Stock Market Interlinkages: Analysis of BRICS Economies Pre and Post Covid-19

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Abstract

The present research aims to check if there exists any relationship between the stock market indices of the five BRICS countries. The benchmark indices of the BRICS countries are chosen for analysis for the time period starting from 1st April 2016 to 31st March 2022 with daily frequency. The analysis has been carried out using various econometric techniques like Granger Causality test and Johansen Cointegration test besides finding the Descriptive statistics and Correlation analysis.

The test results indicate positive correlation between these markets and the level of integration has increased post the onset of Covid-19. According to Granger causality test, there exists some degree of short-term causal relationship between these. Moreover, long-term cointegration has also been observed among them through the Johansen test. The findings of this study suggest that diversification of investment in these countries may not lead to significant gain for investors. The information in this research can be helpful for policy makers, government agencies, and potential investors to make relevant decisions in their respective fields.

Keywords: Stock market, Interlinkage, Covid-19, Investment diversification, Granger Causality Test, Johansen Cointegration Test.

Introduction:

Stock market interlinkages refers to the co-integration between the movements of the markets. Logically, stock markets with a lower degree of interlinkage will give investors a higher chance of reaping benefits as when some parts of the portfolio go down, others will rise. This has been emphasized by Markowitz (1952) in his Portfolio theory which suggests that a diversified portfolio will be favorable only in case of low or negative correlation among the invested securities.

The importance of international stock market relations is also attributable to Grubel (1968), who investigated the benefits of international portfolio diversification.

The onset of the Covid-19 pandemic led to extreme volatility in the global financial markets. The India VIX reached its highest ever level of 70.39 on 27th March 2020. The S&P500 plunged 34% by march end. All markets were in turmoil.

In contrast to this, 2021 witnessed record growth and recovery following the declining intensity of the pandemic. The economic rebound led to robust earnings growth of companies.

In this time of increasing economic activity and liberalization between global markets, studying the interlinkages among stock markets is of high relevance and can become a major criterion for making wise investing decisions.

It is relevant to study these interlinkages, especially between emerging economies, to provide investors with sufficient opportunity to grow and diversify their investments.

The current study focuses on the stock markets of BRICS countries: Brazil, Russia, India, China, and South Africa. Originally BRIC was named by Jim O'Neill, a Goldman Sachs economist, in 2001, claiming that these nations would dominate the world economy by 2050. South Africa joined in December 2010, after an invitation from China. This was done to enhance the strategic co-operation among these emerging economies.

These five nations together encompass more than 29% of the world's land area and about 40% of the global population. Moreover, they had a combined GDP of over $24.44 trillion in 2021, which was slightly more than that of the U.S. Their GDP is forecasted to grow at a steady pace of 2-10% over the next 5 years (Figure 1).

The following table illustrates some of the geographical and economic indicators of the BRICS nations.

Country	Population (in millions)	Total GDP (US$ trillions)	Total GDP World Rank	Per Capita GDP (US$)
Brazil	214	1.6	12th	7518.8
China	1412	17.73	2nd	12556.3
India	1393	3.17	6th	2277.4
Russia	143	1.77	11th	12172.8
South Africa	60	0.42	31st	6994.2

Source: World Bank, 2021

For the purpose of this study, the stock market index of each of the BRICS

countries is taken. BOVESPA (Brazil), IMOEX (Russia), NIFTY50 (India), SSE 100 (China) and FTSE/JSE Top 40 (South Africa). The Covid-19 pandemic has been taken into account and the analysis is done using pre and post covid daily closing data of the respective stock indices.

This research paper has been sequenced in the following way: in the 2nd section a literature review has been done of relevant past studies, the 3rd section discusses the key objectives of this paper, the 4th section lays out the data collected, and methodologies used. This is followed by the 5th section representing the analysis of the data. The results of the analysis performed are explained in the 6th section. The 7th section presents the conclusions of this research and finally, the implications and limitations of the study have been mentioned in the 8th section.

Literature Review:

The stock markets and their interlinkage has been studied by many and has been mainly focused on broad parameters. A more specific and refined research could yield better outcomes for concerned investors.

Looking at the interlinkage of Indian stock market with those of developed nations, Bose and Mukherjee (2005) examined the co-movement of Indian market with developed markets like US, Japan, and others using tools like pairwise and groupwise cointegration and Granger-causality tests. It was found that the US market may not have been playing a unique role in integration of Asian markets. It was found that, ignoring the Indian market from the set of Asian markets leads to no or fewer cointegrating relations; this indicates a unique role of India in the degree of linkages of these stock markets during the recent period of more open capital markets, where FII investments play a key role in synthesizing markets across a region.

