

Journal of Academic Research in Economics

Volume 11

Number 2

July 2019



ISSN 2066-0855

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STOCK MARKET VOLATILITY AND MEAN REVERSION OF BRICS BEFORE AND AFTER CRISIS

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Abstract

In this study, we examine the volatility behavior and mean-reverting phenomenon in BRICS stock markets under the GARCH framework. This paper considers the daily indices of BOVESPA (Brazil), MICEX (Russia), SENSEX (India), SSE (China), JSE (South Africa) from 25th September 1997 to 31st March 2018. To understand the time-varying volatility of these markets, the data are divided into three sub-periods, i.e. prior to the US subprime mortgage crisis, during the crisis and post-crisis periods. The symmetric GARCH results show that during the pre-crisis and crisis period Russian markets are highly volatile while China markets are highly volatile in the post-crisis period. The GJR-GARCH results show that China markets do not have the asymmetric effect in the post-crisis period, indicating the information does not have any impact on market returns volatility. For strategic investment decisions, the mean reversion time is calculated and observed that all the markets are not following the same mean reversion process in all sub-periods of the study.

Keywords: Mean reversion, BRICS stock markets, half-life volatility model, GARCH models.

JEL Classification: C32, G12, G15.

1. INTRODUCTION

The financial markets of any economy help in mobilizing savings from the savers and convert these savings into investments to provide capital for more productive economic activities. There has been considerable focus on empirical analysis on the behavior of stock markets and some studies were conducted before

1990 to understand the behavior of the markets, for instance, Fama(1965,1970), Dryden(1970), Sharma, J.L. et al(1977), Poterba, J.M. (1988). As a result of financial liberalization and integration the market structure of several economies has changed considerably in the last two to three decades. Several researchers such as Atje and Jovanovic (1993), Ross Levine and Zervos (1996), among others have attempted to study this phenomenon and identified the importance of financial markets besides financial institutions for a country's economic growth.

In view of growing financial integration with the world markets, the emerging markets grew in multitude in terms of their stock market capitalization, the value of shares traded, the number of listed stocks, and offered more returns than the developed markets with commensurate risk. Moreover, among these emerging markets, Brazil, Russia, India, China, and South Africa (BRICS) have witnessed an unprecedented change with regard to their stock markets and together they are expected to outperform the most developed markets. These BRICS countries together account for 42% of the world population with 3.1 billion people and have a combined nominal GDP of US \$ 18.8 trillion, about 23.3% of world GDP, combined GDP (PPP) of US\$40. 5 trillion which is around 32% of the world's GDP (PPP) in 2017(WDI, 2019).

The common phenomenon observed in these emerging markets is that a high degree of volatility compared to the developed markets (Bakaert and Harvey (1997); Hull and McGroarty (2014)). The volatility in the stock prices will have a dampening effect on the investment decisions, profits of the firms and individual investors. High degree of volatility impairs the financial system; it also discourages risk-averse investors and raises the cost of capital for firms; it also limits the participation of risk-averse firms from raising required funds for their operations and listing on the stock markets (Pagano, M.,1993). In order to predict the volatility in stock prices, Engle (1982) and Bollerslev (1986) have developed empirical models namely AutoRegressive Conditional Heteroscedasticity (ARCH) and Generalized AutoRegressive Conditional Heteroscedasticity (GARCH). Since then many researchers have been using these GARCH models to predict the volatility of market returns.

One more well-known features of financial markets is asymmetry: bad news causes higher volatility than the good news of the same magnitude, and this has also been interpreted as a leverage effect (Black, 1976: Christie, 1982). The leverage effect suggests that when stock prices decline due to negative shocks, the leverage of the firm increases leading to higher stock price volatility. To accommodate this asymmetric response, Glosten, Jagannathan, and Runkle (1993) have introduced the model and is known as the GJR GARCH (p, q) model.

It is also believed that stock prices rise by receiving positive information and likely to continue for some time. But, investors use fundamental analysis of stocks that are overpriced and sell them and hence the stock prices decline. Eventually, the mean-reversion pattern forms and this may be due to overreaction to financial news (De Bondt & Thaler 1985, 1987) or investors' opportunism (Poterba and Summers (1988)).

In the wake of growing capital markets in emerging economies, particularly in BRICS countries and also the increased disorders during the crisis have necessitated the need to examine the volatility behavior, the news impact, and the mean reversion process on the BRICS markets in different time periods.

In this background, this paper makes an attempt to examine the time-varying volatility and the leverage effect of BRICS stock markets by using the GARCH framework for the period 25th September 1997 to 31st March 2018. This sample period further divided into three sub-periods namely Pre-Crisis, During Crisis and Post-Crisis periods to understand the behavior of the markets due to the global financial crisis of 2008. This study also analyzes the mean reversion property of these BRICS markets.

The paper has been organized as follows. In the second section, we give a brief outline of the studies carried out in this area of research. The third section discusses the data and methodology. The fourth section presents the empirical results of the study. The summary and conclusions are provided in section five.

2. LITERATURE REVIEW

The literature review of the paper presents a brief outline of various studies in three areas- First, studies carried out in the area of volatility behavior in developed and developing markets. Second, studies mainly focused on the volatility behavior of BRICS stock markets. Third, studies examining the mean reversion phenomenon in emerging stock markets. Giorgio De Santis and Selahattin Imrohoroğlu (1994) examined the dynamic volatility behavior of Europe, Asia, Latin America, Germany, UK, US, and the Japan stock markets return using the GARCH model and showed that all the market returns have time-varying volatility and high volatile persistence. Victor Murinde and Sunil Poshakwale (2001) investigated the main features of stock market volatility in the emerging market of European transition economies using GARCH models and found that the European emerging markets have volatility persistence, but, no asymmetric volatility effects for most of the markets. Panayiotis F. Diamandis (2008) investigated the dynamic behavior of stock market volatility in the emerging markets and a developed market (USA) using SWARCH-L model and showed that there was a significant increase in the volatility during the period of crisis for all the markets. Ping Wang and Tomoe Moore (2009) studied the changes in the volatility of new European Union emerging members' stock markets using GARCH models and found that the volatility persistence is reduced significantly during the study period. Kedarnath Mukherjee and Ram Kumar Mishra (2010) tested for the stock market integration and volatility spillover between India and its major Asian counterparts by employing the GARCH model and showed that the intraday returns were positively significant and bi-directional with all the markets. Chkili Walid et al (2011) by using the two regime Markov switching-EGARCH models showed the impact of Foreign Exchange (FX) rate changes on stock market volatility. Naliniprava Tripathy and Ashish (2013) by employing GARCH models forecast the stock market volatility of six emerging countries and confirmed the

volatility persistence and leverage effects in all the markets. Slah and Fathi(2014) investigated the behavior of time-varying volatility in 11 Middle East and North African(MENA) countries using GARCH (1, 1) and found the spillovers from the MSCI world index to MENA stock markets.

