Keywords: Stock market performance; Levene’s test; Volatility; S&P 500; DAX 40; FTSE 250

Abstract: From the pure health crisis that countries faced at the very beginning of the COVID-19 pandemic, in later stages it led to the creation of multiple economic and financial vulnerabilities. When the world economies started recovering from the pandemic negative impacts, Russia started its invasion of Ukraine. The study aims to add to the growing body of literature on the topic of crises caused by the COVID-19 and Russian–Ukraine war by analyzing and comparing the volatility of the world’s leading stock market performance benchmarks in the pre-crisis and crisis periods. For the analysis, Levene’s test is used to check the homogeneity/heterogeneity of variances of stock market returns. Analysis shows that all indexes performed better in the Russian–Ukraine crisis compared to the COVID-19 crisis, i.e., the volatility of returns of all indexes is significantly lower in the Russian-Ukraine crisis compared to the COVID-19 crisis.

1. INTRODUCTION

Since the beginning of the human race, two calamities have scared people the most - disease and war. Especially, if they spread quickly and if many people are exposed to them. Pandemics and wars affect civilization on many levels - people die and are injured, families fall apart, property is destroyed, and overall economic activity suffers as well.

Financial markets, and especially stock exchanges, are considered by many to be the ultimate achievement of human creativity in the field of economics. Apart from the basic function of connecting business entities with surplus and deficit in capital and channeling funds, stock markets are considered the most agile indicator of the state and changes in the economic system.

We live in difficult times. In a short period of just a few years, civilization was hit by two serious disasters - the COVID-19 pandemic and the Russian Federation’s aggression against Ukraine. Global stock markets reacted instantly to both events. After the closure of the regions of Lombardy and Veneto in the north of Italy on February 23, 2020 (which was the first “lockdown” outside of China), the drop in capitalization on global stock markets by the end of February exceeded 6 billion dollars. On the first day of the Russian invasion (February 24th, 2022), the S&P 500 index lost 1.6% of its value, the FTSE 250 fell by 2.83%, and the DAX 40 lost 3.96% of its value.

Both crises have inexorably changed the contours of the global economy. However, additional questions arise: did the crises have the same impact on the financial markets, did the recovery proceed similarly, is the nature of these crises similar, and can they be reacted to in the same way?
2. LITERATURE REVIEW

The outbreak and rapid spread of the COVID-19 pandemic, and especially the pandemic control measures, caused reactions in financial markets around the world, which immediately aroused the interest of researchers. In the economic environment, research was mainly focused in two directions - on the effects on international trade flows and international investment flows. In the first case, the researcher’s focus is on measures taken by governments to protect and preserve trade activity, and in the second mainly on the effect on stock markets, measured by the volatility of prices and yields on securities and indices.

Mirza et al. (2020) already at the very beginning of the pandemic investigated the reaction and timing of the price volatility of European investment funds. On a sample of 266 funds from all categories (equity, bond, treasury, corporate, etc.), in the period January-June 2020, using the Sharp ratio, they measure the reaction of the fund’s performance, and using the GARCH model, they test the variance in returns. The research results indicate a different effect of the pandemic, depending on the type of funds. Capital market funds (equity and bond) recorded the fastest and strongest negative reaction, while the most robust were funds that invest in socially entrepreneurial companies. Treasury funds had a positive yield reaction in the first stage of the pandemic, but their indicators also declined in the continuation of the pandemic.

Beirne et al. (2020) look at the reaction of the financial markets of 38 countries, focusing specifically on 14 emerging economies. The authors base the research on a panel of data with fixed effects for bond yields, share prices, exchange rates, and the volume of the flow of equity and debt capital, on January 4, 2010, until April 30, 2020. Using regression analysis and a structural VAR framework, they showed that emerging markets were more affected by the crisis than advanced economies. Emerging economies in Asia and Europe experienced the sharpest drop in stock prices, bond yields, and exchange rate values due to pandemics, followed by a sudden and significant capital outflow.

The scale of the effects of the COVID-19 crisis on financial markets is perhaps most clearly seen in the research by Baker et al. (2020), using data on daily changes in the prices of securities on American stock exchanges of more than 2.5% since 1900, determined that no previous epidemic of infectious disease had increased the volatility of the American stock market as strongly as COVID-19 (not even an epidemic of the Spanish flu of 1918, which was far more devastating in medical and humanitarian terms).

