THE SHOCKS BETWEEN OIL MARKET TO THE BRIC STOCK MARKETS: A GENERALIZED VAR APPROACH

Rui Dias[1] iD
Paula Heliodoro[2] iD
Paulo Alexandre[3] iD
Cristina Vasco[4] iD

Abstract: *The pandemic (Covid-19) has affected the global economy, and the impact on financial markets seems inevitable. In view of these events, this essay aims to analyse the shocks between the stock market indices of Brazil (BOVESPA), China (SSEC) India (SENSEX), Russia (IMOEX) and oil (WTC), in the period from January 2, 2019 to May 29, 2020. In order to carry out this analysis, different approaches were undertaken with a view to gauging whether (i) the global pandemic has accentuated the shocks between the BRIC financial markets and the WTC? The daily yields do not have normal distributions, show negative asymmetries, leptokurtic, and exhibit conditional heteroscedasticity. In general, we find evidence that the WTC causes the markets of Russia and India, China does not cause any market, and Brazil is not caused by any market analysed. On the other hand, short-term market shocks are relevant and create some arbitrage opportunities. However, our study did not analyse anomalous returns in these financial markets. These findings also open space for market regulators to take action to ensure better information between international financial markets.*

Keywords: *BRIC's markets, Moves, Arbitrage, Portfolio 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).

Understanding the synchronisation between stock markets, as well as the study of the occurrence of turbulence, is important for investors, investment fund managers, academics, in several aspects, namely when implementing efficient portfolio diversification strategies (Dias, da Silva and Dionísio, 2019).

---

[1]   Escola Superior de Ciências Empresarias - Institute Polytechnic of Setúbal, Portugal & CEFAGE, University of Évora, Portugal

[2]   Escola Superior de Ciências Empresarias – Institute Polytechnic of Setúbal, Portugal

[3]   Escola Superior de Ciências Empresarias – Institute Polytechnic of Setúbal, Portugal

[4]   IEFP – Instituto do Emprego e Formação Profissional, Alcácer do Sal, Portugal

This essay aims at analysing the movements among the stock market indices of Brazil (BOVES-PA), China (SSEC) India (SENSEX), Russia (IMOEX), and oil (WTC), in the period from January 02, 2019 to May 29, 2020. In order to carry out this analysis, different approaches were undertaken: (i) the global pandemic has accentuated the shocks between the BRIC financial markets and the WTC? The results suggest that the WTC causes the markets of Russia and India, China does not cause any market, and Brazil is not caused by any market analysed. On the other hand, shocks between markets in the short term are relevant and create some arbitrage opportunities.

This research adds contributions to the literature, namely in the analysis of shocks between oil prices and BRIC stock markets, in the context of the global pandemic outbreak. As far as we know there are studies that have analysed the shocks between several financial markets, in the context of the Covid pandemic, namely the authors Liu, Manzoor, Wang, Zhang and Manzoor (2020) and Zeren and Hizarci (2020). However, the approach was quite different from that followed in this trial.

In terms of structure, this test is organised into 5 sections. In addition to the current introduction, Section 2 presents an analysis of the Literature Review with respect to articles on the movements in international financial markets, Section 3 describes the methodology and Section 4 contains the data and results. 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 and Komárková, 2017).

Raza et al. (2016), You et al. (2017), Mensi et al. (2017), Boubaker and Raza (2017), Bagchi (2017) analysed the synchronizations between the price of oil and the stock markets. Raza et al. (2016) show that oil prices have a negative impact on BRIC's emerging markets. You et al. (2017) show that falling oil prices decrease the profitability of stock markets in pre-crisis periods. Mensi et al. (2017) show the existence of a dependency between oil, and the S&P500, stoxx600, DJI and TSX stock indices. Boubaker and Raza (2017), Bagchi (2017) examined the shocks between oil prices and the BRIC stock exchanges, the authors show significant shocks.

Yao and Kuang (2019), Tiwari et al. (2020), Bhatia et al. (2020) studied the relationships between oil prices and various financial markets. Yao and Kuang (2019) evidence the existence of distinct correlations in various time periods. Tiwari et al. (2020) suggest that the oil market may be a diversification asset for investors in the Japanese and French markets, but investors operating in the remaining G7 markets should be cautious. Bhatia et al. (2020) examined the dynamic relationship between precious metals and G7 stock exchanges and emerging markets (BRIC's). The G7 and BRIC markets exhibit different dynamics with precious metals during the study period (2000-2017).