For BRICS stock markets, Ramona and Jatin(2013) examined the volatility persistence and asymmetric effect for BRIC countries and found that the markets have volatility persistence and asymmetric effect for the study period. Nawal Kishor and R.P. Singh (2014) used GARCH models and found that among the BRICS stock market except for Brazil and China stock market all three markets are affected by the news of US stock market. Using the regime-switching model approach Walid Chkili and Khuong (2014) showed that stock markets have more influence on exchange rates of BRICS economies. George Adu, et al. (2015) used GARCH models and found that all BRICS markets have volatility clustering while the South Africa markets do not have a leverage effect for the study period. Parneet Kaur and Amanjot Singh (2015) using EGARCH model showed that among the BRIC markets, China has a leverage effect during a crisis period. Pramod Kumar and Puja padhi(2015) employed the EGARCH model and found that China market doesn't respond to the news, unlike other group countries' markets. In order to verify the contagion effect of BRICS markets Walid Mensi, et al. (2016) have carried out the study to identify the time-varying correlation between US and BRICS stock markets and found the hypothesis of re-coupling between US and Brazil, India, China, and South Africa but a decoupling with Russia. Xiaoye Jin and Ximeng An (2016) tested for the spillover effects between the US stock market and the emerging stock markets of BRICS and found that the US markets have significant volatility spillover effects on the BRICS stock markets. Siva Kiran and Rao (2017) have used the TGARCH and EGARCH models and found that among the BRIC capital markets, China market doesn't have a leverage effect while the other markets have a leverage effect. Naliniprava Tripathy(2017) examined the stock return volatility of BRIC stock markets using GARCH models and found that China and Russia markets have time-varying long-run volatility while the India and Brazil markets have short-run volatility. A similar study by Heni and Syed (2017) tested the spillover effects of oil prices on the volatility of BRICS stock markets and found strong evidence of time-varying volatility in all markets. Pradiptarathi Panda and Thiripalraju (2018) examined the volatility spillovers and asymmetric among BRICS stock markets using EGARCH model and found the presence spillover among these countries stock markets.

Mean reverting process helps the investors in their investment decisions. With regard to the studies on the mean reverting process of stock prices, there have been several studies in the context of developed and emerging stock markets. Nam, K., et al (2006) by employing EGARCH found that the returns of 30 Down Jones individual stock returns revert faster than the returns of the S&P 500 index. Turan, G and Demirtas (2008) employed GARCH models and found that the EGARCH model showed the fastest mean reversion in S&P index futures. Laura Spierdijk, et al (2012) analyzed the mean reversion in 18 OECD countries during the years

1900-2009 and showed that the mean reversion is faster at the time of great depression, world warII, oil crisis, energy crisis, and Black Monday. Juan Wang, et al (2015) investigated mean reversion process of Asian stock prices by employing Lagrange Multiplier (LM) Fourier unit root test and showed that all the seven Asian stock prices have mean reversion process. Rana Imrose Palwasha, et al (2018) used the ARCH and GARCH model and found that the Pakistan indices such as KSE-100, LSE-25, and ISE-100 exhibited mean reversion. Rizwana Ahmed, R. et al(2018) examined the mean reversion process in developed and emerging stock markets using ARCH and GARCH models and showed that mean reversion is faster in emerging markets than developed markets. Gbenro and Moussa(2019) analyzed the mean reversion property for the West African stock markets using EGARCH model and found that the African Indices viz. Bourse Régionale des Valeurs Mobilières composite (BRVMC) and 10 most liquid assets (BRVM10) have the mean reversion property.

From the above literature, it is clear that the volatility behavior among the emerging and developed markets is time dependent. Here we want to reexamine the volatility behavior and asymmetric effect of information of BRICS markets with time varying periods by dividing the sample period into sub-periods - Pre-crisis, Crisis, and Post-crisis. In addition to volatility behavior here we are testing the mean reversion process of these markets during all the periods.

3. DATA AND METHODOLOGY

In this section we describe the data and give a brief methodology of commonly used methods GARCH (p, q) and GJR-GARCH (p, q) for measuring the volatility and asymmetric effect respectively. Also, discusses the methodology of mean-reversion process.

This study considers the daily returns of the BRICS stock indices, BOVESPA (Brazil), MICEX (Russia), SENSEX (India), SSE (China) and JSE (South Africa) during the period 25th September 1997 to 31st March 2018. To analyze the market behavior of these emerging markets before, during, and post global financial crisis of 2008 the sample period into three periods, Sub-period I as Pre Crisis period from 25th September 1997 to 29th June 2007; Sub-period II as Crisis period from 2nd July 2007 to 29th May 2009 and Sub period III as Post Crisis period from 1st June 2009 to 30th March 2018¹. The closing prices data for Brazil, Russia, India, and China are obtained from the Yahoo finance and South Africa prices are obtained from the Wallstreet Journal site.

The returns of these indices are calculated from the closing prices by using formula, $R_t = \log\left(\frac{p_t}{p_{t-1}}\right) \times 100$, where p_t and p_{t-1} are the closing prices at period (t) and (t-1) respectively.

¹ According to National Bureau of Economic Research(2010), the recovery from the US crisis started in June 2009- from Business Cycle Dating Committee, N.B.(2010).

3.1 GARCH (p, q) MODEL

To model the changes in the variance of time series Engle (1982) introduced ARCH model, latter Bollerslev (1986) extended this model to allow more the conditional change in variance over time as well as changes in time dependent variance, and are known as GARCH models for predicting volatility in the time series.

