"EFFECT OF VOLATILITY SPILLOVER BETWEEN THE FOREX MARKET AND INDIAN STOCK MARKET"

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Abstract:

The outbreak of COVID-19 has caused an unprecedented shock to the Indian economy. In the backdrop of the prevailing pandemic, this paper considers five Asian countries' currency

exchange values and analyses spillover effect of price and volatility against USD and Indian stock market. The duration of the study is for seven years starting from 2016 to 2022; the tool used is bi-variate asymmetric BEKK-GARCH model. The mean, volatility and shock spillover from the currency to the capital markets were studied. Empirical results reveal that there majorly exists a bidirectional spillover between the two markets. It is observed that relation between variance spread from capital market and foreign exchange is not symmetric. This indicates that there was higher volatility caused due to negative shocks when compared to positive shocks. High volatility was witnessed on spillovers as a result of the prevailing pandemic, this reflects that the tentative 'contagion' effect that enhances the volatility and intensifies the effect on the financial market.

JEL Classification: F 31, G 12, G 15, C 58

Keywords: BEKK-GARCH, rate of exchange, spillover, volatility, value of stock

The whole world has witnessed the impact of the onset of COVID-19, which has created an unprecedented shock to the economies across the globe. Uncertainty and Unpredictability are coupled with Volatility which has repercussions on the variance risk. Volatility is seen a signal of disturbance in the market by people, where the securities are not fairly priced, and markets are not behaving the way it should. The fluctuations or volatility in the capital market may significantly impact negatively on the risk averse investors and the economy. Largely increase in volatility of a domestic market impacts the pattern of consumption, decisions related to corporate capital investment, leverage decisions, business cycle and the macro economic variables. Due to the contagious characteristic of volatility, it becomes the need of the hour to know the events of the developed markets and how the emerging markets volatility comoves with it. This co-movement characteristic influences investment decisions, capital budget and variables of the business cycle. The Indian investors have also faced a high rate of uncertainty in relation to the physical as well as financial impact of the ailment. With the advent of liberalization of the economy, there has been an increase in investor's inclination towards international diversification. This has provided an opportunity even for the foreign investors to park their funds in the domestic financial market. Global diversification has enabled the investors to spread their asset portfolio into currency trading, thereby enhancing their reward-to-volatility ratio. The connect between returns from secondary market and currency exchange rate has caught the attention of researchers as well as policy makers from several decades. This interdependency has also magnified the transmission of volatility among stock market and currency. Volatility is significant to the functioning of financial market. It beholds the attention of retail investors, mutual fund managers, regulators and policy makers as it acts as an indicator of financial risk related to investments. As the currency markets trade on varying time zones, it is possible to

analyze if volatility is transmitted across markets. Mean return in stock market price can be explained as the average expected return of a portfolio by considering all the possible outcomes. The extent of interdependence among major Asian currencies and Indian stock market can be studies by measuring the nature and degree of mean and volatility spillovers in these markets.

Stock markets serve as economic barometers. In order to study the relationship between economies, the relationship between the stock markets can be studied as a proxy. Stock markets facilitate direct financing, movements in stock markets not only reflect not just domestic economic conditions but also the level of confidence that domestic and foreign investors have in the economies.

I Review of Literature

Wei, Lua et al. (2020) used Generalized vector autoregressive model (GVAR) and forecast error variances decomposition (FEVD) to measure exchange rate spillover effect of B & R currency market, before and during Covid-19 event. It was found that volatility in single currency led to wider corresponding currency movement resulting in wider risk in trading activities.

Mishra et al.(2007) have made an attempt to examine the inter- connection between Capital market of India and foreign exchange markets using GARCH and EGARCH models. The results proved high degree of integration and transfer of information amongst these two markets.

Jebran and Iqbal (2016) have analyzed the degree of mutual dependency and spillover of volatility of six Asian countries and FOREX. The EGARCH analysis signifies unidirectional movement of volatility from FOREX to capital market of India, but there is no inter-dependency among the above with reference to Japan.

Behera(2010) studied the international market for Indian rupee and the findings using GARCH revealed very significant impact of management and policy of exchange rate in the Indian context.

Dharmendra Singh, M. Theivanayaki M. M. Ganeshwari (2021), studied the volatility spillover effect between the forex market and the capital markets from BRICS Nations. GARCH method was used and they found that in the BRICS countries, spillover from the Forex markets to the capital market is more evident when compared the other way.

Volatility and correlation of cross-border markets has been analyzed by **Solnik et.al. (2019)** and it was concluded that even though there is less degree of correlation among bonds and stocks, it suggests that the domestic security prices are strongly affected by factors at the nation level.

The co-movement of currency and the structure of network correlation of foreign exchange market were examined by **Mai et.al (2018),** and consistency was observed between the network of currency modules and feature of currencies.

Average and variance spillover effects after capital market crash of 1987 was analyzed by **Liu and Pan (1997)** and found that the spillovers increased substantially after the stock market crash and the evidence also indicated the importance of contagion in transmission mechanism.

Naresh et.al (2018), have investigated the spread over effect of $ on significant capital market indices of BRICS nations in the long run and indicated that there has been an increase in nation's stock indices in comparison with the above aspects of the two currencies.

Sudarsana Sahoo, Harendra Behera and Pushpa Trivedi (2017), Investigated the effect of price volatility spillover between the Indian stock markets and the Forex market using BEKK-

GARCH Model to find that the negative shocks in the market resulted in greater volatility in the forex markets.

Though a number of literatures are available the results are inconsistent, this paper is an attempt to find the effect of volatility Spillover between the stock market and the Foreign exchange market.

