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The impact of Ukraine-Russia war on stock market volatility: Evidence from G7 economies.

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Abstract: The current study investigates how the recent war between Ukraine and Russia impacted the volatility of G7 economies of the stock markets in major industrialized countries like United States (US), the United Kingdom (UK), Canada, Japan, France, Germany, and Italy, from January 2, 2022, to December 25, 2022. While it is widely acknowledged that geopolitical events can influence financial markets, the specific effects of the conflict in Ukraine on stock market volatility remain largely unexplored. Understanding how geopolitical events like the Ukraine war affect stock returns can provide insights into the resilience and vulnerability of G7 economies during times of conflict. This knowledge is crucial for policymakers, investors, and market participants in assessing the potential risks and developing appropriate strategies to manage and mitigate the impact on the economy. The paper applies Exponential Generalized Autoregressive Conditional Heteroskedasticity (EGRACH) model to detect the influence of the war on stock markets volatility. EGRACH estimations revealed that there is a direct impact of the information content of the war on the volatility of the majority of the countries under study. More specifically, four countries are negatively influenced by the war, Canada, France, Germany and UK. While three countries are not affected by the news which are Japan, USA and Italy. Granger causality reveals that there is a unidirectional relationship between war news and stock indices of three economies which are Germany, France and Italy. However, other indices did not show any unidirectional relationship (Japan, USA, UK and Canada). To find out if there is a long-term association between indices and the information content of the war, cointegration test was employed. The results showed the long-term association between the two variables.

Keywords: *G7 countries, Stock market indices, volatility, EGARCH model, Cointegration test, Granger causality, Ukraine-Russia war, geopolitical risk.*
Jel classification: *C32; C58; F51; Q34; Q43*

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Introduction

Russia began a "special military operation" on February 24, 2022, signaling the beginning of the military war between Russia and Ukraine. The ongoing conflict between Russia and Ukraine has caused massive casualties and displacement, creating an unprecedented refugee situation in Europe not seen since World War II. This is surprising because Russia has not officially declared war (Yousaf, et.al 2022; Hudson 2016). It also has a variety of detrimental financial repercussions on markets and the world economy.

The crisis between Russia and Ukraine is having major repercussions for both countries as well as perhaps posing a danger to the developed G7 economies (Bagchi & Paul 2023). While it is true that the conflict is primarily affecting Ukraine, whose economy could fall by as much as 8% this year, the advanced economies of the G7— the United States (US), the United Kingdom (UK), Canada, Germany, France, Japan, and Italy—are also severely impacted (http://hdl.handle.net/10419/204257 accessed on June 17, 2022). More generally, one may argue that this war is seriously impeding the world's ability to recover from the COVID-19 pandemic and will probably make inflation worse (Bagchi & Paul 2023).

One of the most important questions that has to be answered is why the G7 markets is so vulnerable to the current conflict and the ways in which it can be impacted by the situation in Ukraine. Firstly, it is important to acknowledge that the G7 nations are leading the sanctions system against Russia and providing financial and military assistance to Ukraine in its conflict with Russia. As a result, these nations have boosted their defense and other war-related spending. This may lead to increased debt and inflation, both of which may cause interest rates to rise. This in turn may have an impact on how much stocks are priced. Second, investors may become less risk-tolerant as a result of war-related occurrences (Verdickt 2020; Wang & Young, 2020). Demand for fixed income assets will increase as a result of investors seeking safer investments during uncertain times, such as government bonds (Costantini & Sousa, 2022; Mohamad, 2022). Stock prices may decline as a result (Leippold & Matthys, 2022; Zaremba et al., 2022). The Ukraine situation has the potential to increase geopolitical risk and uncertainty, which could lead to a flight to safety in the fixed income market instead of investing in stocks (see, for example, Feng et al., 2023). This might increase demand for safe-haven investments like US Treasury bonds, which would reduce yields. In addition, the disruption of the world's supply networks has raised central bank interest rates, supply chain expenses, and inflation.