The GARCH (p, q) model can be represented as

The mean equation is

$$r_t = \mu + \sum_{i=1}^p r_{t-i} + \sum_{j=1}^q \varepsilon_{t-j} \dots \dots \dots (1)$$

The variance equation is

$$\sigma_t^2 = \Omega + \sum_{i=1}^p \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^q \beta_j \sigma_{t-j}^2 \dots \dots \dots (2)$$

This model includes p ARCH terms (ε_{t-i}^2) and q GARCH (σ_{t-j}^2) terms. The sum of ARCH and GARCH ($\alpha + \beta$) terms indicates the level of persistence of volatility of the series. If the sum is close to one (unity) then the volatility is said to be persistence.

3.2 GJR GARCH (p, q) MODEL

In the GARCH (p, q) model, the conditional variance is specified as a linear function of past squared errors and past conditional volatility. The linear GARCH model does not capture the asymmetric changes in stock return volatility. This asymmetry is now a well-known feature of financial markets: bad news causes higher volatility than the good news of the same magnitude, and this has been interpreted as due to a leverage effect (Black, 1976; Christie, 1982). The leverage effect suggests that when stock prices decline due to negative shocks, the leverage of the firm increases leading to higher stock price volatility. So as to accommodate this asymmetric response, Glosten, Jagannathan, and Runkle (1993) have introduced the model and is known as the GJR GARCH (p, q) model.

The Conditional variance of this model is specified as follows:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^p \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^q \gamma_j I_{t-i} \varepsilon_{t-i}^2 + \sum_{k=1}^q \beta_k \sigma_{t-i}^2 \dots \dots \dots (3)$$

From Eq (3), γ_i is the asymmetric or leverage effect and I_{t-1} is the dummy variable used to differentiate the good and bad news i.e., $I_{t-1} = 1$ if $\varepsilon_{t-1} < 0$ indicating bad news, and $I_{t-1} = 0$ if $\varepsilon_{t-1} \geq 0$ indicating good news. The GJR GARCH model specification assumes that unexpected changes in the market returns or ε_t will have a different effect on the volatility of stock return σ_t^2 . Good news will lead to higher return; hence it is associated with higher variance through γ . A non-zero value of γ indicates the asymmetric nature of the returns.

On the other hand, when γ is zero, we get back to the standard symmetric GARCH model.

3.3 MEAN REVERSION AND HALF-LIFE VOLATILITY SHOCKS FOR THE GARCH (1, 1) MODEL

The mean reverting process of the markets is stated as the prices/returns revert to their historical values after a certain time period.

The basic equation of mean reversion from the GARCH (1, 1) process is derived as

$$(\varepsilon_t^2 - \sigma^{-2}) = (\alpha_1 + \beta_1)(\varepsilon_{t-1}^2 - \sigma^{-2}) + \mu_t - \beta_1\mu_{t-1} \dots \dots \dots (4)$$

where
$$\sigma^{-2} = \alpha_1 / (1 - \alpha_1 - \beta_1)$$

The equation (4) represents the unconditional volatility and it can be shown as

$$\mu_t = (\varepsilon_t^2 - \sigma^{-2}) \dots \dots \dots (5)$$

The equation (5) is the mean reversion rate, and the researchers suggest the value of $\alpha_1 + \beta_1$ is close to 1. It is important to know that the scale of $\alpha_1 + \beta_1$ regulates the mean reverting speed. Finally, the expression of half-life for the volatility shocks is:

$$L_{half} = \frac{\ln\left(\frac{1}{2}\right)}{\ln(\alpha_1 + \beta_1)} \dots \dots \dots (6)$$

4. EMPIRICAL ANALYSIS

This section reports the empirical results of the study. The summary statistics of index returns of the sample contains for all the periods are calculated to understand the statistical properties of the BRICS markets returns in all the time periods of the study. The results of the descriptive statistics are presented in table 1.

From table 1 it is observed that the average of BRICS markets returns is negative during the crisis period while positive in all other periods. This confirms that all five markets have experienced a slump during the US financial crisis. The larger values of standard deviation in the case of the Russian market in all periods denote that it is the highly volatile market among the five markets. The Kurtosis values indicate that the return series having fat tails which is a common phenomenon of stock returns.

Table 1. Descriptive Statistics of return series

		Mean	Std. Dev	Skewness	Kurtosis	JB Statistic	ARCH LM(Lag=5)
BOVESPA	Pre Crisis	0.064	2.287	0.465	18.54	24378.67(0.00)	183.98(0.00)
	Crisis	-0.005	2.831	0.088	6.27	211.03(0.00)	101.37(0.00)
	Post Crisis	0.021	1.440	-0.146	5.02	381.25(0.00)	80.82(0.00)
MICEX	Pre Crisis	0.116	3.078	0.148	14.31	12914.63(0.00)	466.74(0.00)
	Crisis	-0.083	3.713	0.109	13.61	2220.84(0.00)	70.51(0.00)
	Post Crisis	0.031	1.407	-0.477	8.32	2704.77(0.00)	150.52(0.00)
SENSEX	Pre Crisis	0.056	1.605	-0.354	6.56	1331.92(0.00)	272.93(0.00)
	Crisis	-	2.631	0.272	6.49	242.88(0.00)	16.62(0.00)
	Post Crisis	0.037	1.029	-0.204	5.00	378.32(0.00)	78.71(0.00)
SSE	Pre Crisis	0.053	1.473	0.056	8.29	2741.15(0.00)	104.39(0.00)
	Crisis	-0.080	2.508	-0.015	4.01	20.21(0.00)	7.80(0.00)
	Post Crisis	0.008	1.437	-0.947	8.71	3241.00(0.00)	276.24(0.00)
JSE	Pre Crisis	0.057	1.238	-0.762	9.83	4972.02(0.00)	406.19(0.00)
	Crisis	-0.046	2.023	0.021	4.10	24.43(0.00)	68.90(0.00)
	Post Crisis	0.040	0.965	-0.161	4.33	173.18(0.00)	119.81(0.00)

The JB statistic for all the markets are statistically significant, thereby indicating the return distributions are non-normal. As the return distribution exhibits leptokurtic and non-normal we use *t* distribution errors in GARCH models. The ARCH-LM test indicates that all the series have rejected the null hypothesis of no ARCH effect. We have selected the ARMA lag order based on the AIC for each market to get the ARMA (m, n)-GARCH (p, q) specification for all time periods of study. The results of GARCH models along with the diagnostic statistics for each market in all the periods are provided in tables 2, 3 and 4.

