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Inter-linkages between the stock exchanges of emerging economies: Evidence from BRICS

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Abstract

The economic liberalization took place in the year 1991, opened up wide range of opportunities to the industries, service providers as well as to the investors. Investors overcome the geographical boundaries to diversify their portfolio to foreign markets. So, it is highly important to understand the inter-linkages among the nations. The present study chosen the Brazil, Russia, India, China and South Africa (BRICS) consortium's stock market indices to analyze the connectedness among them, by taking the daily closing price levels, from 1st of Feb 2015 to 31st of March 2021, applied descriptive statistics, Unit root test, Granger Causality Test and Johansen Co-integration tests are performed. The results unveil that, the data sample is stationary; there exists the inter-linkages among the BRICS nations stock markets. India's stock market has major impacts on Brazil, China, South Africa as well as Russia, where as India will not receive major impacts from China, Russia and South Africa. Study concludes that diversifying the portfolio to foreign countries stock markets benefit the investors with increased returns and reduced risk. The study results helps the investors to diversify their portfolios into foreign stock exchanges to get stabilized returns understanding the relationship among emerging countries stock exchanges.

Keywords: BRICS, Co-integration, Diversification, Emerging economies, Emerging markets, Granger causality, Inter-linkages, Portfolio, Stock markets.
JEL Classification: G15.

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Ethical: This study followed all ethical practices during writing.

Contents

Contribution of this paper to the literature

The Present study emphasizes on the countries in the BRICS consortium have scope for diversification, Study identified that countries that have weaker correlation help investors to diversify their portfolios at times of high economic volatility to get stabilized returns, whereas not much literature stressed identifying countries with weaker integration of stock markets.

1. Introduction

The economic liberalization happened in the year 1991, which was led by prime minister P V Narasimha Rao and then Finance minister Dr. Manmohan Singh, gave rise to the equity markets expansion worldwide, especially the emerging markets grown at the faster rate than any other European markets over the period of time. Alongside, a rapid development and availability of Information Technology provided our investors and traders think globally, diversifying their portfolios, through making investments in other developed and emerging countries stock markets to explore and boost their portfolio returns to the maximum.

Financial integration is the fizzy word in the financial terms. The correlation between the movements of share prices around the stock markets in the world due to the integration existed among the stock markets world - wide. It is precedent that during the crisis time, stock markets collapse together. The global financial crisis of 2007 – 2008, was considered as most serious global crisis, since Great Depression. COVID-19 carried out unprecedented impact on the stock markets leads to deep crash in the global stock markets.

However, way back in 2001, Goldmansach's O'Nill, forecasted the need of BRIC formation to overgrow the global GDP of 1.7% in 2002. O'Nill colleagues Wilson and Purushothaman, authored in "Dreaming with BRICs: The Path of 2050", BRICs economy will grow better than G7 in 2003[1]. Global financial crisis and the oil price crisis in the year 2008 gave a hit back to the BRICS economic growth.

Table 1 presents the GDP growth of BRIC countries since 1994 and forecasted till 2026.

Table 1. The GDP growth of BRIC countries since 1994 and forecasted till 2026.

BRIC countries: Growth rate of the real gross domestic product (GDP) from 1994 to 2026 (Compared to the previous year)

Countries/Year	Brazil	China	India	Russia
1994-2003	2.5	9.4	6	0.7
2006	4	12.7	9.5	8.2
2007	6.1	14.2	10	8.5
2008	5.2	9.6	6.2	5.2
2009	-0.3	9.2	6.6	-7.8
2010	7.5	10.4	10.6	4.3
2011	2.7	9.2	7.2	4.3
2016	-3.28	6.87	8.26	0.19
2017	1.32	6.95	6.8	1.83
2018	1.78	6.73	6.53	2.81
2019	1.41	5.82	4.04	2.03
2020	-4.06	2.27	-7.97	-3.06
2021*	3.66	8.44	12.55	3.76
2022*	2.57	5.57	6.93	3.75
2023*	2.14	5.44	6.82	2.1
2024*	2.02	5.27	6.69	1.8
2025*	2.02	5.12	6.62	1.8
2026*	2.02	4.86	6.54	1.8

Note: * indicates the BRICS country's GDP growth forecast.
Source: World economic outlook (2012) & International Monetory Fund (IMF)@ statista 2021.

