Testing volatility and relationship among BRICS stock market returns

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Abstract
BRICS economies are important in recent times because the economic growth rates will be higher than the growth rates of G-6 economies in the near future. But the year 2020 has smashed up this tendency due to volatile stock markets of BRICS economies. A detailed examination of the BRICS stock market to determine volatility and relationships since the crisis of 2020 is hardly available in the available research. With this in mind, an attempt has been made to track the stock market’s volatility and relationship among the BRICS (Brazil, Russia, India, China, and South Africa) stock market return based on the daily for the period from November 18, 2019 to May 7, 2021. This study deals with the statistical test of GARCH family model and ARDL model. GARCH model shows that the stock market of Russia and India are volatile. The EGARCH model demonstrates that leverage effect exists only in the Indian stock market. ARDL test validates a long-run relationship of the stock market of Russia with China and of the Indian stock market with South Africa. ARDL test also shows a short-run relationship running from the Brazil stock market to the other select stock market, from the Indian stock market to the stock markets of Brazil and South Africa, and from the South African stock market to the Indian stock market. So it can finally be said that investors under the BRICS stock markets should design adequate measures to protect their investments by executing appropriate hedging plan.

Keywords BRICS stock markets · Volatility · Relationship · GARCH · EGARCH · ARDL

JEL Classification F02 · G1 · G15

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Introduction

The stock market operations of the BRICS nations, namely Brazil, Russia, India, China, and South Africa, have seen significant growth over the last decade. It was predicted that the BRICS member countries’ growth rate would accelerate in the near future, possibly exceeding the overall growth rate of the United States and the European countries by 2030. It has been observed in the study of Larionova (2020), the BRICS countries account for 16% of global imports and 19% of global exports. Another advancement made by the BRICS for the strengthening of the global financial system is the establishment of a New Development Bank and the creation of the BRICS Contingent Reserve Arrangement with a $100 billion US dollar cap. For many years, the global economy has been volatile due to a variety of factors. Some of the causes of such volatility might be man-made or natural. Financial weakness, political imbalance, disruption in other macroeconomic elements, natural disasters, etc., are the most typical causes of instability in the stock market of any developed or developing country. Many nations affected due to the outbreak of various diseases and pandemics such as SARS, MERS, Ebola, Zika, Spanish flu, and Swine flu (Cambre 2020; Nathan 2020). The first case of COVID-19 was discovered on November 17, 2019 (Bryner 2020). Because of the coronavirus outbreak, most of the impacted countries around the world have gone into partial or full shutdown. This procedure undoubtedly aids the various countries’ ability to combat the newly created infection. Shutdown, on the other hand, had a highly negative influence on the economy owing to the suspension in production and disruption in the distribution channel, posing an issue of priority with regard to livelihood and life (Bakhshi and Chaudhary 2020). It is well known that investors seek a high rate of return from the stock market, and this is the primary driver of stock market activity. However, owing to a surge in the number of COVID-19 instances and the entire or partial cessation of manufacture and distribution, the stock market’s dynamic power tends to dwindle from day by day.

As per the thinking of the vice president and CFO of the New Development Bank, economic growth will be in a very dangerous situation if the economic slowdown caused by the novel coronavirus persists for an extended length of time. In the research article of Hashmi (2020), we came to know that the member nations of the BRICS country are taking thorough steps to protect their economic situation during this phase. As per the International Monetary Fund report, the world’s market would see a 4.9% decline in growth rate in 2020 as a result of the outbreak of COVID-19, subsequently recovering at a rate of 5.4% in 2021. Although since the Global Financial Meltdown of 2008, it has been noticed that the BRICS member countries have played a crucial role in the international economy as the major driving force. Throughout that period, the BRICS’ average GNP per capita was 5.4%, but the world’s average GNP per capita fell to 1.7% (measured in 2005 SPPPs). According to McKinley (2018), the BRICS GNP per capita might reach 4.5% between 2023 and 2030, which is greater than the global per capita GNP.