Table 2. Results of GARCH model in Pre Crisis Period

	BOVESPA	MICEX	SENSEX	SSE	JSE
μ	0.001* (3.62)	0.002* (4.83)	0.001* (5.311)	0.0002 (1.100)	0.001* (4.53)
AR(1)			0.507* (7.55)		
AR(2)			-0.884* (-15.35)		
AR(3)			0.123* (5.65)		
MA(1)		0.082* (3.60)	-0.416* (-6.35)		0.103* (4.823)
MA(2)			0.814* (13.10)		.055* (2.728)
Ω	0.000016 (3.29)	0.00002 (5.000)	0.000009 (4.03)	0.000007 (3.85)	0.000007 (9.29)
α	0.114* (8.11)	0.19* (8.17)	0.135* (12.84)	0.123* (12.68)	0.136* (9.19)
β	0.85* (50.31)	0.795* (35.55)	0.833* (66.34)	0.853* (80.26)	0.818* (46.29)
$\alpha+\beta$	0.964	0.985	0.968	0.976	0.954
AIC	-5.0514	-4.6929	-5.6679	-5.8484	-6.1826
LBQ ² (1)	0.507 [0.47]	0.577 [0.44]	0.297 [0.37]	0.188 [0.66]	0.153 [0.69]
ARCH LM(3)	4.827 [0.28]	0.015 [0.90]	0.785 [0.37]	0.019 [0.88]	4.384 [0.36]
ARCH LM(5)	5.16 [0.94]	1.883 [0.49]	1.327 [0.63]	0.313 [0.93]	4.77 [0.11]

*, ** denotes the 1% and 5% level of significance

Table 3. Results of GARCH model in Crisis Period

	BOVESPA	MICEX	SENSEX	SSE	JSE
μ	0.0006 (0.66)	0.0004 (0.43)	0.001 (1.08)	0.0004 (0.406)	0.00004 (0.06)
AR(1)		-0.246 (-1.16)			1.108* (11.94)
AR(2)		0.638* (3.27)			-0.886* (-8.40)
AR(3)					-0.025 (-0.448)
MA(1)		0.223 (1.11)	0.104** (1.95)		-1.067* (-14.28)
MA(2)		-0.681* (-3.64)			0.863* (10.67)
Ω	0.00002 (2.07)	0.00001 (2.24)	0.00003 (2.81)	0.000015 (3.66)	0.000007 (1.02)
α	0.089* (2.75)	0.129* (5.22)	0.118* (4.01)	0.053* (4.38)	0.119* (3.80)
β	0.879* (25.86)	0.870* (37.42)	0.865* (27.94)	0.921* (47.32)	0.865* (26.36)
$\alpha + \beta$	0.968	0.998	0.983	0.974	0.984
AIC	-4.5476	-4.4532	-4.6029	-4.5744	-5.1562
LBQ ² (1)	2.979 [0.84]	2.51 [0.11]	0.02 [0.51]	0.842 [0.35]	2.646 [0.11]
ARCH LM(3)	0.704 [0.40]	2.48 [0.21]	0.009 [0.92]	0.029 [0.29]	0.019 [0.88]
ARCH LM(5)	2.158 [0.43]	4.94 [0.86]	1.148 [0.68]	0.47 [0.88]	1.279 [0.65]

*, ** denote the 1% and 5% level of significance

Table 4. Results of GARCH model in Post Crisis Period

	BOVESPA	MICEX	SENSEX	SSE	JSE
μ	0.0003 (1.35)	0.00006 (1.47)	0.0005* (2.86)	0.0001 (0.586)	0.0005* (3.20)
AR(1)			0.068* (3.07)	0.022 (0.95)	-0.044 (-1.45)
AR(2)					-0.057*** (-1.88)
AR(3)					0.902* (29.28)
MA(1)					0.034 (1.45)
MA(2)					0.026 (1.09)
MA(3)					-0.940* (-38.95)
Ω	0.000009 (21.69)	0.000004 (9.78)	0.000001 (3.32)	0.0000006 (4.22)	0.000002 (4.12)
α	0.068* (14.98)	0.058* (7.76)	0.049* (6.57)	0.055* (12.28)	0.083* (7.44)
β	0.89* (112.32)	0.917* (110.4)	0.939* (103.21)	0.943* (237.7)	0.894* (63.81)
$\alpha + \beta$	0.958	0.975	0.988	0.998	0.977
AIC	-5.7325	-5.9767	-6.4671	-6.0725	-6.5780
LBQ ² (1)	0.197 [0.65]	0.001 [0.97]	1.802 [0.17]	1.602 [0.21]	0.526 [0.46]
ARCH LM(3)	0.244 [0.62]	0.05 [0.82]	0.014 (0.90)	2.875 [0.89]	0.309 [0.57]
ARCH LM(5)	0.8009 [0.79]	0.192 [0.96]	0.104 [0.98]	3.53 [0.22]	0.487 [0.88]

*, ** denote the 1% and 5% level of significance

From the tables 2, 3 and 4 we can see that the mean returns of all the indices are positive. The ARMA (m, n) lag orders are chosen by using AIC criterion. The lagged squared residuals parameter(α) and the lagged conditional variance parameter(β) are significant and the sum of both is close to unity which shows the strong volatility persistence for all periods. We also observed that the Russia market has experienced high volatility persistence in pre-crisis and during crisis period, whereas the China market has exhibited high volatility persistence in post crisis period. The diagnostic statistics result indicates that both the tests have failed to reject the null hypothesis of no serial correlation and no ARCH effect in

the model for all the markets in all the sub-periods. For all the markets the most suitable model is GARCH (1, 1) in all the periods which supports many earlier studies. The results are consistent with the findings of Naliniprava Tripathy and Ashish Garg(2013), Ramona Birau and Jatin Trivedi(2013), Nawal Kishor and Raman Preet Singh(2014), Siva Kiran and Rao(2017), and Naliniprava Tripathy(2017) which showed the volatility persistence in BRICS markets.

