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Stock Market Persistence in MENA and OIC Countries

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ABSTRACT

This research paper analyzes how the pandemic caused by the coronavirus has affected eight MENA and three OIC stock market indices using advanced methodologies based on fractional integration. With this methodology we try to measure the persistence of the financial data in order to understand the long-term market dynamics of these two regions and to identify whether the COVID-19 shock has caused structural changes in the time series. Moreover, we want to identify if the shocks in the series have had permanent or transitory effects. The time period examined starts from pre-pandemic times at 2003, and first goes to the end of 2019; then, we also consider the COVID-19 pandemic (with data ending at December 2021) and then extend the analysis onwards to include the war between Russia and Ukraine (data ending at February 2023). The results indicate that there have not been significant long-lasting impacts from the COVID-19 pandemic or the Russia-Ukraine war on the degree of persistence in the series when using monthly data; however, as far as daily and weekly data are concerned the shocks have had some effect on the degree of persistence with daily data in the cases of Egypt, Indonesia, Malaysia, Turkey, and with weekly data for Bahrain, Egypt, Kuwait, Malaysia, Morocco and Turkey.

KEYWORDS

MENA stock market indices; COVID-19; fractional integration; persistence; shocks

JEL

C22; N25

1. Introduction

The last pandemic, COVID-19, brought many challenges to the worlds' economies, including the Middle East and North Africa (MENA) countries as well as the Organization of Islamic Cooperation (OIC) countries. Depending on the level of economic development, different policy measures were put into place, and some of the most effective ones were those taken by the Gulf Cooperation Council (GCC): Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates (Fawcett 2021). As well as impacting on the real economy, the pandemic also significantly affected the financial markets in the Middle East. Regarding the financial markets, Feyen et al. (2021) found that MENA countries had taken, as of April, 2021, fewer financial sector policy measures as a response to the COVID-19 pandemic than other regions around the world, accounting for only 96 out of a total of 3738 measures. Bani-Khalaf and Taspinar (2022) found that the COVID-19 pandemic was an important factor in influencing the financial markets in the Middle East as well as altering investment behavior toward more preventative options. Alkhatib et al. (2022) reported strong correlation between the COVID-19 pandemic and the stock market points for GCC countries, with the latter decreasing with increase in the number of COVID-19 cases. Topcu and Gulal (2020) indicated that among emerging markets, Middle East was less impacted by the COVID-19 pandemic compared to Asian and South American markets. Additionally, Parveen et al. (2021) specified that the Coronavirus pandemic

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had an impact on the behavior of investors, their investment decisions and the exchange volume on the Pakistan Stock Exchange. The study of Bhardwaj, Sharma, and Mavi (2022) disclosed that the COVID-19 pandemic drained stock market integration in the long-term between developing Asian countries.

The objective of this research is to provide an indication as to the degree of persistence of several MENA and OIC stock market indices (BHB, EGX, IDX, KSE, KLSE, MASI, MSM30, PSX, QSE, BIST100, ADX; names are given in Section 4) and how these might have been impacted by the COVID-19 pandemic and the Russia-Ukraine war, also studying their volatility during this period. In fact, during external shocks, in this case the COVID-19 pandemic and the Russia-Ukraine war, analyzing the impact of financial markets is very important for investors, policy makers, portfolio and hedge fund managers. Persistence in financial markets is important since the long memory process is related to the fact that its signal values at two different times are statistically correlated. If this were not the case, we would say that each number is independent of the previous one, there being no dependence between the past and the future and therefore, it would be impossible to analyze and predict the behavior of financial markets. Therefore, the analysis of persistence allows investors to better comprehend the volatility of financial markets. Investors can benefit from it by properly value their assets and give possibility for diversification, while policy makers by adjusting own policies to mitigate the market fall and uncertainty. This technique of exploration has significant policy recommendations, because actions for policy changes are required if shocks signify permanent impacts. It additionally further develops portfolio manager actions, through proposing optimal techniques for modeling volatility. Ultimately, this technique can recover risk management strategies to accurately assess the risk of investment portfolio and to offset possible losses that may arise from investments.

Hence, some of the series cover the period from January 2003, while others start from June 2005, all extend until January 2023 (see Table 1) and are evaluated by applying a very broad fractional integration method. The series actually include three periods: before the pandemic (until December 2019), data ending at December 2021, i.e., two months before the Russia-Ukraine war, and lastly, we spread the sample up to February 2023. We do this to understand whether the effects of the pandemic are still present in the series or otherwise the onset of the Russia-Ukraine war generates a different behavior in the series. The method of analysis is broader than the standard one embraced by numerous past examinations; specifically, it is not limited to traditional polarity in the range of I(0) and I(1) practices, that is, it actually considers a broader performance, for instance, nonstationary mean-returning models taking place when the integration order is within 0.5 to 1. In addition, the method employed is valid in nonstationary contexts unlike the rest of procedures that require first differentiation in case of nonstationary data. Moreover, the limit distribution is standard normal, not requiring the computation of critical values even if deterministic terms are included in the model.

Table 1. Countries under examination and sample size.

	Daily			Weekly			Monthly		
Series	Starting date	Ending date	N. of observations	Starting date	Ending date	N. of observations	Starting date	Ending date	N. of observations
Bahrain	6/1/2005	1/20/2023	5667	6/5/2005	1/22/2023	921	6/30/2005	1/31/2023	212
Egypt	1/21/2003	1/20/2023	6280	1/26/2003	1/22/2023	1044	1/31/2003	1/31/2023	241
Indonesia	1/21/2003	1/20/2023	5205	1/24/2003	1/20/2023	1044	1/31/2003	1/31/2023	241
Kuwait	6/1/2005	1/20/2023	5675	6/5/2005	1/22/2023	921	6/30/2005	1/31/2023	212
Malaysia	1/21/2003	1/20/2023	5202	1/24/2003	1/20/2023	1044	1/31/2003	1/31/2023	241
Morocco	1/21/2003	1/20/2023	5214	1/24/2003	1/20/2023	1044	1/31/2003	1/31/2023	241
Oman	6/1/2005	1/20/2023	5672	6/5/2005	1/22/2023	921	6/30/2005	1/31/2023	212
Pakistan	1/21/2003	1/20/2023	5207	1/24/2003	1/20/2023	1044	1/31/2003	1/31/2023	241
Qatar	6/1/2005	1/20/2023	5672	6/5/2005	1/22/2023	921	6/30/2005	1/31/2023	212
Turkey	1/21/2003	1/20/2023	5213	1/24/2003	1/20/2023	1044	1/31/2003	1/31/2023	241
UAE	6/1/2005	1/20/2023	5674	6/5/2005	1/22/2023	921	6/30/2005	1/31/2023	212