The world has never been more connected. This contributes to the quick “spillover” of crises, but also to a faster recovery because trade relations and the flow of funds were relatively quickly established, as soon as the “lockdown” measures were eased and communication solutions were found in pandemic conditions.

Zaimović and Dedović (2021) compared the reaction of the American capital market to the COVID-19 crisis with the reaction to the onset of the Global Financial Crisis of 2008. Based on data on the return on the S&P 500 index for the period May 5, 2008, to February 5, 2009 (Global Financial Crisis) and September 10, 2019, to June 10, 2020 (COVID-19 crisis) found that the market reaction to the COVID-19 crisis was shallower and shorter than in the case of the 2008 financial crisis. The recovery from the COVID-19 crisis was faster, among other things, due to the strong business performance and price growth of six technology companies (Facebook,
Amazon, Netflix, Alphabet, Apple and Microsoft) whose shares are constituents of the S&P 500 index. The role of IT technology in controlling and adapting living and working conditions during the pandemic benefited these companies, but also indirectly the recovery of the financial market.

The European financial market recovered just as quickly. This is supported by the research of Su et al. (2022) who observed the dynamics of returns before and after the COVID-19 crisis, in ten European financial markets (Germany, France, Italy and Spain, from the group of developed countries, and Russia, Poland, the Czech Republic, Ukraine, Romania and Hungary, as European developing countries). The authors found that the markets recovered in 252 working days (calendar year), and they found a high degree and an increase in the index of market connectivity (from 63.48% to 75.14%), which explains the strong “spillover” effect on the market. Spillover was one of the key features of this crisis.

And just as the global economy recovered from the COVID-19 crisis, the tension in the relations between the Russian Federation and Ukraine escalated again. First, Russia concentrated troops and military equipment in Belarus (a formal ally), and then on February 24, 2022, it began a large-scale military operation in the north and east of Ukraine. Financial markets in Europe and the world are under attack again.

One of the first papers dealing with the impact of Russia's invasion of Ukraine on European financial markets, on global capital markets, by Boungou and Yatié (2022) observes the market reaction in 94 countries. As an indicator of the reaction, the authors use daily returns on stock market indices, dividing the data into two subsets - for one month before and one month after the beginning of the Russian invasion. Using a logarithmic regression model on a panel of market data, the authors conclude that the markets recorded a negative yield reaction even before the start of the conflict, in anticipation of the invasion, but that the reaction was stronger after the start of the war. Also, the drop in returns on indices hit the markets of neighboring countries more strongly, as well as countries that were the first to demand an end to the offensive at the United Nations.

The research of Dias et al. (2022) supports the thesis of increased “contagion” of crisis events in the modern financial markets environment. The authors analyzed the movement of correlation factors among stock market indices of nine Central and Eastern European countries. They measured the dynamics of index volatility, using a family of t-tests, and determined that the level of contagion among markets is highly significant. Through 72 contagion tests, the authors confirmed the existence of 62 market pairs that show significantly high levels of spillover.

A very interesting and innovative approach to the analysis of the effect of Russia's invasion of Ukraine was applied by Yousaf et al. (2022). The authors used the “event study” approach, believing that was a sudden and unpredictable event for the financial markets (“black swan”). They defined the beginning of the war (February 24, 2022) as an event and took the five days before and after this date as the period that the event was limited to. The adjustment period (“estimation window”) was 120 days before the start of the event. The research is based on normal daily returns from the financial markets of the G20 countries, as well as characteristic countries that border the G20 countries and are sensitive to the conflict in question (Romania, Hungary, the Netherlands, Slovakia, Poland), and Ukraine, which is directly affected by the conflict. The results showed that the stock markets of Hungary, Russia, Poland, and Slovakia were the first to
react in anticipation of military actions in Ukraine, achieving negative returns in the days before the event, while the stock markets of the G20 countries, as well as some of the stock markets of neighboring countries, were adversely affected in the days after the invasion.

