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Reaction of African stocks markets to disequilibrium episodes of the COVID-19 infection: Evidence from the top hit African countries

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Abstract. The continued COVID-19 pandemic has had a significant impact on the global economy, with countries battling to contain the infection's spread as it continues to affect nearly every country in the globe. We test for possible explosive behavior (excessive disequilibrium) in COVID-19 infection in the top African impacted economies, given the sensitivity and fragility of stock markets to shocks. The study identifies two (2) separate explosive occurrences in Algeria and Egypt using the Generalized Sup Augmented Dickey-Fuller (GSADF) test. Furthermore, the study examines the influence of the COVID-19 infection's explosive behavior on the stock markets of the countries, taking into consideration the disequilibrium occurrences. The COVID-19 infection's explosive behavior had a negative but insignificant effect on stock returns, leading to an increase in riskiness. This outcome could be explained by the fact that the explosive incidents were transitory and could only have had a momentary impact on stock market returns absorbable overtime. More so, it suggests that investors may have adjusted to the shock of the COVID-19 infection prior to the two explosive occurrences, and that the development of the COVID-19 vaccine reassures for a near halt to the pandemic.

Keywords: COVID-19, stock market, explosive episodes, GSADF, Africa

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Реакция фондовых рынков на эпизоды заражения COVID-19: данные из наиболее пострадавших африканских стран

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Аннотация. Продолжающаяся пандемия COVID-19 оказала значительное влияние на мировую экономику, правительства борются с распространением инфекции, поскольку она продолжает поражать почти все страны мира. В рамках исследования мы проверяем возможное взрывное поведение инфекции COVID-19 в наиболее пострадавших странах Африки, учитывая чувствительность фондовых рынков к потрясениям. Исследование выявило два отдельных случая выбросов в Алжире и Египте с использованием теста Generalized Sup Augmented Dickey-Fuller (GSADF). Кроме того, рассматривается влияние взрывного поведения инфекции COVID-19 на фондовые рынки стран с учетом неравновесных явлений. Взрывное поведение инфекции COVID-19 оказало негативное, но незначительное влияние на доходность акций, что привело к увеличению риска. Этот результат можно объяснить тем фактом, что инциденты были преходящими и могли оказать лишь кратковременное влияние на доходность фондового рынка. Более того, это предполагает, что инвесторы, возможно, приспособились к шоку и что разработка вакцины против COVID-19 дает надежду на то, что пандемия почти остановится.

Ключевые слова: COVID-19, фондовый рынок, эпизоды заражения, GSADF, Африка

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Introduction

The COVID-19 epidemic is an unprecedented event that held the global economic system and temporarily halted activity. The spread of the disease was significant, despite the precautions taken by most countries in the short term. Economic activity had to be interrupted through partial and entire lockdowns due to the inevitable trade-off between infection risk and economic activity. Pandemics have a tendency to affect many sectors, but the economic sector has been particularly hard hit because productive activities had to be halted through partial and entire lockdowns. There have been job losses, company closures, and deaths as a result

of this. In order to maintain economic stability, most governments have had to implement stimulus measures involving monetary and fiscal policies. Tax cuts and financial help for medium and small-scale businesses, as well as food and other needed supplies for needy households, were the most prominent fiscal measures included in the plan. Most central banks lowered their monetary policy rates to help the economy liquidate.

The stock market, which is susceptible to shocks, is one component of the economy that is predicted to be adversely impacted. Though, because the stock market is often reacting to speculations, the pandemic is not likely to have a direct and immediate influence on the stock market. Global stock markets reacted negatively to the mounting cases of the COVID-19 infection (Ashraf, 2020; Baker et al., 2020; Harjoto et al., 2020). Furthermore, Baker et al. (2020) stated that no other infectious disease outbreak, including the Spanish Flu, has had such a strong impact on the stock market as the COVID-19 pandemic. He et al. (2020) and Khan et al. (2020) noted that the impact of the pandemic on the stock market is a short-run effect, and the impact is negated in the long term frame. Yan et al. (2020) found that during the Spanish flu pandemic, the Dow Jones indices that were among the hardest hit only needed three months to recover from the trough dip. Another viewpoint in this debate is the existence of a contagion and spill-over effect to other markets as a result of market integration and interlinkages. Okorie and Lin (2021) discovered evidence of a contagious impact, though it was only temporary. Returns and volatilities both showed this trend.