In Fig. 1, it can be observed that the volatility in the stock market of BRICS exists. During the initial days of the outbreak of this pandemic, the stock market
was most volatile as suggested in Fig. 1, and after that, the situation was stable. Keeping view of this, an attempt has been made to assess the volatility in the BRICS stock market during the outbreak of novel coronavirus. In addition, this research will look at the long-run and short-run linkages between the BRICS stock markets during the same time span. The four major sections have been developed to organize this work. The examination of published studies, followed by the identification of the research gap, is the first section of this study. The methodology of this research is depicted in the second section, which is followed by a summary of the empirical findings in the third section. The fourth and last section of this study is developed with the concluding observations.
Literature review

Multiple prior investigations have been done to measure the volatility of stock prices in several developing as well as developed nations, both during disasters and in usual circumstances. Many of these studies noted the presence of uncertainty in stock market returns in certain nations, but a number did not address it. Prior researches that attempted to determine the connection and volatility in various nations’ stock markets have been discussed in this section.

A negative association on the specified airline companies was identified in the study of Loh (2006) during the SARS pandemic using daily data from December 1, 2002, to July 5, 2003. The study also discovered that during this period, the volatility of share prices for Singapore-based firms was much higher. Then, using GARCH family model in the Nigerian stock market, another investigator, Olowe (2009), noticed the existence of leverage impact as well as stock market volatility. In this study, the researcher used daily data from January 4, 2004, to March 2, 2009, to observe the persistence of volatility and association. In the research of Neokosmidis (2009), extremely significant volatility was noticed in the stock markets of Dow Jones, NASDAQ, NYSE, and S&P 500. The study employed ARCH family models to analyze daily time series data of 6 consecutive years from March 2003 to March 2009. According to Joshi (2010), there is a lot of instability in the stock market of China and India. The researcher focused on daily data from January 1, 2005, to May 12, 2009, and utilizing the GARCH (1,1) model talks about the volatility of the Indian and Chinese stock markets. According to Ichev and Marinc (2018), the volatility of the U.S. and West African financial markets has increased significantly as a result of the Ebola outbreak. In the research work of Wong et al. (2004) and found that the inter-dependencies were increased among stock markets in time of the Asian financial crisis. Joshi (2013) investigated the pre- and post-crisis periods of the BRIC stock market during a ten-year period, from April 1, 2002, to March 31, 2012. The researcher discovered a long-run connection between the Indian stock market and the stock markets of Russia and China using the Engle–Granger cointegration test. Interdependencies were also identified among the BRICS stock market in research of Sharma et al. (2013) on the basis of daily data from April 1, 2005, to March 31, 2010, utilizing VAR model and variance decomposition test. The researchers found that the select nine Asian nations were strongly interlinked with each other utilizing wavelet multiple correlation employing daily data from January 4, 2005, to February 28, 2012, in the study of Tiwari et al. (2013). Dasgupta (2014) used daily data from January 1, 2003, to December 31, 2012, to investigate the association between the BRIC stock markets and discovered a bidirectional causal association between Brazil and the Indian stock market in the short term. Due to its strong effect on the Russian and Brazilian stock markets, the study also finds that the Indian stock market was the premier stock market among the BRIC stock markets. Singh and Singh (2016) used daily data from January 1, 2004, to November 30, 2014, to determine the long-run and short-run connections between the US and BRIC stock markets throughout the pre-crisis and post-crisis periods and discovered long-run
causality throughout both periods. Considering monthly data ranging from 2005 to 2014, Prakash et al. (2017) identify a long-run association between the BRICS stock market, and however, no causation was found in this analysis. In research by Irshad and Palaniappan (2017), no long-run connectivity was found in the BRICS stock market during a ten-year period beginning in January 2005 and ending in November 2015. Guptha and Rao (2017) conducted a study to assess the volatility shocks in the BRICS stock market using closing prices from March 31, 2005, to March 31, 2015. Researchers considered pre-2008 global financial crisis period, crisis period and post to that period and found asymmetry in the BRICS stock market except China. Pereira (2018) observed how the Lehman Bros. and European sovereign debt crisis leads impact of the BRICS stock market considering daily data from January 2003 to January 2013. The researcher observed a long-run as well as the short-run association between the BRICS stock market and also concluded that the shock was much different in the crisis time than in the normal time. Kiran and Rao (2019) used BDSL test and variance ratio test in the study to test the BRICS stock market efficiency using daily data ranging from September 25, 1997, to March 31, 2018. The result confirms that all the BRICS stock markets were weak form efficient during the crisis period and the Indian stock market observed inefficient after the crisis period. In another study of Guptha and Rao (2019) covering daily data from September 25, 1997, to March 31, 2018, it has been observed that Russian stock market was volatile during the crisis period and before the global financial crisis period. On the other hand, high volatility has been observed in the China stock market after the global financial crisis period, but it has no impact on the stock market return under study.