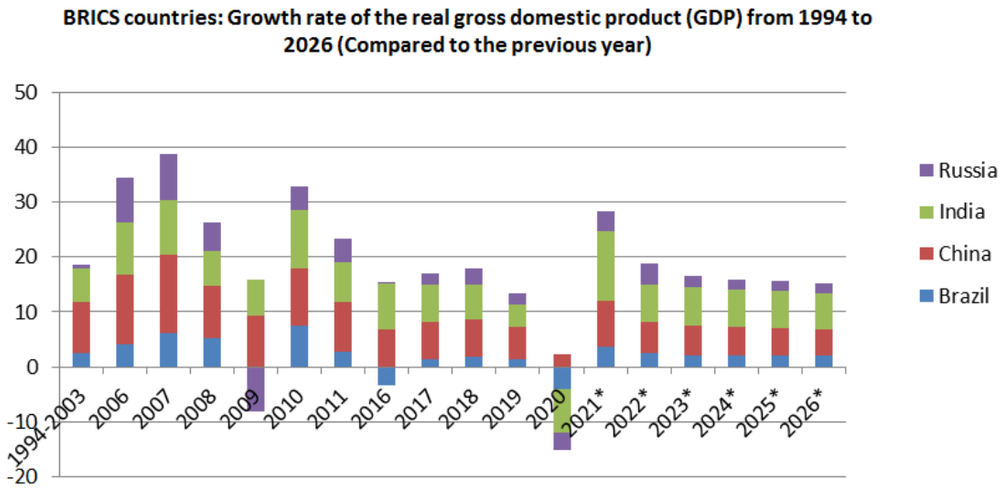

Figure 1.GDP growth of BRICS nations.

Note: * indicates the BRICS country's GDP Growth rate forecast.

Evidence from the Figure 1, it is clear that, as these BRICS country's stock markets (Sharma, Mahendru, & Singh, 2013) are inter-linked, carries both positive and negative impact parallel. 2008 global crisis had unprecedented impact in 2009 leading decreased and negative growth in GDP (Wenjie, Mico, & Malhar, 2019). In 2020, economic growth decelerated due to the impact of COVID-19 pandemic and has carry forward ramifications

in the subsequent years too, other emerging countries and other developed countries too require some more years to recover from the negative impacts of COVID-19 pandemic.

The current efforts are directed to understand the level of relationship, Indian stock market has with other countries in the BRICS consortium. The study flow follows as it mentioned in the below table:
Table 2 presents the flow of the study report

Table 2. Table showing the flow of the study.

Section Number	Content
1	Introduction to the concept
2	Research objectives
3	Review of literature
4	Methodology and data
5	Results of the study Descriptive analysis, unit root test, granger causality test, Johanson Co-integration test
6	Conclusion

2. Objectives of the Study

The study aims to attain the following objectives

(1) To study the return pattern of the stock markets, evident from Brazil, Russia, India, China and South Africa.
(2) To find out the connectedness between stock markets considered for the study.
(3) To scrutiny the recall patterns in the justness markets of BRICS.

3. Review of Literature

Numerous studies already been carried out to understand and analyze the connectedness between the stock markets of India with that of developed as well as emerging countries. Literatures on inter-linkages of global markets, emerging markets and BRICS stock markets are considered to review.

Sharma and Bodla (2011) this research study has been conducted on the sample from benchmark stock exchange indices from India, Pakistan and Srilanka for 7 years long from 2003 to 2010 and concludes that National Stock Exchange (India) have aftermath effects on Karachi Stock Exchanges (Pakistan) and Colombo Stock Exchange (Sri Lanka) and conversely not true. Tripathi and Sethi (2010) This paper investigated the connectedness of Indian stock markets with that of US, China, United Kingdom and Japan Stock market for a period of 1998 to 2008, applied Johansen and Granger's causality test, culminates that, India's stock market is inter-linked with US stock market but not with other sample variables (China, UK and Japan). Unifacial causality was observed. Sharma and Bodla (2010) despite small number of researches deduce, no compatibility between the global stock markets, there exists a connectedness and interdependency among each other stock markets and carries considerable importance due to the increased level of economic development. Cenk and Bibigul (2016) the study investigates the impact of global financial crisis on stock markets of India, China, USA and Japan through Exponential- Generalized AutoRegressive Conditional Heteroscedastic (E-GARCH) model and also examines the volatility spillovers among the sample stock markets using Granger's causality test, the study concludes that precedence to impact of COVID -19, global financial crisis too impacted USA stock market vulnerably with other stock markets in the sample except Shanghai Stock Exchanges. Granger's Causality test results in less volatility spill over experienced by Japan, USA, Indian stock markets received spill over from other stock markets, but China had received no effect.