The African continent was not spared to the pandemic's infectious impacts. In comparison to Europe and America, it is not as overwhelming. However, there are indications that the region has limited testing capability and hence is unable to determine the true condition of the case. However, one thing is certain: when compared to other places, the region has a low fatality rate. Again, it's thought that the pandemic has had an impact on Africa's economy, with the World Health Organization (WHO) reporting the first case on February 14th, 2020 in Egypt. As a result, governments across the region have implemented safety measures such as partial and full lockdown in commercial and capital cities. Flight bans and other transborder traffic measures were also imposed. However, the impact of the epidemic on the stock market is still being felt, particularly in some of the region's largest economies (such as Ethiopia, Nigeria, South Africa, Algeria, and Morocco), which were all moderately affected. There were also signs that the oil-exporting countries had suffered a double tragedy as a result of the global oil price drop caused by a sudden negative demand shock. Again, there is a risk of spillover volatility from other stock markets to Africa's stock, particularly from China, where the virus started (Dutta et al., 2017; Hung, 2020). As of September 2020, the current study is attempting to test the possible exuberant behavior of COVID cases during the first and second waves in the top impacted African countries. The study will also look at how stock prices are expected to react to the shock.

Materials and methods

The current study uses daily case data to identify any explosive episode (or excessive disequilibrium) in the COVID-19 cases adopting the Generalised Sup Augmented Dickey-Fuller test of Phillips et al. (2015). An analysis of investing behavior during the first and second waves of COVID-19 infection was conducted. This was done by the use of an asymmetric GARCH, also known as the Exponential GARCH model Nelson (1991). The Generalized Sup Augmented Dickey–Fuller model, on the other hand, is as follows:

$$\Delta y_t = \alpha_{r1,r2} + \beta_{r1,r2} y_{t-1} + \sum_{i=1}^{k} \psi^{i}_{r1,r2} \Delta y_{t-i} + \varepsilon_t \dots\dots 1;$$

Where y_t is the daily number of new cases of COVID-19, k denotes the lag order and $\varepsilon_t \sim N(0, \sigma^2_{r_1,r_2})$. The ADF statistic (t-ratio) based on this regression is denoted by $ADF^{r_2}_{r_1}$.

In the second instance, the effect of the explosiveness of the COVID cases on the stock market was tested by the GARCH model. The mean and variance equations are given below as:

$$R_t = \alpha + \beta_1 R_{t-1} + \beta_2 Dummy_t + \mu_t \dots\dots 2;$$

$$\log(\sigma^2_t) = \omega + \sum_{i=1}^{p} \alpha_i \left|\frac{\epsilon_{t-i}}{\sigma_{t-i}}\right| + \sum_{j=1}^{q} \beta_j \log(\sigma^2_{t-j}) + \sum_{k=1}^{r} \gamma_k \frac{\epsilon_{t-k}}{\sigma_{t-k}} + \lambda(Dummy_t) \dots\dots 3.$$

The mean equation is given in equation 2 where R_t is the stock market returns, $Dummy_t$ is the period of explosive episodes. Equation 3 gives the variance equation of the EGARCH model where $\log(\sigma^2_t)$ log of the conditional variance, the existence of leverage effect can be detected if $\gamma_1 < 0$ and the effect is asymmetric if $\gamma_1 \neq 0$. Also, the study adopted the (Diebold & Yilmaz, 2009) measure of spillover and connectedness to test for possible infection spillover within the region.

Data

Daily data on stock market prices were sourced from Thomson Reuters corporation from 2nd of January 2019 to 8th of December 2020. While daily data on the daily new infection rate of COVID-19 was sourced from Our World in Data repository (see https://ourworldindata.org/coronavirus). The stock market returns were calculated using daily percentages changes. Outliers were addressed by taking the average of the preceding and succeeding day.

