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AN EMPIRICAL STUDY OF THE EFFECT OF SPILLOVER OF VOLATILITY OF THE INDIAN STOCK MARKET IN THE BRICS STOCK EXCHANGES

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Abstract

This paper study the spillover effect of Indian Stock Markets on the BRICS stock market in relation to portfolio diversification and try to find out a suitable diversification plan available for the portfolio managers globally who has an interest in investing in India. Several methods have been applied which include Granger Causality test, Vector Auto Regression and Dynamic Conditional Correlation to understand the spillover effect in the study. Bidirectional causality and unidirectional causality were tested between India and BRICS economy stock market. The VAR results show that BRICS economies does not affect the return of the Indian stock market. The results of the DCC-MGARCH also confirms these results and we observe no volatility spillover. This brings us to the basic understanding that Indian portfolio managers should explore the possibility of investing in the BRICC stock markets to diversify their portfolio and risk.

Keywords: BRICS Economy Stock Markets Volatility Spillover, Dynamic Conditional Correlation, Portfolio Diversification, Risk Management.

1. INTRODUCTION

BRICS countries are a strategic economic partnership of Brazil, Russia, India, China and South Africa developed to support foreign investment and free flow of capital to increase the growth of these countries. Bhar and Nikolkva (2008) observes. since most of these countries have a mutual requirement of association for economic growth, they take interest in their mutual economic growth. Marco et al (2013) observes that most of these economies can be represented as middle income emerging economies with distinctive large size and they have power to influence the world economies. Grisma& Caruana (2013) shows that these economies help in diversification of portfolio for investors as they are less correlated and are advanced economies. Alori et al (2011) show that these economies provide diversification opportunities to investors and portfolio managers to reduce the risk due to the fact that they belong to different financial zone of development. Chittedi(2009) in the study on developing economies are undergoing constant change and transformation and are integrating with advanced economies constantly.

Badrinath &Apte (2003) observe that integration of the economies has moved to a different level due to advanced technologies. In this context it can be observed that Indian stock markets have integrated to the world's financial markets post liberalization. Using the Autoregressive Conditional Heteroskedasticity (ARCH) family tests to understand the volatility spillover

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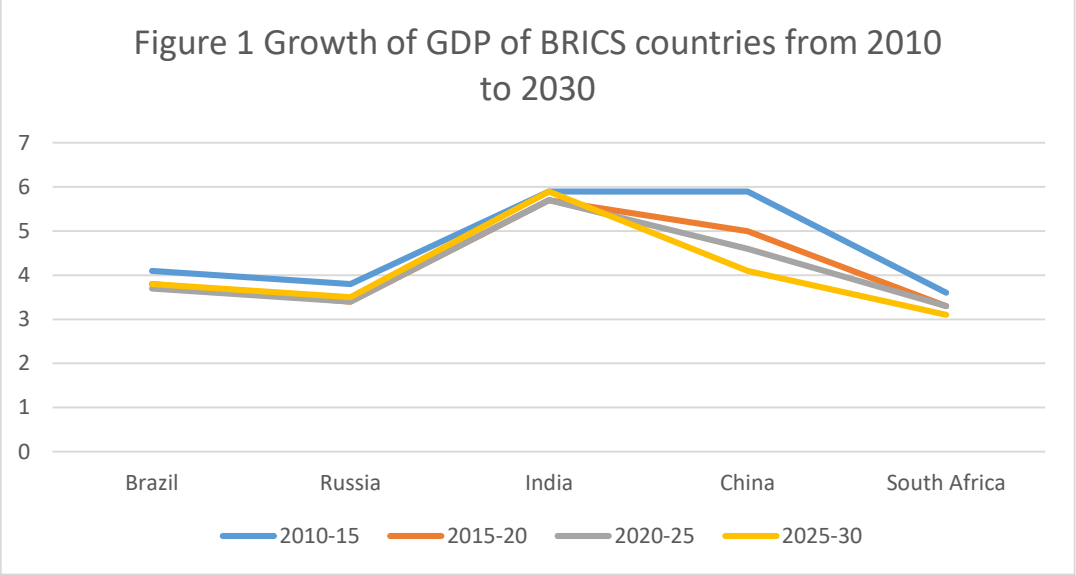
effect has become popular especially for the developing countries which has been affected by the movements of the developed economies' activities. Since, the emerging economies provide good opportunity for investment diversification both at retail and institutional level their potential as financial destination has gained momentum.