II. Data and Methodology

In order to examine the mean, volatility and shock spillover from the currency markets to the stock markets, the values of five Asian countries' currencies against US dollar has been recorded. The purpose of this article is to evaluate the price and spread of fluctuation amongst five Asian countries' currency exchange values against USD and Indian Stock market. The duration for the study was daily data collected from the year 2016 to 2022, resulting in 2543 observations. The historical data of stock market price is taken from National Stock Exchange and for currency values, Investing.com has been referred. The research tool used for empirical analysis is bi-variate asymmetric BEKK-GARCH model, which is used to calculate the volatility of returns for stocks, bonds and market indices. Along with descriptive statistics, volatility spillover calculation, conditional covariance analysis, the following statistical and econometric techniques have been used to analyze the data using R software:

Jarque-Bera(JB) test

One of the most frequently used tests for normality is the Jarque-Bera Test. In many of the statistical tests, normality is one of the assumptions; JB test is generally used prior to these tests to check for normality.

Augmented Dickey Fuller test(ADF)

The correlation for higher-order parametric correction is constructed by Augmented Dickey Fuller test(ADF), IHS(2013). The assumption in this test is that y series pursues AR (p) procedure and there is additio of p lagged various rules of dependent variable y to the other side of the regression test, Tripathi (2019).

$$y = c + \beta t + \alpha y_{t-1} + \emptyset \, \Delta Y_{t-1} + et$$

Where,

$y_{t-1} = Time\ series$ with $oke\ lag$

$\Delta Y_{t-1} = the\ 1st\ differekce\ of\ the\ time\ series\ at\ t-1$

Phillips-Perron(PP test)

Phillips & Perron (1988) have suggested another procedure of managing correlation(serial) when unit root test is done, IHS(2013).

The usual t-statistic is modified:

$$Zt = \left(\frac{\partial^2}{\lambda^2}\right)^{1/2} . t = 0 \left(\frac{\lambda - \sigma^2}{\lambda^2}\right) . \left(\frac{T.SE(\varphi)}{\sigma^2}\right) \quad (1)$$

Kwiatkowski-Phillips-Schmidt-Shin(KPSS) Test

The variance between KPSS and other unit root test is that the series y^t is assumed to be stationary under the null, KPSS(1992).

$$KPSS = (T^{-1} \sum_{t=1}^{T} S^2)/\lambda^2 \quad (2)$$

Granger Causality Test

Granger Causality is an econometric concept of causality that is based on prediction (Tripathi (2019). The test is based on the following two regression equations:

$$y(t) = \Sigma\alpha y(t-i) + c + v(t)$$

$$y(t) = \alpha y(t-i) + \Sigma\beta x(t-\mathrm{j}) + c2 + v2(t) \quad (3)$$

BEKK-GARCH

The characterization and modeling of timeseries data with volatility, such as rate of exchange, rate of rise in price, stock prices etc. can be done with the help of Auto Regressive Conditional Heteroskedasticity (ARCH) model. In this article an attempt is made to analyze the volatility spillover between Indian stock market returns as represented by NSE, using BEKK-GARCH model, BEKK GARCH model which was proposed by Engle and Kroner (1995). In this model, conditional variances and covariance interaction is modeled and as a result, generated the positive conditional covariance matrix. This in turn leads to considerable reduction in number of parameters to be estimated.

$$R_t = \alpha\Gamma R_{t-1} + u_t$$

$$u_t|\Omega_{t-1}\ \Omega\sim \mathrm{N}(0, \mathrm{H}_t)$$

Where,

Return vector $R_t$is represented as

$$\mathrm{R_t} = [\mathrm{R_{1,t}}, \mathrm{R_{2,t}}]$$

Constant vector is denoted by alpha symbol and the residual vector

$\mathrm{u_t} = [\boldsymbol{\varepsilon}_{1,\mathrm{t}}, \varepsilon_{2,\mathrm{t}}]$is the bivariate, conditional normal distribution

$\Omega_{\mathrm{t}-1}$denotes the set of market information during time $\mathrm{t}-1$

H_t Indicates conditional covariance matrix and is presented below for a bivariate GARCH MODEL

Covariance matrix is represented as $H = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix}$

The BEKK model is given below,

$$H_t = C'C + A'\boldsymbol{\varepsilon}\boldsymbol{\varepsilon}'A_{11} + B'H_{t-1}B$$

$$\begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix} = \begin{bmatrix} c_{11,t} & c_{12,t} \\ c_{21,t} & c_{22,t} \end{bmatrix}' \begin{bmatrix} c_{11,t} & c_{12,t} \\ c_{21,t} & c_{22,t} \end{bmatrix} + \begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \end{bmatrix}' \begin{bmatrix} s^2_{1,t-1} & \varepsilon_{1,t-1,}\varepsilon_{2,t-1,} \\ \varepsilon_{2,t-1,}\varepsilon_{1,t-1,} & s^2_{2,t-1} \end{bmatrix} \begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \end{bmatrix} + \begin{bmatrix} \beta_{11,t} & \beta_{12,t} \\ \beta_{21,t} & \beta_{22,t} \end{bmatrix}' \begin{bmatrix} h_{11,t-1} & h_{12,t-1} \\ h_{21,t-1} & h_{22,t-1} \end{bmatrix} \begin{bmatrix} \beta_{11,t} & \beta_{12,t} \\ \beta_{21,t} & \beta_{22,t} \end{bmatrix}$$

Where ,

- C denotes 2x2 upper triangular matrices.
- Matrix A represents the ARCH effect of volatility,
- a_{ij} element indicates effect of volatility of market 'i' on market 'j',
- Matrix B indicates GARCH effect of volatility,
- bij element shows the persistence of volatility spillover between two markets denoted as 'i' and 'j'**.**

III. Sample Selection

The samples are selected based on stratified convenience technique. The IMF report of 2014 and 2019 classifies the Asian economies to Developed and Emerging markets. From these strata's the samples are picked based on convenience.