Marfatia (2017) this research manuscript combines the advantages of parametric and non-parametric approaches to understand the integration and co-movements across the global market, with a sample of 22 leading stock exchange indices, observations been made 18 long years, applied GARCH and WAVELET (A Wave like oscillation with an ampltitude that begins at zero, increases or decreases and then reduces to zero one or more times) model, which concludes that there exists increasingly integration among the selected stock markets in terms of returns, still gives an opportunity to diversify the risk by international portfolio investments, as the study findings conclude that weaker degree of co movement exists at higher frequencies (Rajani & Suresh, 2020). The study has examined the inter linkages among the selected Asian stock markets and remark on COVID-19 impact for the time period of 1st December 2019 to 31st March 2020, concludes that Shanghai stock exchange is negative correlated with other Asian country stock markets, mainly with Indian Nifty. In mid of unexpected financial and health crisis hit stock markets across globe, but country like China and India have their own rebounding strategies, reached high the post recession. Nandy and Chattopadhyay (2019) vector Auto Regression (VAR) analysis, Dynamic Conditional Correlation-Multivriate-Threshold Autoregressive Condi-tional Heteroscedastic (DCC-MV—TARCH) and Granger Causality tests been applied to study the interdependency among the financial markets at different time intervals, study resulted in, significant uneven volatility in domestic and foreign exchange markets as well as between domestic and Asian stock markets. There exists a unifacial movement between the stock markets. Kathiravan et al. (2018) the research manuscript, investigated and resulted that weather factors like, temperature, humidity and wind speed too have significant impact on the stock market returns, same has been proved with the statistical tools on the sample of Indian Stock Market. Babu, Hariharan, and Srinivasan (2016) the study was conducted for a time period from 2009 to 2014 taking the daily data on Asia Pacific stock markets like, Bombay Stock Exchange (India), Australian Stock Exchange, Shanghai Stock Exchange (Chennai), Tokyo Stock Exchange (Japan) and Hong Kong Stock Exchange to test the inter-linkages among these stock markets and witnessed that there exists a long relationship between Asia Pacific Stock Markets.

Singh and Kishor (2017) the study was conducted for the time series return from Indian stock markets and 4 four developed stock market like USA, UK, Japan and Hong Kong stock market to investigate the inter-linkages and relationship among them. It is evidenced that, Indian stock market is influenced by USA and UK, rather have significant effect on Japan and Hong Kong stock markets. The existence of long run relationship among the

selected stock markets was not found. Sharma et al. (2013) study was conducted on the stock market of Brazil, Russia, India, China and South Africa, statistical calculations witnessed the linkage among the stock markets which are picked up as sample, and are influenced by each other stock markets, gives scope for diversification to the investors spread over the BRICS countries. Dua and Tuteja (2016) in this research article, GARCH-BEKK (named after Baba, Engle, Kraft and Kroner) framework was applied to examine the inter-linkages between India and US, foreign exchange and money markets to study the impact of Global financial Crisis on the handpicked samples. The study proves that regarding volatility spillover, Indian financial markets reacts to the domestic as well as US financial market's shocks, but have no much influence on US financial markets. Kumar (2015) the study was conducted to examine the connectedness and co-integration among India and world economy (US, Europe and other emerging markets) and evidenced that the absence of contagious effect on Indian stock market and co-integration exists between Indian and world economy at a low level, but global shocks can sabotage the Indian stock market as well as the entire economy in the long run. Sehgal, Mittal, and Mittal (2019) the study analyzed the vigorous cohesiveness between the BRICS and other emerging country's stock markets, applied Asymmetric Dynamic. Conditional Correlation – Exponential GARCH (ADCC)-EGARCH and Block Aggregation technique, resulted in moderate integration within the BRICS stock markets and with other emerging stock markets too. Adding Mexico, Chile, Hungary, Turkey and Poland along with BRICS creates a better balance among emerging and developed stock markets, which in turn results in superior financial integration.