Ashraf (2020) observed a downturn in the stock market growth rate due to enhancement of confirmed COVID-affected cases using daily stock market data up to April 17, 2020, from January 22, 2020. Baek et al. (2020) confirm volatility at the industry level in the U.S. stock market due in 2020. The researchers confirm that the negative news has a larger impact on the stock market volatility during this period. Bhunia and Ganguly (2020) also confirmed that the Indian stock market was volatile, and the macroeconomic variables were cointegrated. In the research paper of Liu et al. (2020), it has been observed that by reason of such outbreak of novel coronavirus, the stock market of Asian country was affected negatively mostly in compared to the other selected stock markets. In the research paper of Senol and Zeren (2020), long-run association among G7 and European stock market has been observed. Zeren and Hizarci (2020) opine that investors prefer for investment in gold due to the stock market volatility owing to the outbreak of novel coronavirus in different select countries stock markets. Bora and Basistha (2021) investigate how the Indian stock market was volatile during the COVID-19 outbreak using daily data and suggest that during post-coronavirus outbreak, the stock market was much more volatile compared to the earlier period. Thirty-four emerging as well as developed countries’ stock market data have been considered by Uddin et al. (2021) and found that all the stock markets were volatile.

This has been noted in existing researches that academics have shown a strong desire to discover the link and even some assess volatility in stock market returns. Countless studies have been carried out to determine the effects of any crisis time on
stock prices. However, a detailed examination of the BRICS stock market to determine volatility and relationships since the crisis of 2020 is difficult to come by. With this in mind, an attempt has been made to track the BRICS stock market’s volatility and relationship as a result of the pandemic.

**Data used and descriptive statistics**

The trading economics database and the yahoo finance database were used to extract daily time series data. The first case of COVID-19 was reported on November 17, 2019 (Outlook Web Bureau 2020; Bryner 2020), and daily time series data for BRICS member countries were compiled from November 18, 2019, to May 7, 2021. In this analysis, return stock market data were taken into account.

**Descriptive statistics**

According to descriptive statistics from the BRICS stock markets (Table 1), the risk associated with the select stock market during the outbreak of the COVID-19 pandemic seems highest in Brazil, followed by India, South Africa, Russia, and China. The Jarque–Bera statistics probability excludes the null hypothesis of normally distributed returns, confirming that select stock markets were not normally distributed. This demonstrates that the GARCH model is appropriate for evaluating the volatility associated with the select stock market (Tripathi, 2017).

**Research methodology**

The data were analyzed using the GARCH and EGARCH models to test the volatility, and the autoregressive distributed lag model (ARDL) was also used to find out the relationship among the BRICS stock market.

| Table 1: Descriptive statistics                      | Brazil | Russia | India | China | South Africa |
|------------------------------------------------------|--------|--------|-------|-------|--------------|
| Mean                                                 | 0.09   | 0.08   | 0.06  | 0.05  | 0.06         |
| Std. dev                                             | 2.43   | 1.50   | 1.78  | 1.21  | 1.66         |
| Skewness                                             | -1.07  | -0.56  | -1.38 | -0.76 | -0.93        |
| Kurtosis                                             | 15.39  | 11.25  | 15.88 | 9.36  | 10.62        |
| Jarque–Bera                                          | 2332.51| 1022.57| 2557.77| 631.12| 907.80       |
| Probability                                          | 0.00   | 0.00   | 0.00  | 0.00  | 0.00         |
| Observations                                         | 357    | 362    | 367   | 354   | 361          |