The spillover effect between the following pairs has been taken up:

1. NSE returns and USD_CNY

2. NSE returns and USD_HSK
3. NSE returns and USD_PHP
4. NSE returns and USD_JPY
5. NSE returns and USD_SGD

IV. Empirical Results

Volatility Spillover between Exchange Rates and NSE return

I. Table 1 Descriptive statistics of exchange rate change (appreciation/depreciation)

	USD_CNY (%)	**USD_HSK (%)**	**USD_INR (%)**	**USD_JPY (%)**	**USD_PHP (%)**	**USD_SGD (%)**
Airthematic mean	-4.47E-05	-1.83E-06	-0.000105	-7.74E-05	-8.54E-05	-3.71E-05
Md.	.0	.0	.0	.0	.0	.0
Max.	.011765	.004695	.018809	.041673	.015915	.016826
Min.	-.018177	-.003125	-.033448	-.033152	-.015915	-.015304
SD	.001753	.000366	.003877	.006192	.003149	.002575
Skewness	-.596099	.576342	-.488603	.077205	.022109	.263183
Kurtosis	16.50298	23.47055	8.401786	6.083402	5.131539	6.887295
Jarque-Bera	19470.02***	44541.95***	3192.972***	1009.911***	481.6246***	1630.500***
ARCH test (F-Statistics)	68.66***	19.53***	21.3048**	16.1173***	86.5555***	39.7370***
ADF test (t-statistics)	-51.46***	-57.04***	-55.53***	-59.81***	-62.58***	-51.51***

PP test (Adjusted t-statistics)	-51.6975***	-59.68***	-55.44***	-60.66***	-63.21***	-51.59***
KPSS statistics	0.087	0.098	0.094	0.25	0.23	0.17
Observations	2543	2543	2543	2543	2543	2543

Table 1 represents the descriptive statitsics of exchange rate of selected pairs of currencies in against the US dollar for the period of 7 years from 2016 to 2022. It can be found from the results that the mean change in exchange rates of currencies of different countries have recorded depreciation in terms of their respective home currency. In terms of standard deviation, USD_JPY has recorded highest value and USD_HSK with lowest value.

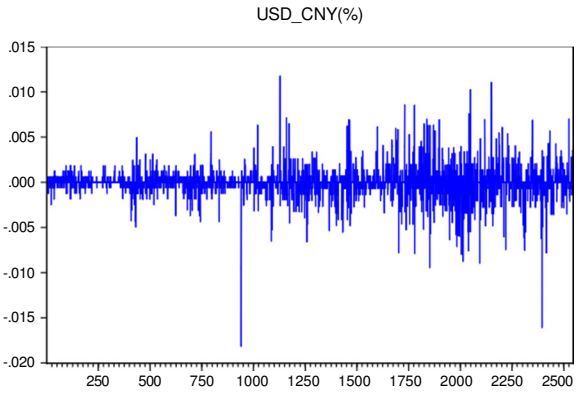
Jarque-Bera(JB) test is used to check the normality of data, test values are found to be statitistically significant at 1% level as the probability values are less than 0.01 for all the currency pairs. This rejects the null hypothesis that the given data series of exchange rate change is normally distributed. To put it clearly, this data series is not normally distributed. This is also confirmed with greater than three value of kurtosis which reveals that the data distrbution is leptokurtic.

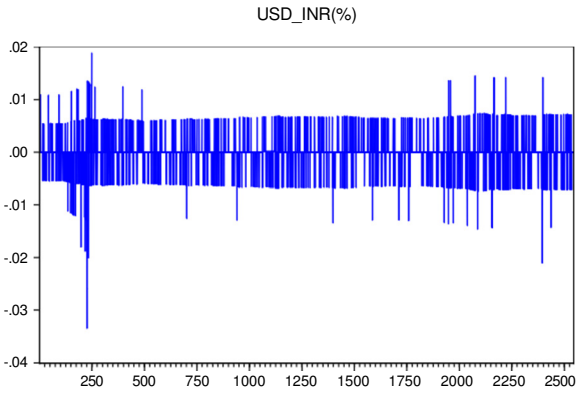
The stationarity of the data is checked using three tests such as Augmented Dickey Fuller test(ADF), Phillips-Perron(PP test) and KPSS statitics. The data series of the exchnage rate change is found to be stationary at level and the same is confirmed through these three tests.It can be found from the above stationarity tests, significant value of 0.00 for both Augmented Dickey Fuller and Phillips-Perron tests. This means that the null hypothesis of data series being non-stationary is not accepted at 1% level of significance . Again, the same is confirmed with the

help of KPSS test where the null hypothesis of variable exchange rate change is stationary is not rejected. Thus indicating that the exchange rate series is stationary at level.

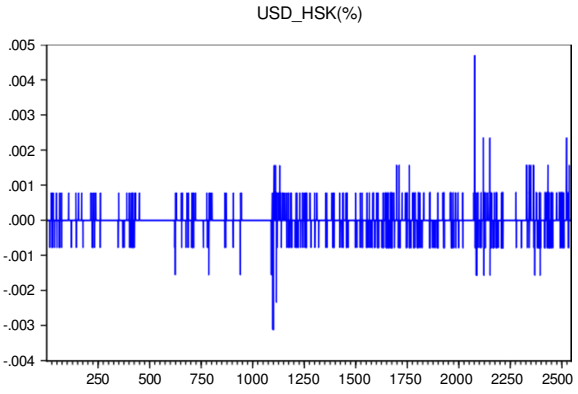
The table above also shows that prevalance of ARCH effect is not there in all exchange rate time series data. The presence of ARCH effect confirms that GARCH-BEKK models can be applied to capture volatility spillover between financial markets.