Studies by Ebrahim (2000), Jaiswal &Jithendranath(2009), Alfreeedi (2011) show that spillover effect of the stock markets and other financial markets of developing economies have greatly helped the investors to take diversification decisions in investment.

BRICS market are receiving increasing attention of global investors due to the pattern of GDP movement and increasing fund mobility amongst these markets. Figure 1 show the projected movement of the GDP of these nations over a period of time



Source: Created from the study by Wilson and Pusrushothman(2003)

The figure 1 clearly show that these economies are moving in the same directions. There is a good opportunity to understand their influence on each other as far as stock markets are concerned. The global spillover effect due to the 2007-08 US sub-prime crisis show high level of dynamic interactions between economies. In this context and the issues discusses in the forgone issues discussed this paper try to understand the spillover effect between the BRICS economies taking India as the reference point. The idea is to provide a wide range of suggestions to investors and economic policy makers to improve decisions for future.

2. LITERATURE REVIEW

Studies show that information flow across capital markets (and more so across stock markets) through volatility channel (correlation in second moments) has been found significant in comparison to returns channels (correlation in fist moments). Hence, Volatility properties are taken as better proxies for understanding information flow across financial markets, capital

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markets and specifically stock markets [Ross (1989); Taerchen& Pitt (1983)]. Multivariate GARCH (MGARCH) with DCC (Dynamic Conditional Correlation) have been shown to be more flexible and efficient in studying time varying correlation and spillover effect and yield better results then univariate models. Babe et al (1998), Bollerslev [(1986)(1990)] and Engle & Nig (1993) demonstrate the complex estimation procedure for implementing DCC model and variance decomposition to study the cross market validity spillover effect.

Claesseens et al (2000) shows the contagion process of intense shock across group economies and defined it as market integration post a dynamic economic shock. Estimation of co-moments of stock markets by Forbes &Rigobon (1999), shows how linkages between different countries can be computed by using different theoretical models from ARCH family. Bianconi et al (2013) use unconditional volatility measures (VAR) to understand cointegration and conditional volatility correlation among stock and bond markets returns.

Nikkinen et al (2013) investigated the transaction of US subprime crisis on BRICS economies and examined the impact of the financial crisis on its financial markets. Results show contagion effect between US and BRICS economies markets. Zonhaiur et al (2014) also show a similar finding in their study about market cointegration.

Aloui et al (2011) examines the cross linkages between BRICS and the US markets during the financial crisis of 2008. The authors observed that there is depending amongst the group economies. Morales &Gassive (2011), Bhar&Nikalva (2008) studied linkages between BRICS and region of the world by using MGARCH and observe varying degree of spillover effect amongst the other economies and BRICS economies.

Studies have been widely done with BRICS and other developed countries. However, thereare very few studies which enquires over the spillover effect within the BRICS economies and then stock markets. This study is taken to fill that gap and it uses the ARCH family equations to study the volatility spill over effect between Indian stock market and the other BRICS economy markets to suggest a wide range of economic breakthroughs.

3. DATA DESCRIPTION

The study uses data of the stock market of Brazil, Russia, India, China and South Africa (BRICS) available from public domain for a period of January 2010 to December 2019. The daily closing indices of these stock market has been collected for the period. The daily adjusted closing prices of stocks in the indices have been converted into daily log return which are the log arithmetic difference of adjacent prices of the two subsequent periods.

Rit =Log (Pit-Pit-1),

Where Rit log return at time t and Pit-q and Pit are two adjacent period daily closing prices of the ith stock in the exchange.

The data for the exchanges used in this study are BOVESPA of Brazil, MICEX of Russia, NIFTY of India , CSI300 of China andJSE of South Africa

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4. METHOD OF STUDY

The study uses Granger Causality, Vector Auto Regression (VAR) and Dynamic Conditional Correlation (DCC) to understand the spillover effect from Indian Stock Market to the BRICS stock exchanges. The study uses Granger Causality Test to understand the bi-directional causality among India and BRICS economies.