Mukhodobwane, Sigauke, Chagwiza, and Garira (2020) the study constructed the volatility modeling for the BRICS countries, as it is a key factor for investors in diversifying the portfolio risk at an international level. Ranking was made in the descending hierarchical order based on the volatility, Chinese stock market stands first, as it is highly volatile, followed by South Africa, Russia, India and lastly Brazil stock markets as it least volatile in BRICS community. The study has taken the daily closing levels of the benchmark indices of BRIC countries for a period of 5 years and through statistical tools like VAR model, Granger's Causality test, evidenced that BRICS Stock markets have effects on each other's stock markets, but con not influence the Chinese stock market. Tripathi and Kumar (2016) an extensive study was conducted to understand the long run relationship between the macro economic factors like inflation, interest rate, GDP, money supply, exchange rate and stock prices among the BRICS countries for a period of 19 years, evidenced that uni-facial causality exists in the long run from stock prices to inflation, interest rates and GDP. Bi-lateral relationship was found between stock prices to oil prices and money supply in the long run. Juneja (2017) the study was with regard to the objective of investigating the volatility amidst BRIC countries from 2007 to 2017 for 10 long years and found that Indian stock market strongly co-integrated with Russian stock market with 62% correlation and weak connectedness with Chinese and Brazilian stock markets with lesser correlation of 16 and 2% respectively.

Allimuthu (2019) it was found that there is interdependency between the stock markets. The study revealed that there was a co-movement of stock prices on an international platform. Further investigation done by Rajkumar (2015) revealed that there is an integration between Indian Stock Market and 3 other markets namely Malaysia, Indonesia and Singapore. A study conducted by Umer, Sevil, and Kamişli (2015) proves that there exists the strong integration between stock prices and exchange rates of 0 emerging markets.

Analysis of the aforesaid literatures in the areas of inter-linkages and volatility spillover among the BRICS countries as well as developed and other emerging stock markets, evidenced that unprecedented pandemics and financial crisis like COVID-19 and Global financial crisis 2008 respectively influence the stock markets across the globe, but India and US economies have their own rebounding strategies to overcome the same. Chinese stock markets are strong enough to absorb the global shocks but does not react and influence by the macro economic factors. Expanding the BRICS consortium with few other emerging economies like Chile, Hungary, Mexico, Poland and Turkey to the BRICS will ensure the emerging markets to over grow the developed countries economic growth. Statistical tools like VAR model, Granger's Causality Test, ADCC-EGARCH model, DCC-MV-TARCH model and rarely Johansen Cointegration tests been applied to carry out the research studies earlier to 2019. Hence the research paper has used Descriptive Statistics, Unit Root Test, Granger's Causality Test and in addition Johansen Co-integration Tests are used to arrive at the results, as study of BRICS stock markets been carried out till 2016, considered the time series secondary data from 2015 to 2021.

4. Methodology and Data

In this research study, we examined the inter linkages between stock exchanges of BRICS countries, to expand, Brazil, Russia, India, China and South Africa. We have used the secondary data, sourced from investing.com, moneycontrol.com and NSE website. We have taken one major stock market index from each country in the sample. Brazil Stock Market index (BOVESPA), The Moscow Exchange (MOEX), National Stock Exchange, Shanghai Stock Exchange and Johannesburg Stock Exchange are selected for the study from Brazil, Russia, India, China and South Africa respectively. Quarterly indices average returns are taken from the first quarter 2015 to four quarter of 2019 for a period of 5 years. The data has been collected for 6 years, as per the observations, average daily market index return is taken. Data analysis is performed by examining their return patterns, descriptive statistics been applied to understand the relationship between the selected variables by calculating the mean, median, standard deviation, skewness, Jarque-Beta are calculated to check the normality of the data distribution. Augmented Dicky –Fuller test under the Unit root test been conducted to check the stationarity of the data. The below mentioned ADF formula is applied:

$$\Delta Yt = \alpha + \beta t + \gamma yt - 1 + \delta 1 \Delta Yt - 1 + \cdots + \delta p - 1 \Delta Yt - p + 1 + \varepsilon t$$

Where α is constant, β the co-efficient on the time series data, ρ the lag order of autoregressive process. The Augmented Dicky- fuller Test results are negative numbers, the greater the negative test values indicate strong rejection of the hypothesis, at some level of confidence, there a unit root.