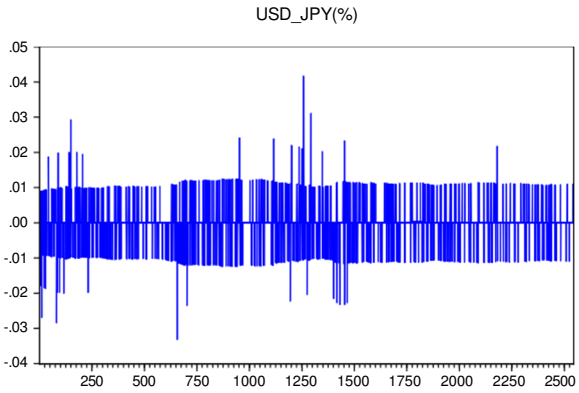
1. Graph 1: D**aily data of exchange rate appreciation /Depreciation**

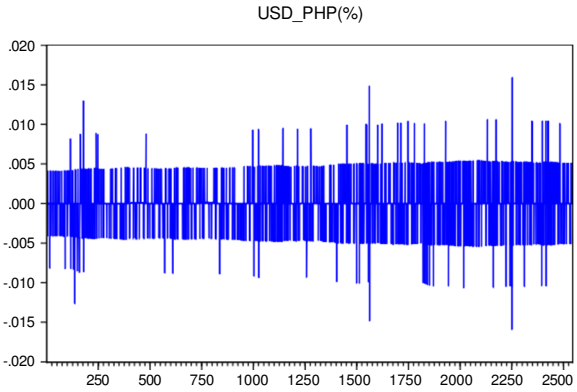


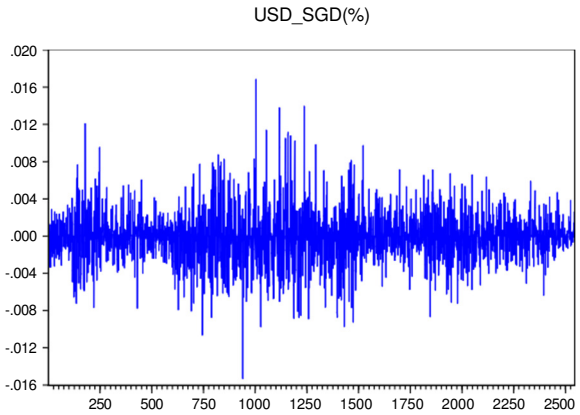


Source: Outcome of analysis using R









The above graphs presents the daily data of exchange rate change of various currencies against US dollars. This shows the mean reversion process for the data series indicating that the data is stationary.

The volatility spillover between Indian stock market returns as represented by NSE are analyzed using BEKK-GARCH model. The results of spillovers namely mean spillover, volatility spillover and shock spillover amongst returns of NSE and difference in exchange rate are presented in the below table:

II. Table 2: Volatility spillover between NSE returns and other selected countries exchange rate

Mean Equation Coefficients					
Transmission of mean spillover from	***NSE→USD_CNY*** 0.35(0.00)[1]***	***NSE→USD_HSK*** 1.09(0.00)[1]***	***NSE→USD_PHP*** 6.98(0.00)[I]***	**NSE→USD_JPY** 0.0003(0.00)[I]**	**NSE→USD_SGD** 0.0004(0.003)[I]***
Transmission of mean spillover from other currency	***USD_CNY →NSE*** -	***USD_HSK→NSE*** -0.27(0.00)[1]*** -0.12(0.00)[2]***	***USD_PHP→NSE*** 3.27E-05(0.039)[I]** 0.00(0.031)[4]**	***USD_JPY →NSE*** -	**NSE→USD_SGD** -0.036(0.042)[1]**
Variance Equation Coefficients (NSE→Other countries' exchange rate)					
	NSE→USD_CNY	***NSE→USD_HSK***	***NSE→USD_PHP***	**NSE→USD_JPY**	**NSE→USD_SGD**
GARCH1	8.97e-07(0.00)***	6.77e-07(0.00)***	8.61e-07(0.00)***	9.163e-07(0.00)***	9.8799e-07(0.00)***
RESID1(-1)^2 term	0.037(0.00)***	0.028(0.00)***	0.0379(0.00)***	0.0338(0.00)***	0.0342(0.00)***
GARCH1(-1) term	0.94(0.00)***	0.959(0.00)***	0.9477(0.00)***	0.9499(0.00)***	0.9482(0.00)***
Variance Equation Coefficients (Other countries' exchange rate→ NSE)					
	USD_CNY →NSE	***USD_HSK→NSE***	***USD_PHP→NSE***	***USD_JPY →NSE***	**NSE→USD_SGD**
GARCH2	2.50e-09(0.00)***	6.512e-09(0.00)***	1.18e-09(0.00)***	3.1024e-07(0.00)***	1.6443e-08(0.00)***
RESID2(-1)^2	0.0029(0.00) ***	0.1753(0.00)***	0.1499(0.00)***	0.0228(0.00)***	0.02581(0.00)***
GARCH2(-1)	0.9970(0.00)***	0.8146(0.00)***	0.5999(0.00)***	0.9694(0.00)***	0.972(0.00)***
Covariance Equations					
Intercept	1.81e-09(0.718)	7.24e-09(0.10)	6.852e-09(0.00)***	1.362e-08(0.64)	-1.532(0.8858)
Combined residuals	0.0104(0.00)***	0.07058	0.0753(0.00)***	0.0274(0.00)***	0.0296(0.00)***
COV1_2(-1) term	0.9720(0.00)***	0.8841(0.00)***	0.7540(0.00)***	0.9596(0.00)***	0.9601(0.00)***

The values inside the round brackets () of Table 2 indicate the probability values, inside square bracket [] denote the lag order, *, ** and *** represent the significance statistically at 1, 5 and 10% respectively.

The first section of the above table shows the mean spillover between NSE returns and selected currency exchange rate. First row indicates the spillover of NSE returns to other currencies namely USDCNY, USDHSK, USPHP, USD-JPY & US$-SGD.

A. Spillover of NSE Returns to variation in exchange rate

All the coefficient values of mean equation displayed in the first row are found to be significant either at 1% or 5% levels.

1. The coefficients of first and fifth lag of USD_CNY are significant at1% level in explaining the spillover in mean from NSE returns to USD_CNY.
2. The coefficients of first, fourth and tenth fifth lag of USD_HSK are significant in explaining the spillover in mean returns from NSE returns to USD_HSK.
3. The Intercept, coefficients of first and third lag of USD_PHP are significant in explaining the spillover in mean returns from NSE returns to USD_PHP. The coefficient to the third lag of USD_PHP is negative which indicates the mean spillover from NSE returns leads to depreciation of Philippines currency against US dollar.
4. The Intercept, coefficients of second lag of USD_JPY are statistically significant in explaining the spillover in mean returns from NSE returns to USD_JPY. The coefficient to the second lag of USD_JPY is negative which indicates the mean spillover from NSE returns leads to depreciation of Japanese currency against US dollar.
5. The Intercept, coefficients of second lag of USD_SGD are significant in explaining the spillover in mean returns from NSE returns to USD_SGD.