Another research focusing on other Asian markets in comparison with markets of developed nations was conducted by Wong, et al (2004) who studied the co-movement between stock markets of Asian emerging economies and few of the developed nations using the method of cointegration. The study concluded that co-movement exists between some of the developed and emerging markets, however others differ from the developed markets with which they share a long-run equilibrium relationship. Moreover, it was observed that the interdependence between the developed and emerging markets increased and intensified after each major stock market crisis. Thus, the benefits of diversification in these markets were said to be few.

Mukherjee and Mishra (2005) applied Engel-Granger (Engel and Granger, 1987) test of causality and cointegration and the Geweke [J. Am. Stat. Assoc. 76(1982) 304] measure of feedback and found out that barring Indonesia, Philippines, Malaysia, Korea, Thailand, and Greece, none of the emerging and developing countries' stock

markets are integrated with the Indian stock market in the long term. In the short term, there exists a lead-lag relationship between the markets, and it varies from period to period.

In contrast to this study Tripathi and Sethi (2012) researched using the Johansen co-integration test and Granger's causality test and concluded that during the study period from 1 January 1992 to 31 December 2009, there existed a positive correlation and the interlinkage of Indian market with advanced emerging economies (Brazil, Hungary, Taiwan, Mexico, Poland, and South Africa) has increased.

Tripathi and Seth (2019) tried to explain the presence of integration among the stock markets of selected SAARC countries within themselves as well as with selected three Developed countries of the world and found that the The extent of linkages among the stock markets has been found to intensify with the passage of time because of opening up of economies, capital market reforms and advancements in Technology.

Some studies have been conducted to look at the interlinkages between stock markets during crisis periods. Aamir Rafique Hashmi and Liu Xingyun made use of simple correlations, Granger causality tests and VAR models and demonstrated that the interlinkages between the selected SEA markets increased after the Asian currency crisis period, and the New York market had strong influence over this region.

Similarly, Prasenjit Chakrabarti, et al (2021) utilize the Detrended Cross-Correlation Analysis (DCCA) along with the network and complexity theories for detecting the contagion effect of the pandemic on the stock markets of G20 countries. The study concluded that Covid-19 has led to contagion in the global equity market, which has increased the risk to diversification in international markets.

Thus, it can be seen that a crisis period usually leads to increased interlinkage between the markets under study.

A more particular study was done of the BRICS countries by Dr Gagan Deep Sharma, et al (2013) who made use of line charts and unit-root tests to check the stationary nature of the selected series; Regression Analysis, Granger's Causality Model, Vector Auto Regression (VAR) Model, and Variance Decomposition Analysis were also performed to find out the linkages between the markets under study. It was found out that the stock markets of the BRICS nations are not influenced by each other to a great extent.

It can be further studied if such a trend is observable within the BRICS nations pre and post the Covid 19 period.

This current study, narrows down the scope of the research to the BRICS countries and in addition to the interlinkage and correlation between the stock indices of these 5 nations, will also

take into account the Covid-19 pandemic and try to find out whether the pandemic has led to any change in the trends observed before and whether diversification of investments in other nations remains a lucrative option or not.

Research Objectives:

This research paper aims to study and determine the interlinkage or relationship between the stock market indices of the five BRICS nations: Brazil, Russia, India, China, and South Africa.

The study will also consider the Coronavirus pandemic and determine if there has been a change or shift in patterns of interlinkage and correlation before and after the onset of the virus.

Earlier studies of stock market interlinkages have drawn a lot of attention from academics. This is because the degree of correlation can have both a positive and a negative effect on the stock markets. However, no other previous study of the BRICS economies has yet taken into account the ongoing pandemic.

The data collected is of the daily closing prices of the five selected stock indices within the period of 6 years, from 1st April 2016 to 31st March 2022, considering the pandemic came into effect in March 2020. The analysis will be conducted using a variety of statistical and advanced econometrics techniques, including Descriptive statistics, Correlation analysis, Granger Causality Test and Johansen Co-integration Test.

Thus, by evaluating all the collected data, it can be concluded whether diversification of investments in these economies remains a favorable course of action.

Data and Methodology:

The data collected is the daily closing values of the stock indices of Brazil, Russia, India, China, and South Africa. It has been collected from the official websites of the respective indices, investing.com and finance.yahoo.com.