Engle (1990), Nelson (1991), and others noticed that the symmetric GARCH models proposed by Bollerslev (1986) have a limitation of not considering the leverage or asymmetric effect (proposed by Black (1976)) in the volatility modeling of returns. The asymmetric effect occurs when the bad news increases the volatility more than the good news of the same magnitude. In a nutshell, an unexpected drop in prices increases volatility more than the unexpected increase in prices. In order to see the impact of news or information on the volatility of these markets we employ the Glosten, Jagannathan, and Runkle(1989), Zakoian(1990) - GARCH model for BRICS market return series. The reason for selecting GJR-GARCH to test for asymmetric effect is that it is the best parametric model and can capture most of the asymmetry than the EGARCH(by Nelson(1991)) model. Also, the variability of the conditional variance is too high in EGARCH compared GJR-GARCH². The results of the GJR- GARCH models are presented in the following tables 5, 6 and 7.

Table 5. Results of GJR-GARCH in Pre Crisis Period

	BOVESPA	MICEX	SENSEX	SSE	JSE
μ	0.0007** (1.993)	0.0016* (3.639)	0.00009* (3.823)	0.0001 (0.504)	0.0007* (3.010)
AR(1)			0.543* (8.432)		
AR(2)			-0.872* (-15.126)		
AR(3)			0.143* (6.678)		
MA(1)		0.088* (3.849)	-0.438* (-6.969)		0.103* (4.82)
MA(2)			0.795* (13.015)		0.055* (2.72)
Ω	0.00002 (8.119)	0.00002 (9.707)	0.00001 (8.351)	0.000006 (6.462)	0.000007 (7.024)
α	0.0071* (0.710)	0.143* (9.653)	0.042* (3.415)	0.096* (8.115)	0.056* (5.659)
β	0.848* (59.65)	0.798* (72.281)	0.807* (58.26)	0.859* (78.69)	0.831* (59.793)
γ	0.176* (10.401)	0.076* (4.641)	0.181* (9.208)	0.048* (3.58)	0.121* (8.071)

² Engle and NG. K (1993)

AIC	-5.0754	-4.6941	-5.6849	-5.8507	-6.1887
LBQ ² (1)	4.564 [0.326]	0.505 [0.47]	0.441 [0.506]	0.087 [0.767]	0.732 [0.392]
ARCH LM(3)	4.768 [0.289]	0.00028 [0.98]	0.0206 [0.885]	0.016 [0.899]	4.214 [0.409]
ARCH LM(5)	4.977 [0.104]	1.690 [0.543]	1.295 [0.647]	0.308 [0.937]	4.857 [0.110]

*, ** denote the 1% and 5% level of significance

Table 6. Results of GJR-GARCH in Crisis Period

	BOVESPA	MICEX	SENSEX	SSE	JSE
μ	0.00010 (0.106)	0.0001 (0.136)	0.0009 (0.844)	0.00006 (0.612)	0.0007 (0.995)
AR(1)		-0.620* (-68.55)			1.097* (11.94)
AR(2)		-0.973* (-94.48)			-0.869* (-8.37)
AR(3)					-0.031 (-0.59)
MA(1)		0.596* (73.68)	0.105** (2.105)		-1.072* (-14.28)
MA(2)		0.979* (127.08)			0.863* (10.80)
Ω	0.00002 (2.964)	0.000009 (3.039)	0.00002 (2.804)	0.000003 (1.411)	0.000003 (1.501)
α	0.013 (0.570)	0.038 (1.590)	0.068* (2.472)	0.049* (5.512)	0.023 (1.100)
β	0.897* (30.937)	0.893* (46.26)	0.863* (26.45)	0.950* (10.65)	0.925* (37.33)
γ	0.165* (3.606)	0.127* (4.293)	0.096* (2.34)	0.066* (5.620)	0.190* (4.492)
AIC	-4.5739	-4.4590	-4.6313	-4.5906	-5.1958
LBQ ² (1)	5.874 [0.153]	2.517 [0.132]	0.415 [0.519]	1.127 [0.569]	3.894 [0.143]
ARCH LM(3)	0.504 [0.477]	1.69 [0.102]	0.952 [0.812]	1.133 [0.769]	4.144 [0.246]
ARCH LM(5)	0.920 [0.756]	1.54 [0.112]	2.076 [0.838]	2.810 [0.729]	4.954 [0.421]

*, ** denote the 1% and 5% level of significance

Table 7. Results of GJR-GARCH Post Crisis Period

	BOVESPA	MICEX	SENSEX	SSE	JSE
μ	0.00009 (0.349)	0.0003 (1.463)	0.0003 (1.529)	0.0001 (0.650)	0.0001 (0.872)
AR(1)			0.076* (3.216)	0.022 (0.936)	-1.409* (-12.91)
AR(2)					-1.130* (-6.02)
AR(3)					-0.649* (-4.58)
MA(1)					1.441* (12.81)
MA(2)					1.120* (5.74)
MA(3)					0.632* (4.21)
Ω	0.000009 (5.844)	0.000004 (9.130)	0.000002 (5.728)	0.000006 (4.119)	0.000001 (5.667)
α	0.0169** (1.978)	0.018* (2.415)	0.00006 (0.007)	0.058* (9.314)	0.0232* (2.946)
β	0.8881* (61.49)	0.919* (111.12)	0.914* (82.57)	0.944* (237.08)	0.9252* (91.913)
γ	0.1033* (6.642)	0.073* (7.487)	0.124* (7.836)	-0.006 (-0.86)	0.155* (9.826)
AIC	-5.7435	-5.9863	-6.4866	-6.0716	-6.6099
LBQ^2(1)	0.6235 [0.430]	0.0018 [0.966]	4.069 [0.131]	1.652 [0.199]	2.2295 [0.135]
ARCH LM(3)	3.097 [0.376]	0.143 [0.988]	5.169 [0.159]	6.165 [0.113]	2.756 [0.43]
ARCH LM(5)	4.288 [0.508]	0.397 [0.995]	5.986 [0.309]	7.130 [0.211]	2.896 [0.716]

*, ** denote the 1% and 5% level of significance

From the tables 5, 6 and 7 we see that asymmetric or leverage effect (γ) is statistically significant in all the series for all the periods except China in post crisis period. This also can be observed from the news impact curves which are provided in Appendix A to E. This signals that during post crisis period, the China market is indifferent to the good or bad news. The results are compatible with the studies conducted by Naliniprava Tripathy and Ashish Garg(2013), Ramona Birau and Trivedi(2013), Parneet Kaur and Amanjot Singh(2015), Pramod Kumar and Puja padhi(2015), and Siva Kiran and Rao(2017). In the case of South Africa market our results are in contrast with the findings of George Adu(2015) which showed the absence of leverage effect.