B. Spillover of exchange rate changes to NSE Returns

Only very few coefficient values of mean equation displayed in the second row of the above table are found to be significant either at 1% or 5% levels.

1. No coefficients of any of the lags of USD_CNY are significant in explaining the spillover in mean from USD_CNY to NSE returns. This indicates that there is no transmission/spillover from USD_CNY change to NSE returns.
2. The coefficients of first and second lag of NSE returns are significant at 1%level in explaining spillover in mean returns from USD_HSK to NSE returns. The coefficients to the first and second lag of NSE returns is negative which indicates the mean spillover from USD_HSK change leads to negative NSE returns.
3. The intercept and coefficient of fourth lag of NSE returns are statistically significant at 5% level in explaining the spillover in mean returns from USD_PHP to NSE returns.
4. No coefficients of any of the lags of USD_JPY are significant in explaining the spillover in mean from USD_JPY to NSE returns. This indicates that there is no transmission/spillover from USD_JPY change to NSE returns.
5. The coefficients of first lag of NSE returns are significant at5% level in explaining the spillover in mean returns from USD_SGD to NSE returns. The coefficients to the first lag of NSE returns is negative which indicates the mean spillover from USD_SGD change leads to negative NSE returns.

Thus there is a mean spillover transmission between NSE returns and USD_HSK, USD_PHP, USD_SGD in both directions. On the other hand, the spillover is unidirectional from NSE returns to USD_CNY and USD_JPY.

C. Spillover of volatility amongst NSE and variation in currency

The above table shows the coefficients of Variance and covariance equations for measuring the volatility spillover between NSE and Exchange rate change. These coefficients are also known as parameters of conditional variance estimated as a part of conditional variance and conditional covariance equations.

RESID(-1) deals with ARCH effect in two variables namely NSE returns and Exchange rate changes namely USDCNY, USDHSK, USPHP, USD-JPY & US$-SGD

In other words, it calculates (mutual) spillover effect of an earlier change in NSE return to exchange rate changes vice-versa.

GARCH(-1) items which calculates presence of variance of returns of NSE and fluctuation in rates of exchange of other places. Moreover it indicates (mutual) spillover effect between

1. NSE returns and USD_CNY
2. NSE returns and USD_HSK
3. NSE returns and USD_PHP
4. NSE returns and USD_JPY
5. NSE returns and USD_SGD

Moreover it indicates the spillover effect of variance of one variable during the last period on the current variance of another variable.

The conditional variance parameters as can be seen from the above table that NSE returns and exchange rate changes are less than one for GARCH1(-1) and GARCH2(-1) respectively for all currency pairs. This is consistent with one of the conditions of BEKK-GARCH model. This reveals high volatility persistence in both the movements in the following pairs

1. NSE returns and USD_CNY
2. NSE returns and USD_HSK
3. NSE returns and USD_PHP
4. NSE returns and USD_JPY
5. NSE returns and USD_SGD

Decomposing GARCH (1,1) equations of GARCH 1 and GARCH 2 reveals that all the coefficients have statistical significance at 1% level (presented as "***" in Table) in the respective conditional variance specifications. When looked into detail, past squared forecast errors denoted as RESID(-1)^2 are found to be statistically significant at 1 percent, indicating the strong evidence of volatility clustering in both the cases of NSE returns and exchange rate changes.

These RESID(-1)^2 coefficients for GARCH 1 and GARCH 2 equations respectively and are significant at 1% level. ARCH coefficients of covariance equation, namely RESID1(-1)*RESID2(-1) and also GARCH term denoted as COV1_2(-1), are statistically significant at 1% level except for USD_HSK. This indicates the spillover effects from shocks in the system variables.

The transmission of volatility and shock are in both directions for the returns from the National Stock exchange and the changes in currency values for the currencies' considered for the study.

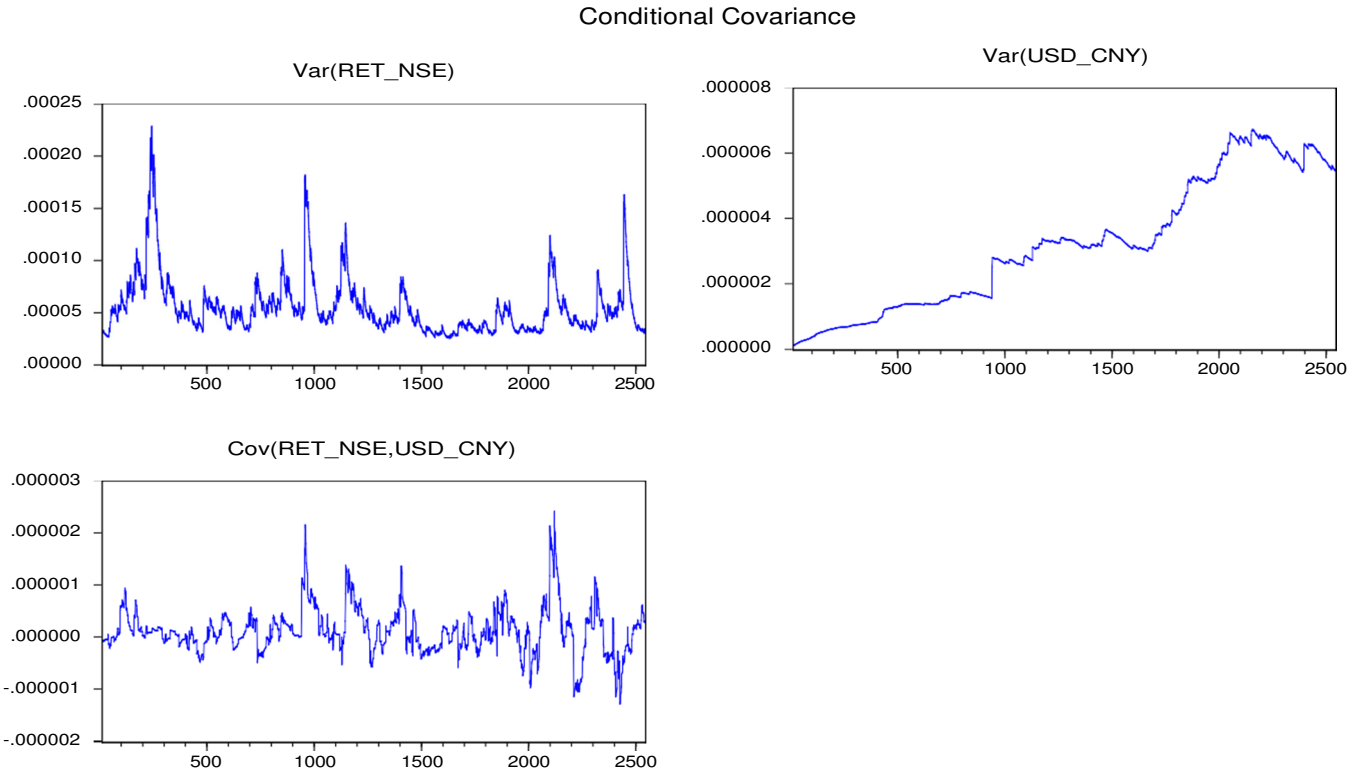
III. Table 3: Summary of Spillover effects between NSE returns and exchange rate changes of countries selected for the study