Despite the fact that the impact of the Coronavirus pandemic on stock markets has featured in several different studies (see, e.g., Abakah, Caporale, and Gil-Alana 2021, 2022; Bentes 2021; Caporale, Gil-Alana, and Poza 2022; Caporale, Gil-Alana, and Lasaosa 2022; Caporale et al. 2022; de Oliveira, Mandal, and Power 2022; Tiwari et al. 2022), no single former examination, to the best of our knowledge, has given exhaustive proof of this relationship for MENA and OIC countries. Thus, the contribution of this work is two-fold. On the one hand, the methodology used to examine persistence in the data and the technique employed which is, in addition to the above-mentioned comments, the most efficient one in the Pitman sense against local departures. This methodology permits us to determine if exogenous shocks in the series will have permanent or transitory effects in a much richer way than the classical methods that simply rely on integer degrees of differentiation. In addition, with a single parameter, the order of integration we can determine if the series are persistent or not. The second contribution are the countries examined and the time period covered in our work. Hence, to our knowledge, this is one of the few studies that analyzes persistence of eight MENA and three OIC stock market indices, with three different frequencies (daily, weekly and monthly) based on the availability in one of the most reliable and accurate database system-Thomson Reuters Eikon. The study by de Oliveira, Mandal, and Power (2022) is one of the few studies we have come across that examines international dataset for 16 stock market indices in three continents over the period from August 1, 2019 to February 18, 2022. The reference article considered long-memory persistence and structural breaks, thereby estimating 80 GARCH family models, 16 pure Markov-Switching models, and 900 combined GARCH and Markov-Switching models. However, it uses different methods and the data range is much shorter as well as does not comprise any of the stock market indices we find important for our examination. Additionally, our study incorporates the situation before and after the appearance of COVID-19 pandemic and Russia-Ukraine war (until the end of January 2023). The study of Caporale, Gil-Alana, and Lasaosa (2022) is a similar study that used fractional integration technique to analyze persistence of ten European stock market indices over the period from 2005 to 2019, including daily, weekly and monthly frequencies. Though, it applies similar technique, the dataset is shorter and the estimate of stock market indices is different from our study. Whereas the related literature on the impact of COVID-19 on stock market persistence has focused mainly on the volatility persistence in the G7's stock markets (Bentes 2021), its effects in other financial markets are neglected. This constraint is overcome by our research.

The remainder of the study is organized in the following way: Section 2 briefly assesses the current literature; Section 3 is dedicated to the methods of the data analysis; Section 4 presents the analyzed data and shows the empirical outcomes displaying the relation between MENA and OIC stock market persistence and the COVID-19 pandemic, as well as the Russia-Ukraine war, while Section 5 comprises a few final remarks as conclusions.

2. Literature Review

As the Coronavirus pandemic started to spread around the world, numerous studies were conducted to investigate explicitly its effect on financial markets, including stock markets globally. For example, Mazur, Dang, and Vega (2021) proved that the failure of stock prices as a result of COVID-19 in March 2020 outlines one of the greatest stock market crashes ever. Cox, Greenwald, and Ludvigson (2020) found market instability, that produced the sharp V-shaped trajectory of the U.S. stock market during the early phases of Coronavirus. Stock market reaction in a sample of 74 countries was also analyzed by Capelle-Blancard and Desroziers (2020), who recommended that stock markets be less responsive to each country's macroeconomic essentials before the pandemics, compared to their short-term response throughout the pandemics (health approaches carried out during the pandemic to restrict the infection transmission as well as macroeconomic approaches intending to help organizations). According to Liu et al. (2020) the coronavirus pandemic impacted negatively on stock market returns globally, although Asian countries faced higher negative returns when

contrasted with different countries. Baker et al. (2020) studied the impact of COVID-19 on the U.S. stock market, and their result showed that limitations from government on business action as well as voluntary social distancing were the principal behind U.S. stock market responding more strongly to the COVID-19 pandemic compared to previous pandemics as, for example, in 1918–19, 1957–58 and 1968. So, Chu, and Chan (2021) used the financial networks methods to analyze the impact of the COVID-19 pandemic on the correlation of stock returns on the Hong Kong financial market and found a partial relation impact as a result of a rise in systemic risk in the financial system throughout the Coronavirus episode. He et al. (2020) evaluated the impact of the COVID-19 pandemic on China, Italy, South Korea, France, Spain, Germany, Japan and the United States of America with observed daily return data and concluded that the COVID-19 pandemic caused a temporary slump in the stock markets of the impacted countries which was below the global average. By using Balanced Worth methodology, Caporale et al. (2022) assessed the impact of the COVID-19 pandemic on the volatility of stock market returns in G20 countries and according to them the government restrictions affected G7 countries more negatively than the pandemic itself. Additionally, they found that both factors impacted negatively on stock markets in the non-G7 countries.

To the best of our knowledge, few examples in the literature applied the fractional integration methodology to analyze the impact of the COVID-19 pandemic on stock markets. Caporale, Gil-Alana, and Poza (2022) used a fractional integration method and found that the COVID-19 pandemic did not impact US monthly stock prices but did affect bond yields. Additionally, Caporale, Gil-Alana, and Abakah (2023) checked the impact of US policy responses to the COVID-19 pandemic on US sectoral stock indices using a fractional integration technique and found that changes in the Effect Federal Funds Rate ensured the main positive impact. Gil-Alana and Claudio-Quiroga (2020) considered the daily price data to analyze the impact of the COVID-19 pandemic on the three Asian stock markets: specifically, the Korean SE Kospi Index, the Japanese Nikkei 225 Index, and the Chinese Shanghai Shenzhen CSI 300 Index for the period July 2006 to September 2020. They found that for the Nikkei 225 Index the shocks are transitory, while for the Kospi and Shanghai Shenzhen indices, the shocks appear to be permanent. According to Caporale, Gil-Alana, and You (2021) stock market integration between the five ASEAN countries and both the US and China became weaker during the COVID-19 pandemic. Salman and Ali (2021) found that GCC stock markets were relatively less affected by Covid-19, compared to the impacts suffered by global stock markets. Other papers dealing with persistence in stock markets and investigating the influence of COVID-19 include Monge, Lazcano, and Parada (2023) and Marcos Ceron and Monge (2023), among others.