Empirical results and discussion
Testing for explosive episodes of COVID-19 new cases in selected African countries

Table 1 shows the results of GSADF tests for explosive episodes described in equation 1. The findings indicate that explosive behavior occurs in the COVID instances only in Algeria and Egypt, with no empirical evidence of such behavior in Ethiopia, Ghana, Kenya, Libya, Morocco, Nigeria, or South Africa (Table 1). The evidence was established for the countries where the occurrences were discovered utilizing the statistical significance of the RTADF-Statistic, i.e., Algeria (0.00) and Egypt (0.00) at a 1% level. As a result, the null hypothesis of a unit root is rejected, and the alternative hypothesis of an explosive root is preferred. By implication, this finding suggests that explosive behavior occurred in Algerian and Egyptian COVID-19 cases during the study period. The conclusion is limited by the inability to pinpoint when such instances occurred in the data. Hence, we used a BSADF (Backward Sup Augmented Dickey-Fuller) test to date-stamp episodes of explosive behavior (Table 2).

Table 1

Generalised sup augmented Dickey—Fuller (SADF) test results for explosive episodes in selected African Countries

Country	RTADF-Statistic	P-value	Remark
Algeria	6.22	0.00	Explosive
Egypt	4.96	0.00	Explosive
Ethiopia	1.31	0.85	Non-Explosive
Ghana	0.55	0.99	Non-Explosive
Kenya	1.05	0.92	Non-Explosive
Libya	1.54	0.77	Non-Explosive
Morocco	0.30	1.00	Non-Explosive
Nigeria	-0.45	1.00	Non-Explosive
South Africa	2.87	0.17	Non-Explosive

Source: Author's computation.

Date-stamping explosive episodes of COVID-19 new cases in Algeria and Egypt

The results of the Backward Sup Augmented Dickey-Fuller (BSADF) test reveal that both Algeria and Egypt had two incidents of explosive behavior (Table 2 and Figure 1). The first episode occurred between 27 June 2020 and 01 August 2020, lasting 36 days, while the second episode occurred between

10 November 2020 and 24 November 2020, lasting 14 days (this is indicated by the shaded region in Figure 1). Egypt, too, has had two instances of explosive behavior. The first episode lasted 30 days and took place between 18/05/2020 and 16/06/2020, while the second lasted 19 days and took place between 17/11/2020 and 05/12/2020. These findings indicate that COVID-19 cases are increasing at an alarming rate, with little chance of returning to the average. In the middle of the explosive occurrences, this could make intervention less successful in managing the pandemic in these countries (Algeria and Egypt).

Table 2

Backward sup augmented Dickey—Fuller (BSADF) test results for date-stamping explosive episodes

Country	Episodes	Start Date	End Date	Number of Explosive Days
Algeria	First	27/06/2020	01/08/2020	36 Days
	Second	10/11/2020	24/11/2020	14 Days
Egypt	First	18/05/2020	16/06/2020	30 Days
	Second	17/11/2020	05/12/2020	19 Days

Source: Author's computation.

The existence or absence of explosive episodes between countries may also show the success of mitigation measures for reducing infection rates between countries. It also demonstrates the role of geographical locations; for example, Algeria and Egypt are bordering countries in North Africa; the first instances in Africa were reported in these countries, and the explosive occurrences were discovered spontaneously in these countries.

Due to the presence of the Suez Canal, Egypt is once again prone to a high rate of infection because it serves as one of Africa's most important commercial hubs. Egypt is also a major tourist destination, attracting travellers from all over the world. Consequently, as one of the largest economies in the North African region, there may be a spillover impact to neighboring nations like Algeria, Tunisia, Libya, and Morocco, among others.

The absence of explosive episodes in other countries such as South Africa, Nigeria, Ghana, and Ethiopia, despite their rising rates, can be attributed to the effectiveness of their preventive measures, which include full lockdown in the capital and infected cities, suspension of international travel, events, and religious gatherings, among other things. However, we cannot ignore the fact that the region's testing capability is inadequate in contrast to other industrialized countries in Europe and America.

