
The study of relationship between price and volume has a significant impact. Increase in volume of trade affects the price changes (Sharma et al. (1996); Gwilym et al. (1999); Ciner (2001) andMcMillan and Speight (2002)).Thisindicates the demand from the investors for the stocks. Since changes in the volume of trade have significant impact on the return the investors can improve the forecasts.

Though past literatures are available the findings are not consistent. Hence it is important for us to know if the information spillover from the other financially integrated markets affect the volume and trade which in turn affects the volatility of returns.

Analysis

Summary Statistics for Volatility of stock market returns (VOLA stands for Volatility of Index returns)

	VOLA_HSI	VOLA_N225	VOLA_NSE	VOLA_PSEI	VOLA_SSE	VOLA_STI
Mean	7.63E-05	0.000126	5.45E-05	0.000280	0.000134	3.49E-05
Median	7.23E-06	8.64E-06	5.11E-06	1.03E-05	5.98E-06	3.99E-06
Max	0.003622	0.013212	0.003718	0.028629	0.007873	0.001928
Min	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SD	0.000195	0.000519	0.000153	0.001634	0.000500	8.80E-05
Skewness	7.090776	15.57696	10.34439	11.19438	8.595062	7.626241
Kurtosis	86.64604	339.7145	184.2743	151.5592	97.44897	110.0866
Jarque-Bera	762664.4	12116042	3527183.	2391595.	976523.4	1239731.
Probability	**0.000000**	**0.000000**	**0.000000**	**0.000000**	**0.000000**	**0.000000**
Sum	0.193910	0.320580	0.138648	0.712072	0.341917	0.088753
ADF test statistic and Probability	-14.08(0.00)	-24.86(0.00)	-13.43(0.00)	-14.68(0.00)	-5.80(0.00)	-7.66(0.00)
Sum Sq. Dev.	9.68E-05	0.000684	5.97E-05	0.006790	0.000636	1.97E-05

Observations	2543	2543	2543	2543	2543	2543

The above table shows the descriptive statistics or summary of volatility in return from the selected stock market index. This table also shows ADF (Augmented Dickey Fuller) test for checking the stationarity of volatility. The probability values are 0.000 for all the stock markets. The null hypothesis (ADF test) of "volatility" variable not being stationary is rejected at 5% level of significance for all the stock markets. Thus, volatility of all the stock markets exhibits stationarity.

Summary Statistics for Volume of stocks traded (VOL stands for Volume of securities traded)

	VOL_HSI	VOL_N225	VOL_NSE	VOL_PSEI	VOL_SSE	VOL_STI
Mean	1.77E+09	130973.4	2.38E+08	212151.7	200831.3	2.40E+08
Median	1.67E+09	121300.0	1.92E+08	111600.0	160100.0	2.23E+08
Std. Dev.	5.93E+08	62992.16	1.45E+08	3249871	126820.8	88315557
Skewness	1.678409	1.659565	2.687036	39.22138	2.013062	2.603799
Kurtosis	8.361161	8.063124	13.82551	1607.082	7.256046	22.25885
Jarque-Bera	4232.754	3877.460	15453.24	2.73E+08	3631.150	42107.46
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	4.49E+12	3.33E+08	6.05E+11	5.39E+08	5.10E+08	6.09E+11
ADF test statistic and Probability	-16.69(0.00)	-5.57(0.00)	-3.37(0.00)	-50.44(0.00)	-4.64(0.00)	-19.53(0.00)
Sum Sq. Dev.	8.93E+20	1.01E+13	5.33E+19	2.68E+16	4.08E+13	1.98E+19
Observations	2539	2539	2539	2539	2539	2539

The above table shows the descriptive statistics or summary of volume of securities traded in selected stock markets. This table also shows ADF (Augmented Dickey Fuller) test for checking the stationarity of volatility. It can be found that the probability values are 0.000 for all the stock markets. The null hypothesis (ADF test) of "volume" variable not being stationary is rejected at 5% level of significance for all the stock markets. Thus, volume of all the stock markets exhibits stationarity

Vector Auto Regression (VAR) Estimates for Volume of Trade and Volatility of selected stock markets

VAR model is used to test the dependency of variables considered for the study. In this section, dependency between volume of trade and volatility of stock market index returns are analysed.To perform VAR modelling, the time series of variables should be stationary. As a first step, trading volume and volatility are tested for stationarity using ADF test (and they are found to be stationary without differencing. Then the following VAR(k) model is estimated where the Akaike Information Criterion (AIC) is used to decide the optimal lag length. Optimal lag length is an important criterion in VAR model for ensuring its accuracy.

The VAR model for Developed and Emerging markets are presented below

Bivariate Vector Auto Regression Estimates (VAR) for Volatility and Trading Volume of Developed Markets

	VOLA_HSI	VOL_HSI		VOLA_N225	VOL_N225		VOLA_STI	VOL_STI
VOLA_HSI(-1)	0.090188***	8.95E+11***	***VOLA_N225(-1)***	0.311936***	8537753***	***VOLA_STI(-1)***	0.121053***	1.64E+11***
	(0.02)	-3.80E+10		(0.02)	(935235.00)		(0.02)	(1.50E+10)
	[4.53678]	[23.7032]		[15.7918]	[9.12899]		[6.09931]	[10.6492]
VOLA_HSI(-2)	0.01854	-7.59E+10	***VOLA_N225(-2)***	-0.104582***	-1355315	***VOLA_STI(-2)***	0.002004	7.28E+10***
	(0.02)	-4.20E+10		(0.02)	(950208.00)		(0.02)	(1.60E+10)
	[0.84448]	[-1.82024]		[-5.21105]	[-1.42633]		[0.09860]	[4.61096]
VOL_HSI(-1)	1.01E-14	0.633171***	***VOL_N225(-1)***	1.25E-09***	0.79863***	***VOL_STI(-1)***	1.72E-14	0.49696***
	-1.00E-14	(0.02)		(4.20E-10)	(0.02)		(2.50E-14)	(0.02)
	[0.97737]	[32.1661]		[3.00286]	[40.6033]		[0.68079]	[25.3426]
VOL_HSI(-2)	2.18E-14**	0.096711***	***VOL_N225(-2)***	-5.13E-10	0.129691***	***VOL_STI(-2)***	5.29E-14**	0.134683***
	-9.70E-15	(0.02)		(4.10E-10)	(0.02)		(2.50E-14)	(0.02)
	[2.24266]	[5.23159]		[-1.24576]	[6.64604]		[2.13852]	[7.01608]
C	1.14E-05	4.14E+08***	***C***	3.89E-06	8394.528***	***C***	1.38E-05**	80021837***
	-1.30E-05	-2.50E+07		(2.30E-05)	(1085.56)		(5.50E-06)	(4299153.00)
	[0.87485]	[16.7046]		[0.16960]	[7.73287]		[2.49342]	[18.6134]