Nevertheless, all of these papers placed their emphasis on the foreign markets with exception of Salman and Ali (2021) that analyzed only daily series of stock indices in GCC and Chinese Stock Index. By distinction, the current study applies fractional integration techniques to analyze the potential effect of the Coronavirus pandemic and Russia-Ukraine war on various MENA and OIC stock markets, a concern which as far as we are aware of was not explored prior to using this method. In this way the acquired suggestion is unique and addresses an exclusive commitment to the overall literature.

3. Methodology

Fractional integration indicates that the number of differences to be adopted in a process to render it stationary I(0) is a fractional value. We start by defining an integrated of order 0, or I(0) process in the following way. We say that a (covariance stationary) process $\{x(t), t = 0, \pm 1, \dots\}$ is I(0) if the infinite sum of its autocovariances, defined as $\gamma(u) = E[(x(t)—Ex(t)), (x(t+u)—Ex(t)]$ is finite, i.e.,

$$\sum_{u=-\infty}^{u=\infty} \mid \gamma(u) \mid < \infty. \tag{1}$$

Alternatively, we can define I(0) (or short memory)) behavior in the frequency domain as follows. A process x(t) displays the property of short memory if its spectral density function, defined as the Fourier transform of the autocovariances, i.e.,

$$f(\lambda) = \frac{1}{2\pi} \sum_{u=-\infty}^{\infty} \gamma_{(u)} e^{i\lambda u}, \tag{2}$$

is positive and finite at any frequency in the spectrum, i.e.,

$$0 < f(\lambda) < \infty, \qquad for\ \lambda\ \varepsilon\ [0, \pi).$$

On the other hand, a process is said to be long memory if the infinite sum of its autocovariances is infinite, i.e.,

$$\sum_{u=-\infty}^{u=\infty} \mid \gamma(u) \mid = \infty. \tag{3}$$

or, using the frequency domain, if the infinite sum of the autocovariances is infinite at some point in the spectrum,

$$f(\lambda) \to \infty, \qquad for\ \lambda\ in\ [0, \pi). \tag{4}$$

Within the many models that satisfy the properties in (3) or (4), a very classical one is the fractional integration approach, that is characterized by the following process,

$$(1 - B)^d x(t) = u(t), \qquad t = 1, 2, \ldots, \tag{5}$$

where B is the backshift operator (Bx(t) = x(t-1)); d is a real value, and u(t) is I(0). This process (with d > 0) satisfies the two properties above, and in particular, its spectral density function tends to infinity as the frequency approaches to zero, i.e.,

$$f(\lambda) \to \infty, \qquad as\ \lambda \to 0^+. \tag{6}$$

Fractional integration was proposed in Granger (1980) based on the observation that many economic aggregates displayed a periodogram with a large value at the zero frequency, suggesting that the series should be differenced; however, once differenced, the periodogram showed a value close to zero at such a frequency, which was clearly an indication of over-differentiation. According to that it should be an intermediate value between 0 and 1. Earlier, Robinson (1978) justified the existence of these processes by means of aggregation of heterogeneous autoregressive processes, and the same argument (aggregation) has been used by many other authors (Taqqu, Willinger, and Sherman 1997; Chambers 1998; Parke 1999; etc.). Fractional integration is now standard in the analysis of economic and financial time series data (see, e.g., Gil-Alana and Robinson 1997; Gil-Alana and Moreno 2012; Abbritti et al. 2016, 2023; etc.).

The fractional differencing parameter can be estimated (and tested) by using parametric or semiparametric techniques. In the present work we use a version of a testing procedure developed in Robinson (1994) that has numerous advantages with respect to other methods. First of all, it is based on the Lagrange Multiplier (LM) principle, and therefore avoiding the direct estimation of the differencing parameter, and providing confidence bands for the non-rejection values of d. In addition, it does not restrict the analysis to the stationary case (d < 0.5) and d can be any real number. Other novel feature of this method is its limiting distribution which is standard normal, being the most efficient method in the Pitman sense against local departures from the null. Finally, this limit distribution results unaffected by the inclusion of deterministic terms like a constant and or linear/nonlinear trends.

4. Data Description and Empirical Results

In this study we analyze the performance of eight MENA and three OIC stock market indices, namely: BHB (Bahrain Bourse, Bahrain), EGX (the Egyptian Exchange, Egypt), IDX (The Indonesian Stock Exchange, Indonesia), KSE (Kuwait Stock Exchange, Kuwait), KLSE (BURSA Malaysia, Malaysia), MASI (Morocco Equity Market Index, Morocco), MSM30 (Oman Stock Market, Oman), PSX (Pakistan Stock Exchange, Pakistan), QSE (Qatar Stock Exchange, Qatar), BIST100 (Borsa Istanbul, Turkey) and ADX (United Arab Emirates Stock Market, United Arab Emirates). In particular, we took into consideration the daily, weekly and monthly closing prices for stock markets where the time period varies due to the accessibility of the data from Thomson Reuters Eikon (see Table 1).

To examine the conceivable effect of the Coronavirus pandemic and the Russia-Ukraine war we use the fractional integration parameter d that measures the degree of persistence. We start with analyzing the models from the beginning of the sourced data until January 1, 2023, then until beginning of Russia-Ukraine war (January 1, 2023), and lastly analyzing again the full data series until January 20, 2023. Figure 1 presents the daily series plots (the reason for not showing the weekly and monthly plots is because they look similar).

Additionally, Tables 2–4 illustrate some descriptive statistics for the three variables in all stock markets. We note that Qatar has the widest range in all the series for daily, weekly and monthly frequencies, while Pakistan has the narrowest. In addition, Bahrain exhibits the most volatile behavior within this group with the highest standard deviation, whereas Pakistan with the lowest standard deviation is the least volatile.

The assessed model is the following:

$$y_t = \alpha + \beta t + x_t, (1 - B)^d x_t = u_t, \qquad t = 1, 2, \ldots, \tag{7}$$

where u(t) is I(0) or a short-memory process which is supposed to be weakly autocorrelated. However, instead of imposing a specific ARMA model, we simply consider its autocorrelation is based on the exponential spectral model of Bloomfield (1973). This is a non-parametric approach in the sense that it has no functional form, simply described in terms of its spectral density function, the logged form of which approximates that of AR structures (see Bloomfield 1973).