The total time period chosen is 1st April 2016 to 31st March 2022. This has been divided into two sub parts, namely pre covid and post covid. The first part is taken till 11th March 2020, which was the date when the Coronavirus was officially declared a pandemic by WHO.

Sub period I (Pre-Covid): 1st April 2016 to 11th March 2020

Sub period II (Post-Covid): 12th March 2020 to 31st March 2022

To move forward with the analysis of the data, the logarithm of the values has been used to make the distribution as “normal” as possible and reduce skewness of the data so that the statistical analysis and results become more valid.

Moreover, the differenced values of the

Log of the indices represent their returns.

All data series have been found to be non-stationery at level, so first difference has been taken for further statistical applications. The variables are integrated of order I(1).

For the purpose of analysis, descriptive statistics and various other advanced statistical methods have been applied.

Correlation Analysis

Correlation, also called dependence refers to the statistical relation between two variables or bivariate data. It may be causal or non-causal.

Correlation analysis is the technique applied to measure the strength of the linear relationship among two variables and to compute their association.

To do this, Karl Pearson's coefficient of correlation is computed, that tells the degree of change one variable undergoes when the other variable changes. It returns a value between -1 and +1, where -1 means a strong negative correlation and +1 depicts a strong positive correlation.

Granger Causality Test

The Granger Causality test is a statistical technique that is used to ascertain whether one time series data is helpful in forecasting another (Granger 1969). If the probability value (p-value) is less than any specified α level, then the null hypothesis will be rejected for that level.

According to Granger causality, if a signal X_1 "Granger-causes" (or "G-causes") a signal X_2, then historic values of X_1 should include data which can assist in forecasting X_2 beyond the data contained in historic values of X_2 alone.

In the current research it is used to find out the short-term causal relationship between the stock market indices of the BRICS countries. For this purpose, the differenced log values of the indices have been used.

The test will be conducted to ascertain if there exists a bi-directional, unidirectional, or no causal relationship between the stock markets of these countries.

Johansen's Cointegration Test

Cointegration indicates that, while several factors can lead to permanent changes in the individual variable, there exists a long-run equilibrium relation connecting the individual variables to each other, represented by some linear combination of them.

This test evaluates the long-term equilibrium relationship between several non-stationery time series data (Johansen 1991). It determines the cointegration between three or more time series. The null hypothesis here is that no cointegrating equations exist.

The Johansen test is bifurcated into two parts, the Trace test, and the Maximum Eigenvalue test. The number of linear

combinations in a time series data is evaluated by the trace test, whereas the eigenvalue is a special scalar; It is obtained when a matrix is multiplied by a vector and the same vector is attained as an answer, along with a new scalar, which is called an eigenvalue.

Total Period	21630.2	636.8	2692.0	932.9	6243.6
SKEWNESS					
Pre Covid	0.283	0.728	-0.355	-0.554	-0.087
Post Covid	-0.812	-0.171	-0.333	-0.677	-0.540
Total Period	-0.047	0.753	0.958	0.306	0.916
KURTOSIS					
Pre Covid	2.050	2.633	2.027	2.103	1.860
Post Covid	3.318	1.987	1.881	3.242	2.931
Total Period	1.853	2.517	3.087	2.525	3.508
JARQUE-BERA					
Pre Covid	41.45	76.32	49.17	68.88	45.04
Post Covid	47.65	19.90	29.55	32.94	20.37
Total Period	67.91	128.35	188.82	30.81	185.30

Source: Author's computation

Tables:

Table 1: Descriptive statistics

	BVSP	IMOEX	NIFTY 50	SSE 100	FTSE/ JSE 40
MEAN					
Pre Covid	79493.2	2305.5	10220.0	5647.9	48697.9
Post Covid	107864.2	3338.0	14038.5	7072.1	56901.3
Total Period	89126.9	2656.1	11516.6	6131.5	51483.4
MEDIAN					
Pre Covid	76653.0	2261.5	10482.2	5808.3	49161.5
Post Covid	110079.5	3424.8	14680.7	7085.3	59037.9
Total Period	89710.0	2485.3	10880.1	6088.9	50359.2
MAXIMUM					
Pre Covid	119528.0	3219.9	12362.3	6575.4	55065.4
Post Covid	130776.0	4287.5	18477.1	8325.9	70105.8
Total Period	130776.0	4287.5	18477.1	8325.9	70105.8
MINIMUM					
Pre Covid	48096.0	1838.3	7546.5	4266.6	42422.4
Post Covid	63570.0	2058.1	7610.3	5061.8	34239.3
Total Period	48096.0	1838.3	7546.5	4266.6	34239.3
STANDARD DEVIATION					
Pre Covid	18195.4	339.6	1263.0	583.9	2822.4
Post Covid	14229.8	515.6	2935.3	748.5	7410.8