According to scholarly research, among the various "black swan" events (such as financial and health crises, elections, natural disasters, and

terrorist attacks) that have an impact on the world's equity markets, war is one of the most important ones. Conflicts involving the military make investors less confident in the company's potential for profit (Leigh et al., 2003; Rigobon and Sack, 2005; Choudhry, 2010; Hudson and Urquhart, 2015; Brune et al., 2015). This uncertainty is reflected in fluctuations in stock prices. For portfolio managers, investors, and regulators in particular, the effects of wars on equity markets are crucial. Therefore, the current research aims to provide empirical data on the financial implications of the armed war between Russia and Ukraine. This data will be useful for formulating successful hedging strategies, portfolio rebalancing decisions, and policy decisions during the continuing military actions. A great deal of analysis has been done on the response and recovery of different financial markets from the COVID-19 shock, and this has led to a recent increase in scholarly interest in evaluating the detrimental financial effects of black swan events. (Yarovaya et al., 2021, 2022a, b; Yousaf, 2021). Just a small amount of research has been done on how military activities effect financial markets, though (See for example: Frey and Kucher2000; Choudhry 2010; Hudson and Urquhart 2015; k, Hudson and Urquhart 2022; Fernandez 2009).

Based on the aforementioned discussion, the importance of undertaking geopolitical conflicts and its impact of stock market performance can be summarized as follows: First of all, stock market performance is closely intertwined with overall economic stability. Understanding how geopolitical events like the Ukraine war affect stock returns can provide insights into the resilience and vulnerability of G7 economies during times of conflict. This knowledge is crucial for policymakers, investors, and market participants in assessing the potential risks and developing appropriate strategies to manage and mitigate the impact on the economy (Izzeldin.et.al 2023). Second, by looking at how the war in Ukraine affects stock markets, investors can learn more about how political events around the world can influence financial markets. This knowledge helps them make smarter investment choices, change their portfolios as needed, and control how much they're invested in countries involved in the conflict. (Kamal et.al 2023; Izzeldin.et.al 2023) Third, studying the impact of the Ukraine war on stock returns of G7 countries can inform policymakers about the effectiveness of their measures and interventions in managing financial market volatility during geopolitical crises. This knowledge can help shape future policy frameworks to improve the resilience of economies and financial systems (Maurya et.al 2023).

The primary research problem in this topic revolves around investigating the effect of the Ukraine war on stock market volatility in G7. While it is widely acknowledged that geopolitical events can influence

financial markets, the specific effects of the conflict in Ukraine on stock market returns remain largely unexplored (see for example Izzeldin, et.al 2023; Taera, et.al 2023; Babar, et.al]2023). Additionally, literature reveals certain gaps concerning the effect of Ukrainian war on stock market returns. First of all, while there have been anecdotal reports and qualitative assessments of the impact of the Ukraine war on stock market returns, a comprehensive quantitative analysis is lacking. There is a need for empirical studies that utilize robust statistical methods to examine the relationship between the conflict and stock market returns volatility. Secondly, although studies have examined the immediate impact of the Ukraine war on stock returns, there is a need to investigate the long-term effects (See for example; Baele and Farooq 2014; Boyer and Zhen 2010; Kim, and Wei 2002; Boungou and Yatie 2022; Kabaddi 2023.)

Based on the aforementioned discussion, the current research aims at answering the following questions:

1) What is the effect of Ukrainian war on stock market returns volatility in the G7?
2) What is the long-term effect of Ukraine war on stock returns volatility in G7?

Findings revealed that there is a direct impact of the information content of the war on the volatility of the majority of the countries under study. More specifically, four countries are negatively influenced by the war, Canada, France, Germany and UK. While three countries are not affected by the news which are Japan, USA and Italy. Granger causality reveals that there is a unidirectional relationship between war news and stock indices of three economies which are Germany, France and Italy. However, other indices did not show any unidirectional relationship (Japan, USA, UK and Canada). To find out if there is a long-term association between indices and the information content of the war, cointegration test was employed. The results showed the long-term association between the two variables.

The rest of this paper is organized as follows; in the following section literature review will be displayed. Data and methodology will be displayed in section 3, empirical results will be displayed in section 4, discussion of the empirical results will be presented in section 5 and conclusion, policy implications, limitations and future research will be presented in section 6.

Theoretical framework and literature review

Theories

The association between political instability and stock market performance has been explained by a number of major hypotheses. These ideas offer several viewpoints on the ways in which political events and

unpredictability may affect financial markets. The three primary theories are as follows:

A. Efficient market hypothesis

The Efficient Market Hypothesis (EMH) suggests that stock prices reflect all the information that's out there, making the market fair and difficult to beat. According to this theory, political instability and related events are quickly assimilated by investors, and stock prices adjust accordingly. In other words, stock market reactions to political instability would be immediate and reflect the consensus view of market participants (Assaf, Gupta and Kumar 2023). Proponents of the EMH argue that it is difficult to consistently profit from trading based on political events, as markets quickly incorporate the new information into prices. The EMH and its ramifications in different financial markets have been the subject of numerous studies. The fundamental work "Efficient Capital Markets: A Review of Theory and Empirical Work" by Eugene Fama served as the impetus for the development of the EMH. Fama conducted a thorough analysis of the empirical data that has been done to date to support the ideas that financial markets are efficient and that it is challenging to regularly beat the market using knowledge that is readily available to the public. Fama & French (1992): Fama and French expanded on the traditional EMH by introducing the concept of the Three-Factor Model, which includes market risk, size, and value factors. Their study examined stock returns over a long-time horizon and found evidence of a size effect (small-cap stocks outperforming large-cap stocks) and a value effect (value stocks outperforming growth stocks), challenging the notion of complete market efficiency. Burton Malkiel popularized the EMH and gave reasons against active portfolio management in his book "A Random Walk Down Wall Street" (Malkiel, 2003). He maintained that market timing and stock selection techniques cannot reliably outperform the market since stock prices exhibit a random walk pattern. Lo & MacKinlay (1999) conducted an extensive empirical study examining the efficiency of stock markets using a variety of statistical tests. Their research analyzed different forms of market efficiency, including weak-form efficiency (informational efficiency in past prices), semi-strong form efficiency (incorporation of publicly available information), and strong form efficiency (incorporation of all information, including private information). They found evidence supporting weak-form efficiency but noted some deviations from semi-strong and strong form efficiency. These studies and many others have contributed to the ongoing debate around the validity and applicability of the EMH. While the EMH has faced criticism and alternative theories have emerged, it remains a significant framework for understanding market efficiency and has shaped the field of finance and investment research.

B. Flight-to-Safety Theory

The Flight-to-Safety theory posits that during periods of political instability, investors tend to seek safe-haven assets and reduce their exposure to risky assets such as stocks. This theory suggests that political turmoil increases uncertainty and risk aversion among investors, leading to a shift of capital away from stocks and towards less risky assets like government bonds or gold. As a result, stock market prices may decline and volatility may increase during times of political instability (Adrian et.al 2019; Bisbee and Honig 2022; Brocato and Smith 2012).

Several studies that look at investors' actions in times of uncertainty or economic stress have examined the Flight-to-Safety hypothesis. These studies look into the flow of money into safer assets and how that affects financial markets. Bekaert and Urias (1996) study looked at how political risk and capital flight are related, with a particular emphasis on how foreign investors behave when there is political unrest. The researchers discovered evidence in favor of the Flight-to-Safety theory using a sample of emerging market nations. During times of elevated political risk, investors reallocate their portfolios towards less risky assets, such U.S. Treasury bonds. The Flight-to-Safety phenomena was examined by Baur and Lucey in relation to the global financial crisis. Their research examined how investors behaved in a variety of financial markets, such as bonds, currencies, and stocks, throughout the crisis. The research provided evidence in favor of the Flight-to-Safety argument, showing that money migrated to safe-haven investments like gold and government bonds while risky assets saw sharp drops. Welch and Goyal (2008): Goyal and Welch investigated the Flight-to-Safety effect and the relationship between stock market performance and market volatility. Their research, which examined data from several stock markets, discovered that investors had a tendency to move their money from volatile assets like Treasury notes to less volatile ones during times of intense market volatility. Lower stock market returns were linked to this flight to less hazardous assets, which is consistent with the Flight-to-Safety argument.

C. Behavioral finance theory

Behavioral finance theory seeks to understand how psychological biases and irrational behavior influence financial decision-making and market outcomes. While the theory primarily focuses on individual and collective investor behavior, it can provide insights into how the Russian-Ukraine war is perceived and potentially impact financial markets (Kantomaa 2022; Illiashenko 2017). Behavioral finance theory suggests that individuals are prone to cognitive biases that affect their decision-making. In the context of the Russian-Ukraine war, cognitive biases such as confirmation bias (favoring information that confirms preexisting beliefs) and availability bias

(relying on readily available information) can shape how investors interpret and react to news related to the conflict. These biases can lead to overreaction or underreaction in financial markets, potentially causing stock prices to deviate from their fundamental values. Behavioral finance theory highlights the tendency of investors to follow the actions of others, leading to herd behavior. In the context of the Russian-Ukraine war, if a significant number of investors perceive the conflict as a significant threat to global stability, they may engage in herding behavior by selling their holdings or reducing exposure to affected markets. This can amplify market volatility and potentially lead to stock market declines as investors collectively react to perceived risks. (Kantomaa 2022; Priem 2022)

Behavioral finance theory emphasizes that individuals tend to be more sensitive to losses than to gains. In the case of the Russian-Ukraine war, if investors perceive the conflict as a negative development that poses risks to their investments, they may exhibit loss aversion behavior by becoming more risk-averse and selling their holdings. This behavior can put downward pressure on stock prices as the selling outweighs buying activity in the market (Bougatef and Nejah, 2024; Kantomaa 2022; Illiashenko 2017).