	US$-CNY	US$-HSK	US$-PHP	US$-JPY	US$-S G D
Mean Spillovers (NSE Returns)	→	⇔	→	⇔	⇔
Shock Spillovers (NSE Returns)	⇔	⇔	⇔	⇔	⇔
Volatility Spillovers (NSE Returns)	⇔	⇔	⇔	⇔	⇔
→ shows one direction of transmission, ← denotes the receiver of volatility ⇔ Denotes transmission in both directions.					

The above table 3, shows the summary of direction of spillover effects in terms of mean, volatility and shock spread amongst returns of NSE and variation in rate of exchange of USDCNY, USDHSK, USPHP, USD-JPY & US$-SGD. In terms of mean spillover between NSE returns and other exchange rate changes, transmission is received from NSE returns to all exchange rate changes. Besides, mean spillover is transmitted from USD_HSK, USD_JPY AND USD_SGD. Shock spillovers and volatility spillovers happen/transmits in both the directions.

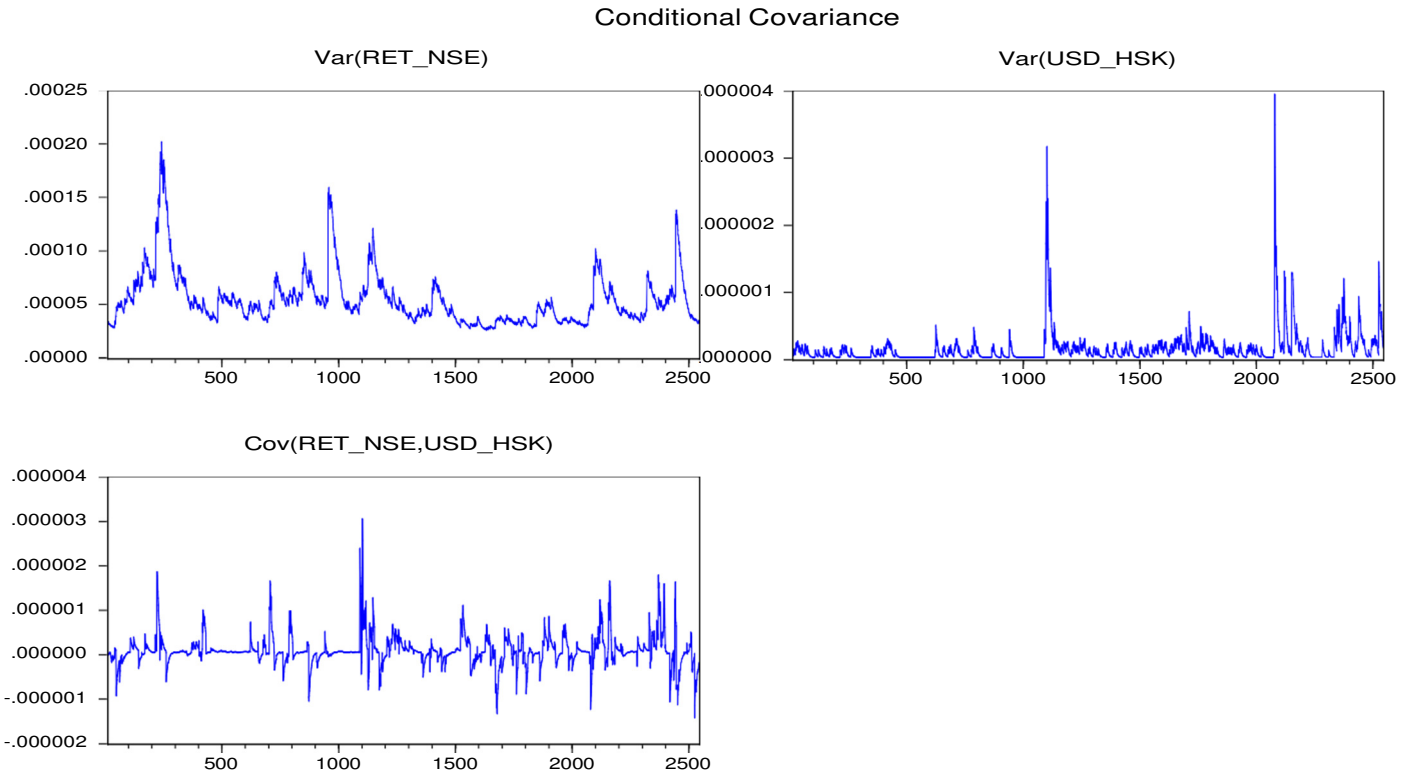
The graphs below presents the conditional covariance of NSE returns with different currency pairs.