The work by Ahmed et al. (2021) is also based on the "event-study" approach, but the authors do not take the beginning of the invasion as the key event, but the day on which the Russian Federation recognized the independence of two regions in the east of Ukraine (February 21, 2022). On that day, European markets recorded abnormally negative returns. The “Estimation window” in this research is 25 days before and after the characteristic event. Using logarithmic regression, the authors determined the highest cumulative abnormal returns in the financial, telecommunications and consumer products sectors, while high abnormal returns are recorded by shares of European companies from the energy sector. In geographical distribution, the markets of Germany, Sweden and Finland suffered the largest negative cumulative returns.

Izzeldin et al. (2022) compare the effect of Russia's invasion of Ukraine on global financial and commodity markets with the effect of two other global crises (the 2008 financial crisis and the COVID-19 pandemic). The period on which the research is based is three months before and three months after the characteristic day chosen as the beginning of the crisis (declaration of bankruptcy of the Lehman Brothers bank on September 15, 2008, announcement of lockdown in Italy on March 9, 2020, and invasion of Russian troops on the territory of Ukraine on February 24, 2022). As a representative of volatility, authors use data on the realized variance of intraday returns in five-minute intervals. The modeling is based on the heterogeneous autoregression model (HAR), and only the volatility test is based on the Markov model, together with the GARCH models. The research results indicate that the stock and commodity markets reacted the fastest to the Russian invasion, but that the intensity of the crisis after the invasion is significantly lower compared to COVID-19 and the financial crisis of 2008. On commodity markets, the highest degree of volatility is recorded in wheat and nickel, because the two countries in conflict are global exporters of these commodities.

3. METHODOLOGY AND DATA

3.1. Data

For the comparison of the COVID-19 and Russian – Ukraine war impact on the stock markets we analyzed and compared the volatility of the world’s leading stock market performance benchmarks in the pre-crisis and crisis periods. The data used in this study were collected using the Market Watch website and included daily adjusted close prices for the S&P 500, DAX 40, and FTSE 250. The periods analyzed are as follows:

- Pre-COVID-19 Crisis period - August 1, 2019 – January 31, 2020;
- COVID-19 Crisis period - February 1, 2020 – July 31, 2020;
- Pre-Russian-Ukraine Crisis period - August 24, 2021 – February 23, 2022;

Indexes examined in the study are S&P500 - the best overall measurement of American stock market performance, FTSE250 - a stock market index comprised of mid-capitalised companies on the London Stock Exchange, and DAX 40 - the benchmark stock market index for the German economy. Index daily prices were converted to returns as follows:
\[ R_t = \ln P_t / \ln P_{t-1} \]  

(1)

where, \( R_t \), \( P_t \), and \( P_{t-1} \) is the daily return, the adjusted closing price of the stock at time \( t \), and the previous day’s adjusted closing price at time \( t-1 \); \( \ln \) represents the natural logarithm.

Checking for stationary return series was done by Dickey and Fuller (1979). The Augmented Dickey-Fuller (ADF) test is estimated by the following equation:

\[ \Delta Y_t = \alpha_0 + \gamma_1 y_{t-1} + \sum_{p=1}^{P} \beta_p \Delta y_{t-p} + \varepsilon_t \]  

(2)

where \( \alpha_0 \) signifies constant, \( p \) represents lag, \( \gamma_1 \) and \( y_{t-1} \) are the equation parameters and \( \varepsilon_t \) denotes a stochastic error term. If the value of the test is less than 0.05, then the test is significant, and the time series is set to be stationary (Bora & Basistha, n.d.).

Table 1 summarizes the descriptive analysis of price and returns for each index in the COVID-19 crisis period. According to the sample taken (\( N = 253 \)) for the S&P 500 index during the period of August 1, 2019, to July 31, 2020, its values ranged from a minimum of 2237.4 to a maximum of 3386.15 with a mean value of \( X = 3025.345 \) and a standard deviation of \( SD = \pm 216.0294 \). British stock market, FTSE 250 index recorded movement in the given period from a minimum of 12829.7 to a maximum of 22108.29 with a mean value of \( X = 18841.78 \) and \( SD = \pm 2273.812 \). The values of the DAX index in the same period ranged from a minimum of 8441.71 to a maximum of 13789, with a mean value of \( X = 12170.12 \) and \( SD = \pm 1194.065 \). Additionally, if we observe the volatility of returns, the biggest volatility in this period was realized by the S&P 500. The skewness values in this analysis carry negative signs, which confirms that the returns are negative and indicates the presence of asymmetry. Furthermore, a negatively skewed return with a high kurtosis value signifies a very high risk of losses in all three stock markets.