From table 2 to 4 we observed that the sum of ARCH and GARCH coefficients is less than one indicating the mean reverting process in all the BRICS markets during all the periods. We have calculated the speed of mean reversion by the half-life method, and the results are presented in table 8.

Table 8. *The results of Mean Reversion process*

		$\alpha+\beta$	$\ln(0.5)$	$\ln(\alpha+\beta)$	L
Pre Crisis	BOVESPA	0.964	-0.693	-0.037	18.905
	MICEX	0.985	-0.693	-0.015	45.862
	SENSEX	0.968	-0.693	-0.033	21.312
	SSE	0.976	-0.693	-0.024	28.533
	JSE	0.954	-0.693	-0.047	14.719
Crisis	BOVESPA	0.968	-0.693	-0.033	21.312
	MICEX	0.999	-0.693	-0.002	692.800
	SENSEX	0.983	-0.693	-0.017	40.426
	SSE	0.974	-0.693	-0.026	26.311
	JSE	0.984	-0.693	-0.016	42.974
Post Crisis	BOVESPA	0.958	-0.693	-0.043	16.154
	MICEX	0.975	-0.693	-0.025	27.378
	SENSEX	0.988	-0.693	-0.012	57.415
	SSE	0.998	-0.693	-0.002	346.227
	JSE	0.977	-0.693	-0.023	29.789

It is observed from table 8 that markets with high/low volatility exhibited the slowest/fastest mean reverting process. It is clear that in the pre-crisis period, crisis period the Russia market and in the post-crisis period the China market has shown high volatility levels and slow mean reverting process relative to other markets. Whereas, the South Africa market in the pre-crisis period, Brazil market in the crisis and the post-crisis period were less volatile thereby the mean reverting process is the fastest compared to other markets. Using the half-life method, we have calculated the speed of mean reversion for all the markets.

The results reveal that in the pre-crisis period Russian market have the highest volatility persistence, thus it takes 45.86 days to revert to half of its mean, while the South Africa market takes only 14.71 days as it has the lowest volatility persistence. During the crisis period, the Russia market takes 692.80 days and Brazil market takes only 21.31 days to revert to half of its mean. In the case of the post-crisis period, China market reverts to half of its mean after 346.22 days while Brazil reverts in 16.15 days. Therefore, we conclude that all those markets with high speed of mean reversion (low volatility) are amenable short term investments while the low speed of mean reversion (high volatility) can be for long term investments.

5. SUMMARY AND CONCLUSION

Ever since the emerging economies initiated reforms in their financial sector the stock markets experienced a remarkable growth due to an increase in foreign capital inflows. However, the asymmetric information in emerging markets results in a high degree of volatility than the developed markets. Thus, it is important to study the volatility behavior of emerging markets and also estimating risk which arises due to excessive volatility in the markets.

This study examines the volatility behavior in BRICS markets using the daily stock indices for the period 25th September 1997 to 31st March 2018. The sample period further divided into three sub-periods as pre-crisis, crisis and post-crisis periods to evaluate volatility persistence due to global financial crisis of 2008 on these markets.

The estimated GARCH results showed that all five markets have volatility persistence in their returns with high volatility in Russia market in the pre-crisis and crisis period, China market in the post-crisis period. The results of GJR-GARCH model reveals that all BRICS markets have a leverage effect in all the periods implying that the negative news increase volatility than the positive news except in China for the post-crisis period. Also, the results show that these markets are mean reverting in all the periods of the study.

REFERENCES

- Ahmed, R. R., Veeinhardt, J., Streimikiene, D., & Channar Z. A. (2018). Mean reversion in International markets: Evidence from GARCH and half-life volatility models. *Economic Research*, 31(1), 1198-1217.
- Adu, G., Alagidede, P., & Karimu, A. (2015). Stock return distribution in the BRICS. *Review of Development Economics*, 5, 98-109.
- Atje, R. & Jovanovic, B. (1993). Stock markets and development. *European Economic Review*, 37, 632-640.
- Bali, T. G. & Demirtas, K. O. (2008). Testing Mean Reversion in Financial Market Volatility: Evidence from S&P 500 Index Futures. *The Journal of Futures Markets*, 28(1), 1-33.
- Bahloul, S. & Abid, F. (2014). Regime- Switching Behaviour in the conditional volatility of MENA stock market returns. *Journal of Emerging Market Finance*, 13(3), 253-278.
- Bakaert, G. & Harvey, C.R. (1997). Emerging equity market volatility. *Journal of Financial Economics*, 43(1), 29-7.
- Bhuyan, R., Robbani, G. M., Talukdar, B., & Jain, A. (2016). Information transmission and dynamics of stock price movements: An empirical analysis of BRICS and US stock markets. *International Review of Economics & Finance*, 46, 180-195.
- Birau, R., & Trivedi, J. (2013). Modeling return volatility of BRIC emerging stock markets using GARCH family models. *Indian Journal of Applied Research*, 3(11), 119-121.
- Black, F. (1976). Studies of stock price volatility changes. In: *Proceeding of the 1976 meetings of the American Statistical Association*, 177-181.
- Bollerslev, T. (1986). Generalized autoregressive conditional heteroskedasticity. *Journal of Econometrics*, 31, 307-327.
- Boubaker, H., & Raza, S. A. (2017). A wavelet analysis of mean and volatility spillovers between oil and BRICS stock markets. *Energy Economics*, 64, 105-117.
- Business Cycle Dating Committee, N.B.(2010). Retrieved March 2, 2019, from <http://www.nber.org/cycles/sept2010.pdf>
- Christle, A. (1982). The stochastic behavior of common stock variance: Value, leverage and interest rate effects. *Journal of Financial Economics*, 10, 407-432.
- Chkili, W., & Nguyen, D. H. (2014). Exchange rate movements and stock market returns in a regime-switching environment: Evidence for BRICS countries. *Research in International Business and Finance*, 31, 46-56.
- De Bondt, W. F. M. & Thaler, R. H. (1985). Does the stock market overreact? *Journal of Finance*, 40, 793-805.