The dynamics between precious metals and G7 stock exchanges show similar patterns, which represents an aggregation behaviour, however, the same does not apply to BRIC countries. In contrast to the existing literature, this study found that silver offers a better coverage capacity than other precious metals, both in the short and long term. To build an optimal portfolio of two

precious metals assets and the stock index, silver appears as the most favourable option for both the short and long term.

In summary, this work aims to contribute to providing information to investors and regulators in BRIC's financial markets, and to assess whether Oil (WTC) is a diversified market when BRIC's markets break. Therefore, the context of this work is to examine the causalities, and short-term shocks, between these markets, and oil (WTC) in the context of the global outbreak (COVID-19).

3. METHODOLOGY

3.1. Data

The prices index data for the financial markets of Brazil, China, India, Russia (BRIC's), and the WTC were obtained from the Thomson Reuters platform. The quotations are daily and comprise the period from January 1st, 2019 to June 29th, 2020 and are 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
Russia	IOMEX
WTC	West Texas Crude

Source: Own elaboration

3.2. Methodology

The development of research has taken place in several stages. The characterization of the sample used was carried out through descriptive statistics, the adherence test of Jarque and Bera (1980). To find out if there is a causal effect between the various BRIC markets and oil (WTC), we will use Granger's causality test. This test uses the VAR (Granger Causality or Block Exogeneity Wald Test) procedure, which uses the Wald statistics, to test the null hypothesis that the coefficients of the endogenous variables lagged in the „cause" variable are null or not „cause" in the Grangerian sense the dependent variable. However, it is important to stress that the result of this test presents a high sensitivity to the number of lags considered in the model, so the first concern is to estimate this value properly, in order to arrive at robust evidence (Gujarati, 2004). In a complementary way we will use the methodology impulse response functions (IRF), with Monte Carlo simulations (1000 repetitions), which provide a dynamic analysis (variable with time), designed from the estimates of the VAR model, making it possible to study the calculated causality relations, even when no causality relations to Granger are previously detected between the variables (Lütkepohl and Saikkonen 1997).

4. RESULTS

Figure 1 shows the evolution of the BRIC and WTC markets, in first differences. The sample comprises the time span from January 1, 2019 to June 29, 2020, which is a very complex period due to the understanding of the global pandemic outbreak (COVID-19). The yields clearly reveal the instability experienced in these markets in the months of January, February and March 2020, with the exception made to the Chinese market which shows sharper shocks in December 2019.
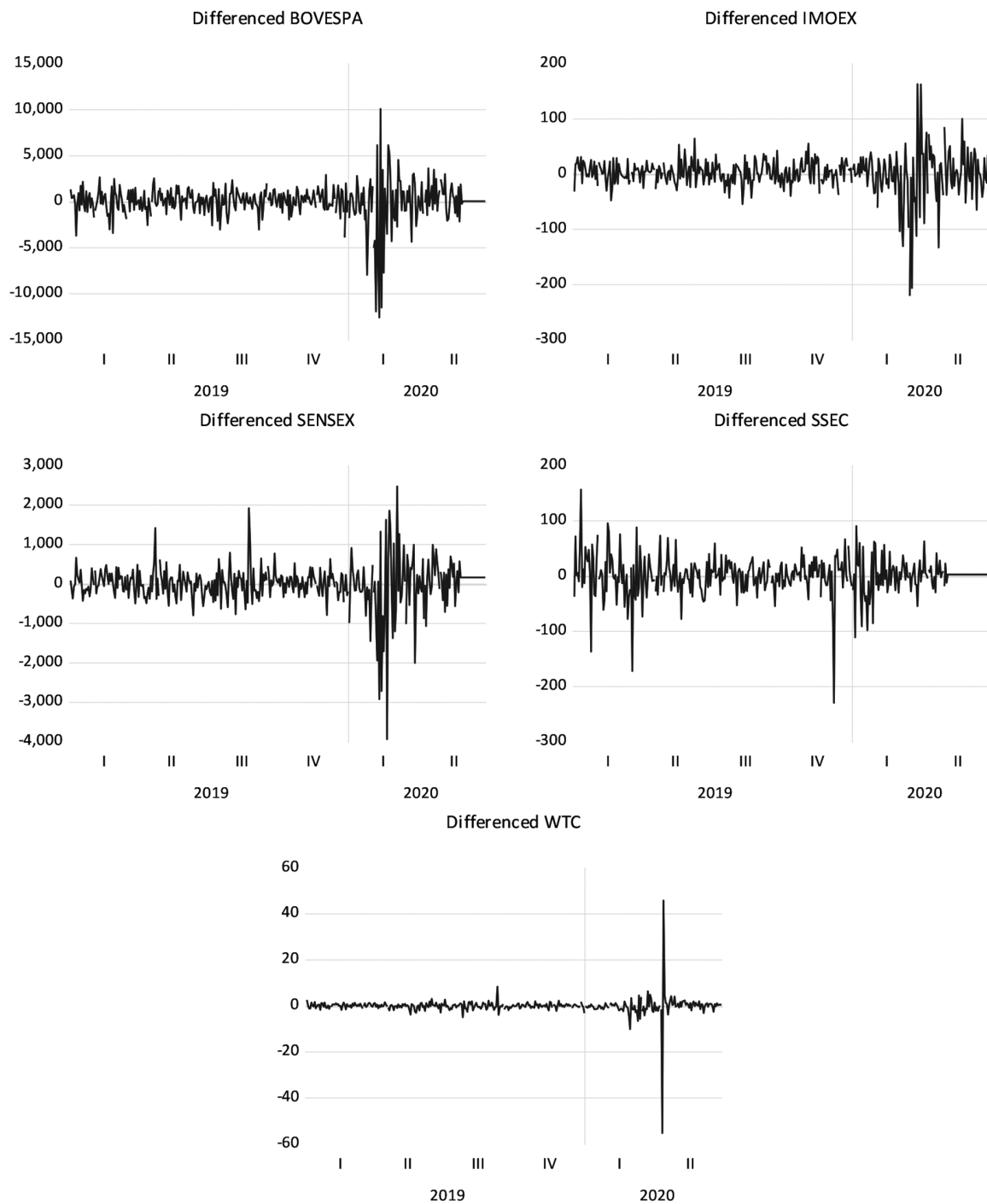
Figure 1. First differences of the 5 financial markets in the full period
Source: Own elaboration.

