The impact of the Russia-Ukraine Conflict on Market Efficiency: Evidence for the developed stock market

Keywords: Efficiency Market; Russian-Ukraine conflict; Hurst Exponent

JEL: C10, C22, C49, G12, G14, G15

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Abstract

This paper investigates the impact of the Russia-Ukraine conflict on the stock market efficiency of six developed countries. The sample is composed of daily stock index data from the United States (US), United Kingdom, Germany, France, Italy and Spain. Market efficiency was analyzed by the multifractal structure of the series of returns in four periods (full series, COVID-19 outbreak, before the conflict and after the conflict). The results show the presence of multifractality of the index's return series in periods of crisis. The evidence rejects the market efficiency hypothesis and indicates the predictability of asset prices in times of instability and global financial crisis. Our findings can help fund managers, institutional investors, and investors in general to make decisions about asset allocation in times of crisis.

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1. Introduction

The idea of predicting asset prices is not new. For decades the financial market has been chasing to find the formula to beat the market and create a perfect portfolio. To do this it will be necessary to identify the assets that are likely to appreciate in the short and long term. The central idea was that prices do not provide all the information about the asset and the investor could make gains from the information passed on. However, asset managers run into the evidence pointed out by Fama (1970) in his seminal research on the Efficiency Market Hypothesis (EMH). Fama (1970) points out that a market where prices always "fully reflect" available information is called efficient. The EMH theory shows that in an efficient market it is not possible to predict future prices with past information. In an efficient market the investor does not systematically make extraordinary gains.

Recent crisis events are important to test the market efficiency hypothesis theory proposed by Fama (1970). The financial market has suffered several shocks caused by the COVID-19 pandemic and the Russia-Ukraine conflict. The literature investigating market efficiency in the period of the COVID-19 outbreak is growing (see Choi, 2021, Alijani et al., 2021, Okorie & Lin, 2021, Ozkan, 2021, Mensi et al., 2020 and Frezza et al., 2021). However, there are few studies investigating the period following the COVID outbreak. Period of the Russia-Ukraine conflict that resulted in volatility shocks. There are studies that investigate financial market connectivity (Boubaker et al., 2022; Umar et al., 2022), the impact on stock returns (Boungou & Yatié, 2022), systematic risk (Qureshi et al., 2022) and evaluate decisions (Tosun & Eshraghi, 2022). In recent literature there is no investigation of market efficiency in the Russia-Ukraine conflict. Ozkan (2021) and Choi (2021) show that the rejection of the Market Efficiency hypothesis in the period of the COVID-19 pandemic is perceived, but in the Russia-Ukraine conflict can this phenomenon also be perceived? This is a question to be explored in the literature.

The aim of this study is to investigate whether market efficiency has changed in the period of COVID-19 crises and Russia-Ukraine conflict in developed stock markets (United States, Germany, United Kingdom, France, Italy and Spain). The efficiency is evaluated using the MF-DFA (Multifractal Detrended Fluctuation Analysis) method.

This paper contributes to the empirical literature on the efficiency of stock markets in times of crisis. The main contribution of this study is the evaluation of efficiency in the period of the Russian-Ukraine conflict and comparison with the recent period of the COVID-19 crisis in developed markets. Choi (2021), Alijani et al. (2021), Okorie & Lin (2021), Ozkan (2021), Mensi et al. (2020) and Frezza et al. (2021) evaluated the efficiency in the period of the COVID-19 crisis, but there are no studies that analyze the aspect of the Russia-Ukraine conflict.

This study is organized as follows. Section 2 the data and methodology used in the study. Section 3 shows and discusses the empirical results of the efficiency analysis. Section 4 presents the final conclusions.

2. Data and methodology

2.1 Data description

We consider the daily returns of the US (S&P500), Germany (DAX), UK (FTSE 100), France (CAC 40), Italy (FTSE MIB) and Spain (IBEX 35) indices. Data is obtained from Refinitiv Eikon. The daily returns of the indices are calculated as follows:

$$R_t = \ln\left(P_t - P_{t-1}\right) \qquad (01)$$

where R_t is the daily returns, P_t is the price at time *t*. Figure 1 shows the stock index returns and prices of the six countries. The volatility clusters in 2020 and 2022 correspond to the periods of the COVID-19 pandemic and the Russia-Ukraine conflict respectively.