****,*** indicates statistical significance at 5% and 1% respectively**
(Standard errors are indicated in '( )' & t-statistics in '[ ]', the number without brackets indicate the coefficient of corresponding lagged variables)

Bivariate Vector Auto Regression Estimates (VAR) for Volatility and Trading Volume of Emerging Markets

	VOLA_PSEI	VOL_PSEI		VOLA_SSE	VOL_SSE		VOLA_NSE	VOL_NSE
VOLA_PSEI(-1)	0.124921***	-7197044	***VOLA_SSE(-1)***	0.126298***	11182061***	***VOLA_NSE(-1)***	0.03547	1.56E+10
	(0.02)	(4.00E+07)		(0.02)	(1416113.00)		(0.02)	(8.60E+09)
	[6.38580]	[-0.18032]		[6.36159]	[7.89630]		[1.78766]	[1.80572]
VOLA_PSEI(-2)	0.171777***	-7255655	***VOLA_SSE(-2)***	0.029884	-132889.1	***VOLA_NSE(-2)***	0.018462	5.62E+09
	(0.02)	(4.00E+07)		(0.02)	(1431514.00)		(1.99E-02)	(8.60E+09)
	[8.78101]	[-0.18179]		[1.48905]	[-0.09283]		[0.93000]	[0.65059]
VOL_PSEI(-1)	-1.81E-12	-0.000824	***VOL_SSE(***	9.91E-10***	0.767807***	***VOL_NSE(***	-6.4E-14	0.674569***

	(9.70E-12)	(0.02)	*-1)*	(2.70E-10)	(0.02)	*-1)*	(4.40E-14)	(0.02)
	[-0.18577]	[-0.04150]		[3.62710]	[39.3855]		[-1.44537]	[34.9313]
VOL_PSEI(-2)	-1.86E-12	-0.000799	***VOL_SSE(-2)***	-1.49E-10	0.18946***	***VOL_NSE(-2)***	8.10E-14	0.234511***
	(9.70E-12)	(0.02)		(2.70E-10)	(0.02)		(4.40E-14)	(0.02)
	[-0.19149]	[-0.04024]		[-0.54959]	[9.78166]		[1.82435]	[12.1436]
C	0.000198***	216420.7***	***C***	-5.59E-05***	7146.896***	***C***	4.76E-05***	20657490***
	(3.30E-05)	(66400.80)		(1.80E-05)	(1287.74)		(6.10E-06)	(2669936.00)
	[6.07939]	[3.25931]		[-3.09398]	[5.54994]		[7.75221]	[7.73707]

,* **indicates statistical significance at 5% and 1% respectively**
(Standard errors are indicated in '( )' & t-statistics in '[ ]', the number without brackets indicate the coefficient of corresponding lagged variables)

The output of VAR estimation is shown for different stock markets in the above tables All the headings presented column wise indicate that these variables are treated as dependent variables. In first column, Volume is kept as dependent variable and lags of Volatility are taken as independent variables whereas in the subsequent column, Volatility is kept as dependent variable and lags of Volume are taken as independent variables. The lagged independent variables are presented row wise in Italics. Standard errors are indicated in '( )' & t-statistics in '[ ]', the number without brackets indicate the coefficient of corresponding lagged variables of VAR equation. The coefficients of the concerned equations of VAR which are significant are denoted with star symbols.

Granger Causality is not a test for true cause and effect relationship. In other words, it is used to check whether past values of one variable is having significant information that leads to prediction of the other variable. X is said to Granger Cause Y if the future values of Y can be better predicted using the past values of both X and Y than it can be ,by using the past value of Y alone.

Pair wise Granger Causality Tests between Volume of trade and Volatility

Ho(Null)	Index	F-Statistic	Prob.
VOLATALITY of HSI does not Granger Cause VOLUME of	HSI	82.1567	0***
	N225	12.2589	0***
	SSE	8.8331	0***
	STI	8.55973	0***
	PSEI	6.37356	0***
	NSE	0.81711	0.5729
VOLUME of HSI does not Granger Cause VOLATALITY OF	HSI	3.65609	0.0006***
	N225	1.40269	0.1996
	SSE	3.35366	0.0015***
	STI	1.11687	0.3493
	PSEI	1.25315	0.2699
	NSE	0.79069	0.5951
VOLATALITY of SSE does not Granger Cause VOLUME of	HSI	21.3329	0***
	N225	5.03429	0.00001***
	SSE	12.1089	0***
	STI	3.89402	0.0003***
	PSEI	0.04698	0.9999
	NSE	0.57198	0.7792
VOLUME of SSE does not Granger Cause VOLATALITY OF	HSI	3.87635	0.0003***
	N225	0.97918	0.4445
	SSE	7.81745	0***
	STI	1.79035	0.0849

	PSEI	0.72284	0.6527
	NSE	1.07382	0.3775
VOLATALITY of N225 does not Granger Cause VOLUME of	HSI	6.08494	0***
	N225	14.3834	0***
	SSE	2.32331	0.0231**
	STI	3.53428	0.0009***
	PSEI	4.10552	0.0002***
	NSE	0.56813	0.7823
VOLUME of N225 does not Granger Cause VOLATALITY OF	HSI	5.28135	0.00001***
	N225	4.6039	0.00004***
	SSE	1.93334	0.0606
	STI	4.13374	0.0002***
	PSEI	1.4306	0.1883
	NSE	4.53559	0.00005***
VOLATALITY of NSE does not Granger Cause VOLUME of	HSI	6.10186	0***
	N225	8.09296	0***
	SSE	0.24872	0.9727
	STI	6.06364	0***
	PSEI	5.74397	0***
	NSE	3.97934	0.0002***
VOLUME of NSE does not Granger Cause VOLATALITY OF	HSI	0.27951	0.9621
	N225	0.35015	0.9306
	SSE	0.66582	0.7012
	STI	1.18874	0.3056
	PSEI	1.18874	0.3056
	NSE	1.0296	0.4079
VOLATALITY of STI does not Granger Cause VOLUME of	HSI	14.9182	0***
	N225	10.2125	0***
	SSE	0.87376	0.5264
	STI	21.1094	0***
	PSEI	6.18618	0***
	NSE	1.66029	0.1143
VOLUME of STI does not Granger Cause VOLATALITY OF	HSI	1.90457	0.0649
	N225	2.29332	0.025**
	SSE	0.77069	0.612
	STI	1.76191	0.0906
	PSEI	0.4202	0.8903
	NSE	0.96647	0.454
VOLATALITY of PSEI does not Granger Cause VOLUME of	HSI	0.40447	0.9
	N225	0.44493	0.8741
	SSE	0.27804	0.9627
	STI	0.87915	0.522
	PSEI	0.02324	1
	NSE	1.15709	0.3243
VOLUME of PSEI does not Granger Cause VOLATALITY OF	HSI	3.53196	0.0009***
	N225	11.1112	0***
	SSE	0.48859	0.8435