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 the yields have positive averages. The market with the most significant standard deviation (risk) is oil (WTC), being the lowest in China (SSEC). The series analysed are lepto-curricular and have asymmetric tabs. In addition, all the yield series showed signs of deviation from the normality hypothesis.

Table 2. Descriptive statistics, in yields, of the 5 financial markets in the full period

	BOVESPA	IMOEX	SENSEX	SSEC	WTC
Mean	4.52E-05	0.000388	0.000311	0.000319	0.001460
Std. Dev.	0.023602	0.013447	0.017064	0.011816	0.058052
Skewness	-1.688931	-1.068808	-1.746468	-1.065231	1.162113
Kurtosis	18.85963	16.43405	21.09384	11.62893	21.28141
Jarque-Bera	4075.536***	2868.167***	5263.611***	1224.460***	5263.986***
Sum	0.016813	0.144218	0.115642	0.118811	0.542981
Sum Sq. Dev.	0.206675	0.067089	0.108033	0.051795	1.250280
Observations	372	372	372	372	372

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

Source: Own elaboration.

To analyse the significance of causality relationships between BRIC's financial markets and the WTC, the VAR Granger Causality/Block Exogeneity Wald Tests model was applied. To determine the number of lags to include in the causality tests, we used the LR, FPE, and AIC criteria, which suggest 9 lags. Fewer lags increase the degrees of freedom, more lags decrease autocorrelation problems. As we previously performed a VAR with 9 lags, and then performed the VAR Residual Serial Correlation LM Tests with 10 lags, the null hypothesis was not rejected, which corroborates that the model presents a robust estimation (see table 3).

Table 3. VAR Residual Serial Correlation LM Tests

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
10	32.65329	25	0.1400	1.311731	(25, 1112.2)	0.1400

Note: *Edgeworth expansion corrected likelihood ratio statistic.

Source: Own elaboration.

The results of Granger's causality tests are shown in Table 4, concerning BRIC's financial markets and the WTC. Granger's causality tests show 8 causal relationships (out of 20 possible). The WTC causes, in the Grangerian sense, Russia and India, while Brazil causes Russia and India, and Russia causes India and China. India causes Russia and the WTC, while the Chinese market causes no market and Brazil is not caused by any market. The Indian and Russian markets are the most caused markets in the sample. These results are in line with the results presented by the authors, Raza et al. (2016), You et al. (2017), Mensi et al. (2017), Boubaker and Raza (2017), Bagchi (2017) which show that oil prices cause shocks in the stock markets.