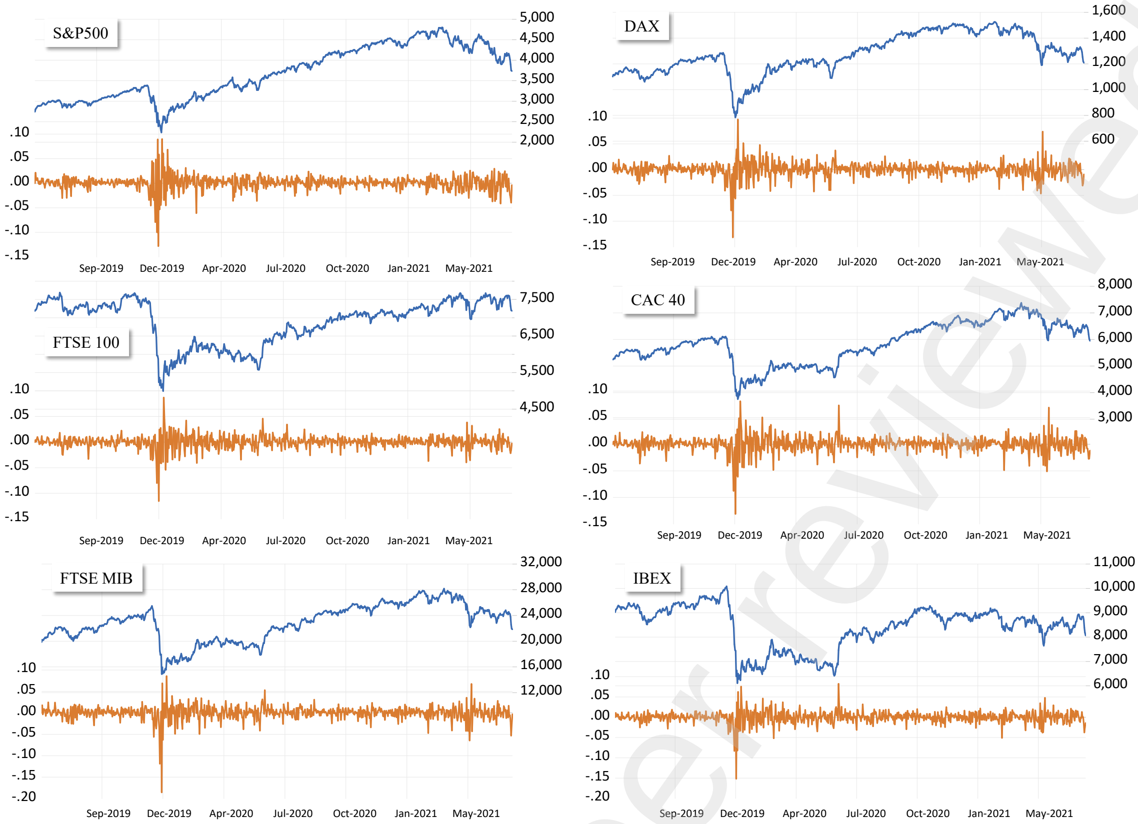

Fig. 1. Daily prices and returns of financial market indices

The efficiency of index returns is measured in the period of the COVID-19 pandemic and Russia-Ukraine conflict. The sample is further divided into four periods: (i) full sample, from June 3, 2019 to December 31, 2019, (ii) COVID-19 period, from January 1, 2020 to July 31, 2020, (iii) before the Russia-Ukraine conflict, from August 1, 2020 to February 23, 2022, and (iv) during the Russia-Ukraine conflict, from February 24, 2022 to June 15, 2022. The period of the COVID-19 pandemic following Choi (2021). The period of the Russia-Ukraine conflict following (Boungou & Yatié, 2022).

Table 1 presents descriptive statistics of stock index returns. The results show that the returns are asymmetric and there is leptokurtosis. We also notice that returns are more volatile during COVID and the Russia-Ukraine conflict. The result of the Jarque-Bera test rejects the null hypothesis of normally distributed returns in the COVID-19 period. In the period before and during the Russian-Ukraine conflict the hypothesis of normality was accepted. The results of the unit root ADF (Augmented Dickey-Fuller) test show that the return series are stationary in all periods.