Behavioral finance theory suggests that investors can get stuck on the first news they hear about an event, like the war in Ukraine. This is called anchoring bias. Because of this, they might judge new information based on that first impression, which can cloud their judgment and lead to investment decisions that are not the best. This could swing stock market prices more than the actual situation deserves (Tosun & Eshraghi 2022; Federle et.al 2022).

Recent research has explored how investor sentiment can be better understood by considering how they react to various external factors, such as media coverage, false information, fear, opinions expressed in the media, and exaggerated excitement (Boungou & Yatié, 2022; Huynh et al., 2021; Khalfaoui et al., 2023). While these behavioral indicators are a good way to directly measure how investors react to major events, they haven't been used in a more comprehensive way to understand investor feelings about war and sanctions. One Once more, previous research has not shed light on how the financial market responds to investor sentiment over economic sanctions in the context of the Ukrainian conflict, both positively and negatively.

Empirical evidence

The impact of wars on stock returns volatility

Studies have shown that uncertainty in politics, specifically the fear of political instability significantly impacted, in a negative way, both the returns investors receive from the stock market and the inherent risk

associated with various financial assets (see, e.g., Gemmill, 1992; Nippani and Medlin, 2002; Mei and Guo, 2004; Li and Born, 2006; Jones and Banning, 2008; Dimic et al., 2015; Kapar & Buigut, 2020; Boungou & Yati´e, 2022). Berkman et al. (2011) emphasize the significance of political crises to explain both the mean and the volatility of stock market returns globally using a number of worldwide political crises. Lehkonen and Heimonen (2015) similarly demonstrate an inverse link between stock returns and political risk using data from 49 emerging nations.

Smales (2017) reported a strong positive correlation between political uncertainty, as exemplified by the Brexit referendum, and increased uncertainty in financial markets. In their analysis of the financial consequences of diplomatic conflicts that have not resulted in violence between Taiwan and mainland China, He et al. (2017) demonstrate that political unrest is linked to a notable decrease in stock market returns. They also discover a correlation between declines in present stock returns and expected future levels of tension. According to Kapar and Buigut (2020), political and economic embargoes against Qatar had a significant effect on the country's stock market volatility. Additionally, Buchung and Kapar (2020) show that the boycott of Qatar has had a significant effect on the stock markets of the GCC nations, with varying results for various sectors and nations. Lastly, Bash and Alsaifi (2019) demonstrate how the stock returns of the Saudi Stock Exchange have been significantly impacted negatively by Jamal Khashoggi's disappearance.

According to Frey and Kucher (2001), conversely, Hudson and Urquhart (2015) found only weak correlations between war-related incidents and UK stock market returns. Considering several war occurrences from the perspective of the global financial market, Schneider and Troeger (2006) found a substantial negative response in the stock market. Generally, past research on the events that took place between markets during a war event had the most bearing on financial markets (see, for example, Izzeldin et al., 2023; Karkowska & Urjasz, 2023; Kumari et al., 2023; Lo et al., 2022).

The impact of Ukraine-Russia war on stock returns volatility

A few recent studies examine how the Russia-Ukraine situation has affected financial markets in various scenarios. For instance, the Russia-Ukraine situation has had a notable negative impact on the performance of global stock market indices, according to Boungou and Yatee (2022). Stock market indexes in developed countries have been more severely and negatively impacted than those in emerging markets, as demonstrated by Boubaker et al. (2022). The European stock markets have suffered greatly as a result of Russia's recognition of the two Ukrainian states as autonomous territories, according to Ahmed et al. (2022). According to Fang and Shao

(2022), the conflict between Russia and Ukraine has had an impact on the commodity markets via financial and economic channels.

Yousaf et al. (2022) used the event study method to investigate the dispute between Russia and Ukraine in the G20 and other particular financial markets. They concluded that the day of the invasion demonstrated the military action's significant negative influence on most financial markets, particularly the Russian market. During the dramatic two weeks that followed the invasion, Tosun and Eshraghi (2022) looked into how the financial markets responded to announcements of enterprises that were staying in Russia. They discovered increased selling pressure and trading volume on remainders, as well as the challenge of making any kind of meaningful judgment when there was political unrest. Generally speaking, the Russia-Ukraine war had a difficult economic influence on other nations as well as the world economy.