	STI	7.18022	0***
	PSEI	0.96903	0.4521
	NSE	1.64636	0.1179

The above table presents the Granger Causality for different pairs of volatility and volume of selected stock markets. *** and ** indicate Granger causality test is significant at 1% level and 5% level respectively.

- For the pairs, VOLATILITY_HSI and VOLUME of selected markets, null hypothesis of no granger causality is rejected at 1% level of significance for all combinations except NSE.So the volatility in HSI granger causes volume in all markets except NSE. It means that the lagged values of VOLATILITY _HSI can better predict Volume in all markets except in Indian Stock Market (NSE).
- For the pairs, VOLUME_HSI and VOLATILITY of selected markets, null hypothesis of no granger causality is rejected at 1% level of significance for Hong Kong and Chinese Stock markets. So the volume in HSI granger causes volatility in HSI and SSE. It means that the Volume of Trade in Hong Kong market can predict the volatility in HSE and SSE.
- For the pairs, VOLATILITY_SSE and VOLUME of selected markets, null hypothesis of no granger causality is rejected at 1% level of significance for all combinations except PSEI and NSE.So the volatility in SSE granger causes volume in all markets except PSEI and NSE. It means that the lagged values of VOLATALITY _SSE can better predict Volume in all markets except in Philippine (PSEI) and Indian Stock Market (NSE).
- For the pairs, VOLUME_SSE and VOLATILITY of selected markets, null hypothesis of no granger causality is rejected at 1% level of significance for Hong Kong and Chinese Stock markets. So, the volume in SSE granger causes volatility in HSI and SSE. It means that the Volume of Trade in Chinese market can predict the volatility in HSE and SSE.
- For the pairs, VOLATILITY_N225 and VOLUME of selected markets, null hypothesis of no granger causality is rejected at 1% level of significance for all combinations except NSE. So, the volatility in N225 granger causes volume in all markets except NSE It means that the lagged values of VOLATILITY _N225 can better predict Volume in all markets except in Indian Stock Market (NSE).
- For the pairs, VOLUME_N225 and VOLATILITY of selected markets, null hypothesis of no granger causality is rejected at 1% level of significance for all combinations except Philippine (PSEI) and China Stock markets (SSE). So, the volume in N225 granger causes volatility in PSEI and SSE. It means that the Volume of Trade in Japan cannot predict the volatility in PSEI and SSE.
- For the pairs, VOLATILITY_NSE and VOLUME of selected markets, null hypothesis of no granger causality is rejected at 1% level of significance for all combinations except SSE. So, the volatility in NSE granger causes volume in all markets except SSE. It means that the lagged values of VOLATILITY _NSE can better predict Volume in all markets except in Chinese Stock Market (SSE).
- For the pairs, VOLUME_NSE and VOLATILITY of selected markets, null hypothesis of no granger causality is not rejected at 1% and 5% level of significance for all combinations. It means that the Volume of Trade in India cannot predict the volatility in other selected markets.
- For the pairs, VOLATILITY_STI and VOLUME of selected markets, null hypothesis of no granger causality is rejected at 1% level of significance for all combinations except SSE and NSE. So, the volatility in STI granger causes volume in all markets except SSE and NSE. It means that the lagged values of VOLATILITY_STI can better predict Volume in all markets except in Indian (NSE) and Chinese Stock Market (SSE).
- For the pairs, VOLUME_STI and VOLATILITY of selected markets, null hypothesis of no granger causality is rejected at 5% level of significance for only Japanese Stock Market (N225). So, the volume in STI granger causes volatility in N225. It means that the Volume of Trade in Singapore can predict the volatility in Japan (N225).
- For the pairs, VOLATILITY_PSEI and VOLUME of selected markets, null hypothesis of no granger causality is accepted for all combinations. It means that the lagged values of VOLATILITY_PSEI cannot predict Volume in all selected markets.
- For the pairs, VOLUME_PSEI and VOLATILITY of selected markets, null hypothesis of no granger causality is rejected at 1% level of significance for Hong Kong (HSI), Japanese Stock Market (N225) and Singapore Stock Market(STI). So, the volume in PSEI granger causes volatility in N225, HSI and STI. It means that the Volume of Trade in Philippine can predict the volatility in HSI, N225 and STI.

Pair wise Granger Causality Tests between Volumes of trade for different markets

Ho(Null)	Index	F-Statistic	Prob.
VOLUME_HSI does not Granger Cause VOLUME of	N225	1.53224	0.1516
	SSE	1.61443	0.1266
	STI	1.30476	0.2438

	PSEI	0.30107	0.9536
	NSE	1.72192	0.0994
VOLUME_SSE does not Granger Cause VOLUME of	HSI	2.51492	0.0141**
	N225	1.02885	0.4085
	STI	0.42031	0.8902
	PSEI	0.12195	0.9968
	NSE	1.04689	0.3959
VOLUME_N225 does not Granger Cause VOLUME of	HSI	1.42496	0.1906
	SSE	0.6017	0.755
	STI	3.25272	0.0019***
	PSEI	1.50358	0.1613
	NSE	3.07766	0.0031***
VOLUME_NSE does not Granger Cause VOLUME of	HSI	0.44505	0.874
	N225	2.23216	0.0291**
	SSE	0.27826	0.9626
	STI	0.92456	0.4861
	PSEI	0.30232	0.9531
VOLUME_STI does not Granger Cause VOLUME of	HSI	1.53511	0.1507
	N225	3.03593	0.0035***
	SSE	0.39256	0.9072
	PSEI	0.47241	0.8551
	NSE	9.02622	0***
VOLUME_PSEI does not Granger Cause VOLUME of	HSI	0.21194	0.9828
	N225	2.97917	0.0041***
	SSE	0.73994	0.6381
	STI	0.27504	0.9638
	NSE	0.33676	0.9374