Across Tables 5–7 we report the estimates of d and the 95% confidence bands for monthly, weekly and daily data respectively with data ending at December 2019, i.e., two months before the pandemic. Tables 8–10 incorporate data up to December 2021, i.e., before the Russia-Ukraine war, while Tables 11–13 include data whose ending period is February 2023.

We impose different structures for the deterministic terms. Thus, in column 2 of the tables we display the results under the assumption that there are no terms, i.e., no constant and no time trend; in column 3 an intercept is permitted, while in column 4 the model incorporates both the intercept and the time trend. We mark in bold the selected case for each series.

We start with the sample ending at December 2019. Using monthly data, the time trend is found to be significant for Bahrain and Indonesia, while for the rest of the countries an intercept is the required deterministic term. The estimated values of d are close to 1 in all cases and the unit root null hypothesis cannot be rejected in any case with the exception of Morocco with d = 1.14, and where the unit root null is rejected in favor of d > 1. Moving to the weekly case, the time trend coefficients are all now insignificant but the values of d are much higher, and d is statistically higher than 1 in all cases except in three series: Qatar, Turkey and the UAE where the unit root null (d = 1) cannot be rejected. Finally, using daily data, (in Table 7), the countries can be grouped into two categories: 1) those where the I(1) hypothesis cannot be rejected (Egypt, Indonesia, Malaysia, Morocco, Qatar, Turkey and the UAE) and 2) those there this hypothesis is rejected in favor of d > 1 (Bahrain, Kuwait and Pakistan).

Tables 8–10 display the results again for monthly, weekly and daily data with data ending at December 2021, i.e., two months before the Russia-Ukraine war. In these models, the assessment of the impact of COVID-19 pandemic on persistence is covered. As with the previous tables, the time

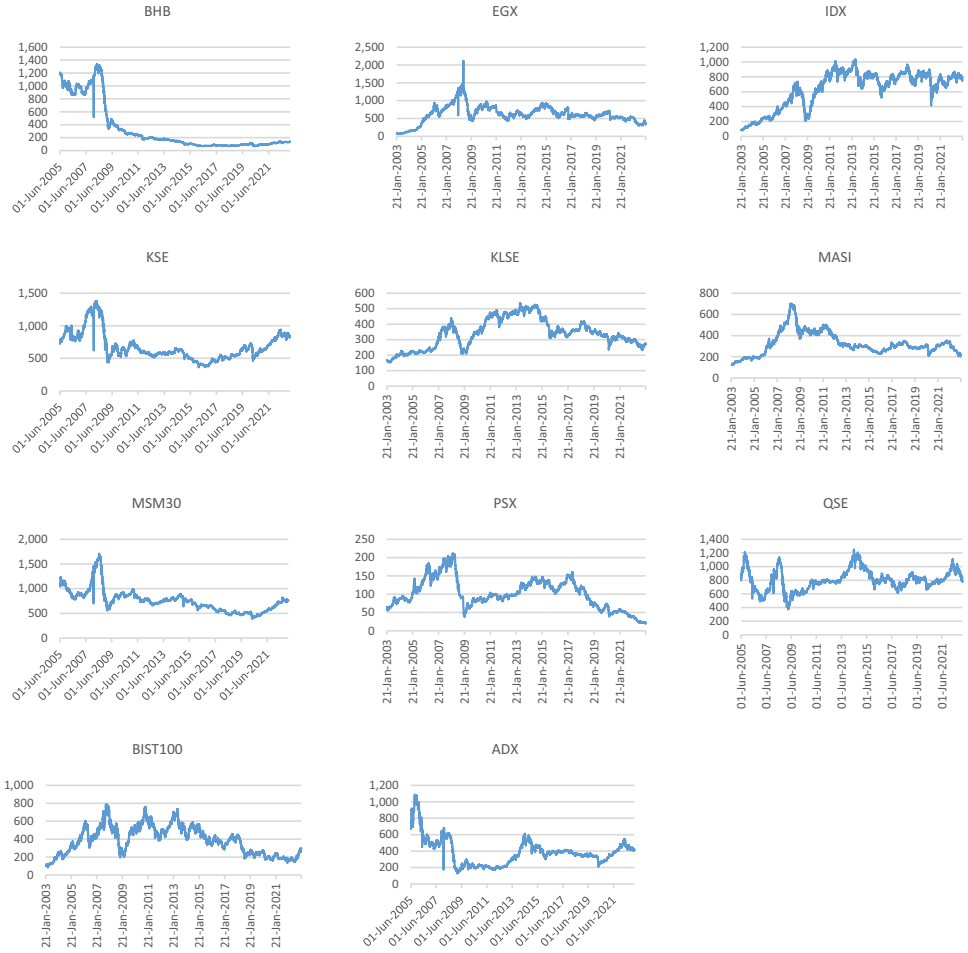

Figure 1. Time series plots.

Table 2. Descriptive statistics: daily data.

Series	Max. value	Min. value	Mean	Std. Dev.	J-B stat.
Bahrain	1338.13	67.85	334.16	365.08	1926.31
Egypt	2119.26	61.31	631.24	241.10	714.28
Indonesia	1039.86	82.09	636.75	247.10	657.74
Kuwait	1382.92	361.65	682.30	215.82	2004.96
Malaysia	535.32	153.73	340.32	93.87	173.80
Morocco	703.40	123.10	323.68	108.51	1078.16
Oman	1710.63	394.83	758.48	227.62	4459.05
Pakistan	211.70	20.14	101.04	40.95	97.09
Qatar	1252.18	375.21	798.06	151.68	51.20
Turkey	789.82	83.00	384.09	156.30	202.00
UAE	1087.54	130.24	383.45	159.77	4064.02

trend coefficient is also statistically significant for Bahrain and Indonesia with monthly data. Starting with this frequency, the I(1) hypothesis cannot be rejected in any single case, with the values of d ranging from 0.95 (Turkey) to 1.19 (Oman). Using weekly data, the case of $d = 1$ is rejected in all cases except for Qatar (1.03) and Turkey (1.05) where the unit root null cannot be rejected. Finally, with daily data, the I(1) hypothesis is not rejected in the majority of cases and is rejected in favor of $d > 1$ for Bahrain and Malaysia (1.05), Oman (1.07) and Pakistan (1.10).

Table 3. Descriptive statistics: weekly data.

