Journal: Primax International Journal of Commerce and Management Research
ISSN: Print ISSN : 2321-3604 Online ISSN: 2321-3612 & Open Access
DOI: 10.17605/OSF.IO/36HTR

OPEN ACCESS

PRIMAX IJCMR VOLUME NO.8, ISSUE NO. 2, JULY- SEPTEMBER 2020

Research Article

Normality of Stock return distribution in the BRICS

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Abstract: The present study has been conducted to test the normality assumption for the behaviour of market returns in the BRICS stock markets. The study has been conducted on daily market returns for the period of 1st April 2011 to 31st March 2019. The stock return normality has been examined using skewness, kurtosis, Shapiro-Wilk, Jarque-Bera and Kolmogorov-Smirnow test. The study has also made an important attempt for testing the normality assumption for market returns over the longer periods, considering specifically blocks of 5, 20, 60, and 120 consecutive market days between 2011 and 2019. Based on the analysis, it can be said that for shorter return periods the empirical distributions of all the countries departed from a normal distribution and reflected asymmetric behaviour. As far as intermediate return periods are concerned some tests rejected of the normality assumption, and others accepted. But for a lengthier period, none of the tests rejected the assumption of normality for any country. Thus, it has been observed that the behaviour of the returns approaches a normal distribution as the length of time increases. This suggests that investors should not rely on the normality of returns assumption while evaluating risk for daily market returns and shorter return periods. However, assumption normality of returns may be valid for longer return periods.
Key words: BRICS, intermediate return, market returns

Introduction

Assumption of a normal distribution of stock return is one of the fundamental assumptions in financial models and theories and these financial models regularly disregard the skewness and kurtosis of the return distribution and assume that the standard deviation is a complete measure of risk. In a normal distribution mean value is found zero and variance is unity. Further, value for skewness at zero and kurtosis at 3 represents that the observed distribution is normally distributed. Random walk model of stock prices is also based on the assumption of normality. Hence, it becomes imperative to study how the distribution of BRICS stock returns fit into a normal distribution. Further, this aspect of stock return normality has, however, become more interesting when the analysis is carried out in the context of international stock markets in the era when globalization has brought financial integration among the nations. The gradual lifting of restrictions on capital flows and relaxation of exchange control in many countries have accelerated integration among the world's capital. However, in the present situation, global markets have tended to become more integrated as a result of common practice towards liberalization and deregulation in the capital markets of both developed as well as emerging countries. Thus, the present study is being contemplated to examine the normality of stock returns hypothesis for some BRICS stock markets. This

paper attempted to seek evidence for the normal distribution using the daily data of stock indices of BRICS stock markets for the period 2011-2019. The paper is organized as follows: Section I is an introduction. Section II provides a brief review of the literature. Section III explains the data and Methodology. Section IV presents empirical results. Finally, concluding remarks are given in Section V.

Review of literature

Mandelbrot (1963) concluded that the distributions of price changes belong to the stable Paretian distributions. Fama (1965) concluded that the distributions were more peaked at the centre and have fatter tails. Press (1967) concluded that stock returns were generated from a mixture of distributions i.e. combinations of normal distributions with different variances. Kon (1984) also found that stock returns seem to be the discrete mixture of normal distributions. Hall, Brorsen and Irwin (1989) found that the distribution of price changes follow the mixture of normal distributions hypothesis. Sergio J. Chión and Carlos N. Véliz C (2008) rejected the normality assumption for the stock returns in the main Latin American stock markets. Damber Singh Kharka and et.al. (2012) concluded that stock returns are not distributed normally in all the countries in the SAARC region. Chalabi et al (2012) concluded that the generalized lambda distribution may be used for modelling the behaviour of daily equity index returns. Arık et al. (2013) conducted a study to examine the distribution of BIST-100 returns over the period 1997 to 2012. It was found that VAR values calculated for daily maximum returns were lower than the monthly maximum returns. Naumoski et al, (2017) examined the distribution of returns of 10 Southeast European emerging countries over the period 2011 to 2016. They used daily, weekly and monthly observations. It was found that stock returns followed a leptokurtic distribution. Further, values of skewness of the distributions of returns for most of the countries were found negative. Lakshmi Viswanathana and S. Maheswaranb (2017) concluded that the long term stock returns are not normally distributed. Aleksandar Naumoski, Stevan Gaber, and Vasilka Gaber-Naumoska (2017) also rejected the assumption of normality. Ezgi Gümüştekin and Güneş Topçu (2018) found that returns follow leptokurtic distribution instead of normal distribution and as the return period increases, distribution of returns approached normal.