H1: There is a negative impact of Ukraine war on stock market volatility in the G7 countries.

The long-term association between political crisis and stock market indices

In this section the long-term impact of political events on stock markets performance will be displayed, as no studies have examined the association between Ukraine war on stock market indices in the long-term. Tajaddini, et.al (2009) aims at examining the long-term influence of political events on stock market indices. More specifically, two political crises were chosen to serve as the study's benchmarks: the US invasion of Iraq in 2003 and the events of September 11, 2001. The main conclusion of this research is that there is a long-term influence of political crises on stock indices volatility. Aslanova and Mammadova (2023) aims at exploring the impact of US Dollar index, the USD/RUB exchange rate, and the prices of natural gas, crude oil, and Brent oil on markets' indices. Using 46-week data for the 2022–2022–December period. The results confirmed that the long-term influence of previously indicated variables on stock market indices during Ukraine war. In Guo, et.al (2021) the aim is to examine the potential short- and long-term effects of political risk and crude oil on the stock, taking into account potential nonlinear, asymmetric, and endogenous characteristics. This paper also attempts to investigate whether the impacts are contingent on market conditions and whether the 2008 financial crisis has altered them. It concludes the long-term influence of political risk and crude oil on stock markets. In the research introduced by Abdelbaki (2013), the author attended to examine the influence of Arab spring revaluations as a measurement of political instability on stock market performance in the short and long-run. the author employs techniques of time series data cointegration; Vector Error Correction Model (VECM). The main conclusion of this research is that the

relation between political instability and stock indices of Egypt is a long-term relation.

Based on the aforementioned results, the second hypothesis is formulated as follows:

H2: There is long-term impact of Ukraine war on stock market volatility.

Data and methodology

Data

In order to ensure a thorough and diversified viewpoint, we chose the G7 countries to determine the worldwide effect of the Russia-Ukraine war. The representativeness of the markets was the criterion used in the selection process; European markets were selected in greater proportion due to the war's stronger impact on them (Deng et al., 2022). Based on capitalization and volume, the most representative stock market index for each nation was picked; the indices that were chosen were comparable since they had the same initial values on a standardized scale. For every stock index that was selected, a thorough time series was created using weekly data from the investing.com website, from January 2, 2022, to December 25, 2022. The nations taken into account and the stock indices examined are listed in Table 1. The weekly index return ($R_{i,t}$) and weekly volatility ($\sigma_{i,t}$) to the using weekly closing index prices was determined using the following formula is:

$$R_{i,t} = \ln\left(\frac{index_{Friday,t}}{index_{Monday,t}}\right) \quad (1)$$

$$\sigma_{i,t} = R_{i,t}^2 \quad (2)$$

Where $index_{Friday,t}$ and $index_{Monday,t}$ are the closing stock market index prices on Friday and Monday respectively, in week t.

Nonejad (2022) showed that there has been a rise in research on uncertain financial phenomena depending on newspaper information in recent years. The Google Search Volume Index (GSVI) was intended to be provided by Google Trends in 2006. Because Google dominates the global market relative to other similar service providers, that is why we chose it. The www.netmarketshare. com webpage states that Google is the search engine with the most global market share. For a specific search term, this algorithm provides the weekly search volume. The following equation (http://www.atlantis-press.com) was used to calculate the GSVI:

$$\text{GSVI} = \frac{number\ of\ queries\ \ for\ each\ keyword}{total\ google\ search\ queries} \quad (3)$$

There is statistical data about keywords in this index. As a result, over a given time frame, the search popularity of any keyword may be seen for every nation. Every user's acquired data creates a trail on Google Trends.

Weekly data collection began on Sundays. As a result, we have to use relationship 1 to determine the indices' weekly return and volatility.

There were a few reasons why we used English search terms. First, both domestic and foreign investors speak English extensively. The majority of trading platforms utilize English, and Google search engines favor English keywords over other languages (Anastasiou et al., 2022; Wanidwaranan and Padungsaksawasdi, 2022). The process of choosing relevant search terms is arbitrary. Nonetheless, we took great care when choosing search terms for this study to make sure they were pertinent to the war between Russia and Ukraine and might offer insightful information on how the conflict was affecting international markets. We kept the terms that had the greatest average Google search frequency over the course of the analysis: "war," "boycott," "disinvestment," "sanctions," "Ukraine," "Russia," and "The Russian—Ukrainian War."