Table 1. Descriptive statistics of S&P 500, FTSE 250 & DAX 40 in COVID-19 crisis

<table>
<thead>
<tr>
<th></th>
<th>S&amp;P 500</th>
<th>FTSE 250</th>
<th>DAX 40</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Obs</strong></td>
<td>253</td>
<td>260</td>
<td>252</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>3025.345</td>
<td>18841.78</td>
<td>12170.12</td>
</tr>
<tr>
<td><strong>Max</strong></td>
<td>3386.15</td>
<td>22108.29</td>
<td>8441.71</td>
</tr>
<tr>
<td><strong>Min</strong></td>
<td>2237.4</td>
<td>12829.7</td>
<td>8441.71</td>
</tr>
<tr>
<td><strong>Std. Dev.</strong></td>
<td>216.0294</td>
<td>2273.812</td>
<td>1194.065</td>
</tr>
<tr>
<td><strong>Variance</strong></td>
<td>46668.69</td>
<td>5170223</td>
<td>1425791</td>
</tr>
<tr>
<td><strong>Skewness</strong></td>
<td>-0.9189121</td>
<td>-0.8877507</td>
<td>-0.4362319</td>
</tr>
<tr>
<td><strong>Kurtosis</strong></td>
<td>4.17431</td>
<td>12.49252</td>
<td>2.210535</td>
</tr>
<tr>
<td><strong>Shapiro-Wilk test</strong></td>
<td>0.81512</td>
<td>5.80064</td>
<td>0.95463</td>
</tr>
<tr>
<td><strong>Skewness - Kurtosis test</strong></td>
<td>(0.0000)</td>
<td>(0.0000)</td>
<td>(0.0000)</td>
</tr>
<tr>
<td><strong>ADF test</strong></td>
<td>-52.097</td>
<td>-13.351</td>
<td>-15.605</td>
</tr>
</tbody>
</table>

Source: Authors

Table 2 summarizes the descriptive analysis for each index in the Russian-Ukraine crisis. As a representative of the US stock market, S&P 500 index during the period of August 24, 2021, to August 24, 2022, ranged from a minimum of 3666.77 to a maximum of 4796.56 with a mean value of \( X = 4347.304 \) and a standard deviation of \( SD = \pm 280.0905 \). The values of the DAX index in the same period ranged from a minimum of 12401.2 to a maximum of 16271.75, with a
mean value of $X = 14681.65$ and $SD = \pm 1047.455$. The FTSE 250 index had a movement in the given period from a minimum of $18315.31$ to a maximum of $24250.85$ with a mean value of $X = 21520.34$ and $SD = \pm 1655.244$. If we look at the mean returns of all three indexes, they are negative which indicates a loss on stock in all three markets in the observed period. Furthermore, the biggest volatility for the period is observed in the DAX 40 index. The skewness and kurtosis values are significantly lower compared to their COVID-19 crisis values which indicates less asymmetry.