Source: own calculation
GARCH model

A GARCH model has a smaller parameter contrasted to an ARCH model. The GARCH models have been frequently revealed to provide more accurate results, and owing to this, the use of the GARCH model has to turn into the criterion technique for the volatility model in time-series data.

\[
\sigma_i^2 = \omega + \sum_{i=1}^{p} \sigma_i \xi_i^2 + \sum_{j=1}^{q} \beta_j \sigma_{i-j}^2
\]

where \(\sigma_i^2\) a function of is lagged values of \(\xi_i^2\) and \(\omega, \{\sigma_i\}_{i=p} \) and \(\{\beta_j\}_{j=q} \) are positive constants. Larger \(\alpha\) values represent higher sensitivity to new information, whereas larger \(\beta\) values represent a higher amount of time for the change to disappear. \((\alpha + \beta)\) gives a measure of the perseverance of the applicable time series, and therefore, larger values for \((\alpha + \beta)\) should be likely toward one and entail larger persistence in volatility.

EGARCH model

EGARCH model is used for recognizing the leverage effect through a generalized exponential distribution. This can be symbolized as

\[
\log \sigma_i^2 = \omega + \sum_{i=1}^{p} \beta_i \log \sigma_{i-1}^2 + \sum_{j=1}^{q} \sigma_i \left( \{\xi_{i-1}\} \mid \sigma_{i-j} \right) + \sum_{i=1}^{p} \gamma_i \left( \xi_{i-j} / \sigma_{i-j} \right)
\]

The equation gets up positive and negative values of \(\varepsilon_i\) to have diverse shocks on volatility. The EGARCH model is asymmetric because the level \(\left( \xi_{i-1} / \sigma_{i-j} \right)\) is integrated with the coefficient \(\gamma_i\). As the coefficient is usually negative, positive impacts make less volatility than negative impacts and all other results being the same.

Empirical results

Correlation statistics

During the outbreak of the novel coronavirus pandemic, correlation statistics (Table 2) show that the stock markets of Russia and South Africa are adversely associated with the stock markets of Brazil. Again the stock market of India and South Africa are negatively connected with the stock market of Russia. Other than all the other BRICS member nations’ stock markets are positively associated with each other.
GARCH test results

ARCH term indicates that the information regarding volatility detected in the earlier period. If the asset return was surprisingly great in either the rising or the descending way, subsequently, the investor will raise the estimate of the variance for the subsequent period. EGARCH (1,1) model creates less contraventions than a GARCH(1,1) model, and this is caused by the information that an EGARCH model comprises the leverage result dimension. The leverage effect confines the asymmetry due to the positive and negative shocks. GARCH (1,1) result of volatility relating to the BRICS stock market during the outbreak of coronavirus pandemic is depicted in Table 3. Brazil has a very high score of $\alpha$, implying that it is more sensitive to the new news, followed by China, India, South Africa, and Russia. Meanwhile, Russia has a high score of $\beta$, signaling that the shift would take longer to recede, followed by India, South Africa, Brazil, and China. During the COVID-19 period, the ARCH impacts are positive and significant in all the select stock markets. GARCH impacts, on the other hand, are also all positive and significant (except in India) within the same time span. In the GARCH (1,1) model, the volatility is calculated as the sum of $\alpha$ and $\beta$, and the combined value of $\alpha$ and $\beta$ fluctuates between 0.91 and 0.98 throughout the COVID-19 period. The experiment finding indicates that during the COVID-19 era, the stock markets of India and Russia experienced greater concentrations of volatility. This demonstrates that perhaps the volatility of stock values might be shown by such a pattern of volatility that is expected to stay across the period.