4.1 Granger Causality Method

Granger (1969) developed a method to study the causality linkages between variables. The logic provided by the method is that A Granger B if the past value of A consist of the relevant information which predicts B. It measures the relative change in the model error when another series in included to make the estimation more intense. It is based two important principles i. Cause happens prior to its effect and ii. Cause consist of unique information about the future values. This method is required to make the series stationary. If two or more series are stationary at the level value then it is applied on I(0). This method ensures that the directional influences of one series on another without priory hypothesis. The test is used to know whether the change in one series affects the change in another series and to identify the direction of causality (Unidirectional, Bidirectional or none).The paper tries to observe bi-directional causality between India and BRICS economy through the test.

4.2 Vector Auto-Regression (VAR) and Variance Decomposition

Vector Auto regression (VAR) to examine if stock returns of Indian equity markets are determined by their lagged returns on the BRICS stock indices. The result of the VAR results would help to understand if the stock returns of Indian stock market as well as of the BRICS explain present stock returns of Indian Stock Markets and make us understand the extent to which Indian stock market are dependent on the other markets in the study.

4.2.1 VAR and Variance Decomposition

To Distinguish the relationship between the two variables several tools within VAR are available. One of the commonly used method is Vector Auto Regression (VAR) that does not distinguish between exogenous and endogenousvariables. Stock and Watson (2001) has extensively promoted VAR model to demonstrate a coherent and credible approach for variance decomposition.

VAR model can be described as given below.

$Y_t = \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \ldots\ldots\ldots + \beta_n Y_{t-n} + \varepsilon t$ ……. Equation (1)

Where;

Y_t = The assets return which his depended of its own lag Y_{t-n}

$\beta_1 \ldots\ldots \beta_n$ = Coefficients of Lagged value of the assets return.

εt = Error terms

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VAR model is used on stationary series and it requires optimal lag. VAR is popular because it is concurrent correlation is not applied for forecasting purpose. Optimal lag is determined through the AIC, BIC or HQ information criterion. Once the optimal lag is determined the variable with variance decomposition had to be checked. Variable decomposition permits to compute the amount of the variability in dependent variable which is lagged by its own variance. In this study the variance decomposition to understand the variability in Indian stock market due to its own lag and the lags of the BRICS stock exchanges.

4.3 Dynamic Conditional Correlation (DCC)

Dynamic Conditional Correlation- GARCH model is applied to capture the degree of volatility correlation changes between two variables. Engle (2002) introduced the integration between two variables (in this case two markets) is depicted by conditional correlation in movement which is time varying in nature. It captures the dynamic correlation of returns.

The DCC is explained as given below

Let r_t be the asset return consisting vector n x 1, which can be depicted as $r_t = a + a_1 \quad r_{t-1} + \varepsilon t.$

Where;

a= constant

a_1 = the coefficient of lagged of returns and;

$\varepsilon t = H_t \quad (1/2)\ Z_t$ in which H is the covariance matrix of the assets return and Z is a vector n x 1 of independent and identically distributed residuals. The DCC model is estimated in two stages. Stage 1: The parameters of GARCH are determined and stage 2 correlation is determined. The model is expressed as $H_t = D_t\ R_t\ D_t$. In this equation, H_t is denoted d as the estimator of conditional correlation. D may be expressed as diag (h1r1/2,……..h1/2nt). D_t is conditional standard deviation which is n x n diagonal matrix and extracted from GARCH whereas R_t is the conditional correlation. R_t is presented as

$$R_t = Q_t^* - 1 Q_t \quad Q_t^* \quad -1 \quad \text{…….. Equation (2)}$$

Where;

$Q_t = (1\text{-}a\text{-}b)\ Q + \alpha\varepsilon t\ -1\varepsilon tT\text{-}1 + bQ_{t\text{-}1}$

Q = unconditional covariance matrix of the standardized errors that can be depicted as Cov [εtεT].

