INTEGRATION IN BRIC STOCK MARKETS: AN EMPIRICAL ANALYSIS

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Abstract: *This paper aims to analyse financial integration in the markets of Brazil, China, India and Russia (BRIC's), from July 2015 to June 2020, being the sample split in pre and during the global pandemic (Covid-19). In order to carry out this analysis, different approaches were undertaken to analyse two issues, namely, whether: (i) the global pandemic has accentuated the interdependencies in the BRIC financial markets? If so, how it has influenced the efficiency of portfolio diversification. The results suggest very significant levels of integration, in the Covid period these evidences diminish the chances of portfolio diversification in the long term. In turn, the analysis of the relationship between markets, in the short term, through the impulse response functions, in a period of global pandemic, shows positive/negative movements, with statistical significance, with persistence exceeding one week. In addition, there was no immediate adjustment in prices between markets, due to the high levels of shocks identified. Regarding the implementation of efficient portfolio diversification strategies, we consider that a good option for investors would be to avoid investments in stock markets. In this sense, one suggestion could be to invest in derivatives, gold and sovereign debt markets, with the purpose of diversifying portfolios and mitigating the risk arising from the global pandemic. The authors consider that the results achieved are of interest to investors seeking opportunities in these exchanges, as well as to policy makers to undertake institutional reforms in order to increase the efficiency of stock markets and promote the sustainable growth of financial markets.*

Keywords: *COVID-19; Financial integration; Arbitration; Risk diversification.*

1. INTRODUCTION

The COVID-19 outbreak has caused global concern. On 30 January, the WHO declared it a global health emergency. The easy spread of this virus has caused uncertainty in the global population. This epidemic has also changed people's lifestyles, millions of people have been put in isolation to reduce virus transmission, companies have closed to control the spread of the virus, causing income losses and leading to significant levels of unemployment. Worldwide, flights were cancelled, and transport systems were shut down. In general, economic activities were disrupted and stock markets fell sharply (Saadat, Rawtani, and Hussain, 2020).

The interdependence and integration of financial markets are quite distinct concepts, and the interdependence between markets is associated with the phenomenon of price movements between different markets, even though there is no economic basis for or enough knowledge of the

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facts that led to this joint movement. On the other hand, we are dealing with integrated markets when assets with similar risk but belonging to different markets are associated with similar returns (Tilfani, Ferreira, Dionisio, and Youssef El Boukfaoui, 2020).

In the same context, Grubel (1968), Levy and Sarnat (1970) argue that investing in international stock markets is substantiated by the fact that the correlation between assets is less than that examined in domestic assets. Therefore, the low correlation between international stock markets is a key factor in portfolio diversification. This essay aims to analyse financial integration in Brazil, China, India and Russia (BRIC's) in the context of the global pandemic (COVID-19). Different approaches have been undertaken to carry out this analysis in order to analyse two issues, namely whether: (i) has the global pandemic accentuated interdependencies in the BRIC financial markets? If so, how has it influenced the efficiency of portfolio diversification? The results suggest very significant levels of integration, in the Covid period these evidences diminish the chances of portfolio diversification in the long term. In turn, the analysis of the relationship between markets, in the short term, through the impulse response functions shows positive/negative movements, with statistical significance, with persistence exceeding one week. In addition, there was no immediate adjustment in prices between markets, due to the high levels of shocks identified.

This research adds two main contributions to the literature. The first contribution refers to the study of risk diversification in BRIC's financial markets. As far as we know, this is the first study that analyses these financial markets in isolation, in the context of the Covid pandemic. However, there are studies that have analysed the integration and diversification of risk in BRIC markets, namely, the authors Tripathy (2015), Siddiqui (2015), Ranjan Dasgupta (2016). However, the approach was quite different from that followed in this paper. The second contribution is econometric in nature, as results are compared between econometric methods and mathematical models that have the possibility of evaluating correlations in the context of non-stationarity. In particular, the Gregory and Hansen (1996) which demonstrates the presence of integration between financial markets with broken structures and, in a complementary way, the VAR-IRF model with the purpose of checking the links of these markets in the short term and assessing whether these markets provide international investors with a good diversification of their portfolios. In terms of structure this test is organised into 5 sections. Section 1 is represented by the current introduction. Section 2 presents a Literature Review regarding articles on integration in financial markets. Section 3 describes the data and methodology. Section 4 contains the results. Finally, Section 5 presents the general conclusions of the work.