Table 4. Granger Causality Tests / Block Exogeneity Wald Tests, Full Period

	BOVESPA	IMOEX	SENSEX	SSEC	WTC
BOVESPA	********	0.33(9)	1.43(9)	1.46(9)	1.55(9)
IMOEX	1.71(9)*	********	2.11(9)**	0.52(9)	7.29(9)***
SENSEX	12.19(9)***	3.79(9)***	***********	1.17(9)	4.50(9)***
SSEC	0.70(9)	11.59(9)***	0.53(9)	********	0.42(9)
WTC	1.19(9)	48.97(10)***	3.55(10)***	0.42(9)	********

Note: The lateral values in parentheses refer to lags. ***. **. *. represent significance at 1%. 5% and 10%. respectively.

Source: Own elaboration.

The IRF methodology, with Monte Carlo simulations (see figure 2), tested the degree of response of the variables among the stock market indices of Brazil (BOVESPA), China (SSEC) India (SEN-

SEX), Russia (IMOEX) and oil (WTC), to changes (impulses) of a standard deviation of each of the variables mentioned. These results show the prompt response to market shocks, reflected on the following day, but also the speed of market information processing. In all cases, innovations of their own and other pairs generate statistically significant positive/negative responses on 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. These results are validated by the authors Morales and Andreosso-O´Callaghan (2020), Şenol and Zeren (2020), Mzoughi et al. (2020) which show significant shocks from the global pandemic (COVID-19).
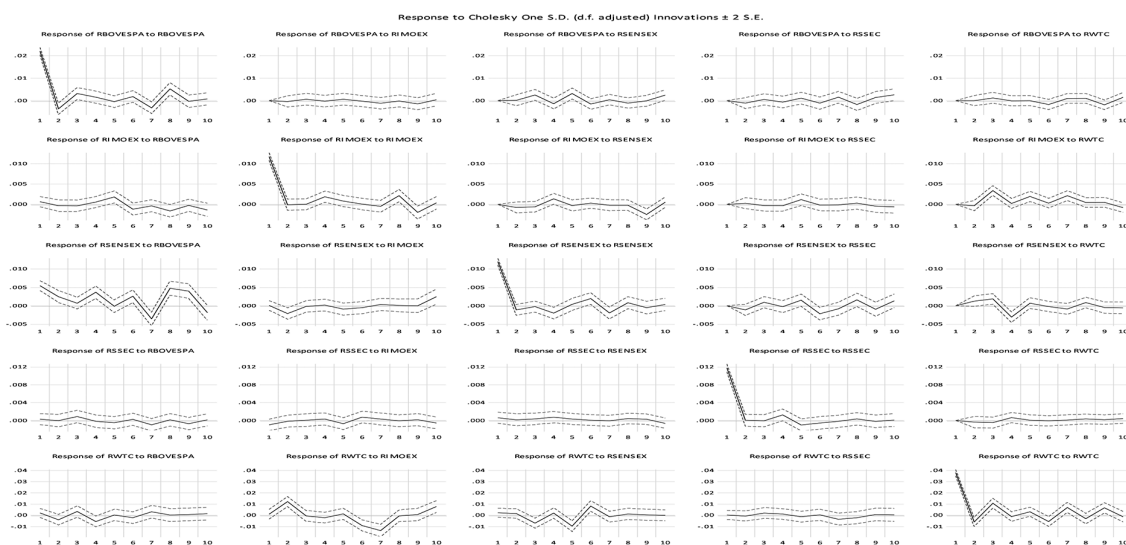

Figure 2. WTC and BRIC financial markets, with Monte Carlo Simulations, in the Full Period

Source: Own elaboration.

5. CONCLUSION

The overall conclusion to be retained and sustained in the results obtained, through tests performed with econometric models, demonstrates that at the end of the sample the global pandemic has a significant impact on the adjustment of the financial markets analysed. The results indicate that the WTC and the BRIC stock markets have significant causalities, which may call into question efficient portfolio diversification strategies. On the other hand, short-term market shocks are relevant and create some arbitrage opportunities. These findings also open space for market regulators to take action to ensure better information between international financial markets.