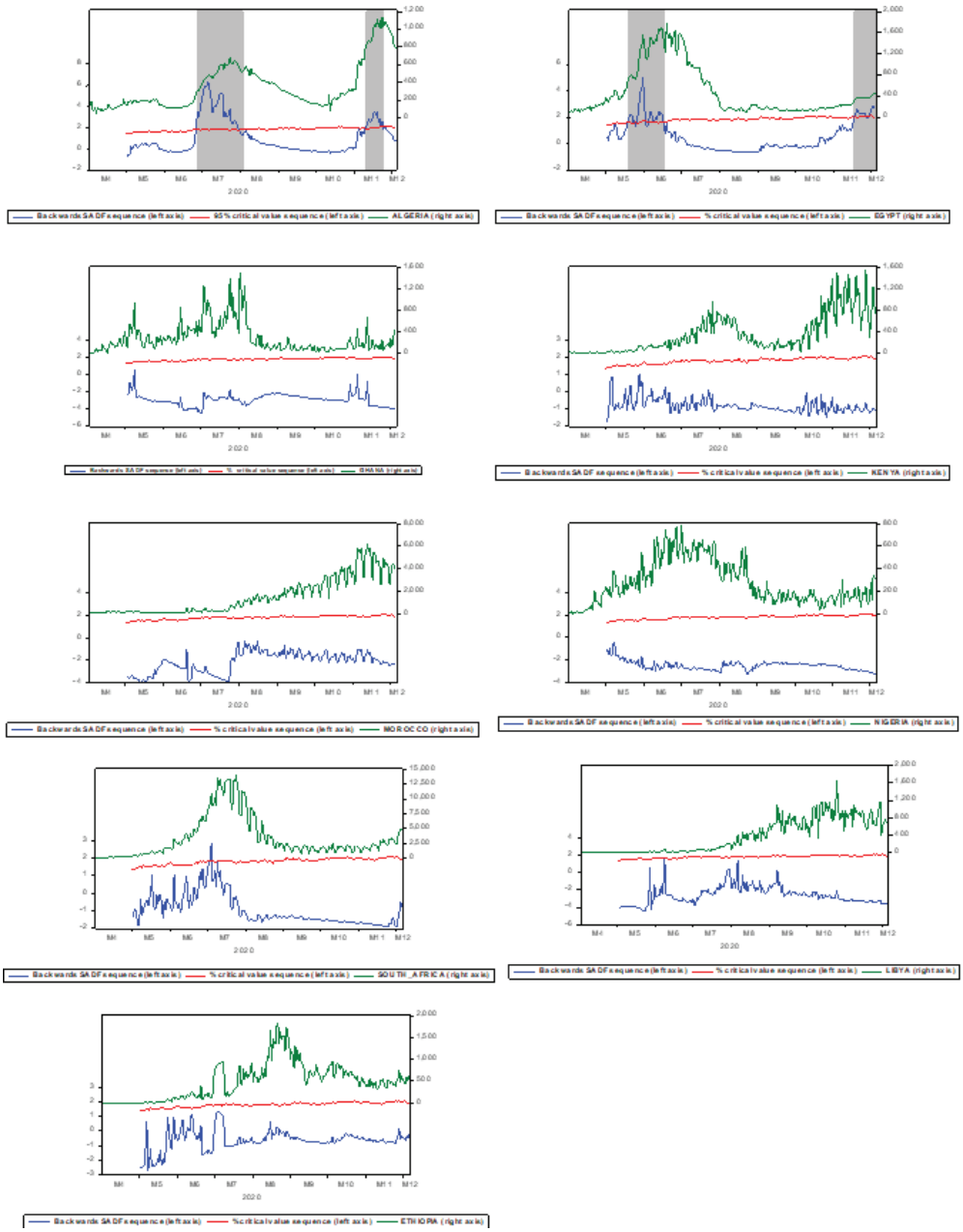

Figure 1. Backward Sup Augmented Dickey-Fuller (BSADF) Test Results for Date-Stamping Explosive Episodes

Source: Author's computation.