Table 2: Correlation

	Brazil	Russia	India	China	South Africa
Brazil					
Pre Covid	1	0.3728	0.2075	0.0793	0.3112
Post Covid	1	0.2749	0.4762	0.1694	0.5284
Total Period	1	0.2953	0.3633	0.1142	0.4275
Russia					
Pre Covid		1	0.3091	0.1869	0.4784
Post Covid		1	0.3679	0.0632	0.3957
Total Period		1	0.3477	0.1028	0.4079
India					
Pre Covid			1	0.2287	0.4414
Post Covid			1	0.2588	0.5515
Total Period			1	0.2290	0.5056
China					
Pre Covid				1	0.2935
Post Covid				1	0.2692
Total Period				1	0.2756
South Africa					
Pre Covid					1
Post Covid					1

Total Period	1

Source: Author's computation

Table 3: Granger Causality test – 2 Lag – Daily data (Pre Covid)

	Dlog BVSP	Dlog IMOEX	Dlog NIFTY 50	Dlog SSE 100	Dlog FTSE/ JSE 40
Dlog BVSP	N/A	→	→		→
Dlog IMOEX		N/A			
Dlog NIFTY50			N/A		
Dlog SSE100				N/A	
Dlog FTSE/JSE 40		→	→		N/A

Source: Author's computation

Table 4: Granger Causality Test – 2 Lag – Daily data (Post Covid)

	Dlog BVSP	Dlog IMOEX	Dlog NIFTY 50	Dlog SSE 100	Dlog FTSE/ JSE 40
Dlog BVSP	N/A		→		
Dlog IMOEX		N/A	→	→	
Dlog NIFTY 50			N/A	→	
Dlog SSE100				N/A	
Dlog FTSE/ JSE 40	→		↔		N/A

Source: Author's computation

Table 5: Granger Causality Test – 2 Lag – Daily data (Total Period)

	Dlog BVSP	Dlog IMOEX	Dlog NIFTY 50	Dlog SSE 100	Dlog FTSE/ JSE 40
Dlog BVSP	N/A		→		→
Dlog IMOEX	↔	N/A	→	→	
Dlog NIFTY50			N/A	→	
Dlog SSE100				N/A	
Dlog FTSE/ JSE 40		→	↔	→	N/A

Source: Author's computation

Results:

Descriptive Statistics

From Table 1 it can be seen that despite the downfall from the pandemic, all five stock markets have recovered and made new all-time highs, which is significantly higher than their mean values for the total period. This can be attributed to the decrease in coronavirus cases all over the world and a positive sentiment developing among investors.

The skewness values of all the indices range between -1 and +1, suggesting that the data is moderately skewed. The kurtosis values are generally less than 3 for all indices over all time periods, suggesting that the data is platykurtic.

Lastly, the Jarque-Bera test has values far from zero and indicates that the data set is not normally distributed.

Correlation Analysis

It can be inferred from Table 2, there is a positive correlation between all the stock market indices over the selected time periods.

It can also be noticed that the correlation has increased between all the nations pre and post the onset of the pandemic, with the exception of the following combinations: Brazil and Russia, Russia and China, Russia and South Africa, and China and South Africa.

Moreover, the South African market is significantly correlated with the markets of all other BRICS countries.

Thus, it can be concluded that after the pandemic, the BRICS stock markets have become slightly more closely related.

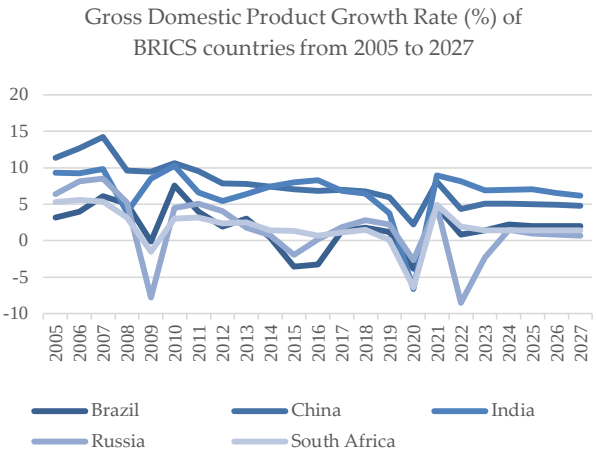
Granger Causality Test

The Granger causality test has been conducted on the differenced log series of the collected data. According to this test, it is observed that before the pandemic there were few causal relationships between the five markets and there were hardly any short-term relations present. However, these relationships have increased in the post covid time period, as the markets have become more integrated.