- For the pairs, VOLUME_HSI and VOLUME of selected markets, null hypothesis of no granger causality is accepted for all combinations. It means the Volume of Trade in HSI does not predict the Volume of trade in other markets
- For the pairs, VOLUME_SSE and VOLUME of selected markets, null hypothesis of no granger causality is accepted for all combinations except for Hong Kong. So, the volume in SSE granger causes volume in HSI. It means the Volume of Trade in SSE does not predict the Volume of trade in other markets except HSI.
- For the pairs, VOLUME_N225 and VOLUME of selected markets, null hypothesis of no granger causality is accepted for all combinations except for India and Singapore. So, the volume in N225 granger causes volume in STI and NSE. It means the Volume of Trade in N225 does not predict the Volume of trade in other markets except STI and NSE.
- For the pairs, VOLUME_NSE and VOLUME of selected markets, null hypothesis of no granger causality is accepted for all combinations except for Japan. So, the volume in SSE granger causes volume in N225.It means the Volume of Trade in NSE does not predict the Volume of trade in other markets except N225.
- For the pairs, VOLUME_STI and VOLUME of selected markets, null hypothesis of no granger causality is accepted for all combinations except for Japan and India. So, the volume in STI granger causes volume in NSE and N225.It means the Volume of Trade in STI does not predict the Volume of trade in other markets except N225 and NSE.
- For the pairs, VOLUME_PSEI and VOLUME of selected markets, null hypothesis of no granger causality is accepted for all combinations except for Japan.So the volume in PSEI granger causes volume in N225. It means the Volume of Trade in PSEI does not predict the Volume of trade in other markets except N225.

Variance decomposition

Once the VAR system and Granger tests were estimated, the Variance decomposition and Impulse response functions are used These are short run dynamic estimates. The variance decomposition measures the proportion of the movement of the nstepahead forecast error variance of a variable in the VAR system that is attributable to its own shock and from any other variable present in the system. The results of variance decomposition of Volatility and Trading Volume are displayed in below tables.

Variance decomposition of Volatility and Trading Volume of HSI,N225 and STI

	Variance Decomposition of VOLA_HSI:			Variance Decomposition of VOLA_N225:			Variance Decomposition of VOLA_STI		
Period	S.E.	VOLA_HSI	VOL_HSI	S.E.	VOLA_N225	VOL_N225	S.E.	VOLA_STI	VOL_STI
1	0.0002	100	0	0.0002	100.00	0.00	0.002	100.00	0.00
2	0.0002	99.96	0.04	0.0002	99.68	0.32	0.002	99.98	0.02
3	0.0002	99.66	0.34	0.0002	99.53	0.47	0.002	99.74	0.26
4	0.0002	99.49	0.51	0.0002	99.43	0.57	0.002	99.65	0.35
5	0.0002	99.38	0.62	0.0002	99.35	0.65	0.002	99.59	0.41
6	0.0002	99.31	0.69	0.0002	99.27	0.73	0.002	99.57	0.43
7	0.0002	99.27	0.73	0.0002	99.20	0.80	0.002	99.55	0.45
8	0.0002	99.24	0.76	0.0002	99.14	0.86	0.002	99.55	0.45
9	0.0002	99.22	0.78	0.0002	99.09	0.91	0.002	99.54	0.46
10	0.0002	99.21	0.79	0.0002	99.04	0.96	0.002	99.54	0.46
	Variance Decomposition of VOL_HSI:			**Variance Decomposition of VOL_N225:**			**Variance Decomposition of VOL_STI**		
Period	S.E.	VOLA_HSI	VOL_HSI	S.E.	VOLA_N225	VOL_N225	S.E.	VOLA_STI	VOL_STI
1	368000000	0.01	99.99	23304.09	0.03	99.97	67677790	0.05	99.95
2	468000000	13.33	86.67	30073.69	1.68	98.32	77052837	3.85	96.15
3	515000000	15.43	84.57	35309.66	2.31	97.69	82837506	6.95	93.05
4	544000000	16.58	83.42	39335.62	2.55	97.45	85523087	8.15	91.85
5	561000000	17.21	82.79	42591.93	2.66	97.34	86915522	8.71	91.29
6	572000000	17.56	82.44	45289.18	2.73	97.27	87630398	8.99	91.01
7	579000000	17.78	82.22	47559.38	2.78	97.22	88002588	9.13	90.87
8	584000000	17.91	82.09	49490.56	2.82	97.18	88196478	9.21	90.79
9	586000000	17.99	82.01	51146.33	2.85	97.15	88297709	9.24	90.76
10	588000000	18.04	81.96	52574.63	2.88	97.12	88350593	9.26	90.74