Spill-over effects of COVID-19 new cases among selected African countries

The study uses the test of Diebold and Yilmaz (2009) to see if the COVID-19 infection was linked across nations. The results show that, while the first instance in Africa was detected in Egypt, there is evidence of diffusion from Egypt to South Africa, Nigeria, and Ghana. Again, there are hints that North African countries such

as Morocco, Algeria, Libya, Tunisia, and Egypt have substantial ties. This illustrates the role of geographic location in the propagation of the virus, with the region accounting for half of Africa's top ten cases (Table 3).

Table 3

Diebold—Yilmaz index of spill-over of COVID-19 among selected African countries

	SA	Morocco	Tunisia	Egypt	Ethiopia	Nigeria	Libya	Algeria	Kenya	Ghana	From others
South Africa (SA)	86.4	0.8	0.4	5.3	1.9	3.2	0.1	1.9	0.1	0.0	13.6
Morocco	1.0	84.1	0.4	0.3	0.1	0.3	12.1	1.7	0.0	0.0	15.9
Tunisia	2.6	29.7	55.4	0.0	0.3	0.3	10.5	0.7	0.3	0.0	44.6
Egypt	6.1	0.1	0.1	87.8	2.8	2.4	0.2	0.0	0.3	0.3	12.2
Ethiopia	1.5	3.0	0.3	0.9	88.6	3.8	0.5	0.0	0.3	1.0	11.4
Nigeria	6.7	1.8	0.1	19.9	4.7	65.6	0.4	0.5	0.2	0.1	34.4
Libya	0.5	41.1	1.9	1.0	7.7	0.7	46.5	0.2	0.3	0.2	53.5
Algeria	5.1	20.0	4.7	0.4	1.3	0.5	1.1	65.8	0.9	0.2	34.2
Kenya	11.2	38.9	1.6	0.2	1.0	1.0	3.6	5.2	36.8	0.6	63.2
Ghana	14.9	2.5	0.1	1.9	0.1	1.6	1.1	2.3	1.4	74.1	25.9
Contribution to others	49.4	137.9	9.4	29.8	19.9	13.8	29.7	12.6	3.8	2.4	308.8
Contribution including own	135.8	222.0	64.8	117.7	108.5	79.4	76.2	78.5	40.6	76.5	30.9%

Source: Author's computation.

Effects of explosive episodes of COVID-19 Egyptian stocks market returns

Due to the non-availability of data for the Algerian stock market, only the Egyptian stock market data was considered. The estimates obtained using equation 2 and 3 are presented in Table 4. The estimates indicate that the explosive episodes of COVID-19 have a negative but insignificant (statistical) impact on the Egyptian Stocks Market returns. This evidence is indicated by the negative value of the coefficient (-0.0601) of the explosive episodes (dummy) in the mean equation. This suggests that during the explosive episode of the COVID-19, investors in the Egyptian Stocks Markets suffered more losses than experienced in the nonexplosive period.

Table 4

Impact of explosive episodes of COVID-19 on Egyptian stocks market return and volatility

Variable	Coefficient	Std. Error	z-Statistic	Prob.
Mean Equation: $R_t = \alpha + \beta_1 R_{t-1} + \beta_2 Dummy_t + \mu_t$				
Rt-1	0.180774	0.043398	4.165462	0.0000
Explosive Episodes (Dummy)	-0.060116	0.180955	-0.332217	0.7397
Variance Equation: $\log(\sigma_t^2) = \omega + \beta \log(\sigma_{t-1}^2) + \alpha \left\| \frac{\varepsilon_{t-1}}{\sigma_{t-1}} \right\| + \gamma \frac{\varepsilon_{t-1}}{\sigma_{t-1}} + \lambda Dummy_t$				
Constant	-0.168234	0.056277	-2.989387	0.0028
Last Month Forecast Variance	0.242905	0.079212	3.066528	0.0022
Asymmetric Term (News)	-0.129109	0.042587	-3.031645	0.0024
GARCH	0.932538	0.029977	31.10862	0.0000
Explosive Episodes (Dummy)	0.011964	0.068367	0.174995	0.8611
Adjusted R-squared: 0.055302, Durbin-Watson stat: 1.833427, and Heteroskedasticity Test (ARCH):) 0.8577				

Source: Author's computation.