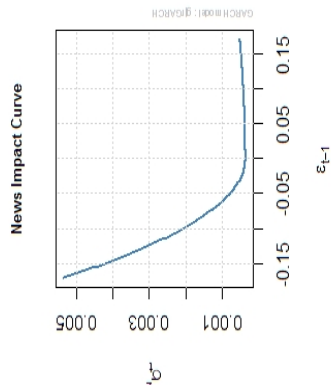
- De Bondt, W. F. M. & Thaler, R. H. (1987). Further evidence on investor overreaction and stock market seasonality. *Journal of Finance*, 42,557-581.
- De Santis, G., & Imrohoroglu, S. (1994). Stock returns and volatility in emerging financial markets. (Discussion Paper 93, 1- 18.). Federal Reserve Bank of Minneapolis.
- Diamandis, P. F. (2008). Financial liberalization and changes in the dynamic behavior of emerging market volatility: Evidence from four Latin American equity markets. *Research in International Business and Finance*, 22(3), 362-377.
- Dryden, M. M. (1970). Filter tests of U.K. share prices. *Applied Economics*, 1(4), 261–275.
- Engle, R. (1982). Autoregressive conditional heteroskedasticity with estimates of the variance of UK inflation. *Econometrics*, 50, 987-1008.
- Engle, R. F. & Ng, K. V. (1993). Measuring and testing the impact of news on volatility. *The Journal of Finance*, 48(5), 1749-1778.
- Fama, E. F. (1965). The behavior of Stock market prices. *Journal of Business*, 38, 34-105.
- Fama, E. F.(1970). Efficient capital markets: A review of theory and empirical work. *The Journal of Finance*, 25(2), 383-417.
- Gbenro, N., & Moussa, K. R. (2019). Asymmetric mean reversion in low liquid markets: Evidence from BRVM. *Journal of Risk and Financial Management*, 12(38), 1-19.
- Glosten, L., Jagannathan, R., & D. Runkle.(1993). On the Relationship between the expected value and the volatility of the nominal excess return on stocks. *Journal of Finance*, 48(5), 1779-1801.
- Hull, M., & McGorarty, F. (2014). Do emerging markets become more efficient as they develop? Long memory persistence in equity indices. *Emerging Market Review*, 18, 45-61.
- Jin, X., & An, X. (2016). Global financial crisis and emerging stock market contagion: A volatility impulse response function approach. *Research in International Business and Finance*, 36, 179-195.
- Kaur, P., & Singh, A. (2015). Investigating the leverage effect and volatility in the BRIC countries' equity markets after the U.S. financial crisis. *The Journal of Wealth Management*, 17(4), 93-100.
- Kishor, N., & Singh, R. P. (2015). Stock return volatility effect: Study of BRICS. *Transactional Corporations Review*, 6(4), 406-418.
- Levine, R., & Zervos, S. (1996). Stock market development and long-rung growth. *World Bank Economic Review*, 10(2), 323-339.
- Mensi, W., Hammoudeh, S., Nguyen, D. K., & Kang, S. H. (2015). Global financial crisis and spillover effects among the US and BRICS stock markets. *International Review of Economics & Finance*, 42, 257-276.

- Mukherjee, K. N. & Mishra, R. K. (2010). Stock market integration and volatility spillover Indian and its major Asian counterparts. *Research in International Business and Finance*, 24(2), 235-251.
- Murinde, V., & Poshakwale, S. (2001). Volatility in the emerging stock markets in Central and Eastern Europe: Evidence on Croatia, Czech Republic, Hungary, Poland, Russia and Slovakia. *European Research Studies*, 4(3-4), 73-101.
- Naik, K. P. & Padhi, P. (2015). Stock market volatility and equity trading volume: Empirical examination from BRIC. *Global Business Review*, 16(5), 28-45.
- Nam, K., Kim, S. W., & Arize, A. C. (2006). Mean reversion of short-horizon stock returns asymmetry property. *Review of Quantitative Finance and Accounting*, 26(2), 137-163.
- Nelson, D. (1991). Conditional heteroskedasticity in asset returns: A new approach. *Econometrics*, 59, 347-370.
- Pagano, M.(1993). The flotation of companies on the stock market. *European Economic Review*, 37, 1101-25.
- Palwasha, R. I., Ahmad, N., Ahmed, R. R. & Veinhardt, J. (2018). Speed of mean reversion: An empirical analysis of KSE, LSE and ISE indices. *Technological and Economic Development of Economy*, 24(4), 1435-52.
- Panda, P., & Thiripalraju, M. (2018). Return and volatility spillovers among stock markets: BRICS countries experience. *Afro-Asian Journal of Finance and Accounting*, 8(2), 148-166.
- Poterba, J. M., & Summers, L. H. (1988). Mean reversion in stock prices: Evidence and implications. *Journal of Financial Economics*, 22(1), 27-59.
- Sharma, J. L. & Kennedy, R. E. (1977). A comparative analysis of stock price behaviour on the Bombay, London and New York Stock Exchanges. *Journal of Financial and Quantitative Analysis*, 12(3), 391-413.
- Sivakiran, G. K, & Prabhakar Rao,R. (2017). The volatility behaviour of emerging BRICS stock markets. *International Journal of Management and Development Studies*, 6(8), 95-111.
- Spierdijk, L., Bikker, J. A. & van den Hoek, P. (2012). Mean reversion in international stock markets: An empirical analysis of the 20th century. *Journal of International Money and Finance*, 31, 228-249.
- Tripathy, N., & Garg, A. (2013). Forecasting stock market volatility: Evidence from six emerging markets. *Journal of International Business and Economy*, 14(2), 1-25.
- Tripathy, N. (2017). Do BRIC countries stock market volatility move together? An empirical analysis of using multivariate GARCH models. *International Journal of Business and Emerging Markets*, 9(2), 104-123.
- Walid, C., Chaker, A., Masood, O., & Fry, J. (2011). Stock market Volatility and Exchange Rates in Emerging countries: A Markov-state switching approach. *Emerging Markets Review*, 12(3), 272-292.