Q* = is the diagonal matrix comprising of square root of diagonal of Qt. Therefore, Qt* is shown as diag (q1/211t, q1/22t ……q1/2mnt).

a and b are directional conditional correlation parameters

Bolerslev (1986) pointed out that, $\alpha+b > 1$, signifies that GARCH model is stationary which says that the volatility shock is mean reverting and time decaying. Thus, it has to satisfy the condition, satisfy $a \geq 0$, $b \geq 0$ and $a+b < 1$. Hence, a low conditional correlation between two economic identities indicates more diversification opportunities and vice versa.

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a_{dcc} and β_{dcc} signify that the estimates achieved from DCC- MGARCH are time variant. Where, a_{dcc} measures the volatility impact for short time span that includes the persistence of residual from previous period.

B_{dcc} measures the long-term impact of a shock on conditional correlation.

Yu et al (2010) in their study indicated that an increase in conditional correlation leads to increase in integration of the market. It through light on decouping or recouping over the time period between the economies. If the conditional correlation between two economies falls, then there is a decouping and vise a vie. DCC-MGARCH is represented as $H_t = D_tR_tD_t$, where D_t is time varying standard deviation of series derived from univariate GARCH model and R_t is R diag Q and Q diag Q Engle (2020) commented that the DCC-MGARCH is a dynamic model witnessed with the time varying mean, variance and covariance.

5. RESULTS AND DISCUSSIONS

Descriptive statistics results show that Brazil stock market data is symmetrical and slightly skewed to the right. Kurtosis is 2.8 and is close to normal distribution ±3. Jarque-Bera test probability well exceed 0.01 p value and hence the data is normally distributed. Russian stock exchange shows a skewness of 0.174, symmetrical and slightly skewed to right. Kurtosis is close to 3 hence normally distributed. Indian stock marketSkewness is 0.152 almost symmetrical data and slightly skewed to the right. Kurtosis is 3.05 and has sharp central peak and lang tails. Jargue-Bera shows that the data is normally distributed. The data of the Chine stock market show a skewness of -0.246 and is skewed to the right. Kurtosis of 4.3 compared to normal distribution ±3 shows that data is concentrated around the mean. Jarque-Bera statistics show that data is normally distributed since it has value of 1.8%. Hence, the data is normally distributed. The data of South African stock market is skewed at 0.173 symmetrical and sightly skewed to the right. Kurtosis is close to 3 and hence normally distributed. Jarque-Bera test is higher compared at 1% level and hence normally distributed.

Table 1: Descriptive Statistics

Descriptive Statistics	BOVESPA (Brazil)	MICEX (Russia)	NIFTY (India)	CSI300 (China)	JSE of South Africa
No of observations	2088	2088	2088	2088	2088
Medan	-0.00248	-0.002551	0.001549	-0.10549	0.002531
Minimum	0.148300	0.184613	0.176579	0.225137	0.17326
Maximum	0.140830	-0.159933	-0.149733	-0.325120	0.169922
Mean	1.06	1.95	2.07	5.61	1.09
Standard Deviation	0.049170	0.067385	0.053455	0.087938	0.057285
Skewness	0.258992	0.174140	0.152428	-0.246660	0.057285
Kurtosis	2.798804	2.990200	3.845476	4.301787	2.86030
Jarque-Bera	1.826996	0.718258	3.5000324	4.301787	2.86030
p-value	0.901190	0.698284	0.1737460	0.018368	0.696232

Source: Computed

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Table 2 indicate the results obtained from Granger-Causality test of various series. The current study tries to understand the spillover effect of Indian stock market (NSE) and BRICS countries stock markets. Gupta and Guidi (2002) shows the use of causality test to identify the direction of transmission of volatility and the degree to which one economies volatility impact another market or economy and obtained very meaningful results. As discussed earlier, table 2 presents the result of the bi-directional causality between Indian stock market (NSE) against the BRICS economies stock exchanges.