2. LITERATURE REVIEW

The assessment of the current state of financial integration and shocks between markets is also relevant from a cost versus benefit perspective. The literature commonly agrees that financial integration brings benefits in good times. However, in times of crisis, high financial integration increases the probability of contagion, due to the close interrelationship between financial markets through proximity to markets. Overall, in the long run, the benefits of financial integration are expected to outweigh the costs (Babecký, Komarek e Komárková, 2017).

Tripathy (2015), Siddiqui (2015), Ranjan Dasgupta (2016) analysed financial integration in BRIC's markets. Tripathy (2015) shows the existence of a bi-directional causal relationship between the Indian and Russian markets, the Brazilian and Russian markets. Furthermore, the

Chinese market does not show any level of integration with the other BRIC markets. On the contrary, Siddiqui (2015) show that the stock markets of Brazil, Russia, India and China (BRIC) are not integrated in the long term and in the short term there are no causal relationships between these markets. Already Ranjan Dasgupta (2016) shows that the BRIC markets are integrated showing that these markets do not offer any opportunity for diversification with the USA.

Özer, Kamışlı and Kamışlı (2016) show hybrid results by not being able to show movement between the market of Germany, Austria, Czech Republic, Croatia, Lithuania and Greece. These findings have important implications for international investors, portfolio managers and policy makers. While the authors Moagar-Poladian, Clichici and Stanciu (2019) show that the markets of Central and Eastern Europe show a significant level of integration during the European financial crisis. Jawadi, Chlibi and Cheffou (2019) studied the movements between the US market and the G6, BRICS and MENA markets. The authors show that the MENA and BRICS markets are segmented with the US market, while the G6 markets show integration. Already Salisu, Ndako, Adediran and Swaray (2020) have analysed integration in Islamic markets and show that markets are integrated and that this behaviour can be influenced by global economic conditions.

Liu, Manzoor, Wang, Zhang and Manzoor (2020) studied the impact of the coronavirus outbreak on 21 stock indexes. The authors show significant structural breaks due to the COVID-19 outbreak. Already Zeren and Hizarci (2020) analysed the effects of the Covid-19 epidemic on stock markets in the period 23 January 2020 and 13 March 2020. The authors show levels of causality between the number of deaths from the global outbreak and the financial markets. It was understood that the global cases of the outbreak have cointegration relationships with the ESO, KOSPI and IBEX35 markets, but not with the FTSE MIB, CAC40, DAX30 markets.

In summary, this work aims to contribute to the provision of information to investors and regulators in the BRIC markets, where individual and institutional investors seek diversification benefits, as well as to help promote the implementation of policies that contribute to the efficiency of these markets.

3. METHODOLOGY

3.1. Data

The prices index data for the financial markets of Brazil, China, India and Russia (BRIC's) were obtained from the Thomson Reuters platform. The prices are daily and comprise the period from July 1st 2015 to June 29th 2020, being the same divided into two pre-Covid (July 1st/2015 to December 31st/2018) and Covid (January 2nd/2019 to June 29th/2020) sub-periods, being the same in local currency to mitigate exchange rate distortions.