**Table 2. Descriptive statistics of S&P 500, FTSE 250 & DAX 40 in Russian – Ukraine crisis**

<table>
<thead>
<tr>
<th></th>
<th>S&amp;P 500</th>
<th>FTSE 250</th>
<th>DAX 40</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Price</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obs</td>
<td>253</td>
<td>253</td>
<td>262</td>
</tr>
<tr>
<td>Mean</td>
<td>4347.304</td>
<td>-0.002828</td>
<td>21520.34</td>
</tr>
<tr>
<td>Max</td>
<td>4796.56</td>
<td>0.0301055</td>
<td>24250.83</td>
</tr>
<tr>
<td>Min</td>
<td>3666.77</td>
<td>-0.0412338</td>
<td>18315.31</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>280.0905</td>
<td>0.0130582</td>
<td>1655.244</td>
</tr>
<tr>
<td>Variance</td>
<td>78450.67</td>
<td>0.0001705</td>
<td>2739832</td>
</tr>
<tr>
<td>Skewness</td>
<td>-0.5364806</td>
<td>-0.3289479</td>
<td>-0.0921465</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>2.324066</td>
<td>3.532856</td>
<td>1.685452</td>
</tr>
<tr>
<td>Shapiro-Wilk test</td>
<td>0.98403</td>
<td>0.97704</td>
<td>0.95577</td>
</tr>
<tr>
<td>Skewness- Kurtosis test</td>
<td>7.02</td>
<td>11.51</td>
<td>24.96</td>
</tr>
</tbody>
</table>

**Source:** Authors

### 3.2. Research Methodology

The research questions that we aim to address with this study are: if the nature of the COVID-19 crisis and the Russian-Ukraine crisis is similar and how can we compare the effects of these two crises on stock markets? Particularly, we are interested to find out if the two analysed crises have caused stock markets to react similarly or differently and to compare their recovery patterns. Finally, we would like to examine if the reaction of financial markets, given that the financial markets are driven by investor sentiment, can help us to understand and distinguish the nature of economic crises.

To answer these research questions, Levene's test has been employed. Levene's test is a statistical hypothesis test used to assess whether the variance of a particular variable is the same across different groups or categories (Levene, 1960). Its application in stock market analysis has provided valuable insights into the volatility, risk characteristics, and spillover effects of different stock markets, periods, and industries. For instance, González et al. (2019) used Levene's test to the performance of sector portfolios from Islamic and conventional stock markets before, during, and after the recent Global Financial Crisis (GFC). Similarly, Bevanda et al. (2021) examined the performance of value and growth stock portfolios after the GFC, and among other statistical methods, Levene's homogeneity test was applied. Ahmed et al. (2021) used the test to investigate the impact of COVID-19 on the Indian stock and commodity markets during the different phases of the lockdown. In addition, the authors compared the effect of COVID-19 on the Indian stock and commodity markets during the first and second waves of the COVID-19 spread. Levene’s test was also applied for the assessment of the comparison of government policies during the Global Financial Crisis and the COVID-19 Crisis (Zaimović & Dedović, 2021).
Levene's test is an alternative to the Bartlett test and is less sensitive to departures from normality and thus more suitable for the analysis of index returns. The Levene's test is defined as:

$$H_0: \delta_1^2 = \delta_2^2 = \cdots = \delta_k^2$$

$$H_a: \delta_i^2 \neq \delta_j^2$$

If the p-value of this test is less than 0.05 significance level, it means that we can reject the null hypothesis of equality of variances of two samples, and vice versa if p-value of this test is higher than 0.05 significance level, we accept the null hypothesis (Tudor, 2008).

4. FINDINGS

Figure 1 shows the graphical representation of the movement of the return series of three indexes analyzed in the COVID-19 crisis. COVID-19 has suddenly increased volatility. The S&P 500 index price reached its highest and lowest points on February 19, 2020, and March 23, 2020, respectively. It took this index 33 days to reach its minimum, and it fell by 33.92%. This is also shown by the fact that a minimum return value of -12.77% occurred on March 16, 2020, and a maximum of 8.97% occurred on March 24, 2020. The DAX index's maximum value and minimum values happened on February 19, 2020, and March 18, 2020, respectively. It took this index 30 days to reach its minimum, and it declined by 38.78%. Additionally, a minimum return value of -13.06% occurred on March 11, 2020, and a maximum of 10.41% occurred on March 23, 2020. When it comes to the FTSE 250 index price, the maximum value occurred on January 2, 2020, and the minimum value occurred on March 19, 2020. It took this index 55 days to reach its minimum, and it fell by 41.97%. This is also shown by the fact that a minimum return value of -09.10% occurred on March 12, 2020, and a maximum of 8.04% occurred on March 24, 2020.