Table 1
Descriptive Statistics

Statistic	Obs.	Mean	Std. Dev.	Min.	Max	Skew.	Kurt.	JB	ADF	Q(10)
Full Sample										
US (S&P500)	766	0.000	0.015	-0.128	0.090	-0.988	17.216	6574.9*	-7.67*	261.6*

Germany (DAX)	769	0.000	0.014	-0.131	0.097	-1.003	17.452	6794.7*	-27.4*	29.3*
UK (FTSE100)	767	0.000	0.013	-0.115	0.087	-1.157	16.388	5891.8*	-28.5*	43.7*
France (CAC40)	780	0.000	0.015	-0.131	0.081	-1.128	15.789	5382.7*	31.2*	-28.0*
Italy (FTSE MIB)	773	0.000	0.016	-0.185	0.086	-2.523	30.996	25827.9*	-17.9*	38.4*
Spain (IBEX35)	778	0.000	0.015	-0.152	0.082	-1.433	20.030	9518.6*	-17.4*	42.6*
During COVID-19										
US (S&P500)	147	0.000	0.027	-0.128	0.090	-0.690	8.187	176.4*	-17.84*	109.73*
Germany (DAX)	147	0.000	0.024	-0.131	0.097	-1.053	10.543	375.6*	-11.63*	-11.62**
UK (FTSE100)	147	-0.002	0.022	-0.115	0.087	-0.959	8.861	232.9*	-12.69*	29.99*
France (CAC40)	149	-0.001	0.025	-0.131	0.081	-1.204	8.931	250.9*	-12.27*	27.34*
Italy (FTSE MIB)	149	-0.001	0.027	-0.185	0.086	-2.497	18.365	1598.7*	-7.07*	25.18*
Spain (IBEX35)	149	-0.002	0.025	-0.152	0.075	-1.543	11.568	507.9*	-6.82*	34.23*
Before Russia-Ukraine conflict										
US (S&P500)	394	0.001	0.010	-0.036	0.024	-0.557	3.995	36.6*	-20.38*	15.08
Germany (DAX)	399	0.001	0.010	-0.042	0.037	-0.641	5.846	159.9*	-21.23*	14.62
UK (FTSE100)	396	0.001	0.009	-0.037	0.046	-0.042	5.536	105.7*	-20.87*	18.42**
France (CAC40)	404	0.001	0.011	-0.049	0.073	0.138	9.984	802.1*	-20.11*	12.33
Italy (FTSE MIB)	400	0.001	0.011	-0.047	0.053	-0.314	5.593	116.9*	-20.21*	9.35
Spain (IBEX35)	402	0.001	0.012	-0.051	0.082	0.520	9.642	742.1*	-20.04*	6.71
During Russia-Ukraine conflict										
US (S&P500)	77	-0.001	0.016	-0.041	0.029	-0.362	2.667	1.9	-8.58*	8.6261
Germany (DAX)	77	-0.001	0.018	-0.046	0.074	0.689	6.138	36.2*	-8.85*	5.8856
UK (FTSE100)	74	-0.001	0.013	-0.040	0.038	-0.205	4.345	6.1**	-9.45*	9.1772
France (CAC40)	77	-0.001	0.018	-0.051	0.069	0.450	5.293	18.7*	-9.25*	6.5552
Italy (FTSE MIB)	77	-0.001	0.019	-0.064	0.067	-0.070	5.861	25.3*	-8.84*	3.8336
Spain (IBEX35)	77	0.000	0.015	-0.038	0.048	-0.043	3.901	2.5	-8.18*	6.6513

Notes: JB indicates the Jarque-Bera test. ADF indicates the Augmented Dickey Fuller unit root test. Q(10) indicate the Ljung-Box test of returns to lag order of 10 serial autocorrelations. (*) denote p-value<0,01, (**) denote p-value<0,05

2.2 Methodology

In this study, market efficiency is investigated with the MF-DFA (Multifractal Detrended Fluctuation Analysis) method. The MF-DFA method was proposed by Kantelhardt et al. (2022) and applied by Choi (2021). According to Kantelhardt et al. (2022) the MF-DFA method consists of five steps as follows:

Step 1: Determine the "profile" *Y(i)*, *(i = 1,2,...,N)*

$$Y(i) = \sum_{k=1}^{i} (x_k - \overline{x}) \qquad (02)$$

where x_k is a time series with finite length N and $\overline{x} = \frac{\sum_{k=1}^{N} x_k}{N}$.

Step 2: Divide the profile *Y(i)* into $N_s = int\left(N/s\right)$ on overlapping sub-time series of length *s*. The length of the *N* series may not be a multiple of *s*. To consider the rest of the series we repeat the same procedure at the end of the sample. Thus, 2Ns segments are obtained altogether.