Table 1. The name of countries and their indices used in this paper

Country name	Index
Brasil	BOVESPA
China	SSEC
India	SENSEX
Rússia	IOMEX

Source: Own elaboration

3.2. Methodology

The development of research has taken place in several stages. The characterization of the sample used was done through descriptive statistics, the adherence test. In order to analyse the integration between the BRIC markets we will use the model of Gregory and Hansen (1996). To measure and evaluate the shocks (movements) between markets, in the short term, we will use the methodology impulse response functions (IRF), with Monte Carlo simulations, because they provide a dynamic analysis (variable with time), generated from the estimates of the VAR model, thus allowing us to study the causality relations calculated, even when we do not detect previously the causality relations Granger between the variables (Lütkepohl and Saikkonen 1997).

4. RESULTS

Figure 1 shows the evolution of the BRIC markets in % of the differences. The sample comprises the time span from July 1, 2019 to June 29, 2020, which is a very complex period due to the understanding of the outbreak of the global pandemic (COVID-19). The yields clearly reveal the instability experienced in these markets in February, March and April 2020.

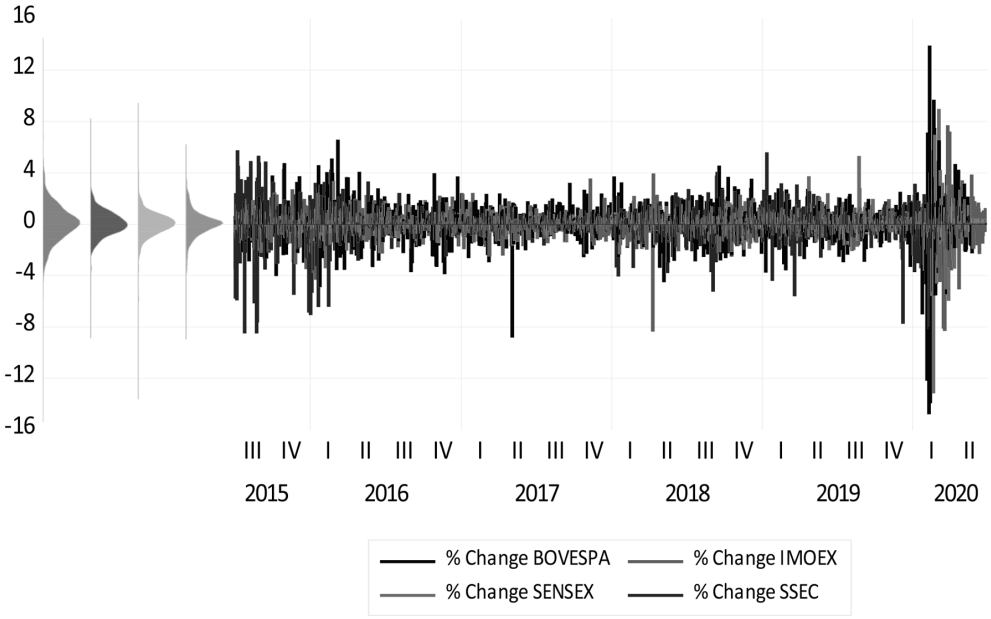

Figure 1. Evolution, as % of differences, of the 4 financial markets, in the period from 01/07/2015 to 29/06/2020

Source: Own elaboration

Table 2 shows the main descriptive statistics of the financial markets under analysis, as well as the Jarque-Bera adherence test. The analysis of the descriptive statistics allows us to assess that most of the returns have positive daily averages, except for the China market (SSEC). The market that presents the most significant standard deviation (risk) is that of Brazil (BOVESPA), being the smallest verified in Russia (IMOEX). On the other hand, all the series of returns showed signs of deviation from the hypothesis of normality, given the coefficients of asymmetry and kurtosis. The series analysed are lepto-curricular and have asymmetric tabs. Additionally, all the yield series showed signs of deviation from the normality hypothesis, since the Jarque-Bera test allows rejecting the null hypothesis of normality (H_0) in favour of the alternative (H_1), not normality, for the significance level of 1%.