Furthermore, during the explosive episodes that occurred from 18/05/2020 to 16/06/2020 and 17/11/2020 to 05/12/2020, the result indicates a 0.012 increase in market risk (volatility). The increase, however, is not statistically significant, as the p-value of 0.861 indicates.

There are two viable counter-arguments here. First, considering that most African stock markets are not as sophisticated as other stock markets such as the S&P 500, Dow Jones, and Nikkei, among others, and that the pandemic did not start in the region, a spillover impact is likely. However, this effect could be mitigated because portfolio investors may only see the overall shock as a short-term consequence that would fade over time. Second, the moments of explosiveness were transient and coincided with the first and second waves of the infection; thus, while the effect was immediate, the negative significant effect may have been drowned out by the stock portfolio holders' reaction. This is in line with the findings of (He et al., 2020; Khan et al., 2020), who found a similar effect for the Shanghai Composite Index, which was badly impacted in the near term but rebounded in the long run.

The asymmetric term has a negative value (–0.1291), although the volatility coefficient (GARCH) is positive and extremely near to one (0.9325). Thus, there appears to be a difference in the impact of good and bad news on volatility, with bad news increasing volatility more than positive news of comparable scale. As a result, in this market, investors are more prone to bad news than good news (emphasizing the consequences of lockdown and movement restrictions on company sales, earnings,

dividend/share price). The findings also revealed signs of volatility clustering and shock persistence. As a result, a period of high volatility will be followed by another period of high volatility, and vice versa for a time of low volatility. As a result, the increased volatility caused by the Pandemic, and particularly its explosive events, is expected to endure and extend beyond the COVID-19 era.

Conclusion

The current study aims to see if the enduring COVID-19 infection could have an explosive effect on the stock markets of the worst-affected African countries. Using the method of Phillips et al. (2015), the researchers discovered traces of explosive occurrences in COVID-19 infection in Algeria and Egypt during the first and second waves. This could be due to the success of infection control and relaxing measures used. However, there were no comparable incidents in other top-hit nations in the area, including South Africa, Ethiopia, Morocco, Nigeria, and Ghana. We further investigate the impact of the COVID-19 infection in these countries, where the episodes of explosive behavior were detected and accounted for. The COVID-19 infection had a negative but not significant effect on the investors, showing that they had reacted to the shock, but that the effect had been counteracted because the episodes were only short-lived. This conforms to the study of (He et al., 2020; Khan et al., 2020) that found a short-run negative effect of COVID-19 infection on the stock market, but no long-term influence because the effect appears to fizzle over time, as seen with the Chinese Shanghai Composite Index.

Dedication

This article is dedicated to our brother and friend Abubakar Sadiq Yahuza, who died of colon cancer. He was a promising true scholar who thrived on learning and assisting others in their pursuit of knowledge.