### Table 2  Correlation statistics

| Source: own calculation |
|--------------------------|
| Brazil | Russia | India | China | South Africa |
| Brazil | 1.00 | | | |
| Russia | -0.07 | 1.00 | | |
| India | 0.10 | -0.09 | 1.00 | |
| China | 0.07 | 0.10 | 0.05 | 1.00 |
| South Africa | -0.05 | -0.01 | 0.19 | 0.07 | 1.00 |

### Table 3  GARCH (1, 1) test results

| Source: own calculation; figures in parenthesis indicate p value |
|--------------------------|
| Brazil | Russia | India | China | South Africa |
| $\omega$ (constant) | 0.21 (0.01) | 0.04 (0.00) | 0.05 (0.03) | 0.15 (0.00) | 0.12 (0.00) |
| $\alpha$ (arch effect) | 0.27 (0.00) | 0.11 (0.00) | 0.17 (0.00) | 0.26 (0.00) | 0.17 (0.00) |
| $\beta$ (garch effect) | 0.67 (0.00) | 0.86 (0.00) | 0.81 (0.38) | 0.65 (0.00) | 0.75 (0.00) |
| $\alpha + \beta$ | 0.94 | 0.97 | 0.98 | 0.91 | 0.92 |
**EGARCH test results**

In detecting the unbalanced impact of information and cognition on volatility and leverage, the EGARCH (1,1) model is appropriate. The existence of the leverage effect is described by the negative and statistically significant gamma (γ) in the EGARCH (1,1) model. This implies that positive shocks had a little implication on the conditional variance and also that the leverage effect (γ) is anticipated to have been negative and statistically significant. After the COVID-19 outbreak, the sum of α and β in the EGARCH (1,1) model varied between −0.02 and 1.33. It has been said that when the combined value of α and β exceeds 1, there are more ARCH and GARCH impacts on volatility, and along with that the conditional variance is also volatile. The EGARCH outcome demonstrates the effect of leverage impact in the Indian stock market during the coronavirus epidemic since the sum of α and β is greater than 1 (Table 4).

An indicator of asymmetrical volatility is the gamma (γ) parameter. The leverage impact in the model can be seen in a negative and significant value of gamma (γ). The leverage impact is only feasible in India’s stock market, where the gamma value is −0.48, which has been significant at 5% during the COVID-19 epidemic.

**Bound test results**

The bounds test is generally rooted in the joint F statistic that its asymptotic allocation is non-customary under the null hypothesis of no cointegration. The null hypothesis is not accepted when the value of F statistic is more than the upper bounds value. The result (in Table 5) shows there exists cointegration in all the equations.

**Autoregressive distributed lag test results**

The ARDL technique of cointegration has been used to investigate the long-run relationship between the BRICS stock markets. At a 5% significance level, the ARDL finding shows the existence of a long-run relationship between the stock markets of Russia and China and the stock markets of India and South Africa. The value of f-statistics with probability reveals that a 1% increase in China stock prices raised the Russian stock market by 13% and while a 1% rise in the Russian...

| Source: own calculation; Figures in parenthesis indicate p value | Brazil | Russia | India | China | South Africa |
|---------------------------------------------------------------|-------|--------|-------|-------|--------------|
| ω (constant)                                                 | −0.21 (0.00) | −0.06 (0.06) | 0.81 (0.00) | −0.31 (0.00) | 0.96 (0.53) |
| α (arch effect)                                              | 0.33 (0.00) | 0.11 (0.01) | 0.58 (0.00) | 0.47 (0.00) | 0.01 (0.83) |
| β (garch effect)                                             | −0.15 (0.00) | −0.13 (0.00) | 0.30 (0.00) | −0.12 (0.94) | 0.01 (0.76) |
| α + β                                                        | 0.18 | −0.02 | 1.33 | 0.35 | 0.02 |
| γ (leverage effect)                                          | 0.94 (0.00) | 0.96 (0.00) | −0.48 (0.00) | 0.83 (0.00) | 0.01 (0.99) |
stock prices boosted the Chinese stock market by 8%. Again, a 1% increase in the Indian stock market raised the South African stock market by 17%, and a 1% increase in the South African stock market raised the Indian stock market by 19% under the investigation (Table 6).