Table 2. Descriptive statistics, in yields, of the 4 financial markets in the full period

	BOVESPA	IMOEX	SENSEX	SSEC
Mean	0.000485	0.000416	0.000271	-0.000216
Std. Dev.	0.017721	0.011096	0.011586	0.013702
Skewness	-1.270587	-0.964421	-1.817829	-1.313148
Kurtosis	19.39696	15.13801	30.58782	11.56917
Jarque-Bera	14408.30	7905.035	40522.01	4203.835
Sum	0.608915	0.521909	0.339800	-0.271698
Sum Sq. Dev.	0.394107	0.154517	0.168464	0.235612
Observations	1256	1256	1256	1256

Note: ***. ** represent significance at 1% and 5%. respectively.

Source: Own elaboration

Table 3 shows the results of the Gregory-Hansen test, and easily detects 6 pairs of integrated markets. The markets of China and Russia show 3 integrations (in 3 possible). While the markets of Brazil and India do not show integration with their peers, that is, they are segmented. These results do not call into question the implementation of efficient diversification strategies, especially in markets that do not show integration. These results are partially corroborated by the author Siddiqui (2015).

Table 3. Gregory-Hansen tests, Pre-Covid period (01/07/2015 to 31/12/2018)

Markets	t-statistic	Method	Lags	Break Date	Results
IMOEX / BOVESPA	-5.75***	Trend	1	10/03/2017	Cointegration
IMOEX / SENSEX	-5.55***	Trend	1	16/03/2017	Cointegration
IMOEX / SSEC	-5.70***	Trend	1	10/03/2017	Cointegration
SSEC / BOVESPA	-4.88*	Regime	5	02/05/2018	Cointegration
SSEC / SENSEX	-5.02*	Regime	5	10/05/2018	Cointegration
SSEC / IMOEX	-4.80*	Regime	0	01/09/2017	Cointegration

Source: Own elaboration

Notes: Data worked on by the authors (software: Stata). The AIC information criterion was chosen. The critical values are found in Gregory and Hansen (1996). The critical values for the ADF and Zt parameters are: −5,45 (1%); −4,99 (5%); −4,72 (10%). For the Za parameter, the critical values are: −57,28 (1%); −47,96 (5%); −43,22 (10%). The asterisks ***, **, * indicate statistical significance at 1%, 5% and 10%, respectively.

Table 4 shows the integration results in the Covid period, and we easily see that integration in BRIC markets has increased significantly, which calls into question the hypothesis of diversification. The markets of Brazil, Russia and China show 3 integrations (out of 3 possible), while India presents 2 integrations. In addition, we note that the breakdown in structure is mostly in 2020. These results are in line with the authors' studies Moagar-Poladian, Clichici and Stanciu (2019), Caporale, Gil-Alana and Poza (2020), Milos, Hatiegan, Milos, Barna and Botoc (2020), which show high levels of integration in stock markets, questioning whether portfolio diversification will be efficient.

Notes: Data worked on by the authors (software: Stata). The AIC information criterion was chosen. The critical values are found in Gregory and Hansen (1996). The critical values for the ADF and Zt parameters are: −5,45 (1%); −4,99 (5%); −4,72 (10%). For the Za parameter, the critical values are: −57,28 (1%); −47,96 (5%); −43,22 (10%). The asterisks ***, **, * indicate statistical significance at 1%, 5% and 10%, respectively.

Table 4. Gregory-Hansen tests, Covid period (02/01/2019 to 29/06/2020)

Markets	t-statistic	Method	Lags	Break Date	Results
BOVESPA / SENSEX	-5.39**	Regime	1	04/06/2019	Cointegration
BOVESPA / IMOEX	-5.00**	Trend	0	28/04/2020	Cointegration
BOVESPA / SSEC	-5.28***	Trend	0	06/02/2020	Cointegration
IMOEX / BOVESPA	-5.93***	Trend	5	10/03/2020	Cointegration
IMOEX / SENSEX	-5.97***	Trend	5	10/03/2020	Cointegration
IMOEX / SSEC	-5.99***	Trend	5	10/03/2020	Cointegration
SENSEX / BOVESPA	-45.00*	Trend	1	13/06/2019	Cointegration
SENSEX / SSEC	-4.80*	Regime	5	27/02/2020	Cointegration
SSEC / BOVESPA	-5.10**	Trend	3	06/02/2020	Cointegration
SSEC / SENSEX	-5.19**	Trend	3	25/03/2019	Cointegration
SSEC / IOMEX	-4.76*	Trend	3	25/03/2019	Cointegration