Step 3: Estimate the linear trend for each of 2Ns segments. Use a series least squares fit. According to Choi (2021) the variance is determined as follows.

$$F^2(s,v) = \begin{cases} \frac{1}{s}\sum_{i=1}^{s}\left\{Y[(v-1)s+i] - \hat{Y}_v^m(i)\right\}^2, & v = 1,2,\dots,N_s \\ \frac{1}{s}\sum_{i=1}^{s}\left\{Y[(N-(v-N_s)s+i] - \hat{Y}_v^m(i)\right\}^2, & v = N_s+1, N_s+2,\dots,2N_s \end{cases} \quad (03)$$

where $\hat{Y}_v^m(i)$ is fitting polynominal with order *m* in segment *v*. In this study we use a linear polynomial (m = 1).

Step 4: Determine the average of all segments and estimate the fluctuation function of order *q*. For $q \neq 0$ the function is determined as follows.

$$F_q(s) = \left\{\frac{1}{2N_s}\sum_{v=1}^{2N_s}\left[F^2(v,s)\right]^{q/2}\right\}^{1/q} \quad (04)$$

For *q =0* the fluctuation function is determined as follows.

$$F_0(s) = \exp\left\{\frac{1}{4N_s}\sum_{v=1}^{2N_s} ln\left[F^2(v,s)\right]\right\} \quad (05)$$

Step 5: From the Eqs. (04) and (05) calculate the scaling or power-law relationship as follows.

$$F_q(s) \sim s^{h(q)} \quad (06)$$

where *h(q)* represents the generalized Hurst exponent. Compute the relationship between log-log of *Fq(s)* and *s* for each value of *q*.

$$\log\left(F_q(s)\right) = h(q) \cdot \log(s) + c \quad (07)$$

According to Kantelhardt et al. (2022), for *q = 2*, *h(2)* is identical to the well-known Hurst exponent. The series follows a random walk for *h(2) = 0.5*. The series is persistent when *h(2) > 0.5* and anti-persistent for *h(q) < 0.5*.

Following Choi (2021) the degree of multifractality Δh is defined as follow.

$$\Delta h = \max(h(q)) - \min(h(q)) \quad (08)$$

In addition, the width of the multifractal spectrum $\Delta\alpha$ is defined as follow.

$$\Delta\alpha = \max(\alpha) - \min(\alpha) \quad (09)$$

We calculate the spectrum asymmetry parameter, as suggested by Choi (2021).

$$\theta = \frac{(\alpha_0 - \alpha_{min}) - (\alpha_{max} - \alpha_0)}{(\alpha_0 - \alpha_{min}) + (\alpha_{max} - \alpha_0)} \tag{10}$$

where α_0 is the α value at the maximum of $f(\alpha)$.

The asymmetry parameter Θ determines the dominance of fluctuations for the multifractal spectrum. For Θ = 0, large and small fluctuations lead a lot to multifractality. The parameter Θ > 0 implies that large fluctuations contribute substantially to the multifractal spectrum. For Θ < 0, smaller fluctuations constitute a dominant multifractality source. The R-Package "MFDFA" was used in the analyses... For Θ = 0, large and small fluctuations greatly lead to multifractality. The parameter Θ > 0 implies that large fluctuations contribute substantially to the multifractal spectrum. For Θ < 0, smaller fluctuations constitute a dominant multifractality source. The R-Package "MFDFA" was used in the analyses.

3. Results and discussion

The values of the generalized Hurst exponent *h(q)* were estimated using the fluctuation function *log2(Fq(s))* versus *log2(s)* over the range $q \in [-10,10]$. Fig. 2 shows the plot of the Hurst exponent *h(q)* over the range q for market returns. The results describe that the series of returns show signs of multifractality perceived by the curvature of the generalized Hurst exponent values. The values of the generalized Hurst exponent decrease as q increases. The results are most evident in the COVID-19 period. The curvature values are more intense. The value of ΔH (Table 2) for the COVID-19 outbreak are higher than the other periods. During the Russian-Ukraine conflict, multifractality is also present compared to the period before the conflict. Only in S&P500 returns there is no evidence. For smaller fluctuations (q<0) the markets are more persistent (larger values of the generalized Hurst exponent) for the COVID-19 period. In the period of the Russia-Ukraine conflict the persistence values are higher than the pre-conflict period. However, the persistence values in the Russia-Ukraine conflict were lower than the persistence values in the COVID-19 outbreak. This shows that the persistence of COVID-19 was high. This is consistent with the findings of Kakinaka & Umeno (2022) that investigated cryptocurrency and Choi (2021) for the stock market in the United States.