Series	Max. value	Min. value	Mean	Std. Dev.	J-B stat.
Bahrain	1335.17	68.96	330.20	365.90	323.30
Egypt	2119.26	63.96	618.48	248.65	240.96
Indonesia	1023.06	83.86	637.37	247.22	132.86
Kuwait	1382.92	372.11	680.22	213.61	326.79
Malaysia	530.79	154.88	340.46	93.88	35.07
Morocco	699.38	123.10	323.73	108.73	219.24
Oman	1701.92	397.19	756.91	227.83	686.02
Pakistan	209.94	20.52	101.10	41.01	19.33
Qatar	1252.18	384.44	804.06	150.51	9.19
Turkey	778.26	89.44	384.12	156.34	40.18
UAE	1087.53	133.04	389.47	166.04	705.87

Table 4. Descriptive statistics: monthly data.

Series	Max. value	Min. value	Mean	Std. Dev.	J-B stat.
Bahrain	1305.92	69.31	327.22	364.86	78.66
Egypt	1450.99	67.67	616.62	247.09	21.82
Indonesia	1021.63	83.86	636.08	248.07	30.58
Kuwait	1371.32	378.57	679.22	213.17	73.31
Malaysia	519.49	155.99	340.15	94.09	8.10
Morocco	697.52	127.66	323.08	108.91	48.52
Oman	1634.43	410.62	752.64	222.78	155.07
Pakistan	206.05	20.52	100.17	41.02	4.36
Qatar	1249.16	392.44	802.16	150.45	1.98
Turkey	789.82	91.43	384.40	156.98	8.96
UAE	1055.14	142.01	388.58	164.89	158.13

Table 5. Estimates of d: monthly data ending at December 2019.

Series	No terms	An intercept	Intercept and a time trend
Bahrain	0.97 (0.83, 1.19)	1.06 (0.89, 1.31)	1.06 (0.89, 1.30)
Egypt	1.02 (0.89, 1.19)	1.11 (0.98, 1.30)	1.10 (0.98, 1.27)
Indonesia	0.98 (0.85, 1.19)	0.93 (0.76, 1.17)	0.95 (0.81, 1.18)
Kuwait	0.98 (0.83, 1.20)	1.11 (0.90, 1.39)	1.11 (0.91, 1.39)
Malaysia	0.95 (0.82, 1.14)	1.08 (0.91, 1.32)	1.07 (0.91, 1.30)
Morocco	0.98 (0.84, 1.17)	1.14 (1.02, 1.32)	1.15 (1.02, 1.32)
Oman	0.94 (0.80, 1.17)	1.27 (0.90, 1.66)	1.26 (0.90, 1.71)
Pakistan	1.01 (0.87, 1.24)	0.97 (0.82, 1.59)	0.97 (0.82, 1.15)
Qatar	0.96 (0.80, 1.20)	1.00 (0.75, 1.32)	1.00 (0.76, 1.32)
Turkey	0.98 (0.84, 1.15)	0.98 (0.85, 1.21)	0.98 (0.83, 1.20)
UAE	0.98 (0.80, 1.26)	1.08 (0.92, 1.38)	1.08 (0.90, 1.35)

Table 6. Estimates of d: weekly data ending at December 2019.

Series	No terms	An intercept	Intercept and a time trend
Bahrain	1.00 (0.93, 1.10)	1.16 (1.09, 1.26)	1.16 (1.09, 1.25)
Egypt	1.00 (0.94, 1.08)	1.08 (1.02, 1.16)	1.08 (1.02, 1.16)
Indonesia	1.01 (0.92, 1.10)	1.11 (1.02, 1.19)	1.11 (1.02, 1.18)
Kuwait	1.00 (0.93, 1.10)	1.11 (1.03, 1.21)	1.11 (1.03, 1.21)
Malaysia	0.99 (0.92, 1.08)	1.08 (1.02, 1.19)	1.08 (1.02, 1.18)
Morocco	1.00 (0.94, 1.09)	1.08 (1.02, 1.16)	1.08 (1.02, 1.16)
Oman	0.99 (0.92, 1.09)	1.14 (1.07, 1.23)	1.14 (1.07, 1.23)
Pakistan	1.01 (0.95, 1.10)	1.08 (1.01, 1.19)	1.07 (1.01, 1.19)
Qatar	1.01 (0.93, 1.11)	1.03 (0.94, 1.11)	0.81 (0.94, 1.11)
Turkey	1.01 (0.93, 1.08)	1.04 (0.97, 1.14)	1.05 (0.97, 1.14)
UAE	1.01 (0.94, 1.09)	1.06 (0.98, 1.14)	1.05 (0.98, 1.14)

Table 7. Estimates of d: daily data ending at December 2019.

Series	No terms	An intercept	Intercept and a time trend
Bahrain	1.01 (0.97, 1.05)	1.05 (1.01, 1.10)	1.05 (1.01, 1.09)
Egypt	1.00 (0.96, 1.05)	0.96 (0.92, 1.01)	0.96 (0.92, 1.01)
Indonesia	1.00 (0.96, 1.05)	0.99 (0.95, 1.03)	0.99 (0.95, 1.03)
Kuwait	1.00 (0.96, 1.04)	1.05 (1.01, 1.10)	1.05 (1.01, 1.10)
Malaysia	1.00 (0.96, 1.05)	1.02 (0.99, 1.06)	1.02 (0.99, 1.06)
Morocco	1.00 (0.96, 1.04)	0.98 (0.95, 1.02)	0.98 (0.95, 1.02)
Oman	1.00 (0.96, 1.05)	1.09 (1.04, 1.13)	1.09 (1.04, 1.13)
Pakistan	1.01 (0.97, 1.04)	1.11 (1.07, 1.14)	1.11 (1.07, 1.14)
Qatar	1.00 (0.96, 1.04)	1.00 (0.96, 1.05)	1.00 (0.96, 1.05)
Turkey	0.99 (0.95, 1.03)	1.00 (0.96, 1.04)	1.00 (0.96, 1.04)
UAE	1.01 (0.97, 1.05)	1.05 (0.99, 1.08)	1.04 (0.99, 1.08)

Table 8. Estimates of d: monthly data ending at December 2021.