Table 2: Result of Granger Causality of various series

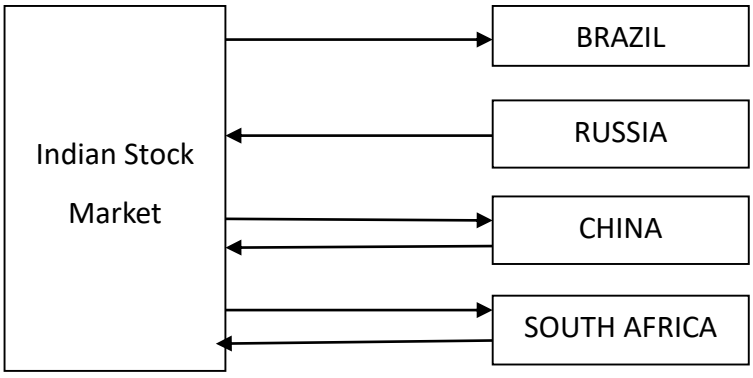
Null Hypotheses	Values	Probability
BOVERSPA does not granger cause NIFTY	1.0723	0.2386
NIFTY does not granger BOVERSPA	-22.7872	0.0007***
MICEX does not granger cause NIFTY	-32.8726	0.0230*
NIFTY does not granger cause MICEX	0.3216	0.68
CSI300 does not granger cause NIFT	3.3456	0.0176*
NIFTY does not granger cause CSI300	3.1268	0.0032**
JSE does not granger cause NIFTY	3.2162	0.0001**
NIFTY does not granger cause JSE	2.8672	0.0012*

Source: Computed

The results show that Indian stock market Granger causes Brazil but Brazil Stock exchange does not Granger Cause Indian Stock Market. The Russian stock exchange Granger causes Indian stock market where as Indian Stock market does not Granger Cause Russian Stock Market. Both China and South African stock market shows bi-directional granger cause effect.

In sum it is observed that South Africa and China has bidirectional causality with Indian stock market and the rest of the market does not show bi-directional causality with Indian stock market. Besides, China and SA have bidirectional causality. Others have unidirectional causality.

Fig 2: Diagrammatic representation of Granger Causality



Source: Created

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Table 3 show the interdependence of Indian stock market on the BRICSs stock market. The results show that NIFTY is affected by NIFTY lag 1 of NSE significantly, NIFTY is affected by China stock exchange Lag 1 and Lag2 and South African Stock exchange Lag 2 significantly at 1 % level. NIFTY is affected by South African stock exchange at lag1 by 5% significance level. The other exchanges do not affect the NIFTY in a significant manner.

Table 3: Result of VAR based on NIFTY

Variables	Estimates	Std.Error	t-value	Pr(>|t|)
NIFTY.11	0.0673	0.0112	2.3621	0.00012**
BOVERSPA.11	0.0148	0.0132	0.6340	0.7621
BOVERSPA.12	-0.0136	0.0023	0.6772	1.362
MICEX.11	-0.2312	0.1324	0.7342	0.9342
MICEX.12	0.3412	0.1233	0.7763	0.9432
CSI300.11	0.0572	0.0010	1.3642	0.00001**
CSI300.12	0.1236	0.0021	2.3641	0.00012**
JSE.11	0.1324	0.0213	1.0234	0.00001*
JSE.12	0.1326	0.0132	1.0342	0.00011**
Const	0.0003	0.0012	1.8762	0.1762
Residual Standard error	0.09432			
DF	2087			
Multiple R -Squared	0.0913			
F-statistics	2.621			
P Value	0.0004321			

Source: Computed

The results of table 3 shows that the Indian Stock Market is influenced by China and South African stock markets. Whereas the Brazilian and the Russian stock markets do not influence the Indian stock market.

The variance decomposition has a similar finding. Table 4 show the variance decomposition. It is observed that the variance decomposition of India (NSE) is impacted by its own lagged values, followed by China and South African stock market lagged values. The other economies namely Russia and Brazil do not explain any value. Hence, they do not impact the Indian stock market returns and there is no spillover.