Data and Methodology

The daily returns of the BRICS stock return have been used to investigate the normality of returns. The period of the present study has been taken to be the period starting from 01.04.2011 up to 31.03.2019. Daily closing index values were collected for indices for the above specified period to calculate the daily returns on each index. The data source used for

this purpose is yahoo finance. The return is calculated as the logarithmic difference between two consecutive prices in a series. The logarithm returns have been taken as these are treated theoretically and empirically superior to simple return. Blocks of 1, 5, 20, 60 and 120 consecutive market days have been used to examine whether the distribution of returns approaches normal distribution overtime or not. The descriptive or summary statistics used in the present study consist of the mean, standard deviation, minimum return, maximum return skewness, and kurtosis. Preliminary evidence on the normality of distribution of return series under consideration has been gathered from the skewness, kurtosis, and their standardized coefficients. Generally, value for zero skewness represents that the observed distribution is normally distributed. Further, the value for kurtosis at 3 represents that the observed distribution is normally distributed. To test the significance of skewness and kurtosis standardized coefficients of skewness and kurtosis have been calculated. The values for the standardized coefficients outside the range of -1.96 and 1.96 provide clear signal regarding deviation from a normal distribution at 5 % level of significance. Further, three types of normality tests, Shapiro-Wilk, Jarque-Bera and Kolmogorov-Smirnow tests have been used to investigate normality of returns.

Table 1: BRICS stock market indices Country

	Brazil	Russia	India	China	South Africa
Exchanges	Sao Paulo Stock Exchange	Moscow Stock Exchange	Bombay Stock Exchange	Shanghai Stock Exchange	Johannesburg Stock Exchange
Index	BOVESPA Index	Russian Trading System Index	SENSEX Index	SSE Composite Index	Johannesburg All Share Index

V Empirical Analysis

The empirical results are presented as below

Descriptive Statistics

Table 1 provides descriptive statistics of the empirical distributions of the stock market returns under study. All markets exhibited negative coefficients of skewness. It means that in these markets there is a possibility of left asymmetric distributions and a mean value lower than the mode and the median. Highest coefficient of skewness is found in the stock market of China and the lowest coefficient of skewness is of the stock market of Brazil. Negative skewness means a higher probability of extreme negative returns relative to extreme positive returns, which is in contrast to the prediction of symmetric distributions such as the normal distribution that shows equal probabilities for extreme cases. The asymmetrical behaviour evident for returns implies serious shortcomings when considering the standard deviation as the sole measure of risk.

Table 1: Descriptive Statistics of the Distributions of Daily Returns

Market	Min. Statistic	Max. Statistic	Mean Statistic	Std. Deviation Statistic	C.V.	Skewness			Kurtosis		
						Statistic	Std. Error	Z	Statistic	Std. Error	Z
Brazil	-.0921	.0639	.000162	.0146085	9017.59	-.135	.055	-2.455	1.923	.110	17.482
Russia	-.1325	.1325	-.000273	.0178428	-6535.82	-.375	.055	-6.818	7.133	.109	65.440
India	-.0612	.0370	.000348	.0093396	2683.79	-.201	.055	-3.655	2.043	.110	18.573
China	-.0887	.0560	.000021	.0138782	66086.67	-.954	.056	-17.036	6.583	.111	59.306
South Africa	-.0362	.0416	.000279	.0094622	3391.47	-.165	.055	-3.000	1.327	.110	12.064

* Values for the standardized coefficients outside the range of -1.96 and 1.96 would signal a departure from a normal distribution at the $p < .05$ significance level.

Further, Table 1 shows that for all the markets, values for kurtosis were different from three, pointing toward a non-normal distribution. The lowest kurtosis corresponded to South Africa and the highest to China. It is clear from the values of kurtosis for the stock markets of Russia and China that these markets follow leptokurtic distributions, which exhibit fat tails and high peaks to normal distributions. Thus, in these markets, nonnormal distribution characterized by negative asymmetry and fat tails. Thus, in these stock markets, a situation of higher probabilities for extreme negative returns emerges than would in the case of a normal distribution. Leptokurtic distributions severely restrict the appropriateness of using the standard deviation of a distribution as the sole means of identification of risk. Based on analysis of skewness and kurtosis, there is the possibility of all the markets demonstrating non-normal distributions.