2. Conditional Covariance of NSE returns and USD_CNY Exchange rate change

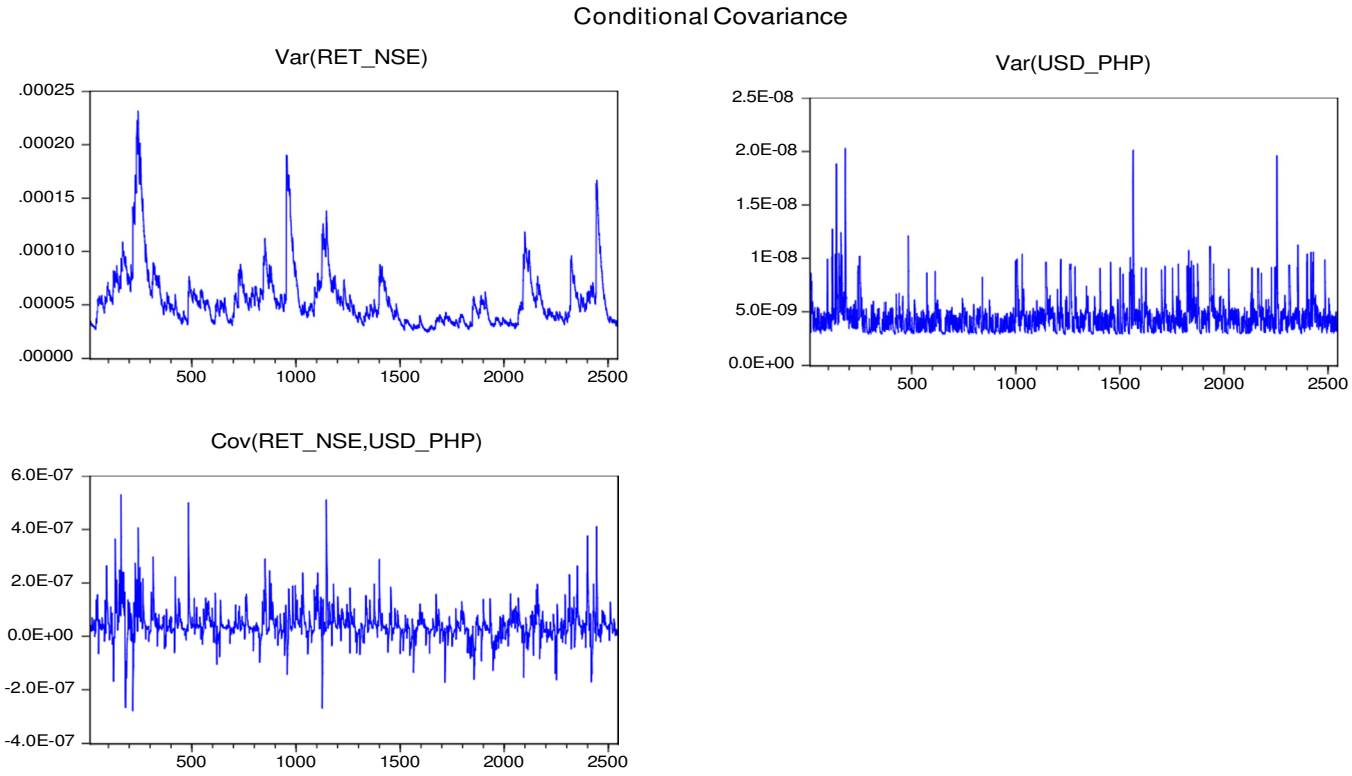


Source: Outcome of analysis using R software

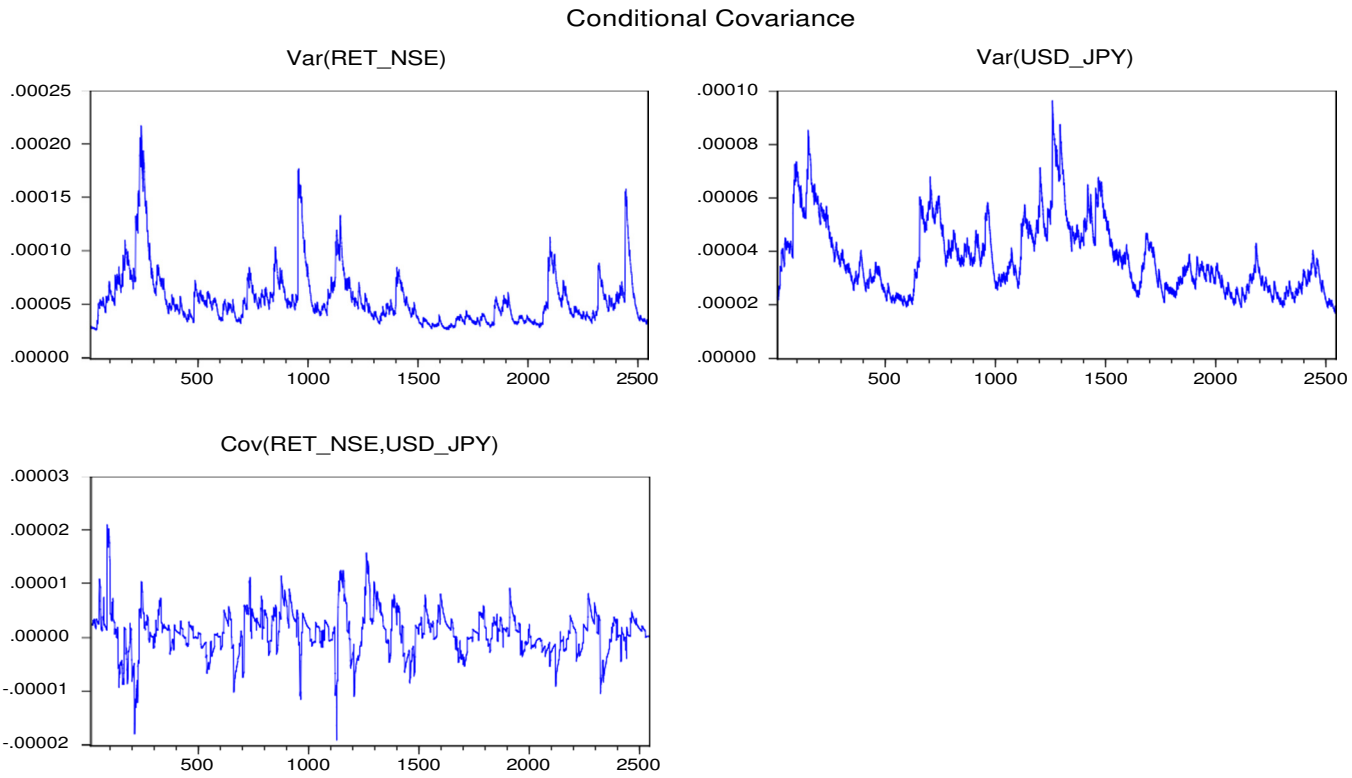
3. Conditional Covariance of NSE returns and USD_HSK Exchange rate change