Series	No terms	An intercept	Intercept and a time trend
Bahrain	0.97 (0.83, 1.16)	1.04 (0.89, 1.27)	1.05 (0.90, 1.27)
Egypt	1.02 (0.90, 1.20)	1.11 (0.97, 1.28)	1.10 (0.97, 1.28)
Indonesia	1.01 (0.86, 1.21)	0.94 (0.73, 1.18)	0.96 (0.80, 1.17)
Kuwait	0.98 (0.83, 1.18)	1.05 (0.86, 1.31)	1.05 (0.86, 1.31)
Malaysia	0.96 (0.84, 1.13)	1.07 (0.92, 1.26)	1.07 (0.92, 1.26)
Morocco	0.98 (0.85, 1.14)	1.07 (0.97, 1.22)	1.07 (0.97, 1.23)
Oman	0.96 (0.81, 1.14)	1.19 (0.86, 1.64)	1.19 (0.87, 1.63)
Pakistan	0.99 (0.86, 1.16)	0.96 (0.83, 1.11)	0.96 (0.83, 1.12)
Qatar	0.97 (0.81, 1.18)	0.97 (0.76, 1.27)	0.97 (0.76, 1.27)
Turkey	0.94 (0.83, 1.10)	0.95 (0.83, 1.12)	0.95 (0.84, 1.13)
UAE	1.01 (0.86, 1.24)	1.09 (0.91, 1.33)	1.08 (0.91, 1.33)

Table 9. Estimates of d: weekly data ending at December 2021.

Series	No terms	An intercept	Intercept and a time trend
Bahrain	1.00 (0.93, 1.07)	1.19 (1.12, 1.29)	1.19 (1.11, 1.29)
Egypt	0.99 (0.93, 1.06)	1.08 (1.02, 1.16)	1.08 (1.02, 1.15)
Indonesia	1.00 (0.94, 1.08)	1.09 (1.02, 1.17)	1.09 (1.02, 1.17)
Kuwait	0.98 (0.92, 1.07)	1.12 (1.04, 1.20)	1.12 (1.04, 1.20)
Malaysia	0.98 (0.91, 1.06)	1.09 (1.02, 1.16)	1.08 (1.02, 1.16)
Morocco	1.00 (0.93, 1.09)	1.08 (1.02, 1.16)	1.08 (1.02, 1.15)
Oman	1.00 (0.93, 1.09)	1.14 (1.06, 1.23)	1.14 (1.06, 1.23)
Pakistan	1.00 (0.92, 1.06)	1.07 (1.00, 1.17)	1.07 (1.00, 1.17)
Qatar	1.01 (0.93, 1.08)	1.03 (0.95, 1.11)	1.03 (0.95, 1.11)
Turkey	1.02 (0.96, 1.10)	1.05 (0.96, 1.12)	1.05 (0.96, 1.12)
UAE	1.01 (0.94, 1.10)	1.05 (1.00, 1.14)	1.05 (1.00, 1.14)

Table 10. Estimates of d: daily data ending at December 2021.

Series	No terms	An intercept	Intercept and a time trend
Bahrain	1.00 (0.96, 1.04)	1.05 (1.01, 1.09)	1.05 (1.01, 1.09)
Egypt	0.98 (0.95, 1.03)	0.99 (0.96, 1.04)	0.99 (0.96, 1.04)
Indonesia	1.02 (0.98, 1.06)	1.00 (0.96, 1.04)	1.00 (0.96, 1.04)
Kuwait	0.99 (0.96, 1.04)	1.01 (0.98, 1.05)	1.01 (0.98, 1.05)
Malaysia	1.00 (0.96, 1.04)	1.05 (1.01, 1.10)	1.05 (1.01, 1.10)
Morocco	0.99 (0.96, 1.04)	1.00 (0.96, 1.04)	1.00 (0.96, 1.04)
Oman	1.00 (0.96, 1.04)	1.07 (1.01, 1.10)	1.07 (1.01, 1.10)
Pakistan	0.96 (0.92, 1.01)	1.10 (1.06, 1.14)	1.10 (1.06, 1.14)
Qatar	1.00 (0.96, 1.04)	0.99 (0.95, 1.04)	0.99 (0.95, 1.04)
Turkey	1.00 (0.95, 1.03)	0.99 (0.95, 1.03)	0.99 (0.95, 1.03)
UAE	1.00 (0.96, 1.05)	1.01 (0.98, 1.05)	1.01 (0.98, 1.05)

Table 11. Estimates of d: monthly data ending February 2023.

Series	No terms	An intercept	Intercept and a time trend
Bahrain	0.97 (0.85, 1.16)	1.03 (0.90, 1.23)	1.03 (0.91, 1.22)
Egypt	1.05 (0.93, 1.21)	1.10 (0.98, 1.25)	1.10 (0.98, 1.26)
Indonesia	0.99 (0.87, 1.16)	0.91 (0.76, 1.12)	0.93 (0.81, 1.11)
Kuwait	0.95 (0.84, 1.17)	1.01 (0.86, 1.28)	1.01 (0.86, 1.28)
Malaysia	0.97 (0.85, 1.15)	1.07 (0.92, 1.25)	1.06 (0.92, 1.26)
Morocco	0.97 (0.85, 1.14)	1.08 (0.96, 1.24)	1.07 (0.96, 1.23)
Oman	0.96 (0.82, 1.15)	1.18 (0.92, 1.55)	1.18 (0.92, 1.55)
Pakistan	1.05 (0.87, 1.17)	0.99 (0.88, 1.15)	0.99 (0.88, 1.16)
Qatar	0.94 (0.81, 1.16)	0.99 (0.75, 1.28)	0.99 (0.75, 1.27)
Turkey	1.01 (0.90, 1.19)	0.98 (0.85, 1.17)	0.97 (0.84, 1.17)
UAE	0.98 (0.82, 1.18)	1.09 (0.92, 1.33)	1.09 (0.92, 1.32)

Finally, we extend the sample up to February 2023. Once more, the time trend coefficient is found to be significant in the cases of Bahrain and Indonesia with monthly data. If we focus on this frequency, we observe that all values of the differenced parameter d are around the I(1) case, since this hypothesis cannot be rejected in any single case. The estimated values range between 0.93 in Indonesia and 1.18 in Oman, but the value of 1 appears in all confidence bands across the series.For the weekly data, we observe that the values are much higher, and the unit root null hypothesis, i.e., $d = 1$, is rejected in a number of cases in favor of values above 1. In fact, this hypothesis cannot be rejected for Qatar, Turkey and UAE, and the value 1 appears as the lower value in the interval in the cases of Malaysia and Pakistan. In all the other cases, d is found to be significantly above 1. Finally, for the daily data, the results are more heterogeneous; thus, the unit root null is rejected in favor of $d > 1$ in the case of Pakistan, while for Qatar and the UAE we cannot reject the null of mean reversion, since the estimated value of d is significantly below 1.