Normality Tests

Shapiro-Wilk, Jarque-Bera, and Kolmogorov-Smirnov tests have been applied to confirm whether the distributions of the returns are normal or not. Table 4 shows the results of the normality test. Evident in Table 4, the hypothesis of normality was rejected at 1% level of significance level for all the markets for all the tests performed.

Table 2: Tests of Normality of the Distributions of Daily Returns

Market	Kolmogorov-Smirnov[a]		Shapiro-Wilk		Jarque-Bera test	
	Statistic	Sig.	Statistic	Sig.	Statistic	Sig.
Brazil	.033	.000	.986	.000	307.62	.000
Russia	.057	.000	.939	.000	4293.71	.000
India	.048	.000	.982	.000	354.80	.000
China	.096	.000	.905	.000	3783.69	.000
South Africa	.048	.000	.985	.000	154.03	.000

Normality over Time

Normality over time involves examining whether longer return periods approach a normal distribution or not. The study involved considering periods of 5, 20, 60, and 120 block days. The results related to the analysis of normality overtime related to BRICS stock markets are presented below separately for each country.

Brazil

The descriptive statistics of the return series of Brazil stock market return have been provided in Table 3. It is clear from the table that Z score for skewness is more than the specified limit for daily return and thus, it shows departures from a normal distribution for daily return. Also, the coefficients of standardized skewness exhibited negative signs for different time blocks. Further, it is also revealed from the Table 3 that based on standardized kurtosis hypothesis of normal distribution could not be rejected for 20, 60, and 120 market days. Thus, from the information in Table 3, one can conclude that there is a possibility of market return behaviour approaching a normal distribution as the length of time increases.

Table 3: Descriptive Statistics of the Distributions of Returns for Brazil

	Minimum Statistic	Maximum Statistic	Mean Statistic	Std. Deviation Statistic	CV	Skewness			Kurtosis		
						Statistic	Std. Error	Z	Statistic	Std. Error	Z
1 day	-0.092	0.0639	0.0002	0.0146	9004.53	-0.135	0.055	-2.455	1.923	0.11	17.48
5 day	-0.114	0.1404	0.0008	0.0308	3661.50	-0.042	0.134	-0.313	1.586	0.268	5.91
20 day	-0.167	0.1876	0.0016	0.0603	3820.52	0.066	0.249	0.265	0.649	0.493	1.31
60 day	-0.184	0.1687	0.0123	0.1088	883.05	-0.212	0.414	-0.512	-1.362	0.809	-1.68
120 day	-0.262	0.3401	0.0226	0.1850	819.14	0.384	0.564	0.681	-1.054	1.091	-0.96

Shapiro-Wilk, Jarque-Bera, and Kolmogorov-Smirnov tests have been applied to confirm whether the distributions of the returns of the stock market index are normal or not. Table 4 shows that all tests of normality rejected the normality assumption for daily returns. Further, except for the Kolmogorov-Smirnov test, all the other tests rejected the normality assumption for periods of 5 market days. For 20 and above market days, the normality assumption could not be rejected based on any of the tests. It can be said based on the above analysis that the empirical data indicate a non-normal distribution for the short time horizon and behaviour of stock return could be approaching a normal distribution as the time horizon increases.

Table 4: Brazil: Normality Tests

	Kolmogorov-Smirnov[a]		Shapiro-Wilk		Jarque-Bera test	
	Statistic	Sig.	Statistic	Sig.	Statistic	Sig.
1 day	.033	.000	.986	.000	307.62	.000
5 day	.042	.200	.984	.001	32.78	.000
20 day	.062	.200	.990	.706	1.25	.533
60 day	.142	.101	.929	.036	2.61	.270
120 day	.191	.121	.936	.302	1.13	.566

Russia

The descriptive statistics of the return series of the stock market of Russia have been provided in Table 5. Based on coefficients of standardized skewness and kurtosis, it can be said that the behaviour of the distributions have been found symmetrical for time blocks of more than 60 market days and hypothesis of normality is rejected for time blocks of 200 or fewer market days. The result suggests the possibility of market return distribution approaching a normal distribution as the period increases.