The following table reveals the G7 countries included in current research sample and the abbreviations used in the empirical part discussions.

Table 1: The sample and abbreviations

The variable	Abbreviation
Canada weekly index	CWI
USA weekly index	USAWI
France weekly index	FWI
Japan weekly index	JWI
Germany weekly index	GWI
UK weekly index	UKWI
Italy weekly index	IWI

Methodology

As we started our study, we made sure the generated time series was stationary. The Augmented Dickey—Fuller unit root test (ADF), which is frequently used in volatility research, was utilized to achieve this goal (Jiang et al., 2012; Youssef et al., 2021). The following is the equation:

$$\Delta Y_t = \alpha + bt + \delta Y_{t-1} + \sum_{i-1}^{k} \Delta\delta_i Y_{t-i} + \xi_t \quad (4)$$

Where ΔY_t describes a mathematical model for analyzing changes in a variable Y over time t and t-1, k is the number of lags in the model, α is the constant and b is the coefficient of the trend. Consequently, stationarity is tested whether or not it is as follows: It is assumed that if the p-value < 0.05, it is statistically significant and accordingly it rejects the null hypothesis that the unit root exists, which means that the time series is stationary and if it is higher than the critical value, the null hypothesis is accepted, that is, the non-

stationary time series, and then we test the first difference, and if it is not stationary, we repeat the test for the difference of a higher degree and so on.

For checking the presence of conditional heteroscedasticity in the data the study used the ARCH LM test (Engle,1982). the null hypothesis is that there is no conditional heteroscedasticity in the data, meaning that the variance of the error term is constant over time. The alternative hypothesis suggests the presence of conditional heteroscedasticity, indicating that the variance of the error term is not constant but varies with the level of some other variable(s) in the model. The test involves regressing the squared residuals from the original model on lagged squared residuals. The LM (Lagrange Multiplier) statistic is then computed from this regression, and its significance is assessed to determine whether there is evidence of conditional heteroscedasticity.

Causality between volatility and news is established via the Granger test (Hsieh et al., 2020). The Granger causality test (Granger and Lin, 1995) was then applied to determine the direction and causal relationship between variables, with the null hypothesis stating that the independent variable doesn't Granger cause the dependent variable, against the alternative. For every index return, paired Granger causality tests were performed. Bidirectional causality for test pairs across national boundaries is feasible, as Tantaopas et al. (2016) proposed (Kumeka et al., 2022).

Investigations into what is causing this volatility are still under progress. Each nation was subjected to a vector autoregression (VAR) model in order to highlight war news as the main source of volatility. Sims (1980) developed a paradigm that permits the use of multivariate time series. Each variable in our example is represented by a linear expression of its prior values in a two-equation model; this is known as a two-variable VAR model. Each variable's previous values were taken into account, in addition to a serially uncorrelated error term.

$$R_t = \alpha_1 + \sum_{i=1}^{k} \delta_i R_{t-i} + \sum_{i=1}^{k} \beta_i GSVI_{t-i} + \xi_{1t}$$
$$GSVI_t = \alpha_2 + \sum_{i=1}^{k} \vartheta_i GSVI_{t-i} + \sum_{i=1}^{k} \theta_i R_{t-i} + \xi_{2t} \quad (5)$$

In these equations, variables α_1 and α_2 are constant terms; δ, ϑ, β, and θ are the coefficients; and $\xi_{1t}$and ξ_{2t} are white noise error terms (Kubiczek & Tuszkiewicz, 2022; Zhang & Mao, 2022).

The bivariate VAR Eq. 5 contains the null hypothesis (R_t is not a cause of GSVI) and the alternative hypothesis (R_t causes GSVI). The econometric model was chosen and used as follows: When it comes to time-series research, the GARCH model (Bollerslev, 1986) and the ARCH model (Engle, 1982) are commonly used (Sims, 1980). Because conditional and unconditional variances differ, these models meaningfully test and assess returns and

volatility simultaneously. Unconditional variances are independent of time, whereas conditional variances rely on past occurrences.

$$Y_t = \mu_t + \omega_t X_t, X_t \sim N(0,1), \quad (6)$$

$$\varepsilon_t = \omega_t X_t, \varepsilon_t \sim N(0, \omega_t^2), \quad (7)$$

$$\omega_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i \varepsilon^2{}_{t-i} + \sum_{j=1}^{p} \beta_j R_{t-j} \quad (8)$$