Granger Causality Test (GCT) is a non-parametric test used to check the hypothesis and to determine the time series data is enough to forecast the other variable. GCT is used to test the reliability of the available data to predict the future using the past data removing the anomalies. The below formulas are used to arrive at the results:

$$(\Delta Xt = \alpha x + \sum \beta x, i \Delta Xt - i + k\, i = 1 \sum \gamma x, i \Delta Yt - i + \varepsilon x, t)$$

$$(\Delta Yt = \alpha y + \sum \beta y, i\Delta Yt - i + k\, i = 1 \sum \gamma y, i\Delta Xt - i + \varepsilon y, t)$$

Johansen's Co-integration Test is used to determine the co-integration exists among time series data and to check the validity of co-integration relationship, using maximum likelihood estimates approach. The below mentioned formula is used to validate and check the co-integration among the multi-variables.

$$X_t = \mu + \phi D_t + \Pi p X_{t-p} + \ldots + \Pi_1 X_{t-1} + e_{t,} \quad t = 1, \ldots, T$$

For the data analysis, the above said statistical tools will be applied on the selected benchmark indices for the time period starts from the first quarter of 2015 up to fourth quarter of 2019. As many literatures were carried out up to the year 2016, chosen the study period from 2015 to conduct the extended study on understanding the connectedness among the BRICS countries.

5. Results of the Study

We undertake the above-mentioned statistical tools to analyze and interpret the data to arrive at the results to frame the conclusion with respect to the inter-linkages between the BRICS countries. Firstly, taken the daily close price levels, daily average returns of the benchmark indices from 1st of March 2015 to 31st March of 2021are taken and calculated mean, median, standard deviation, skewness, kurtosis and other indicators to interpret the data to understand the return and risk trend among the BRICS nations stock market indices.

Table 3. Descriptive statistics.

Index	Brazil (BVSP)	Russia (MOEX)	India (NSE)	China (SSE)	South Africa (JSE)
Mean	0.066	0.047	0.003	-0.004	0.007
Median	0.089	0.042	0.025	0.066	0.000
Maximum	6.597	3.964	5.833	5.764	7.001
Minimum	-9.410	-8.344	-8.302	-8.491	-9.569
Std deviation	1.414	0.960	0.971	1.493	1.647
Skewness	-0.331	-0.630	-1.068	-1.066	-0.065
Kurtosis	6.450	8.435	14.300	9.324	5.125
Jarque-Beta	636.904	1605.708	6822.664	2297.444	233.745
Probability	0.000	0.000	0.000	0.000	0.000
Sum	81.919	58.328	3.483	-5.476	8.352
Sum sq. dev	2471.883	1140.69	1165.282	2757.717	3355.124
Observations	1238	1238	1238	1238	1238

Note: BVSP (Bovespa index), MOEX (Moscow exchange), NSE (National stock exchange), SSE (Shanghai stock exchange companies index), JSE (Johannesburg stock exchange).

In Table 3, referring to the mean values for the selected benchmark indices, 0.066170, 0.047115, 0.002813, -0.004423 and 0.006746 for Brazil, Russia, India, China and South Africa respectively. Brazil has the highest index average returns compared to other indices in the consortium; China has the negative average returns. Standard deviation values explain the data spread over the mean values, Russia has the std. dev. Value of 0.960282, which is less compared to other indices, depicts the less risk and data spread out close to mean values, vice-versa with South Africa has 1.646908, the highest std. dev. Values shows the highest risk comparatively, results in less average returns. Skewness helps in measuring the degree and direction data asymmetry. Skewness of Brazil and South Africa are -0.33086 and -0.065069 respectively, which is between the reference value of -0.5 to 0.5, hence the data is fairly symmetrical, Russia with the skewness value of -0.629600, the data is moderately distributed, but India and China's data are highly skewed on the left side. All the sample indices have the kurtosis values higher than 3, denotes that the data sets have the heavier tails than the normally distributed data.