REFERENCES

Babecký, J., Komarek, L., & Komárková, Z. (2017). Financial integration at times of crisis and recovery. *International Finance Review*. https://doi.org/10.1108/S1569-376720170000018010
Bagchi, B. (2017). Volatility spillovers between crude oil price and stock markets: evidence from BRIC countries. *International Journal of Emerging Markets*. https://doi.org/10.1108/IJoEM-04-2015-0077

Bhatia, V., Das, D., & Kumar, S. B. (2020). Hedging effectiveness of precious metals across frequencies: Evidence from Wavelet based Dynamic Conditional Correlation analysis. *Physica A: Statistical Mechanics and Its Applications*. https://doi.org/10.1016/j.physa.2019.123631

Boubaker, H., & Raza, S. A. (2017). A wavelet analysis of mean and volatility spillovers between oil and BRICS stock markets. *Energy Economics*. https://doi.org/10.1016/j.eneco.2017.01.026

Dias, R., da Silva, J. V., & Dionísio, A. (2019). Financial markets of the LAC region: Does the crisis influence the financial integration? *International Review of Financial Analysis*. https://doi.org/10.1016/j.irfa.2019.02.008

Gujarati, D. N. (2004). *Basic Econometrics. New York*. https://doi.org/10.1126/science.1186874

Jarque, C. M., & Bera, A. K. (1980). Efficient tests for normality, homoscedasticity and serial independence of regression residuals. *Economics Letters*, *6*(3), 255–259. https://doi.org/10.1016/0165-1765(80)90024-5

Liu, H., Manzoor, A., Wang, C., Zhang, L., & Manzoor, Z. (2020). The COVID-19 outbreak and affected countries stock markets response. *International Journal of Environmental Research and Public Health*. https://doi.org/10.3390/ijerph17082800

Lütkepohl, H., & Saikkonen, P. (1997). Impulse response analysis in infinite order cointegrated vector autoregressive processes. *Journal of Econometrics*, *81*(1), 127–157. https://doi.org/10.1016/S0304-4076(97)00037-7

Mensi, W., Hammoudeh, S., Shahzad, S. J. H., & Shahbaz, M. (2017). Modelling systemic risk and dependence structure between oil and stock markets using a variational mode decomposition-based copula method. *Journal of Banking and Finance*. https://doi.org/10.1016/j.jbankfin.2016.11.017

Morales, L., & Andreosso-O´Callaghan, B. (2020). Covid-19 - Global Stock Markets "Black Swan." *Critical Letters in Economics & Finance*.

Mzoughi, H., Urom, C., Uddin, G. S., & GUESMI, K. (2020). The Effects of COVID-19 Pandemic on Oil Prices, CO2 Emissions and the Stock Market: Evidence from a VAR Model. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3587906

Raza, N., Jawad Hussain Shahzad, S., Tiwari, A. K., & Shahbaz, M. (2016). Asymmetric impact of gold, oil prices and their volatilities on stock prices of emerging markets. *Resources Policy*. https://doi.org/10.1016/j.resourpol.2016.06.011

Saadat, S., Rawtani, D., & Hussain, C. M. (2020). Environmental perspective of COVID-19. *Science of the Total Environment*. https://doi.org/10.1016/j.scitotenv.2020.138870

Şenol, Z., & Zeren, F. (2020). Coronavirus (COVID-19) and Stock Markets: The Effects of the Pandemic on the Global Economy. *Avrasya Sosyal ve Ekonomi Araştırmaları Dergisi*.

Tiwari, A. K., Trabelsi, N., Alqahtani, F., & Raheem, I. D. (2020). Systemic risk spillovers between crude oil and stock index returns of G7 economies: Conditional value-at-risk and marginal expected shortfall approaches. *Energy Economics*. https://doi.org/10.1016/j.eneco.2019.104646

Yao, C. Z., & Kuang, P. C. (2019). A study of lead–lag structure between international crude oil price and several financial markets. *Physica A: Statistical Mechanics and Its Applications*. https://doi.org/10.1016/j.physa.2019.121755

You, W., Guo, Y., Zhu, H., & Tang, Y. (2017). Oil price shocks, economic policy uncertainty and industry stock returns in China: Asymmetric effects with quantile regression. *Energy Economics*. https://doi.org/10.1016/j.eneco.2017.09.007

ZEREN, F., & HIZARCI, A. (2020). THE IMPACT OF COVID-19 CORONAVIRUS ON STOCK MARKETS: EVIDENCE FROM SELECTED COUNTRIES. *Muhasebe ve Finans İncelemeleri Dergisi*. https://doi.org/10.32951/mufider.706159