The volatility in these equations is represented by the term, ω_t^2 nd consists of ARCH (q) and GARCH (p) α_0 is a constant; the persistence of volatility is shown by the parameter α_i>0 , the reaction speed of volatility to market shocks is indicated by the parameter β_j >0 represent the reaction speed of volatility to market shocks; and ε_t represents the residual terms. In order to have a stationary covariant process, the following prerequisite needs to be met (Engle, 1982):

$$\sum_{i=1}^{p} \alpha_i + \sum_{j=1}^{q} \beta_j < 1 \quad (9)$$

In the Exponential Generalized Autoregressive Conditional Heteroskedasticity (E- GARCH) model, the coefficients have negative values. Furthermore, for the same size shock, negative shocks affect volatility more than positive shocks. As a result, the model takes into account both the asymmetric impacts of volatility and leverage.

$$\text{Ln}(\omega_t^2) = \alpha_0 + \sum_{i=1}^{p} \alpha_i \frac{|\varepsilon_{t-i}| + \delta_i \varepsilon_{t-i}}{\omega_{t-i}} + \sum_{j=1}^{q} \beta_j h_{t-j} \quad (10)$$

In Eq(10), whenε_{t-i} is positive, the total effect of ε_{t-i} is $(1+\delta_i)$, alternatively whenε_{t-i} is negative, the total effect of ε_{t-i} is $(1-\delta_i)|\varepsilon_{t-i}|$. Having a negative value of ε_{t-i} greatly affects volatility, resulting in a negative value for δ_i (Alomari et al., 2021).

Empirical results

Descriptive statistics

We examined how the conflict between Russia and Ukraine affected financial markets around the world. Table 2 shows data on how stock market returns changed over the entire period, measured using logarithms. The table includes statistics like average returns, middle values (medians), the highest and lowest returns, how spread out the data is (standard deviation), and a test to see if the returns follow a normal distribution (Jarque-Bera test).

It is shown that for every series deemed asymmetric, the skewness indicator has values other than zero. If the conflict has had a negative effect on the observable stock market indicators, it is shown by a value smaller than zero. The distribution peak is to the left of the mean skewness. As a result, the mean value moves to the left and is less than the median value. The stock indices of JWI and USAWI exhibit positive skewness, with a bias towards the

right. The majority of values were centered on the left tail, with the right tail typically being longer than the left.

The amplitudes of extreme values are displayed by the kurtosis indicator. Of the indices, four out of seven had a value greater than three, and the remaining indices had values between two and three. This result indicates that the data series has thicker tails than a normal distribution and that the index performance is leptokurtic. Excess kurtosis in the examined series suggests a high likelihood of obtaining extreme values. The three variables with the highest values were CWI (+6.71). The lowest values seen during the same period was USAWI (+2.52). Because stock markets are interconnected, expectations about extreme values are zonally grouped. Table 2 shows that the skewness of the majority of indices is negative and nearly zero.

The variables distribution is shown by the Jarque-Bera test. Time-series normality was eliminated as a null hypothesis at the 1% critical level, meaning that the test's corresponding probability was zero. Table 1 shows that for 4 of the investigated indices, the probability is zero and the resulting numerical values are significantly different from those derived from a normal distribution. The lower risk levels were due to the more stable stock markets for the indices (JWI) and (USAWI) that reported values higher than 0.01.

Tablee2: Descriptive statistics

Series	Canada index	France index	Germany index	Japan index	UK index	USA index	Italy index
Mean	-0.002	-0.0017	-0.002	-0.001	0.0001	-0.003	0.0028
Median	0.001	-0.001	-0.001	-0.004	0.003	-0.009	0.0029
Maximum	0.056	0.057	0.057	0.066	0.040	0.06	0.050
Minimum	-0.128	-0.102	-0.101	-0.066	-0.06	-0.057	-0.065
Std. Dev.	0.031	0.027	0.028	0.025	0.019	0.0322	0.022
Skewness	-1.16	-0.831	-0.560	0.312	-0.728	0.479	-0.295
Kurtosis	6.71	4.937	4.749	3.406	4.422	2.522	3.45
JB	41.60***	13.8***	9.174***	1.182	8.808**	2.44	1.175
Prob.	0.000	0.000	0.010181	0.5536	0.01222	0.294	0.5555