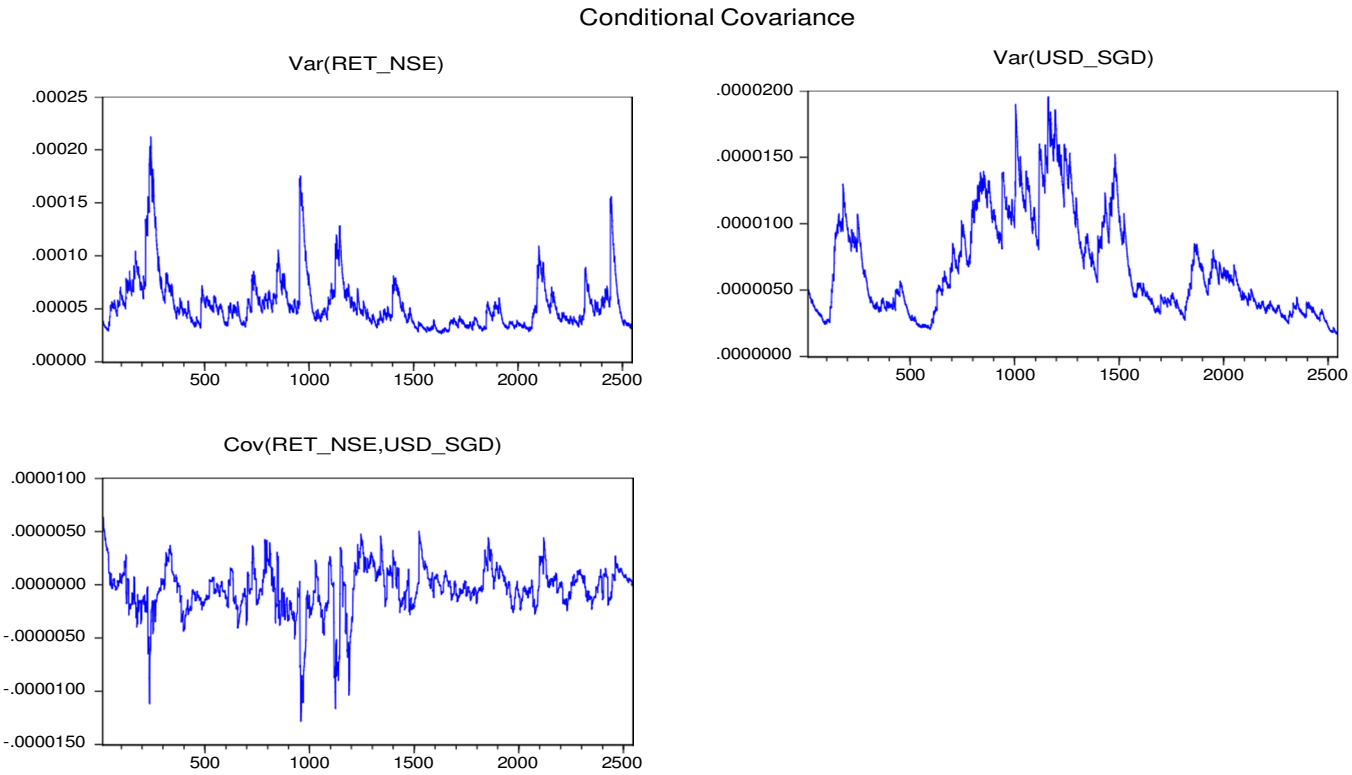
4. Conditional Covariance of NSE returns and USD_PHP exchange rate change



5. Conditional Covariance of NSE returns and USD_JPY Exchange rate change



6. Conditional Covariance of NSE returns and USD_SGD Exchange rate change



The above graphs show represents the conditional variance and covariance returns from the National stock exchange and the various currency exchange rates considered for study. The graphs from the NSE returns and the currency exchange rates a continuous show upward and downward movement. These swings or oscillations seen in the conditional variance and conditional covariance graphs confirm the endurance in shocks and volatility in the time series data sets collected for the analysis.

V. Conclusion:

This paper focused on examining the volatility spillover between the returns for the National stock exchange and the legal tender switch over rates against the US$ from selected Asian countries. Model that was used was BEKK GARCH to analyze mean and variance spread amongst the NSE and the exchange rates and it was found that mean spillover transmits between NSE returns and USD_HSK, USD_PHP, USD_SGD in both directions. On the other hand, the spillover is unidirectional from NSE returns to USD_CNY and USD_JPY. While the Volatility and shock spillover is bidirectional for stock market and the currency exchange rate. Since there is transmission of volatility between this pair of financial instruments investors should make suitable strategies to diversify their international portfolio and thus minimize risk.

Crestmont Research in the year 2020 reported the results of relationship between stock market volatility and performance and their results showed that the probability of markets declining is greater at the times of higher volatility and lower volatility has greater probability of a bullish market. The investors can analyze the long-term volatility in stock market and rebalance their portfolio to optimize their returns

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