![Figure 1. COVID-19: Stock market performance – Return series](source)

From this analysis of the trend of S&P 500, DAX 100, and FTSE 250, it is seen that within the data set analyzed the minimum value of the index was due to the COVID-19 pandemic and it is what caused a big turmoil in markets in the observed dataset. It can be deduced that the COVID-19 crisis is a V-shaped crisis as all the indexes experienced a sharp and sudden drop in value, but also recovered quickly (within a year from the start of the COVID-19 pandemic). In addition, it is obvious
from the return series below that the COVID-19 pandemic has caused increased volatility in the crisis period compared to pre-crisis and caused clustering volatility (where periods of low volatility are followed by low volatility and periods of high volatility are followed by periods of high volatility).

Figure 2 presents the graphical representation of the movement of the return series for three indexes observed in the Russian-Ukraine war. It is obvious that during the whole period, the volatility was present, and there is no clear cut to see what exact event started the crisis as there is on the COVID-19 return series graph. Both the pre-crisis and crisis period has been quite volatile, and the DAX index is the most volatile mainly due to its geographical closeness to Ukraine. For the DAX index, the maximum value happened on January 5, 2022, and the minimum value happened on July 5, 2022. It took this index 128 days to reach its minimum, and it declined by 23.79%. Additionally, a minimum return value of -4.05% occurred on March 4, 2022, and a maximum of 7.62% occurred on March 9, 2022. For S&P 500 index price, the maximum value occurred on December 31, 2021, and the minimum value occurred on June 16, 2022. This index dropped by 23.55% and took 116 days to reach its minimum. S&P 500 minimum return value of -4.1% occurred on May 18, 2022, and a maximum return value of 3.01% occurred on June 24, 2022. The FTSE 250 index price ranged from its highest value on September 1, 2021, to its lowest value on July 5, 2022. This index dropped by 24.48% and took 220 days to reach its minimum. In the observed period, the FTSE 250 minimum return value of -3.7% occurred on January 24, 2022, and a maximum return value of 4.33% occurred on March 9, 2022.

What is seen from the Russian-Ukraine dataset trend analysis for S&P 500, DAX 100 and FTSE 250 indexes is a constant downward trend and the fact that the recovery did not happen in the period analyzed. This crisis is characterized by a more prolonged period of economic downturn compared to the sudden drop in the COVID-19 crisis. This is further seen from the fact that indexes in the analyzed period dropped half as much as in the COVID-19 crisis, with much lower oscillations and twice as much time to reach its minimum value.

We used Levene’s test for equality of variances to find out whether the variances of two periods are equal. The calculated p-values for all three datasets are lower than the level of significance of 0.05, which allows us to reject the null hypothesis and accept the alternative hypothesis of unequal variances for all three datasets. From period before the COVID-19 to the COVID-19 period, the standard deviation of returns increased 3.7 times, 2.9 times, and 3.0 times for the S&P 500, FTSE
250, and DAX 40, respectively. On the other hand, from the period before the Russian invasion to the period after the invasion, the standard deviation of returns increased 1.6 times, 1.4 times, and 1.6 times for S&P 500, FTSE 250, and DAX 40, respectively. We demonstrate that both crises significantly impacted the volatility of all examined indexes, with the COVID-19 crisis experiencing a greater increase in volatility than the Russian-Ukraine crisis. While comparing the effects of the COVID-19 crisis and Russian-Ukraine on stock market volatility, we discovered that they were statistically different. Volatility, measured by the standard deviation of the index, in the COVID-19 crisis, is roughly twice as high as it was in the Russian-Ukraine crisis.

This proves that the two crises are fundamentally different. Namely, in the COVID-19 crisis after the first shock caused by anti-crisis measures (epidemiological) the markets started a sharp recovery, while the recovery after the Ukrainian crisis was slow (and questionable). This leads to the conclusion about the "artificial" character of the COVID-19 crisis where international trade and investment funds were forcibly and unexpectedly interrupted. As soon as the basic conditions and adaptation modalities were created the situation was stabilized, and recovery started. In the Ukrainian crisis, the disruption is fundamental - the food and energy markets are distorted, and the EU introduced economic sanctions against Russia. Value chains are irreversibly broken, and all market participants know that they will not recover (certainly not quickly), more than likely they will have to be replaced. The markets reacted even in anticipation of the (inevitable) crisis. These conclusions can be supported by the faster recovery of the S&P index than the European indices.