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Appendix

Pairwise Granger Causality Testskk

Date: 03/03/21 Time: 23:16

Sample: 4/02/2020 12/05/2020

Lags: 1

Table 1

Null Hypothesis	Obs	F-Statistic	Prob.
MOROCCO does not Granger Cause SOUTH_AFRICA SOUTH_AFRICA does not Granger Cause MOROCCO	247	0.70610 1.17408	0.4016 0.2796
TUNISIA does not Granger Cause SOUTH_AFRICA SOUTH_AFRICA does not Granger Cause TUNISIA	247	0.59434 1.40775	0.4415 0.2366
EGYPT does not Granger Cause SOUTH_AFRICA SOUTH_AFRICA does not Granger Cause EGYPT	247	8.46343 7.38549	0.0040 0.0070
ETHIOPIA does not Granger Cause SOUTH_AFRICA SOUTH_AFRICA does not Granger Cause ETHIOPIA	247	0.01519 1.75247	0.9020 0.1868
NIGERIA does not Granger Cause SOUTH_AFRICA SOUTH_AFRICA does not Granger Cause NIGERIA	247	10.3740 12.4883	0.0015 0.0005
LIBYA does not Granger Cause SOUTH_AFRICA SOUTH_AFRICA does not Granger Cause LIBYA	247	0.56250 0.17828	0.4540 0.6732
ALGERIA does not Granger Cause SOUTH_AFRICA SOUTH_AFRICA does not Granger Cause ALGERIA	247	0.59078 0.19514	0.4429 0.6591
KENYA does not Granger Cause SOUTH_AFRICA SOUTH_AFRICA does not Granger Cause KENYA	247	0.46780 0.77227	0.4947 0.3804
GHANA does not Granger Cause SOUTH_AFRICA SOUTH_AFRICA does not Granger Cause GHANA	247	0.70081 25.5711	0.4033 8.E-07
TUNISIA does not Granger Cause MOROCCO MOROCCO does not Granger Cause TUNISIA	247	0.22520 14.7313	0.6355 0.0002

Continuation of the Table 1

Null Hypothesis	Obs	F-Statistic	Prob.
EGYPT does not Granger Cause MOROCCO MOROCCO does not Granger Cause EGYPT	247	2.28293 0.61465	0.1321 0.4338
ETHIOPIA does not Granger Cause MOROCCO MOROCCO does not Granger Cause ETHIOPIA	247	0.26622 0.54146	0.6063 0.4625
NIGERIA does not Granger Cause MOROCCO MOROCCO does not Granger Cause NIGERIA	247	1.54693 4.91861	0.2148 0.0275
LIBYA does not Granger Cause MOROCCO MOROCCO does not Granger Cause LIBYA	247	16.4466 41.4627	7.E-05 6.E-10
ALGERIA does not Granger Cause MOROCCO MOROCCO does not Granger Cause ALGERIA	247	1.45334 4.01130	0.2292 0.0463
KENYA does not Granger Cause MOROCCO MOROCCO does not Granger Cause KENYA	247	0.34333 19.0637	0.5585 2.E-05
GHANA does not Granger Cause MOROCCO MOROCCO does not Granger Cause GHANA	247	0.62211 4.73733	0.4310 0.0305
EGYPT does not Granger Cause TUNISIA TUNISIA does not Granger Cause EGYPT	247	2.60829 0.09268	0.1076 0.7611
ETHIOPIA does not Granger Cause TUNISIA TUNISIA does not Granger Cause ETHIOPIA	247	0.86213 0.31735	0.3541 0.5737
NIGERIA does not Granger Cause TUNISIA TUNISIA does not Granger Cause NIGERIA	247	2.28859 2.74096	0.1316 0.0991
LIBYA does not Granger Cause TUNISIA TUNISIA does not Granger Cause LIBYA	247	23.9350 14.9449	2.E-06 0.0001
ALGERIA does not Granger Cause TUNISIA TUNISIA does not Granger Cause ALGERIA	247	0.27612 0.00033	0.5997 0.9855
KENYA does not Granger Cause TUNISIA TUNISIA does not Granger Cause KENYA	247	1.08895 6.80836	0.2977 0.0096
GHANA does not Granger Cause TUNISIA TUNISIA does not Granger Cause GHANA	247	2.07589 3.45134	0.1509 0.0644
ETHIOPIA does not Granger Cause EGYPT EGYPT does not Granger Cause ETHIOPIA	247	5.15103 0.27994	0.0241 0.5972
NIGERIA does not Granger Cause EGYPT EGYPT does not Granger Cause NIGERIA	247	0.30856 24.6715	0.5791 1.E-06
LIBYA does not Granger Cause EGYPT EGYPT does not Granger Cause LIBYA	247	0.92733 5.54920	0.3365 0.0193
ALGERIA does not Granger Cause EGYPT EGYPT does not Granger Cause ALGERIA	247	1.80111 0.89809	0.1808 0.3442
KENYA does not Granger Cause EGYPT EGYPT does not Granger Cause KENYA	247	1.25080 0.54594	0.2645 0.4607
GHANA does not Granger Cause EGYPT EGYPT does not Granger Cause GHANA	247	3.05465 8.94318	0.0818 0.0031
NIGERIA does not Granger Cause ETHIOPIA ETHIOPIA does not Granger Cause NIGERIA	247	1.77569 0.63541	0.1839 0.4262
LIBYA does not Granger Cause ETHIOPIA ETHIOPIA does not Granger Cause LIBYA	247	0.44506 6.39245	0.5053 0.0121