Hurst exponent values (q=2) were greater than 0.5 in the COVID-19 outbreak and lower during the Russia-Ukraine conflict. Hurst exponent values (q=2) were greater than 0.5 in the COVID-19 outbreak and lower during the Russia-Ukraine conflict. The results indicate that there is long-term persistence in the series of the COVID-19 period. Price predictability is higher in the COVID-19 period. On the other hand, the series in the period of the Russian-Ukraine conflict proved to be anti-persistence. According to Cajueiro & Tabak (2004) markets are efficient in the weak form for H=0.5. The values of the Hurst exponent $H(2) \neq 0{,}5$ show that markets are not efficient in times of crisis.

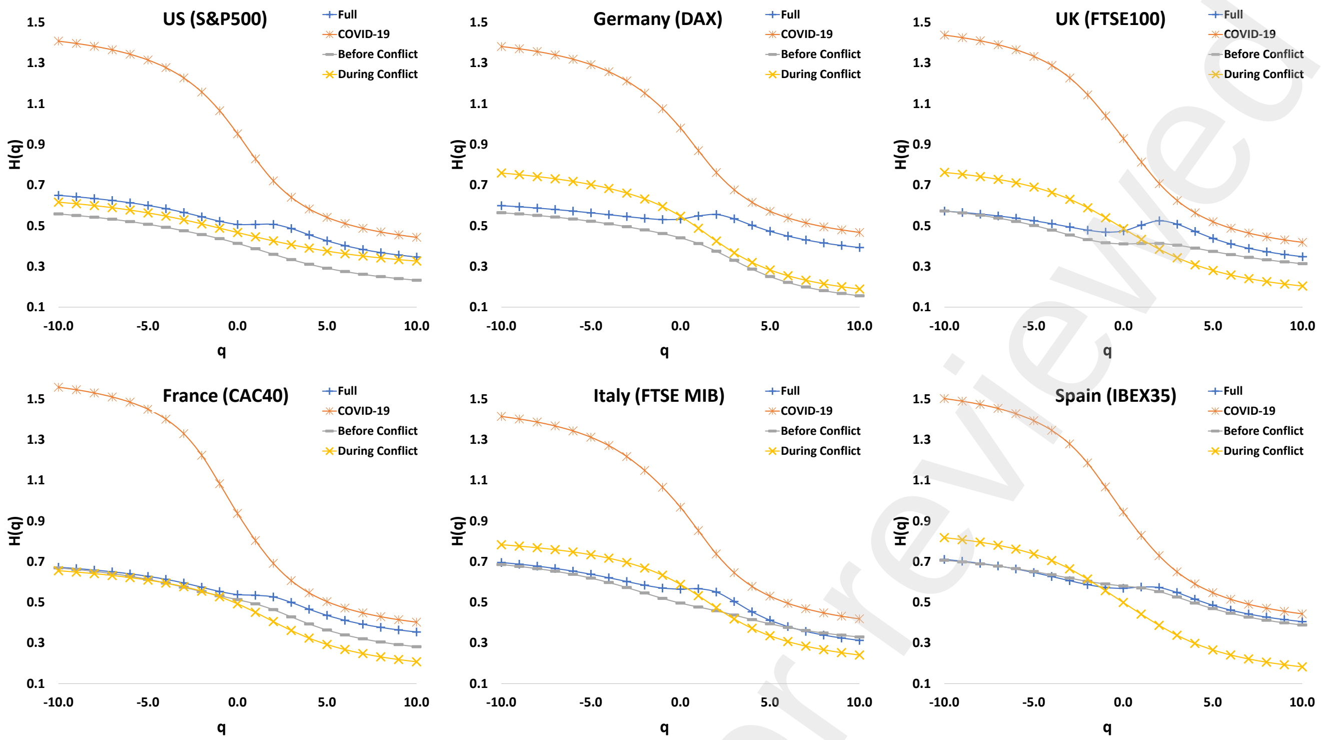

Fig. 2. Generalized Hurst exponents *h(q)* of stock index returns for the full sample, COVID-19 period, before the Russia-Ukraine conflict and after the Russia-Ukraine conflict.

Table 2 shows the results of the multifractal spectrum parameters for stock index returns. The results confirm the evidence presented by Fig. 1. The COVID-19 outbreak period has larger degree of multifractality (see $\Delta\alpha$ and Δh). The period during the Russia-Ukraine conflict also showed higher values of the degree of multifractality compared to the period before the conflict. This evidence shows that the series of returns are more correlated in periods of global financial crisis. The asymmetry values (Θ) were negative in the period of the COVID-19 outbreak for the markets. Small fluctuations contribute more than large fluctuations. Evidence similar to the findings of Choi (2021). On the other hand, the results for the Russia-Ukraine conflict were different. The asymmetry values were positive for the returns of the indices of Germany (DAX), France (CAC40) and Italy (FTSE MIB) and negative for the returns of the United States (S&P500), United Kingdom (FTSE 100) and Spain (IBEX 35).