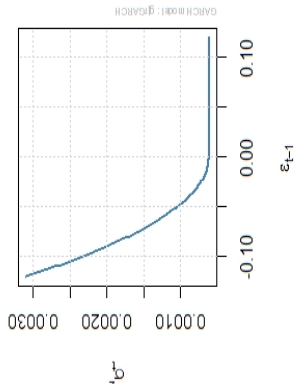
- Wang, P. & Moore, T. (2009). Sudden changes in volatility: The case of five central European stock markets. *Journal of International Financial Markets, Institutions, and Money*, 19(1), 33-46.
- Wang, J., Zhang, D., & Zhang, J. (2015). Mean reversion in stock prices of seven Asian stock markets: Unit root test and stationary test with Fourier functions. *International Review of Economics & Finance*, 37, 157-164.

APPENDIX - A: News Impact Curves for BOVESPA

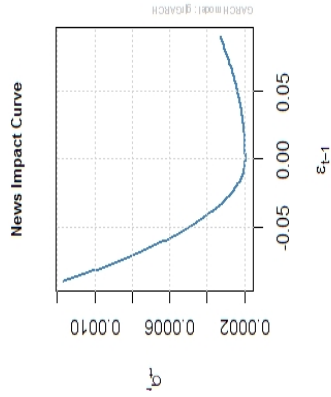
Pre-Crisis



Crisis

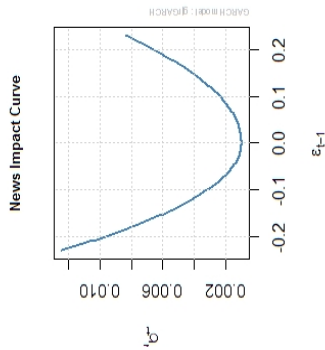


Post-Crisis

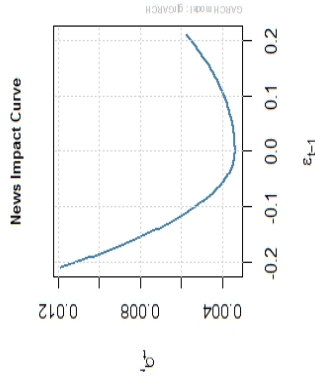


APPENDIX - B: News Impact Curves for MICEX

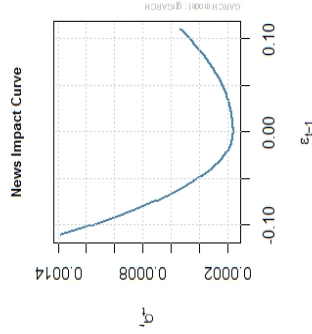
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Crisis

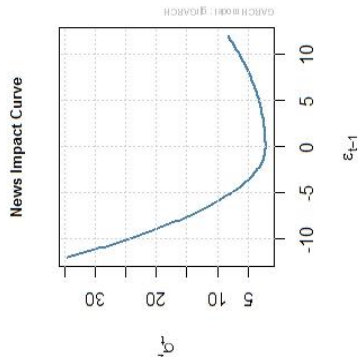


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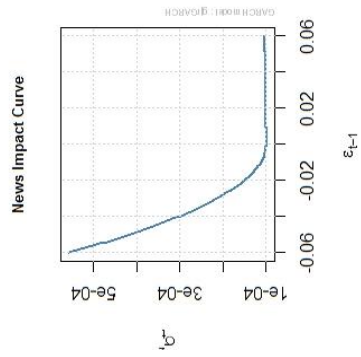


APPENDIX - C: News Impact Curves for SENSEX

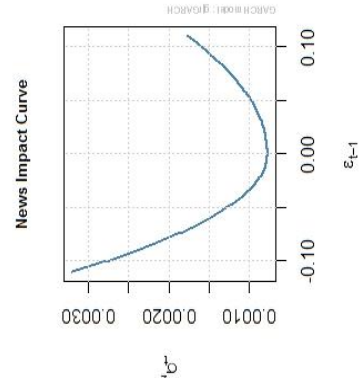
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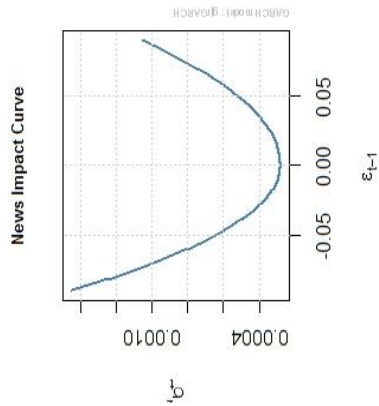


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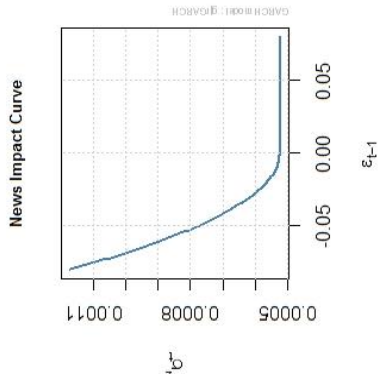


APPENDIX - D: News Impact Curves for SSE

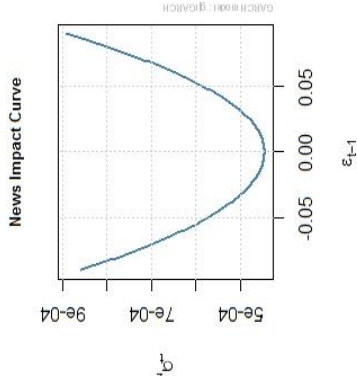
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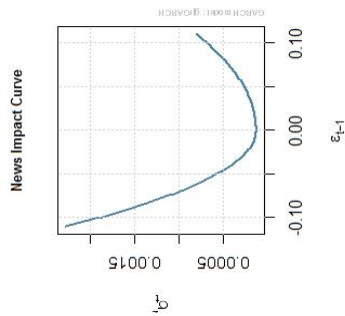


Post-Crisis

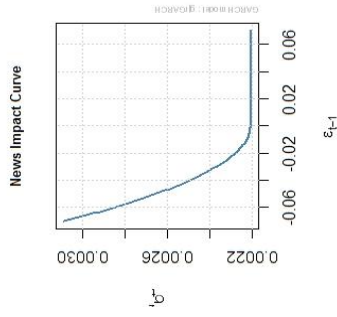


APPENDIX - E: News Impact Curves for JSE

Pre-Crisis



Crisis



Post-Crisis