Table 4: Result of Variance Decomposition NIFTY

Period	NIFT	BOVERSPA	MICEX	CSI300	JSE
[1.]	1.0000	0.000	0.0000	0.0000	0.0000
[2.]	0.9832	1.0000	0.0	0.7286	0.8324
[3.]	0.9134	0.0320	1.0000	0.8347	0.7893
[4.]	0.8734	0.0023	0.2346	1.0000	0.0349
[5.]	0.9123	0.0001	0.0126	0.0432	1.0000

Source: Computed

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Table 5 show the result of the Dynamic Conditional Correlation (DCC) which concentrates on the interface amongst the stock markers. The DCC-GARCH has been used to understand the volatility and co-volatility dynamics between the BRICS stock exchanges and the Indian stock exchange. The value of 'mu' and 'omega' are the intercepts. The effect of the pervious disturbances in error term is available from the mean equation is denoted by ARCH effect denoted here by alpha1 which measures the volatility impact in short time span. The effect of previous variance by GARCH is denoted by beta1 which measures the impact of volatility over long time span. Both the coefficient alpha1 and beta1 impact conditional correlation. All the ARCH and GARCH terms are the stock market under study are significant which show that there is persistence in volatility. Thus, we can conclude that there is volatility impact in short time span and long-time span as well in all these markets. The current conditional variance is affected as the coefficients of alpha and beta are positive in all the cases. The sum of ARCH and GARCH coefficients is less for India as well as the other BRICS stock market. We implicate that higher the sum lower will be volatility decay. The pecking order of volatility decay is given in table 6.

Table 5: Result of Dynamic Conditional Correlation

Variables	Estimates	Std. Error	t-value	Pr(>|t|)
NIFTy.mu	0.0001	0.0002	2.3546	0.0026
NIFTY. omega	0.0000	0.0000	0.9765	0.0012
NIFTY.alpha1	0.0236	0.0016	0.8734	0.0001
NIFTY.beta1	0.9543	0.0011	0.6547	0.0003
BOVERSPA.mu	0.1673	0.0123	0.8965	0.0023
BOVERSPA. omega	0.0000	0.0000	2.6735	0.0034
BOVERSPA.alpha1	0.0005	0.0002	1.3256	0.1403
BOVERSPA. beta1	0.0034	0.0034	1.3465	0.0124
MICEX.mu	0.0112	0.0065	1.3367	0.1023
MICEX. omega	0.0000	0.0000	1.3356	0.0024
MICEX.alpha1	0.0002	0.0443	0.9876	0.0016
MICEX. beta 1	0.0001	0.0342	0.8787	0.0005
CSI300.mu	0.03467	0.4561	0.7756	0.0237
CSI300. omega	0.0000	0.0000	0.9874	0.0001
CSI300.alpha1	0.0367	0.0003	0.2345	0.0001
CSI300. beta1	0.8756	0.0006	0.3656	0.0000
JSE.mu	0.0001	0.0067	0.9323	0.0001
JSE. omega	0.0000	0.0000	0.2346	0.0156
JSE.alpha1	0.0436	0.0125	0.3456	0.0124
JSE.beta1	0.7654	0.0181	0.3129	0.0092
[Joint]dcca1	0.0073	0.9872	0.3398	0.0345
[Joint]dccb1	0.3421	0.8572	0.3872	0.0467

Source: Computed

The volatility decay is slowest in Indian stock market followed by Chinese stock market and South African stock market. On examining the volatility spillover between India and BRICS stock market by applying DCC-MGARCH model. The combined effect of ARCH and GARCH effect can be seen through dcca1 and dcca2. We observe that both dcca1 and dcca2 are positive

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and significant. This means that there is integration and asymmetric effect from India to BRICS stock markets. There is volatility spill over between India and BRICS economies and is in conformity of our earlier inferences. We had observed that China and South Africa were highly integrated to India and that the GDPs of the all the BRICS nation were in tandem. This provide limited diversification opportunities between most of these countries. However, we had earlier seen that China and South Africa are the ones which are highly integrated. The rest of the countries i.e, Brazil andRussia has good diversification opportunities for investors and portfolio managers in institutional domain.

Table 6: Pecking order of Volatility decay.