Table 2
Multifractal spectrum parameters for stock index returns in periods.

	α_{Max}	α_{Min}	α_0	$\Delta\alpha$	ΔH	θ
US (S&P500)						
Full Sample	0.7134	0.2573	0.5074	0.4561	0.3031	0.0967
During COVID-19	1.5104	0.3364	0.8290	1.1740	0.9643	-0.1608
Before Russia-Ukraine conflict	0.6259	0.1586	0.3872	0.4673	0.3260	-0.0216
During Russia-Ukraine conflict	0.6856	0.2618	0.4459	0.4238	0.2897	-0.1312
Germany (DAX)						

Full Sample	0.6497	0.3025	0.5629	0.3472	0.2059	0.5000
During COVID-19	1.4820	0.3549	0.8693	1.1271	0.9138	-0.0872
Before Russia-Ukraine conflict	0.6203	0.0545	0.4130	0.5658	0.4083	0.2672
During Russia-Ukraine conflict	0.8323	0.0855	0.4880	0.7468	0.5704	0.0779
UK (FTSE100)						
Full Sample	0.6335	0.2500	0.5463	0.3835	0.2242	0.5452
During COVID-19	1.5508	0.3108	0.8133	1.2400	1.0186	-0.1895
Before Russia-Ukraine conflict	0.6593	0.2348	0.4134	0.4245	0.2589	-0.1585
During Russia-Ukraine conflict	0.8470	0.1138	0.4333	0.7332	0.5586	-0.1285
France (CAC40)						
Full Sample	0.7300	0.2625	0.5346	0.4675	0.3181	0.1641
During COVID-19	1.6713	0.2937	0.8041	1.3776	1.1553	-0.2590
Before Russia-Ukraine conflict	0.7386	0.1864	0.4925	0.5522	0.3875	0.1087
During Russia-Ukraine conflict	0.7157	0.1098	0.4510	0.6059	0.4475	0.1263
Italy (FTSE MIB)						
Full Sample	0.7706	0.2086	0.5670	0.5620	0.3829	0.2754
During COVID-19	1.5267	0.3024	0.8528	1.2243	0.9953	-0.1009
Before Russia-Ukraine conflict	0.7687	0.2494	0.4770	0.5193	0.3564	-0.1234
During Russia-Ukraine conflict	0.8456	0.1357	0.5329	0.7099	0.5425	0.1190
Spain (IBEX35)						
Full Sample	0.7923	0.3144	0.5755	0.4779	0.3060	0.0927
During COVID-19	1.6173	0.3298	0.8293	1.2875	1.0589	-0.2241
Before Russia-Ukraine conflict	0.7756	0.2931	0.5705	0.4825	0.3185	0.1498
During Russia-Ukraine conflict	0.9101	0.0882	0.4419	0.8219	0.6356	-0.1393

Autocorrelation between markets during the crisis period is common (Frezza et al., 2021). The results of this study show that the hypothesis of market efficiency in the periods investigated is rejected. The different characteristics between the COVID-19 outbreak and the Russia-Ukraine conflict can be explained by the characteristic of the shock in the market. The COVID-19 outbreak has directly affected the global economy. The uncertainties generated by the outbreak of COVID-19 cause information asymmetries in the financial market. On the other hand, the Russia-Ukraine conflict is not a recent case. There were years when diplomatic frictions had already occurred. The war was just the trigger for the conflict.

4. Conclusion

This study is the first to investigate the impact of the Russia-Ukraine conflict on the efficiency of stock markets in developed countries. A comparative analysis with the COVID-19 pandemic was also investigated. We analyzed stock indices for the US, Germany, UK, France, Italy and Spain. The multifractal detrended fluctuation analysis method (MF-DFA) was used.

Our findings show that in periods of high volatility the series has multifractality. Such evidence may be the result of extreme events that serve as a source of multifractality. However, there is the possibility that it is a feature of the fat tail distribution of returns. For future research we suggest: a) testing the hypothesis of the cause of multifractality by the fat tail distribution property using scrambled returns. b) analyze the impact of the Russia-Ukraine conflict on other stock markets. Emerging economies is a suggestion.

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