As a robustness approach we also conducted the analysis with alternative parametric and semi-parametric methods. In particular, we first tried with Sowell's (1992) maximum likelihood approach the results, though quantitatively different in some cases, they were qualitatively very similar to those reported across Tables 5–13, and summarized in Table 14. The same can be said with the semiparametric methods (Shimotsu and Phillips 2005) though here the results were highly sensitive to the choice of the bandwidth numbers. Employing non-linear models for the deterministic components, the coefficients were found to be statistically insignificant in all cases.

The summary of the results discussed previously is shown in Table 14. The mean reverting cases appear in bold type. The red color designates an increase, while the blue color represents a decrease in the values of degrees of persistence. In general, the degree of persistence is found mainly to decrease in the full sample, with some slight increases in each frequency. When using the full sample including the Russia-Ukraine war, the value of d is found to decrease, especially in the case of Oman (MSM30) at the daily frequency (from 1.09 to 0.96), Indonesia (IDX) at the weekly frequency (from 1.11 to 1.08) and Kuwait (KSE) at the monthly frequency (from 1.11 to 1.01). Our data show that the increase in uncertainty induced by the COVID-19 pandemic and Russia-Ukraine war is not having a long-term impact on stock market volatility and that it will shortly return to the pre-Covid levels. In general, the differences when using the full sample decrease significantly in the cases of Bahrain, Kuwait, Oman, Qatar and UAE at the daily frequency, which suggests that the Russia-Ukraine war has had a very large effect on the degree of persistence of stock markets in some countries, while in some other countries very little effect. A related study to the current one is Bentes (2021), which found a marked increase in persistence levels following the onset of the COVID-19 pandemic in G7 countries, as well as the work by de Oliveira, Mandal, and Power (2022), which demonstrated that COVID-19 had an impact on both volatility regimes and long-memory persistence in the main global stock indices. Regarding the impact of COVID-19 on the degree of persistence of stock markets, we found that the differences are very minor, that suggests that it had very little effect on the degree of persistence of stock markets at the daily frequency. Though at weekly and monthly frequencies, the lack of statistical significance in

Table 12. Estimates of d: weekly data ending at February 2023.

Series	No terms	An intercept	Intercept and a time trend
Bahrain	0.99 (0.92, 1.07)	1.19 (1.11, 1.28)	1.18 (1.11, 1.28)
Egypt	0.98 (0.92, 1.05)	1.09 (1.03, 1.17)	1.09 (1.03, 1.16)
Indonesia	1.02 (0.94, 1.08)	1.08 (1.01, 1.18)	1.08 (1.01, 1.18)
Kuwait	0.98 (0.92, 1.07)	1.11 (1.04, 1.20)	1.11 (1.04, 1.20)
Malaysia	1.00 (0.94, 1.07)	1.07 (1.00, 1.15)	1.06 (1.00, 1.15)
Morocco	1.00 (0.94, 1.07)	1.10 (1.04, 1.19)	1.10 (1.04, 1.19)
Oman	1.00 (0.93, 1.08)	1.12 (1.05, 1.20)	1.12 (1.05, 1.20)
Pakistan	1.00 (0.93, 1.08)	1.07 (1.00, 1.16)	1.07 (1.00, 1.16)
Qatar	0.87 (0.77, 0.99)	0.81 (0.70, 0.97)	0.81 (0.70, 0.97)
Turkey	1.00 (0.94, 1.09)	1.05 (0.98, 1.14)	1.05 (0.98, 1.14)
UAE	1.01 (0.95, 1.09)	1.05 (0.99, 1.13)	1.05 (0.99, 1.13)

Table 13. Estimates of d: daily data ending at February 2023.

Series	No terms	An intercept	Intercept and a time trend
Bahrain	0.99 (0.96, 1.04)	0.97 (0.94, 1.00)	0.97 (0.94, 1.00)
Egypt	0.99 (0.95, 1.03)	1.02 (0.98, 1.05)	1.02 (0.98, 1.05)
Indonesia	0.98 (0.94, 1.02)	1.00 (0.96, 1.04)	1.00 (0.96, 1.04)
Kuwait	1.00 (0.97, 1.05)	0.96 (0.93, 1.00)	0.96 (0.93, 1.00)
Malaysia	0.99 (0.95, 1.03)	1.03 (1.00, 1.07)	1.03 (1.00, 1.07)
Morocco	1.00 (0.96, 1.04)	1.00 (0.97, 1.04)	1.00 (0.97, 1.04)
Oman	1.00 (0.96, 1.05)	0.96 (0.93, 1.01)	0.96 (0.93, 1.01)
Pakistan	1.00 (0.95, 1.04)	1.07 (1.03, 1.11)	1.07 (1.03, 1.11)
Qatar	1.00 (0.96, 1.04)	0.91 (0.88, 0.94)	0.91 (0.88, 0.94)
Turkey	1.00 (0.96, 1.04)	1.02 (0.98, 1.05)	1.02 (0.97, 1.05)
UAE	1.01 (0.96, 1.04)	0.94 (0.91, 0.97)	0.94 (0.91, 0.97)

the differences implies that the impact of the COVID-19 epidemic and Russia-Ukraine war on the persistence of stock markets has been minimal. A similar study to the present one is Topcu and Gulal (2020), which revealed that the impact of COVID-19 on emerging stock markets (including similar countries to those analyzed in our study) to be negligible. Likewise, Caporale, Gil-Alana, and Lasaosa (2022) showed that, despite a decline in volatility persistence, the COVID-19 epidemic has had no significant effect on the degree of persistence of the European stock market indices, which is consistent with our findings for the data ending at December 2021.

Another reflection of these results is that at least for these markets there is not a systematic pattern in relation with the data frequency. A similar result to the present one is Gil-Alana, Shittu, and Yaya (2014) which studies persistence and volatility in European, American and Asian stocks bull and bear markets. They suggest that there is not a systematic pattern across all indices; that is consistent with our findings for the MENA and OIC countries. Also, it is worth noting the lack of mean reversion, except for the cases of Qatar and the UAE with daily data (Table 13). Concerning the weekly series (Table 12) absence of mean reversion takes place in all the cases, except for the case of Qatar. Finally, for the monthly series (Table 11) mean reversion is not found in any single case.