Source: Own elaboration

To analyse the significance of the causal relationships between the profitability of the four markets under analysis, the VAR Granger Causality/Block Exogeneity Wald Tests procedure was applied. To determine the number of lags to include in the causality tests, we used the HQIC (Hannan-Quinn information criterion), which suggests 6 lags. Fewer lags increase the degrees of freedom, more lags decrease the autocorrelation problems. As we previously performed a VAR with 6 lags, and then performed the VAR Residual Serial Correlation LM Tests with 7 lags, the null hypothesis was not rejected, which corroborates that the model presents a robust estimation.

The IRF methodology, with Monte Carlo simulations (see figure 2), tested the degree of response of the variables in the markets of Brazil, China, India and Russia, to changes (impulses) of one standard deviation of each of the mentioned variables. These results show the prompt response to market shocks, reflected on the following day, but also the speed of information processing in the markets. In all cases, innovations of their own and other pairs generate positive/negative responses on the following day, but shocks between markets have little significance. These results are in line with the authors' evidence Özer, Kamışlı e Kamışlı (2016).

Figure 3 shows the results of the IRF-VAR model, in the Covid period, with reflection on the following day, but also the speed of the markets in information processing. In all cases, the innovations of their own and other pairs generate statistically significant positive/negative responses the following day, at the 5% significance level. Given the one-day maturity, the response of each market to shocks in its own market exceeds the size of the response to shocks in other markets, in virtually all markets. Few situations have failed to do so. We can therefore infer that the assumption of market efficiency is questionable, since the forecast of market movement can be improved by considering the lagged movements of the other markets, allowing for arbitrage operations.

5. CONCLUSION

The general conclusion to be retained and, supported by the results obtained, through tests performed with econometric models, demonstrates that the global pandemic has a significant impact on the memory properties of BRIC's financial market indices. We found that the level of financial integration and the shocks between markets increased significantly in the Covid period. These markets also prove to be inefficient in their weak form due to the high levels of arbitrage identified. In conclusion, we consider that these evidences are relevant for policy makers and investors in relation to regional development policies and portfolio diversification strategies in BRIC's financial markets.