Ending of the Table 1

Null Hypothesis	Obs	F-Statistic	Prob.
ALGERIA does not Granger Cause ETHIOPIA ETHIOPIA does not Granger Cause ALGERIA	247	1.45573 2.25735	0.2288 0.1343
KENYA does not Granger Cause ETHIOPIA ETHIOPIA does not Granger Cause KENYA	247	1.14538 0.56069	0.2856 0.4547
GHANA does not Granger Cause ETHIOPIA ETHIOPIA does not Granger Cause GHANA	247	0.01225 0.10547	0.9120 0.7456
LIBYA does not Granger Cause NIGERIA NIGERIA does not Granger Cause LIBYA	247	5.43196 4.17262	0.0206 0.0422
ALGERIA does not Granger Cause NIGERIA NIGERIA does not Granger Cause ALGERIA	247	0.03157 0.13159	0.8591 0.7171
KENYA does not Granger Cause NIGERIA NIGERIA does not Granger Cause KENYA	247	0.46522 0.03047	0.4958 0.8616
GHANA does not Granger Cause NIGERIA NIGERIA does not Granger Cause GHANA	247	4.62858 19.0977	0.0324 2.E-05
ALGERIA does not Granger Cause LIBYA LIBYA does not Granger Cause ALGERIA	247	1.21612 0.16534	0.2712 0.6846
KENYA does not Granger Cause LIBYA LIBYA does not Granger Cause KENYA	247	8.50053 6.25855	0.0039 0.0130
GHANA does not Granger Cause LIBYA LIBYA does not Granger Cause GHANA	247	1.35988 6.33038	0.2447 0.0125
KENYA does not Granger Cause ALGERIA ALGERIA does not Granger Cause KENYA	247	8.69431 25.3792	0.0035 9.E-07
GHANA does not Granger Cause ALGERIA ALGERIA does not Granger Cause GHANA	247	0.14032 0.74742	0.7083 0.3881
GHANA does not Granger Cause KENYA KENYA does not Granger Cause GHANA	247	0.07349 0.08822	0.7866 0.7667

Table 2

Discussion of results on the impact of explosive episodes of COVID-19 on Egyptian stocks market

Country	Egypt	Ethiopia	Ghana	Kenya	Libya	Morocco	Nigeria	Algeria	South Africa
Egypt	1.00	–0.33	0.39	–0.20	–0.52	–0.45	0.70	–0.14	0.38
Ethiopia	–0.33	1.00	–0.03	0.24	0.47	0.33	0.06	0.28	0.17
Ghana	0.39	–0.03	1.00	0.11	–0.39	–0.31	0.61	0.21	0.70
Kenya	–0.20	0.24	0.11	1.00	0.54	0.76	0.00	0.75	0.27
Libya	–0.52	0.47	–0.39	0.54	1.00	0.83	–0.43	0.35	–0.24
Morocco	–0.45	0.33	–0.31	0.76	0.83	1.00	–0.39	0.57	–0.19
Nigeria	0.70	0.06	0.61	0.00	–0.43	–0.39	1.00	0.12	0.73
Algeria	–0.14	0.28	0.21	0.75	0.35	0.57	0.12	1.00	0.39
South Africa	0.38	0.17	0.70	0.27	–0.24	–0.19	0.73	0.39	1.00

Bio notes / Сведения об авторах

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