Variance decomposition of Volatility and Trading Volume of PSEI, SSE and NSE

	Variance Decomposition of VOLA_PSEI:			Variance Decomposition of VOLA_SSE:			Variance Decomposition of VOLA_NSE:		
Period	S.E.	VOLA_PSEI	VOL_PSEI	S.E.	VOLA_SSE	VOL_SSE	S.E.	VOLA_NSE	VOL_NSE
1	0.002	100.00	0.00	0.002	100.00	0.00	0.0002	100.00	0.00
2	0.002	100.00	0.00	0.002	99.51	0.49	0.0002	99.92	0.08
3	0.002	100.00	0.00	0.002	99.24	0.76	0.0002	99.90	0.10
4	0.002	100.00	0.00	0.002	98.94	1.06	0.0002	99.90	0.10
5	0.002	100.00	0.00	0.002	98.66	1.34	0.0002	99.89	0.11
6	0.002	100.00	0.00	0.002	98.39	1.61	0.0002	99.89	0.11
7	0.002	100.00	0.00	0.002	98.14	1.86	0.0002	99.88	0.12
8	0.002	100.00	0.00	0.002	97.90	2.10	0.0002	99.88	0.12
9	0.002	100.00	0.00	0.002	97.68	2.32	0.0002	99.88	0.12
10	0.002	100.00	0.00	0.002	97.47	2.53	0.0002	99.88	0.12
	Variance Decomposition of VOL_PSEI:			**Variance Decomposition of VOL_SSE:**			**Variance Decomposition of VOL_NSE:**		
Period	**S.E.**	**VOLA_PSEI**	**VOL_PSEI**	**S.E.**	**VOLA_SSE**	**VOL_SSE**	**S.E.**	**VOLA_NSE**	**VOL_NSE**
1	3251103	0.00	100.00	34217.97	0.05	99.95	66636653	0.01	99.99
2	3251125	0.00	100.00	43399.82	1.24	98.76	80428124	0.13	99.87
3	3251151	0.00	100.00	51293.66	1.53	98.47	92642260	0.20	99.80
4	3251153	0.00	100.00	57674.61	1.78	98.22	102000000	0.24	99.76
5	3251155	0.00	100.00	63156.20	1.94	98.06	109000000	0.26	99.74
6	3251155	0.00	100.00	67942.17	2.04	97.96	115000000	0.28	99.72
7	3251155	0.00	100.00	72188.34	2.12	97.88	119000000	0.29	99.71
8	3251155	0.00	100.00	75995.28	2.18	97.82	123000000	0.30	99.70
9	3251155	0.00	100.00	79436.45	2.22	97.78	127000000	0.31	99.69
10	3251155	0.00	100.00	82566.74	2.26	97.74	129000000	0.31	99.69

Variance decomposition model indicates the extent to which the shock in one variable will affect the other variable and the effect of its own shock. The above table aboveshows the variance decomposition values for Developed markets.
The output is shown for a period of 10 days.

- Response of volatility of Hong Kong market (HSI) to its own shock is significantly greater than the shock due to its trading volume. That means the volatility in the index can be explained mainly by its own shock for all the ten-day period. Whereas the Response of volume traded in Hong Kong market (HSI) to the shock in volatility is less initially which increases gradually from period one to ten. However, the response of volume traded is majorly caused by the volume itself.
- Response of volatility of Japan (N225) to its own shock is significantly greater than the shock due to its trading volume. That means the volatility in the index can be explained mainly by its own shock for all the ten-day period. Whereas the Response of volume traded in Japanese stock market (N225) to the shock in volatility is less initially which increases marginally from period one to ten. However, the response of volume traded is majorly caused by the volume itself.
- Response of volatility of Singapore (STI) to its own shock is significantly greater than the shock due to its trading volume. That means the volatility in the index can be explained mainly by its own shock for all the

ten-day period. Whereas the Response of volume traded in Singapore stock market (STI) to the shock in volatility is less initially which increases marginally from period one to ten. However, the response of volume traded is majorly caused by the volume itself.

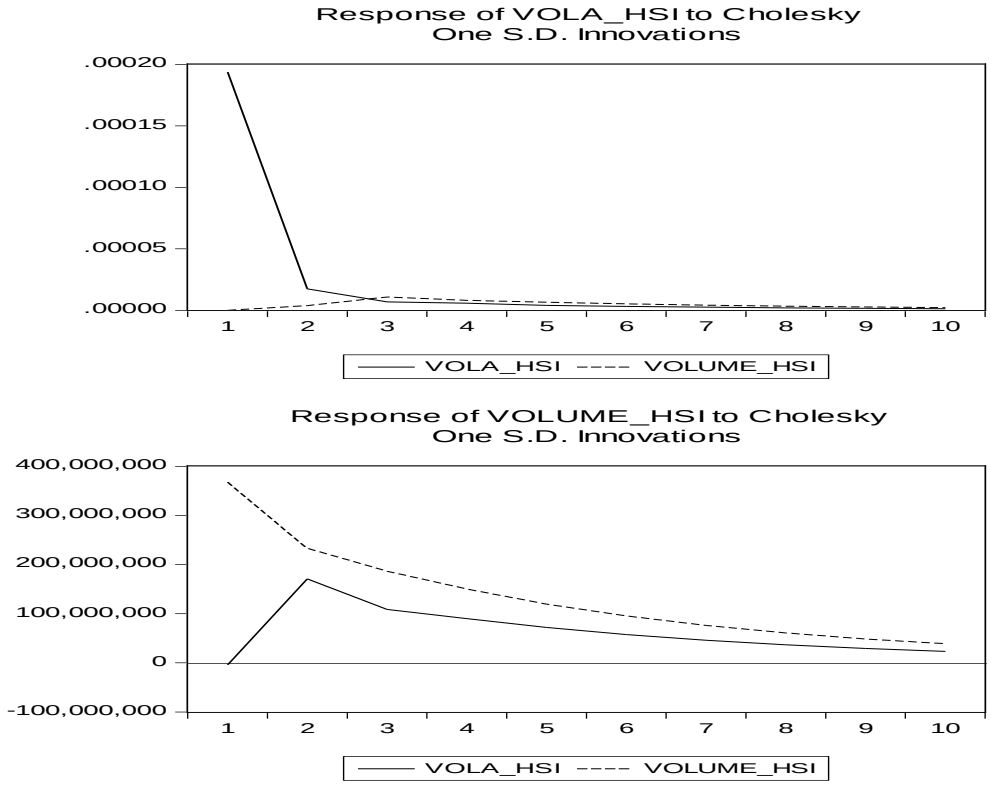
The volatility in all the developed stock markets is seen as a response of its own shock and not significantly by the shock in the volume of shares traded.

The above table above shows the variance decomposition values for all the Emerging markets.
The output is shown for a period of 10 days.