In Table 7, the short-run relationship between the BRICS stock market has been represented using the Wald test. At a 5% significance level, the Wald results verified that the Brazilian stock market was connected to the other chosen stock markets in the short run. During the same time period, the Indian stock market was linked to the stock markets of Brazil and South Africa, although South Africa’s stock market having a short-run association only with the Indian stock market at a 5% significance level.

Table 5  Bound test results

| Dependent Variable | Lags | F Statistic | upper bounds value | Decision   |
|--------------------|------|-------------|--------------------|------------|
| Brazil             | 8    | 7.69        | 3.49               | Cointegration exists |
| Russia             | 8    | 11.09       | 3.49               | Cointegration exists |
| India              | 8    | 8.33        | 3.49               | Cointegration exists |
| China              | 8    | 56.43       | 3.49               | Cointegration exists |
| South Africa       | 8    | 9.06        | 3.49               | Cointegration exists |

Source: own calculation

Table 6  ARDL test results for long-run coefficient

| Brazil | Russia | India | China | South Africa |
|--------|--------|-------|-------|--------------|
| Brazil | –      | 0.01 (0.84) | 0.13 (0.06) | 0.10 (0.29) | – 0.09 (0.20) |
| Russia | −0.04 (0.19) | – | −0.07 (0.10) | 0.13 (0.04) | −0.00 (0.94) |
| India  | 0.07 (0.06) | −0.09 (0.15) | – | 0.05 (0.46) | 0.19 (0.00) |
| China  | 0.03 (0.17) | 0.08 (0.04) | 0.02 (0.42) | – | 0.04 (0.23) |
| South Africa | −0.05 (0.15) | −0.00 (0.96) | 0.17 (0.00) | 0.08 (0.22) | – |

Source: own calculation; Figures in parenthesis indicate p value

Table 7  ARDL test results for short-run coefficient

| Brazil | Russia | India | China | South Africa |
|--------|--------|-------|-------|--------------|
| Brazil | –      | 14.68 (0.00) | 15.73 (0.00) | 14.84 (0.00) | 14.93 (0.00) |
| Russia | 0.83 (0.43) | – | 1.44 (0.23) | 2.08 (0.12) | 0.03 (0.96) |
| India  | 3.11 (0.04) | 2.75 (0.06) | – | 1.67 (0.18) | 7.81 (0.00) |
| China  | 0.98 (0.37) | 2.09 (0.12) | 0.37 (0.68) | – | 0.77 (0.45) |
| South Africa | 1.04 (0.35) | 0.01 (0.98) | 6.44 (0.00) | 0.75 (0.46) | – |

Source: own calculation; Figures in parenthesis indicate p value
Residual test results

The residuals of the ARDL cointegration model must be checked once the model has been tested. The results of the CUSUM test (shown in Fig. 2) demonstrate that all the models are stable.

The probability of the Jarque–Bera statistics in the histogram (in Table 8) demonstrates that all the models are normally distributed. The $F$-statistics value in Breusch–Godfrey serial correlation test (in Table 7) validates that only in the model

![CUSUM test graphs for Brazil, Russia, India, China, and South Africa](image)

Source: own calculation

Fig. 2  CUSUM test. Source: own calculation
of Russia, there exists serial correlation. ARCH heteroskedasticity test (in Table 7) talks about the homoskedastic trend only in the stock market of China.

Conclusions

In the recent past, it has been observed that the BRICS country plays a dynamic role in the world’s economy. BRICS comprise with 41% of the world’s population and also contribute 16% of world trade and 16% of world’s GDP. In comparison to pre-pandemic forecasts, the April 2021 WEO predicted that nearly 95 million individuals had slipped below the poverty line in 2020. While studying the impact of COVID-19 on labor markets for 2020, the International Labour Organization anticipated an 8.8% decrease in the business hours, an 8.3% decrease in international labor income, and 81 million job losses (IMF 2021).