One significant point that can be seen from the tables is that the China stock market (SSE100) does not granger cause any other market over all time periods. Moreover, in the pre covid period it was not granger caused by any other market as well (Table 3). This implies that the SSE100 does not hold influence over the rest of the markets.

The Bovespa can be seen to granger cause all the other stock markets, except China, over the total period and can be said to have the most influence among the BRICS nations' markets.

Over the total time period, there is two-way causality found between Russia and Brazil, and India and South Africa.



In conclusion, the stock markets of BRICS nations are influenced by each other, and this influence has become more widespread after the arrival of Covid-19.

Johansen Cointegration Test

This test has been applied on the log series of the data, to determine whether there is any long-term causal relationship between the five stock indices. It is based on Trace and Maximum Eigenvalue statistics.

Based on this test, it is observed that there is one cointegrating equation in the total time period. And as per the Trace test and Maximum Eigenvalue test there exists long term relationship between these markets. Thus, it can be inferred that they do get affected by fluctuations or movements in each other.

In the pre covid period, such a relationship was not found as per Trace test and Maximum Eigenvalue test. So, no long-term cointegrating relation could be established. However, after the beginning of the pandemic 2 cointegrating equations have been noticed and long-term cointegrating relation has been found among these markets.

Overall, it can be said that the long-term relationship between the five markets has increased, and they have become more integrated post covid-19.

Figures:

Figure 1:

Source: IMF World Economic Outlook

Conclusion:

This research study analyzes the interlinkages between the stock market movements of the five BRCIS countries, with focus on the pre and post Covid-19 time periods, from 1st April 2016 to 31st March 2022. The breaking point is 11th March 2020, when WHO announced the coronavirus to be a global pandemic.

The daily closing values of each of the BRICS stock indices, namely Bovespa (BVSP), MOEX Russia Index (IMOEX), NIFTY 50, Shanghai Stock Exchange Top 100 (SSE 100), and FTSE/JSE Top 40 has been collected for this research.

The data has been analyzed using the indicators of descriptive statistics, Karl Pearson's coefficient of correlation and some other complex methods. These include the Granger Causality test to determine the short-term causal relationship between the selected stock indices and the Johansen Cointegration Test to determine the long-term causal relationship between the same.

The tests and analysis conducted have been performed on pre covid, post covid and total time periods.

The findings of the research suggest that there is some degree of positive relation between these markets. The Granger causality test shows that over the total time period the causal relation between these markets has increased, except in the case of China.

This shows that the Chinese stock market does not hold influence over the other four stock markets. The South African and Russian stock markets are least influenced by the others in the post covid time period, this might be due to the prevailing political tensions and war between Russia and Ukraine continuing since February 2022. It also shows that the Brazil stock market has influence over all the others apart from China.

According to the Johansen Cointegration test, there exists a long-term relationship between these countries. This can be seen from the Trace and Maximum Eigenvalue statistics. Moreover, this relation is established after the onset of covid-19. Hence, it can be said that the BRICS markets are now more cointegrated than before.

Implications of the research:

The information present in this paper can be utilized by national policy makers, government agencies, investors or by researchers wanting to further delve into this topic.

The BRICS countries are tightly knit economically and politically. Hence while framing of policies, policy makers of one nation should keep in mind the prevailing conditions in the other four countries as the impact of one can be felt in another as well. By anticipating for change, precautionary measures can be taken in advance.

The research analysis also suggests that it will not be beneficial for investors to diversity their portfolio among these countries due to presence of significant degree of positive correlation between the BRICS stock markets. Thus, it will be difficult to obtain high gains through only diversification.

Limitations and further research

The present paper focuses on the relationship between the BRICS nations only, it can be useful to further study the interlinkages between the BRICS, which are the developing economies and G7 countries, which are the advanced emerging economies. Moreover, similar research can be conducted using other econometric tools or over a larger time period. That will also assist to determine where the investors should look forward to expand and diversify. However, the interlinkages are subject to change with the introduction of new policies by the countries or the occurrence of any stock market crisis.

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