5. Conclusions

In this article we have studied the degree of persistence in the level and volatility of eight MENA and three OIC stock market indices. In particular, the study utilizes fractional integration techniques to assess persistence at the daily, weekly and monthly data. Persistence is estimated by comparing the pre-pandemic period (during the period 2003–2019) to the frequencies prolonged until January 2022 that covers the COVID-19 pandemic period and to those from a sample extended up to February 2023 which includes the Russia-Ukraine war. Additionally, the findings of the impact of COVID-19 (the data ending at December 2021) show that for the monthly data the COVID-19 has had effects in the stock markets of Bahrain and Indonesia, for the weekly data

Table 14. Summary of the results.

	Daily			Weekly			Monthly		
Series	Pre-Covid	Covid	Russia-Ukraine war	Pre-Covid	Covid	Russia-Ukraine war	Pre-Covid	Covid	Russia-Ukraine war
Bahrain	1.05 (1.01, 1.10)	1.05 (1.01, 1.09)	0.97 (0.94, 1.00)	1.16 (1.09, 1.26)	1.19 (1.12, 1.29)	1.19 (1.11, 1.28)	1.06 (0.89, 1.30)	1.05 (0.90, 1.27)	1.03 (0.91, 1.22)
Egypt	0.96 (0.92, 1.01)	0.99 (0.96, 1.04)	1.02 (0.98, 1.05)	1.08 (1.02, 1.16)	1.08 (1.02, 1.16)	1.09 (1.03, 1.17)	1.11 (0.98, 1.30)	1.11 (0.97, 1.28)	1.10 (0.98, 1.25)
Indonesia	0.99 (0.95, 1.03)	1.00 (0.96, 1.04)	1.00 (0.96, 1.04)	1.11 (1.02, 1.19)	1.09 (1.02, 1.17)	1.08 (1.01, 1.18)	0.95 (0.81, 1.18)	0.96 (0.80, 1.17)	0.93 (0.81, 1.11)
Kuwait	1.05 (1.01, 1.10)	1.01 (0.98, 1.05)	0.96 (0.93, 1.00)	1.11 (1.03, 1.21)	1.12 (1.04, 1.20)	1.11 (1.04, 1.20)	1.11 (0.90, 1.39)	1.05 (0.86, 1.31)	1.01 (0.86, 1.28)
Malaysia	1.02 (0.99, 1.06)	1.05 (1.01, 1.10)	1.03 (1.00, 1.07)	1.08 (1.02, 1.19)	1.09 (1.02, 1.16)	1.07 (1.00, 1.15)	1.08 (0.91, 1.32)	1.07 (0.92,1.26)	1.07 (0.92, 1.25)
Morocco	0.98 (0.95, 1.02)	1.00 (0.96, 1.04)	1.00 (0.97, 1.04)	1.08 (1.02, 1.16)	1.08 (1.02, 1.16)	1.10 (1.04, 1.19)	1.14 (1.02, 1.32)	1.07 (0.97, 1.22)	1.08 (0.96, 1.24)
Oman	1.09 (1.04, 1.13)	1.07 (1.01, 1.10)	0.96 (0.93, 1.01)	1.14 (1.07, 1.23)	1.14 (1.06, 1.23)	1.12 (1.05, 1.20)	1.27 (0.90, 1.66)	1.19 (0.86, 1.64)	1.18 (0.92, 1.55)
Pakistan	1.11 (1.07, .14)	1.10 (1.06, 1.14)	1.07 (1.03, 1.11)	1.08 (1.01, 1.19)	1.07 (1.00, 1.17)	1.07 (1.00, 1.16)	0.97 (0.82, 1.59)	0.96 (0.83, 1.11)	0.99 (0.88, 1.15)
Qatar	1.00 (0.96, 1.05)	0.99 (0.95, 1.04)	0.91 (0.88, 0.94)	1.03 (0.94, 1.11)	1.03 (0.95, 1.11)	0.81 (0.70, 0.97)	1.00 (0.75, 1.32)	0.97 (0.76, 1.27)	0.99 (0.75, 1.28)
Turkey	1.00 (0.96, 1.04)	0.99 (0.95, 1.03)	1.02 (0.98, 1.05)	1.04 (0.97, 1.14)	1.05 (0.96, 1.12)	1.05 (0.98, 1.14)	0.98 (0.85, 1.21)	0.95 (0.83, 1.12)	0.98 (0.85, 1.17)
UAE	1.05 (0.99, 1.08)	1.01 (0.98, 1.05)	0.94 (0.91, 0.97)	1.06 (0.98, 1.14)	1.05 (1.00, 1.14)	1.05 (0.99, 1.13)	1.08 (0.92, 1.38)	1.09 (0.91, 1.33)	1.09 (0.92, 1.33)

In blue, cases where a decrease in the order of integration is found with respect to the previous subsample. In red, cases where an increase in the order of integration is found with respect to the previous subsample.

in Qatar and Turkey and lastly for the daily data in Bahrain, Malaysia, Oman and Pakistan. The findings indicate that with regard to the daily series neither the COVID-19 pandemic nor Russia-Ukraine war have had a significant impact on the degree of persistence of the cases of Bahrain, Kuwait, Malaysia, Oman, Pakistan, Qatar and the UAE stock market indices. Regarding the weekly and monthly series in Indonesia, Oman, Pakistan, Qatar, the UAE stock market indices will not have significant long-lasting impacts in any samples. Whereas the situation is opposite, meaning that both shocks, COVID-19 and Russia-Ukraine war (the data ending at February 2023), have had impacts in the stock market of Oman at the daily frequency, Indonesia at the weekly frequency and Kuwait at the monthly frequency. Additionally, the results show that the indices are nonstationary I(1) though fractional degrees of integration with values to some extent lower or above 1 are similarly conceivable in a few cases, that is in accordance with the findings revealed by Caporale et al. (2022; Caporale, Gil-Alana, and Lasaosa 2022).

One shortcoming in this study is that it does not take into account nonlinear data structures. It is true that examining nonlinearities is significant in this situation because fractional integration might be falsely created by breaks that have not been considered. The emphasis is on the effect of the COVID-19 pandemic and the Russia-Ukraine war on the degree of persistence of the frequencies of interest; though, the time period studied embraces additional conceivable disruptions, such as the global financial crisis of 2007/08, that will be addressed in future study.

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