**Table 3. Analysis of differences in the volatility of S&P 500, FTSE 250 & DAX 40 caused by COVID-19 and Russian – Ukraine crisis**

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>S&amp;P 500</td>
<td>Mean</td>
<td>0.00068153</td>
<td>0.00011141</td>
<td>0.00055846</td>
<td>-0.00171154</td>
<td>0.00050019</td>
<td>-0.00041966</td>
</tr>
<tr>
<td></td>
<td>Std. Dev.</td>
<td>0.00810183</td>
<td>0.02922109</td>
<td>0.00852861</td>
<td>0.02444822</td>
<td>0.00907526</td>
<td>0.02671554</td>
</tr>
<tr>
<td></td>
<td>Obs</td>
<td>127</td>
<td>126</td>
<td>130</td>
<td>130</td>
<td>126</td>
<td>126</td>
</tr>
<tr>
<td></td>
<td>W0</td>
<td>45.974344</td>
<td>40.444394</td>
<td>38.067516</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pr &gt; F</td>
<td>0.0000000</td>
<td>0.0000000</td>
<td>0.0000000</td>
<td></td>
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</tr>
</tbody>
</table>

| FTSE 250 | Mean | -0.00045969 | -0.00010451 | -0.00098663 | -0.00058901 | -0.00616760 | -0.00079244 |
| DAX 40 | Std. Dev. | 0.00986899 | 0.01566918 | 0.00901525 | 0.01300737 | 0.01075290 | 0.01664713 |
|       | Obs | 127 | 126 | 130 | 130 | 126 | 128 |
|       | W0 | 16.790849 | 13.741631 | 15.656393 |
|       | Pr > F | 0.00005637 | 0.00025634 | 0.00009842 |

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<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>S&amp;P 500</td>
<td>Mean</td>
<td>-0.00004596</td>
<td>-0.00001051</td>
<td>-0.00009863</td>
<td>-0.00005890</td>
<td>-0.00061676</td>
</tr>
<tr>
<td></td>
<td>Std. Dev.</td>
<td>0.00986899</td>
<td>0.01566918</td>
<td>0.00901525</td>
<td>0.01300737</td>
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5. CONCLUSION

COVID-19 has shocked financial markets across the globe with its sheer and extraordinary impact that is further intensified by the lockdown measures imposed by the majority of countries' governments. Not long after the global economy recorded recovery from the COVID-19 crisis, the tension in the relations between the Russian Federation and Ukraine worsened and on
February 24, 2022, Russia invaded Ukraine. Both crises have inevitably changed the shape of the global economy, however, the following questions arise: Was the impact of these two crises the same, did the recovery progress similarly, is the nature of these crises similar? The main aim of this paper was to respond to these questions and for the analysis we employed Levene's test. Its application in stock market analysis has provided valuable insights into the volatility, risk characteristics, and spillover effects of different stock markets.

The findings of our analysis proved that the effects of the COVID-19 crisis and Russian-Ukraine on stock market volatility were statistically different. Volatility, measured by the standard deviation of the observed index, in the COVID-19 crisis, is roughly twice as high as it was in the Russian-Ukraine crisis.

Our analysis also implies that COVID-19 and the Russia–Ukraine crisis are fundamentally different. From the presented results it can be concluded that the COVID-19 crisis is a V-shaped crisis as all the indexes experienced a sharp and sudden drop in value, but also recovered quickly (within a year from the start of the COVID-19 pandemic) due to anti-crisis measures (epidemiological). However, in the case of the Ukrainian crisis, the market disruption is of a fundamental nature, and it is characterized by a more extended period of economic downturn compared to the rapid drop in the COVID-19 crisis. This is further supported by the fact the indexes in the analyzed period dropped half as much as in the COVID-19 crisis, with much lower oscillations and twice as much time to reach its minimum value compared to the COVID-19 crisis.

References


Bora, D., & Basistha, D. (n.d.). The Outbreak of COVID-19 Pandemic and Its Impact on Stock Market Volatility: Evidence from a Worst-affected Economy. [https://doi.org/10.21203/rs.3.rs-57471/v1](https://doi.org/10.21203/rs.3.rs-57471/v1)