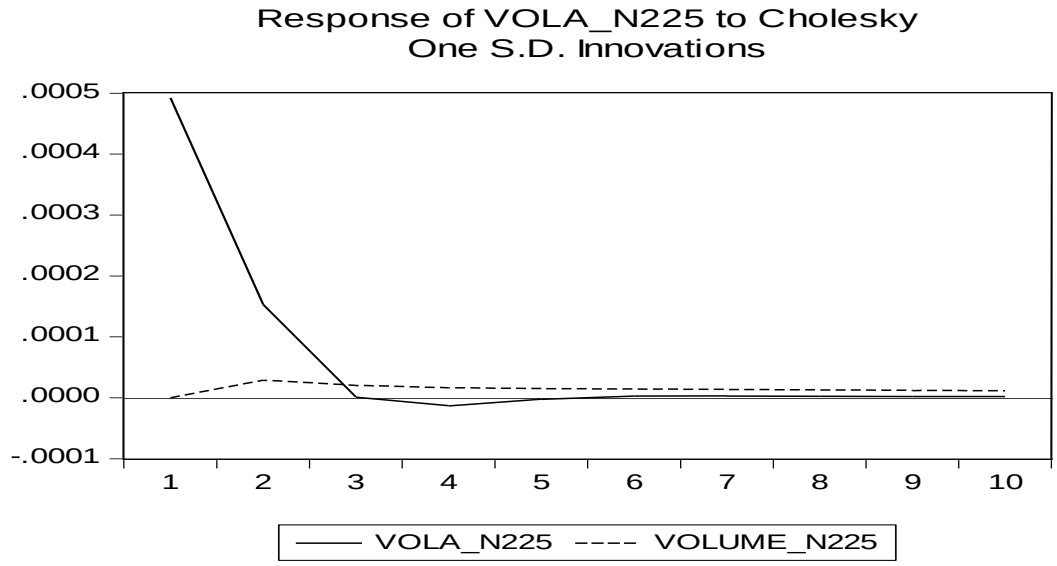
- The volatility of Philippine Stock market Index (PSEI) is completely a response of it its own shock and the shock in volume of trade has no Impact. A similar behavior is seen in the response by the volume traded, it reacts only to the shock in volume and not to the volatility seen in the Stock market.
- Response of volatility of Chinese Stock market Index (SSE) to its own shock is significantly greater than the shock due to its trading volume. That means the volatility in the index can be explained mainly by its own shock for all the ten-day period. Whereas the Response of volume traded in Chinese stock market (SSE) to the shock in volatility is less initially which increases marginally from period one to ten. However, the response of volume traded is majorly caused by the volume itself.
- Response of volatility of Indian Stock market Index (NSE) to its own shock is significantly greater than the shock due to its trading volume. That means the volatility in the index can be explained mainly by its own shock for all the ten-day period. Whereas the Response of volume traded in Indian Stock market (NSE) to the shock in volatility is less initially which increases marginally from period one to ten. However, the response of volume traded is majorly caused by the volume itself.

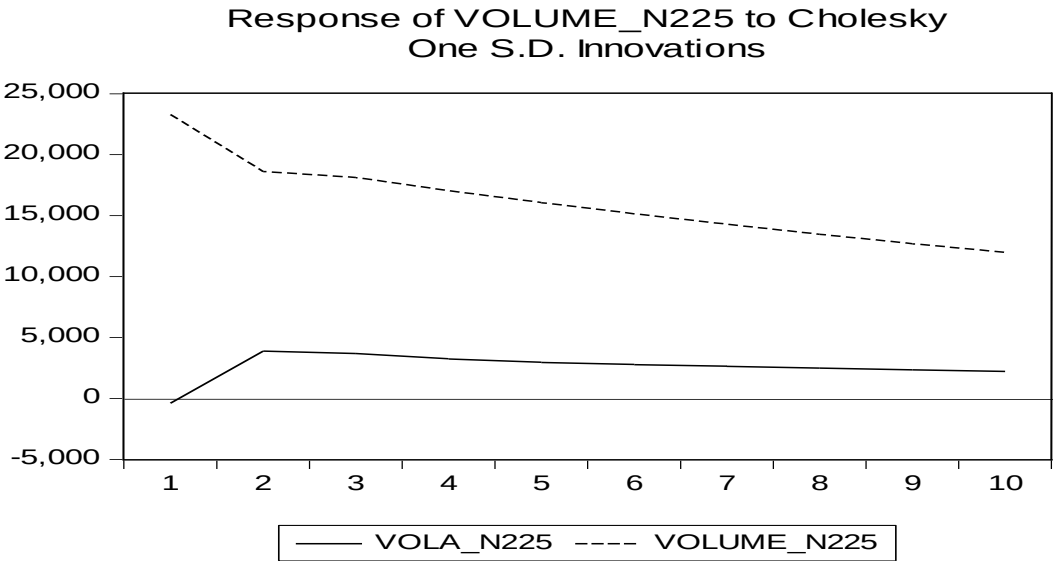
The volatility in all the emerging stock markets can be seen as a response of its own shock and cannot be explained significantly by the shock in the volume of shares traded.
The graphs belowindicates impulse response function (variance decomposition is presented in the table is shown in the form of impulse response function graph). All the graphs reveal the divergence of variable due to its own shock and later converge. This indicates the effect of its own shock (volume or volatility) is comparatively more in the initial period and later converges or reduces gradually.