Table 5: Descriptive Statistics of the Distributions of Returns for Russia

	Minimum Statistic	Maximum Statistic	Mean Statistic	Std. Deviation Statistic	CV	Skewness			Kurtosis		
						Statistic	Std. Error	Z	Statistic	Std. Error	Z
1 day	-.1325	.1325	-.000273	.0178428	-6535.82	-.375	.055	-6.818	7.133	.109	65.440
5 day	-.2007	.1214	-.001660	.0409028	-2464.02	-.624	.133	-4.692	2.852	.265	10.762
20 day	-.3251	.1508	-.005143	.0752788	-1463.71	-.902	.241	-3.743	2.809	.478	5.877
60 day	-.2950	.2702	-.014552	.1384189	-951.20	-.104	.409	-0.254	-.529	.798	-0.663
120 day	-.4786	.3321	-.042947	.2242405	-522.13	-.251	.564	-0.445	-.604	1.091	-0.554

It is clear from Table 6 that all the normality tests rejected the normality assumption for the periods of 1 and 5 market days. As far as the period of 20 market days is concerned, the tests of Jarque-Bera and Shapiro-Francia led to the rejection of the normality assumption. For the periods of 60 and 120 market days, no tests allowed for the rejection of the normality hypothesis.

Table 6: Russia: Normality Tests

	Kolmogorov-Smirnov[a]		Shapiro-Wilk		Jarque-Bera test	
	Statistic	Sig.	Statistic	Sig.	Statistic	Sig.
1 day	.057	.000	.939	.000	4293.718	.000
5 day	.071	.000	.961	.000	130.748	.000
20 day	.071	.200*	.954	.001	41.570	.000
60 day	.083	.200*	.984	.886	.597	.741
120 day	.151	.200*	.976	.922	.547	.760

India

Table 7 revealed that the values of Z- score for skewness are found outside the specified range [-1.96,1.96] for the time blocks of 1day and 20 days. For kurtosis, values of Z- score for skewness are found outside the specified range [-1.96,1.96] for daily returns only. Based on analysis of skewness and kurtosis, the result suggests the possibility of market return distribution approaching a normal distribution as the period increases.

Table 7: Descriptive Statistics of the Distributions of Returns for India

	Minimum Statistic	Maximum Statistic	Mean Statistic	Std. Deviation Statistic	C.V.	Skewness			Kurtosis		
						Statistic	Std. Error	Z	Statistic	Std. Error	Z
1 day	-.0612	.0370	.000348	.0093396	2683.79	-.201	.055	-3.655	2.043	.110	18.573
5 day	-.0531	.0686	.002705	.0213460	789.13	-.090	.138	-0.652	.287	.275	1.044
20 day	-.1239	.1031	.006529	.0409600	627.35	-.515	.243	-2.119	.544	.481	1.131
60 day	-.1315	.1472	.018973	.0634196	334.26	-.283	.414	-0.684	-.209	.809	-0.258
120 day	-.1905	.2309	.039705	.1155402	291.00	-.537	.564	-0.952	.186	1.091	0.170

Table 8 shows that the normality assumption was rejected for daily returns for all tests performed. For all other time blocks no test of normality considered understudy rejected the normality assumption.

Table 8: India: Normality Tests

	Kolmogorov-Smirnov[a]		Shapiro-Wilk		Jarque-Bera test	
	Statistic	Sig.	Statistic	Sig.	Statistic	Sig.
1 day	.048	.000	.982	.000	354.801	.000
5 day	.047	.097	.992	.097	1.320	.516
20 day	.075	.196	.981	.162	5.104	.077
60 day	.087	.200	.988	.966	0.559	.756
120 day	.117	.200	.960	.660	0.660	.718

China

The descriptive statistics of the return series of the stock market of China have been presented in Table 9. It is clear from the table that the values of Z- score for Kurtosis are found outside the specified range [-1.96,1.96] for all the time blocks understudy whereas Z score of the coefficient of skewness is found within the specified limit for all the time blocks under study.