5.1. Unit Root Test

Augmented Dickey-Fuller test, usually calculated in the time series data sample to know the data stationarity and non-stationary data status, before carrying out the Granger Causality test. The ADF test statistic results will be in negative, higher the negative values, stronger the rejection of null hypothesis, means existence of unit root. From the Table 3, T-statistics values are higher than the test critical values at different levels of confidence i.e., 1%, 5% and 10% of all the BRICS countries. Therefore, in all five cases, null hypothesis is rejected, otherwise alternative hypothesis is accepted and that proves the data sample is stationary. The ADF test results are presented in Table 4 and Table 5, the t-statistics and test critical values at 1%, 5% and 10% confidence level.

Table 4. Unit root test for Brazil- BVSP return.

Sl. No.	Indices	T-statistic value	Probability	Test critical values		
				1% level	5% level	10% level
1	Brazil (BVSP)	-40.05749	0	-3.435	-2.863	-2.568
2	Russia (MOEX)	-37.68531	0	-3.435	-2.863	-2.568
3	India (NSE)	-24.43402	0	-3.435	-2.863	-2.568
4	China (SSE)	-36.54019	0	-3.435	-2.863	-2.568
5	South Africa (JSE)	-23.56307	0	-3.435	-2.863	-2.568

Table 5. Summary of unit root test.

Sl. No.	Indices	Level		
		ADF t-statistics	P-value	Hypothesis
1	Brazil (BVSP)	-40.0575	0.000	Accept H_1
2	Russia (MOEX)	-37.685	0.000	Accept H_1
3	India (NSE)	-24.434	0.000	Accept H_1
4	China (SSE)	-36.540	0.000	Accept H_1
5	South Africa (JSE)	-23.563	0.000	Accept H_1

Note: Hypothesis: Ho: Data not stationary.
H1: Data is stationary.

5.2. Granger Causality Test

Table 6 implies the Granger Causality test (GCT) is performed to understand the connectedness among the BRICS nations. GCT is performed at 5% significance level, which determine whether A variable helps in forecasting the B variable, the probability value will be 0.05, which evidence that, Brazil and Russsia's stock markets are interconnected to each other, ups and downs in each one's market returns have carry forward effect on one another. Similarly, India and Brazil markets are connected with each other. India's stock market has impact on China, South Africa and Russia, but will not be affected by the same. China holds influence on Brazil, Russia have impact on South Africa's stock market returns. Other combination has the p-value more than 0.05, cannot reject the null hypothesis, means the remaining returns does not granger cause the other market returns. Granger cause test explains the cause-and-effect relationship among the sample stock markets.

Table 6. Pairwise Granger causality tests.

Sample: 13/10/2015-31/3/2021			
Lags: 2			
Null hypothesis:	**Obs.**	**F-statistic**	**Probability**
JSE does not Granger cause BVSP	1476	0.091	0.913
BVSP does not Granger cause JSE		0.804	0.448
MOEX does not Granger cause BVSP	1472	6.273	0.002
BVSP does not Granger cause MOEX		4.580	0.010
NSE does not Granger cause BVSP	1476	30.139	0.001
BVSP does not Granger cause NSE		5.675	0.004
SSE does not Granger cause BVSP	1473	3.956	0.019
BVSP does not Granger cause SSE		0.813	0.444
MOEX does not Granger cause JSE	1479	4.560	0.011
JSE does not Granger cause MOEX		1.330	0.265
NSE does not Granger cause JSE	1483	3.322	0.036
JSE does not Granger cause NSE		0.591	0.554
SSE does not Granger cause JSE	1477	0.295	0.745
JSE does not Granger cause SSE		0.579	0.560
NSE does not Granger cause MOEX	1480	8.368	0.000
MOEX does not Granger cause NSE		0.609	0.544
SSE does not Granger cause MOEX	1473	0.422	0.656
MOEX does not Granger cause SSE		1.486	0.227
SSE does not Granger cause NSE	1477	0.179	0.836
NSE does not Granger cause SSE		3.915	0.020

Hypothesis Ho: There is no Granger Causality between variables.