Impulse response function (Both Volume and Volatility) graph for HIS

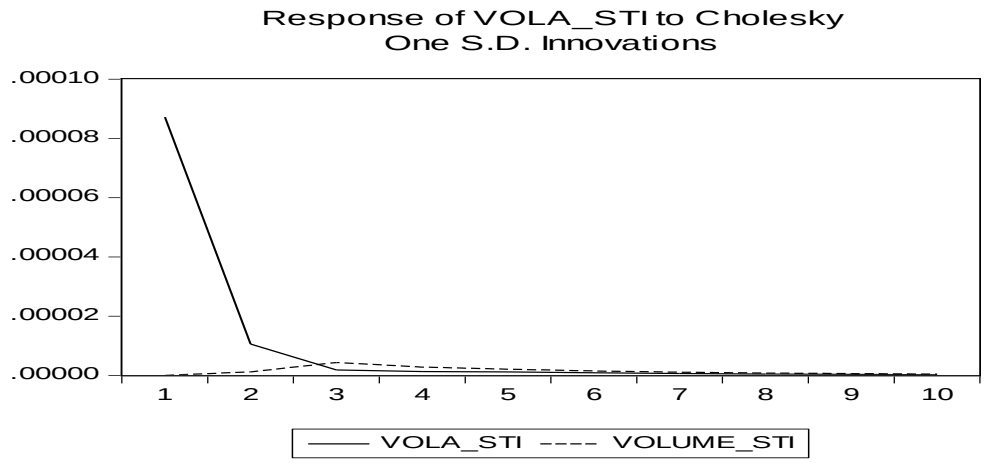


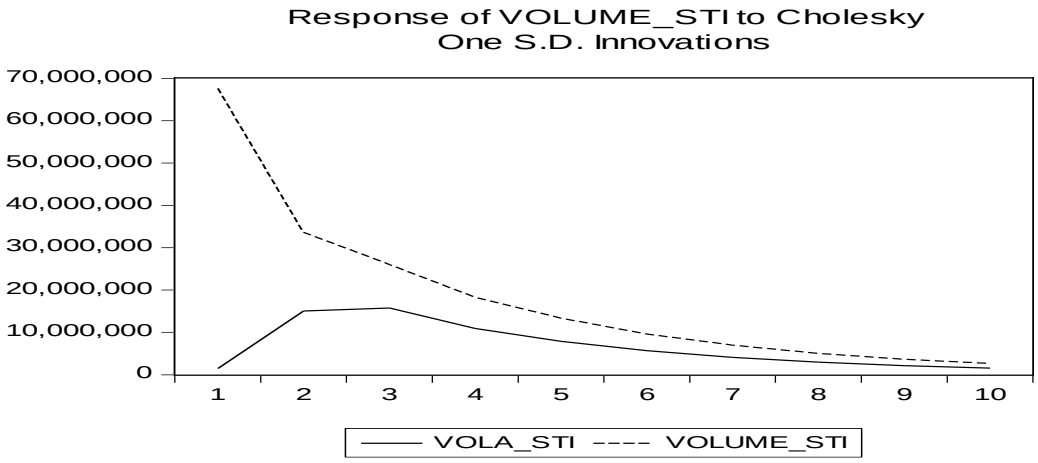
Impulse response function (Both Volume and Volatility) graph for N225



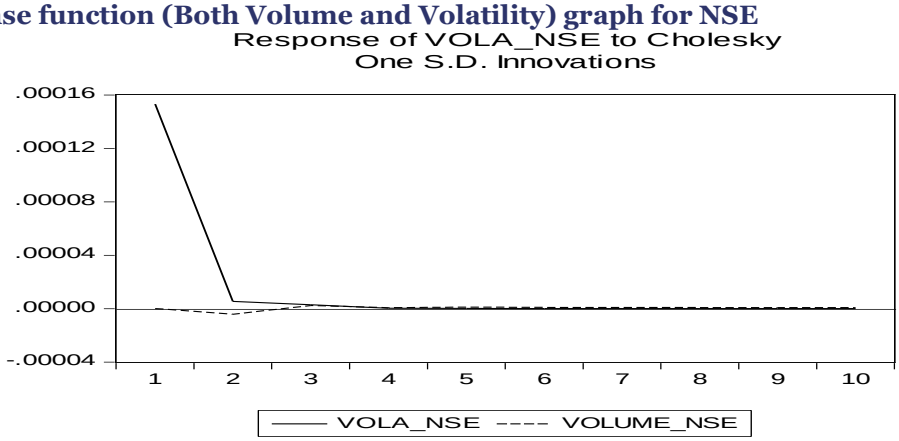


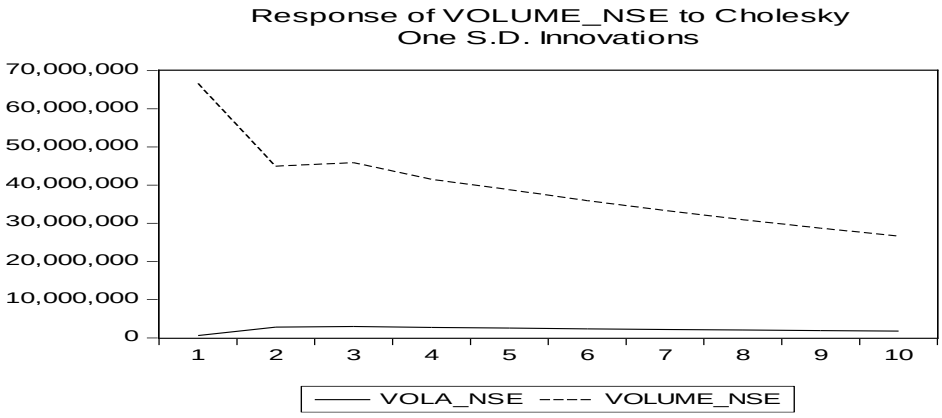
Impulse response function (Both Volume and Volatility) graph for STI