Table 9: Descriptive Statistics of the Distributions of Returns for China

	Minimum Statistic	Maximum Statistic	Mean Statistic	Std. Deviation Statistic	c.v.	Skewness			Kurtosis		
						Statistic	Std. Error	Z	Statistic	Std. Error	Z
1 day	-0.0887	0.0560	0.000021	0.0139	66244.23	-0.954	0.056	-17.036	6.583	0.111	59.306
5 day	-0.1458	0.1056	-0.000295	0.0319	-10792.71	-0.499	0.135	-3.696	2.551	0.27	9.448
20 day	-0.2431	0.1874	-0.001156	0.0656	-5677.94	-0.367	0.245	-1.498	2.733	0.485	5.635
60 day	-0.1615	0.3549	-0.005493	0.1087	-1979.63	1.32	0.421	3.135	2.911	0.821	3.546
120 day	-0.2110	0.4791	0.005534	0.1667	3011.58	1.431	0.564	2.537	3.527	1.091	3.233

As evident in Table 10, all the tests permitted rejection of the normality assumption for the time blocks of 1day, 5 days and 20 days. For the time block of 60 days, Shapiro-Wilk and Jarque-Bera test led to the rejection of the normality assumption. For the time block of 120 days, only the Jarque-Bera test allowed for rejection of the normality assumption and none of the other tests rejected the normality assumption.

Table 10: China: Normality Tests

	Kolmogorov-Smirnov[a]		Shapiro-Wilk		Jarque-Bera test	
	Statistic	Sig.	Statistic	Sig.	Statistic	Sig.
1 day	.096	.000	.905	.000	3783.695	.000
5 day	.054	.022	.967	.000	97.266	.000
20 day	.101	.016	.947	.001	28.031	.000
60 day	.134	.166	.911	.014	14.820	.000
120 day	.129	.200	.890	.056	7.582	.022

South Africa

Table 11 revealed the descriptive statistics of the return series of the stock market of South Africa. It is clear from the table that for all periods of market days except daily returns, coefficients of skewness and kurtosis could not lead to the rejection of the possibility of a normal distribution.

Table 11: Descriptive Statistics of the Distributions of Returns for South Africa

	Minimum Statistic	Maximum Statistic	Mean Statistic	Std. Deviation Statistic	c.v.	Skewness			Kurtosis		
						Statistic	Std. Error	Z	Statistic	Std. Error	Z
1 day	-.0362	.0416	.000279	.0094622	3391.47	-.165	.055	-3.000	1.327	.110	12.064
5 day	-.0605	.0682	.001188	.0200382	1686.72	-.039	.134	-0.291	.574	.267	2.150
20 day	-.0871	.0890	.003908	.0358171	916.51	-.251	.247	-1.016	.169	.490	0.345
60 day	-.1214	.0878	.018124	.0529985	292.42	-.719	.414	-1.737	-.058	.809	-0.072
120 day	-.1022	.1103	.030860	.0658856	213.50	-.454	.564	-0.805	-.802	1.091	-0.735

Table 12, all tests permitted rejection of the assumption of normality for daily return. For all other time blocks, the tests of normality allowed for the acceptance of the normality assumption.

Table 12: South Africa: Normality Tests

	Kolmogorov-Smirnov[a]		Shapiro-Wilk		Jarque-Bera test	
	Statistic	Sig.	Statistic	Sig.	Statistic	Sig.
1 day	.048	.000	.985	.000	154.03	.000
5 day	.038	.200	.994	.241	4.230	.120
20 day	.065	.200	.987	.454	1.001	.606
60 day	.132	.169	.938	.067	2.576	.276
120 day	.139	.200	.932	.259	1.018	.600

Conclusion

The present study has been undertaken to test the normality assumption for the behaviour of market returns in the BRICS stock markets. The study has been conducted on daily market returns for the period of 1st April 2011 to 31st March 2019. The stock return normality has been examined using skewness, kurtosis, Shapiro-Wilk, Jarque-Bera and Kolmogorov-Smirnow test. The study has also made an important attempt for testing the normality assumption for market returns over the longer periods, considering specifically blocks of 5, 20, 60, and 120 consecutive market days between 2011 and 2019. Based on the analysis, it can be said that for shorter return periods the empirical distributions of all the countries departed from a normal distribution and reflected asymmetric behaviour. As far as intermediate return periods are concerned some tests rejected of the normality assumption,

and others accepted. But for a lengthier period, none of the tests rejected the assumption of normality for any country. It is concluded from the results of the study that the normality hypothesis has been rejected for all these markets for shorter return periods and accepted for longer return periods. Thus, it has been observed that the behaviour of the returns approaches a normal distribution as the length of time increases. This suggests that investors should not rely on the normality of returns assumption while evaluating risk for daily market returns and shorter return periods. However, assumption normality of returns may be valid for longer return periods.

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