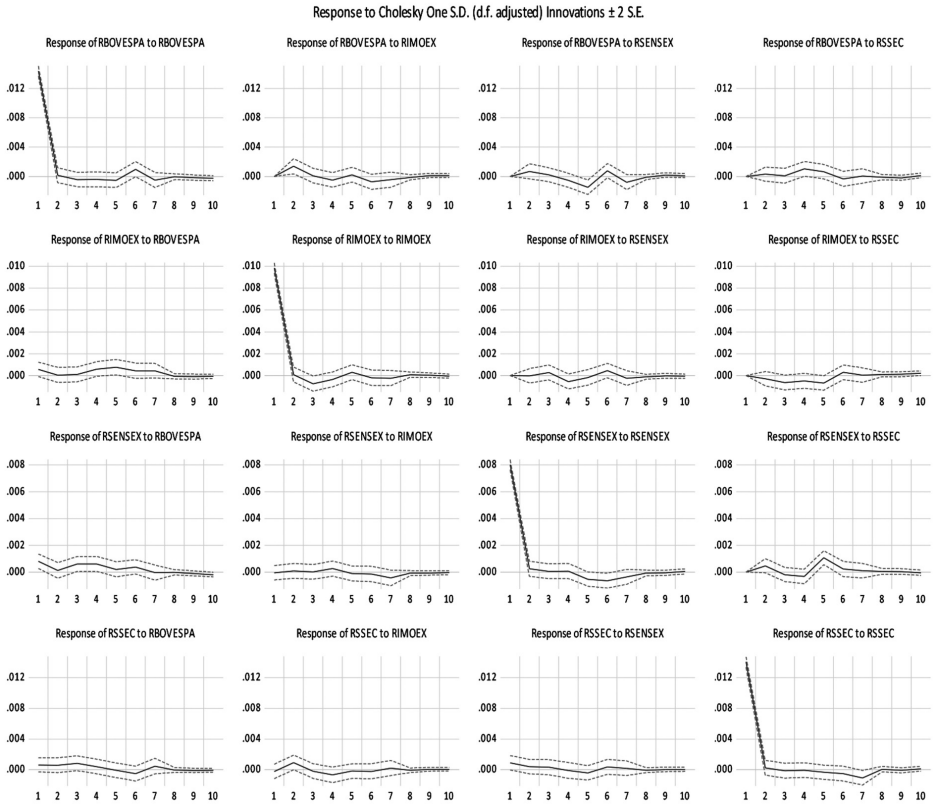

Figure 2. IRF Graphs, with Monte Carlo Simulations, in the Pre-Covid period.
Standard Errors: Monte Carlo (1000 repetitions)
Source: Own elaboration

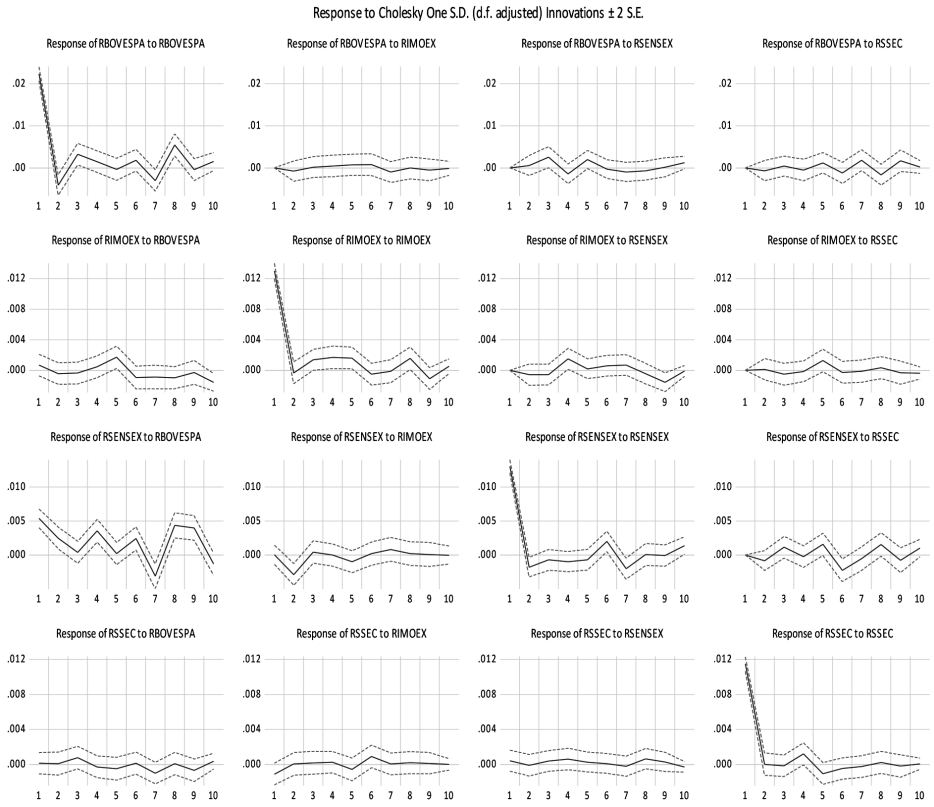

Figure 3. IRF charts, with Monte Carlo Simulations, in the Covid period.
Standard Errors: Monte Carlo (1000 repetitions)
Own elaboration

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