The intention of this research is to investigate the volatility and linkage of the BRICS stock market returns in the long and short-run during the COVID-19 epidemic. The outcome of descriptive statistics reveals that the Brazilian stock market is prone to high risk throughout the study period. The result of the GARCH test demonstrates that there is a higher degree of instability in the stock markets of Russia and India under this research. As a result of instability in the stock market, the decisions of the investors may be affected. The leverage impact has been observed only in the stock market of India during this pandemic period as per the EGARCH test result. ARDL test validates a long-run relationship of the stock market of Russia with China and of the Indian stock market with South Africa. ARDL test also shows a short-run relationship running from the Brazil stock market to the other select stock market, from the Indian stock market to the stock markets of Brazil and South Africa, and from the South African stock market to the Indian stock market. Finally, it may be argued that the negative news in this pandemic situation impacted severely on the BRICS stock markets. A negative and low correlation indicates that there exist huge diversification opportunities in these markets. The promising economies will still growth, however, progressively that will influence global economy on the long-run. In the meantime, support between promising economies play a crucial role in encouraging pluralism and stability in foreign issues as well as trim down their reliance on developed economies. Since each of the BRICS economies has restricted

|                      | Normality test (J-B statistics) | Serial correlation test (F-statistics) | Heteroskedasticity test (F-statistics) |
|----------------------|---------------------------------|---------------------------------------|----------------------------------------|
| Brazil               | 3233.31 (0.00)                  | 2.81 (0.06)                           | 2.14 (0.05)                            |
| Russia               | 993.40 (0.00)                   | 5.50 (0.00)                           | 13.48 (0.00)                          |
| India                | 2627.37 (0.00)                  | 1.46 (0.23)                           | 3.72 (0.00)                           |
| China                | 615.08 (0.00)                   | 0.27 (0.76)                           | 0.93 (0.45)                           |
| South Africa         | 633.30 (0.00)                   | 0.12 (0.88)                           | 10.38 (0.00)                          |

Source: own calculation; figures in parenthesis indicate p value
influence, strengthening support is not simply a condition to fight the financial crisis, however, also a protected option for the five economies to develop jointly in the post-COVID period.

As the early impacts of the epidemic were apparent, business in goods and services slowed in the first quarter of 2020. While overall services trade declined considerably in the first quarter of 2020, travel services were particularly severely impacted, falling by more than 24%. Personal protective equipment, ventilators, thermometers, sanitizers, and other COVID-19-related medical items had extremely significant growth in the 2nd quarter of 2020; for instance, in May 2020, such products saw an 186% rise over the same time in 2019. Many non-medical COVID-19-related items, such as home office equipment, such as Wi-Fi routers, laptops, and portable storage, grew rapidly in the second quarter. When comparing the economies of China, the United States, and the European Union, it is clear that the automobile and chemical sectors have seen major reductions. China had development in textiles and office machinery, as well as precision instruments and communications equipment to a lesser extent (UNCTAD 2020).

Investors under the BRICS stock markets should design adequate measures to protect their investments by executing appropriate hedging plan. As recommended in the report, venture capitalists should be mindful of the increased volatility implicit in BRICS stock markets. Separate study should be made to identify how the trade shock and volatility measures to the other non-BRICS nations.

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Availability of data and materials The datasets generated and/or analysed during the current study are available in the yahoo finance and trading economics repository and the links are as follows: https://finance.yahoo.com/quote/%5EBVSP/history/, https://in.finance.yahoo.com/quote/IMOEX.ME/history/, https://in.finance.yahoo.com/quote/%5ENSEI/history/, https://finance.yahoo.com/quote/000001.ss/history/, https://tradingeconomics.com/south-africa/indicators

Code availability Not applicable.

Declarations

Conflict of interest We have no competing interest.

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