Rank	Exchange	Volatility decay
1.	NIFTY	0.9779
2.	CSI300	0.9123
3.	JSE	0.8089
4.	BOVERSPA	0.0039
5.	Micix	0.0003

Source: Computed

6. TAKEAWAYS FOR DECISIONS

During the course of the discussion in this paper we have observed that the spillover effect between the BRICS nation economies represented by their stock indices returns and Indian economy represented by NSE index returns for the period of study. We observed that there is no spillover effect between the Indian stock market and Brazil and Russia. However, there is strong spillover effect between India, South Africa and China. This gives the investors and the portfolio managers at institutional level to diversify their portfolio in Brazil and Russia. However, the good part of the discussion is that there is good integration between the markets as indicated by the DCC-MGARCH and hence there is good opportunity to open up trade between these markets and make the purpose of these economic cooperation stronger.

7. CONCLUSION

This study tried to find out the spillover effect of the stock market in relation to India from the BRICS economies stock markets. The study is carried over a period of ten years and ARCH family models have been used to understand the spillover effect. The study shows that there is no spillover between Brazil, Russia and Indian Market. There is spillover effect between India, China and South Africa. This study had opened some understanding for investors and portfolio managers who manage institutional funds. The countries like Brazil and Russia gives then good diversification opportunities while china and South Africa may not do so. However there is general integration between these markets and hence provide good opportunity amongst these economies to make this economic cooperation stronger.

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References

1) Aloui, R., Nguyen, D.K. & Ben Aïssa , M.S., (2011). Global financial crisis, extreme interdependences, and contagion effects: The role of economic structure?. Elsevier.

2) Alfreedi A (2011), Structural failure models and use of GARCH, IJIAS, 10, 800-891

3) Badrinath, H.R., &. Apte G. Prakash. (2003). Volatility spillovers across stock, call money and foreign exchange markets, http://www.nse-india.com/content/research/comppaper109.pdf

4) Bhar, R. &Nikolova, B., (2008), Return, volatility spillovers and dynamic correlation in the BRIC equity markets: An analysis using a bivariate EGARCH framework. Elsevier.

5) Bianconi M, Yoshino J A &Marchodo de souse M.O (2013), BRICS and the US financial Crisis: An empirical investigation of stock and bond market, Emerging Market returns, 14, 76-109

6) Bollerslev, T. (1986). Generalized autoregressive conditional heteroskedasticity. *Journal of econometrics*, *31*(3), 307-327.

7) Bollerslev, T. (1990). Modelling the coherence in short-run nominal exchange rates: a multivariate generalized ARCH model. *The review of economics and statistics*, 498-505.

8) Chittedi , R. (2009), Global Stock Markets Development and Integration: with Special Reference to BRIC Countries. Munich Personal RePec Archive (MPRA).

9) Claessens, S., Park , Y.C. &Dornbusch,R. (2000), Contagion: Understanding How It Spreads. The International Bank for Reconstruction and Development / The World Bank. Dooley,

10) Ebrahim, S. K. (2000). *Volatility transmission between foreign exchange and money markets* (No. 2000-16). Bank of Canada.

11) Engle R K & Nag V.K (1993), Measuring and Tresting the impact of news on volatility, Journal of Finance, 48, 1749-1778

12) Forbes and Rigobon , 1999. no contagion, only interdependence: measuring stock market co-movements. National bureau of economic research.

13) Jaiswal K &Jithendranath M (2009), Spillover effect of the Indian stock market on related economies of third world countries, Journal of Risk Management, 14, 75-86

14) Morales , L. &Gassie , E., (2011). Structural breaks and financial volatility: lessons from BRIC countries.

15) Ross, S. A. (1989). Information and volatility: The no-arbitrage martingale approach to timing and resolution irrelevancy. *The Journal of Finance*, *44*(1), 1-17.

16) Taerchen S & Pitt A (1983), Why spillover effect implicates developing economies, IJIAS, 12, 162-178

17) Wilson D and Purushothaman R(2003), Dreming with BRICS: Path to 2050, Global Economic Papers No 99, New York, Goldman Sachs.

18) Zouhair, M., Lanouar, C. &Ajmi, A.N. 2014. Contagion versus Interdependence: The Case of the BRIC Countries During the Subprime Crises. Emerging Markets and the Global Economy. Elsevier.