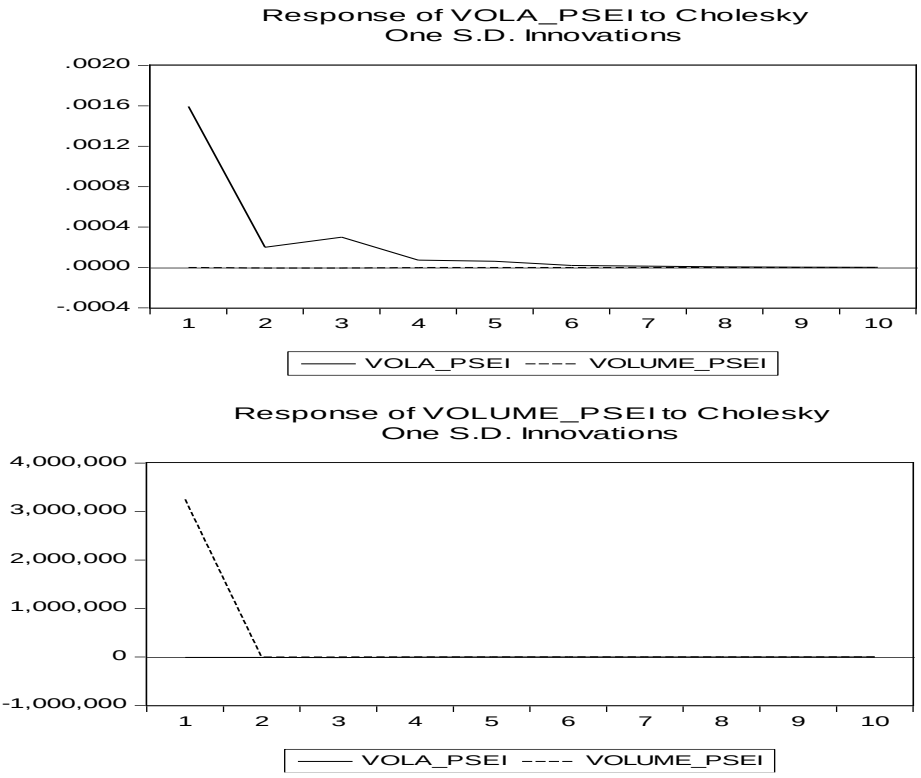


Impulse response function (Both Volume and Volatility) graph for NSE

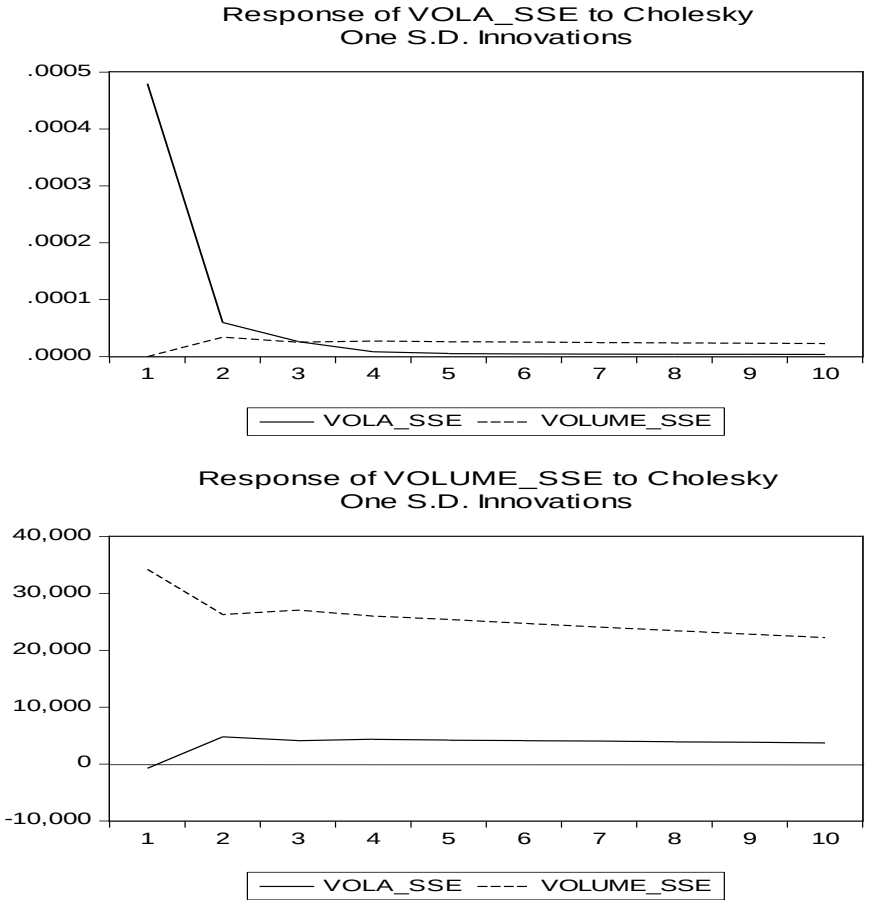




Impulse response function (Both Volume and Volatility) graph for PSEI



Impulse response function (Both Volume and Volatility) graph for SSE



The reaction of a variable to an impulse in another variable is represented by Impulse response plots. From the above graphs it can be seen that the volatility in the HSI can be explained due to its own shock for the first period which marginally decreases from the period two. There is very minute effect of volume on the Volatility of HSI. The volume of trade in HSI is majorly affected by its volume itself initially but contribution of volatility in its market is also observed. The volatility and volume in N225 is majorly explained by the same variable. The other variable has a very in significant effect on the other. A similar behavior can be observed in the Singapore market (STI) as well.

In case of emerging stock markets, volatility in NSE can be seen due to its own shock, the volume has no significant explanation on the volatility. The other way is also true in case of NSE. The same pattern can be seen for in SSE as well. But in case of PSEI 100% of explanation is seen from the own shock, that is impulse in volume has no effect on the volatility and vice versa.

Findings on Volume of trade and Volatility

The causation between Volume and Volatility was estimated for all the markets using Granger causality test. Volatility in returns from HSI caused volatility in volume in all markets except NSE; Volatility in returns from SSE caused volatility in volume in all markets except NSE and PSEI. Volatility in returns from N225 caused volatility in volume in all markets except NSE, Volatility in returns from NSE caused volatility in volume in all markets except SSE, Volatility in returns from STI caused volatility in volume in all markets except NSE and SSE, and volatility in PSEI does not cause volatility in volume in any of the markets under consideration.

Volatility in Volume in HSI caused volatility in return in HSI itself and SSE, Volatility in Volume in SSE caused volatility in return in SSE itself and HSI, Volatility in Volume in N225 caused volatility in return in all markets except SSE and PSEI, Volatility in Volume in NSE did not cause volatility in any of the markets, Volatility in Volume in STI caused volatility in return in N225 and Volatility in Volume in PSEI caused volatility in return in all the developed markets under consideration.

The dependency between Volume of trade and Volatility was assessed with the help of VAR model in the presence of multiple variables. Volatility in returns and Volume in HSI are statistically dependent on the first lag of Volatility seen in HSI and second lag of Volume. Volatility in returns and Volume in N225 are statistically dependent at 1% level of significance on the first lag of Volatility seen in returns from N225 and on Volume. Volatility in returns and Volume in STI are statistically dependent on the first lag of Volatility seen in STI and second lag of Volume. Volatility in returns in PSEI is statistically dependent on the first lag of its own Volatility. Volatility in returns and Volume in SSE are statistically dependent at 1% level of significance on the first lag of Volatility seen in returns from SSE and Volume. Volume in NSE is statistically dependent at 1% level of significance on the first lag of its Volume.

Variance decomposition is another way to evaluate how one financial variable affects the other. It indicates the extent to which the shock in one variable affects the other variable and the effect of its own shock. From the output for the period of ten days, Response of volatility of HSI to its own shock is comparatively higher and is found to marginally increase from periods one to ten than the shock due to its trading volume. But the impact of Volume is relatively lesser on volatility in case of HSI. The Similar pattern is observed for the response of volatility of NSE, N225, SSE and STI. In case of volatility of PSEI, major shock happens as a response to its own shock for the periods one to ten and no contribution to shock is made by the volume. The same behavior is observed for volume decomposition in the Philippines market.

The understanding of volume of trade and the study of its pattern gives an idea about the strength or the investors opinion about the future behavior of stocks or in general the entire market. The trading participants can observe the signals from the volume to make decisions and optimize the portfolio.

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