5.3. Johansen's Co-Integration Test

Co-integration test is suitable to study inter-connectedness in the long term under the time series data. Both Engle and Trace co-integration test has been conducted on the data sample. Table 7 and Table 8 presents the test results, with reference to the same, Trace statistics values are much lesser than the critical value, so suggest to reject the null hypothesis. Under maximum Eigen statistics test values are much higher than the critical values, states that reject the H_0 means there exists the integration among the sample i.e., BRICS nations stock market returns are interconnected and sensitive to the changes in stock markets return of other member nations. The detailed Johansen Co-integration test results are shown as below:

Table 7. Results of co-integration test.

Hypothesis	Eigen value	Trace Statistics	Critical value 0.05	Max eigen statistics	Critical value 0.05	Prob.
None	0.219	1414.941	69.819	361.058	33.877	0
At most 1	0.202	1053.883	47.856	329.053	27.584	0
At most 2	0.167	724.830	29.797	266.701	21.132	0
At most 3	0.159	458.129	15.495	251.977	14.265	0
At most 4	0.132	206.152	3.841	206.152	3.841	0

Hypothesis: Ho: There is no co-integration (No Long run relation between Variables).

Table 8. Table showing Johansen co-integration test results.

Sample (Adjusted):10/3/2015 - 30/3/2021
Included observations: 1460 after adjustments
Trend assumption: Linear deterministic trend
Large interval (In first differences): 1 to 4
Unrestricted cointegration rank test (Trace)

Hypothesized no. of CE(s)	Eigen value	Trace statistic	0.05 Critical value	Prob**
None*	0.219	1414.941	69.819	0
At most 1*	0.202	1053.883	47.856	0
At most 2*	0.167	724.830	29.797	0
At most 3*	0.159	458.129	15.495	0
At most 4*	0.132	206.152	3.841	0

Note: Trace test indicates 5 cointegrating eqn(s) at the 0.05 level.
*Denotes rejection of the hypothesis at the 0.05 level.
**MacKinnon, Haug, and Michelis (1999) probability-values.
Unrestricted co-integration rank test (Maximum eigenvalue).

Hypothesized no. of CE(s)	Eigenvalue	Max-eigen statistic	0.05 Critical value	Prob.**
None*	0.219	361.058	33.877	0
At most 1*	0.202	329.053	27.584	0
At most 2*	0.167	266.701	21.132	0
At most 3*	0.159	251.977	14.265	0
At most 4*	0.132	206.152	3.841	0

Note: Max-eigenvalue test indicates 5 cointegrating eqn(s) at the 0.05 level.
*Denotes rejection of the hypothesis at the 0.05 level.
**MacKinnon et al. (1999) probability-values.

6. Conclusion

The research study is conducted to test and understand the inter-connectedness among the stock markets of BRICS nations. As a sample selected, BOVESPA from Brazil, MOEX from Russia, National Stock Exchange (NSE) from India, Shanghai Stock Exchange (SSE) from China and JSE from South Africa for the time period 1st February 2015 to 31st of March 2021. Average daily returns of the stock markets indices been taken to carry out the study. Descriptive statistics has been calculated to know the average return and risk associated with the stock markets. Among the BRICS nations, Brazil evidenced the highest average returns, China having the negative returns on the sample time. Russia ensured moderate return with moderate risk, India and South Africa results in high market risk with low returns. Unit Root Test has been carried out to check the stationary of the data set, before applying the Grangers Causality test. Higher the negative values of ADF test, stronger the rejection of null hypothesis, the t-statistics value are higher the critical value in all the given circumstances, hence alternative hypothesis is accepted, so the data is stationary at 1%, 5% and 10% of confidence level.

Granger Causality Test has performed and resulted that p-value less than 0.05 denotes that weak correlation exists between the countries stock markets and p value with greater than 0.05 are the countries have significant impact on other countries stock exchanges.

hence H_0 can be rejected, which evidence that, Brazil and Russia's stock markets are interconnected to each other, ups and downs in each one's market returns have carry forward effect on one another. Similarly, India and Brazil markets are inter-linked. Johansen Co-integration Test also results in rejecting the null hypothesis, means, the existence of connectedness between BRICS nation's stock market returns. It is proved from the time series statistical analysis that, BRICS nation's stock market indices are inter-linked, the depth of connectivity flow varies between nations. India's stock market has major impacts on Brazil, China, South Africa as well as Russia, where as India will not receive major impacts from China, Russia and South Africa.

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