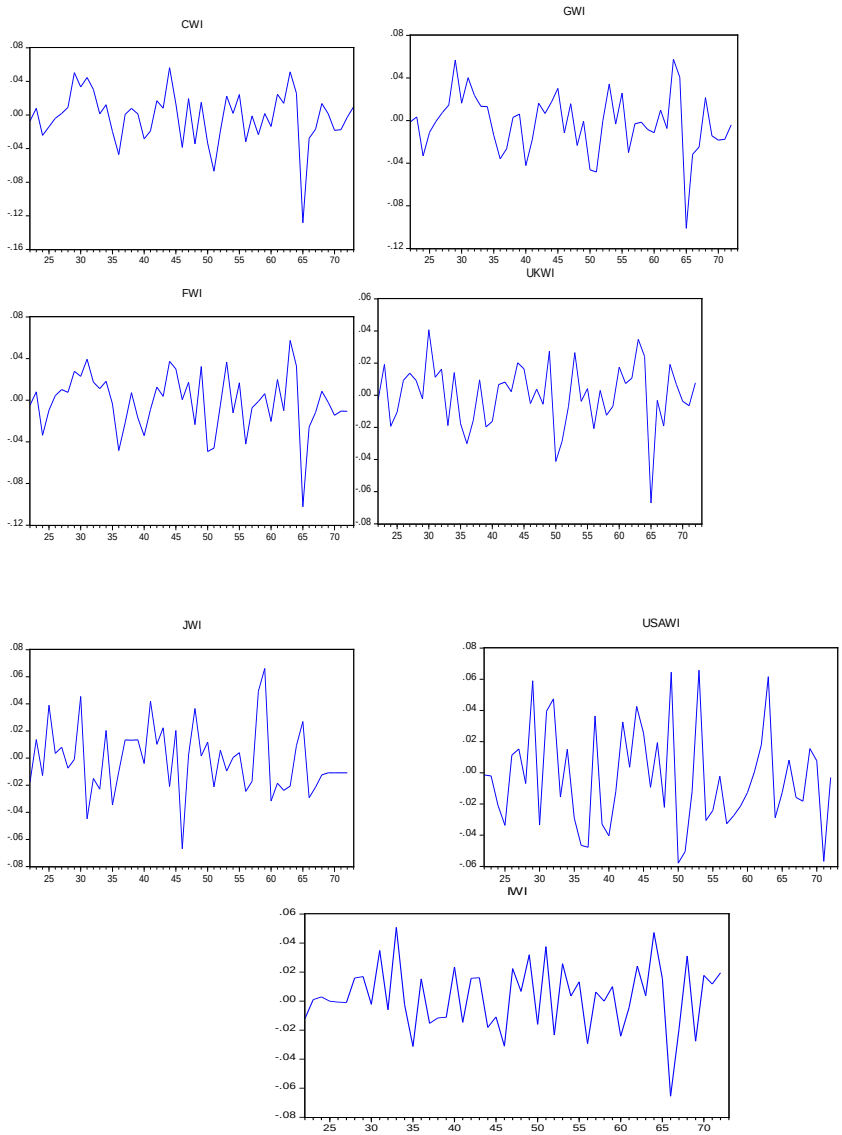

Figure 1. weekly index returns during the analyzed period

The ADF test was used to look at the stationarity of the stock indexes. Based on the results, the unit root null hypothesis was rejected because the test value was below the critical threshold for all relevance levels. The weekly returns at the 1%, 5%, and 10% levels were statistically significant. This study's statistical results show that the characteristic polynomial roots have a modulus less than one, which leads to a stable equation (refer to table 3). Consequently, the series does not follow stochastic processes and is stationary. Figure 1 illustrates the stationarity of the series by displaying the weekly returns for each series.

Table 3: Augmented dicky fuller test

ADF	T-statistic	Probability	ADF	T-statistic	Probability
CWI	-5.786837	0.0000	FWI	-6.163927	0.0000
1% level	-3.565430		1% level	-3.568308	
5% level	-2.919952		5% level	-2.921175	
10% level	-2.597905		10% level	-2.598551	
GWI	-5.629949	0.000	JWI	-7.347079	0.000
1% level	-3.568308		1% level	-3.568308	
5% level	-2.921175		5% level	-2.921175	
10% level	-2.598551		10% level	-2.598551	
UKWI	-6.869148	0.000	USAWI	-7.383811	0.000
1% level	-3.568308		1% level	-3.568308	
5% level	-2.921175		5% level	-2.921175	
10% level	-2.598551		10% level	-2.598551	
IWI	-8.656302	0.000			
1% level	-3.568308				
5% level	-2.921175				
10% level	-2.598551				

Note: ***, ** and * denotes 1%, 5% and 10% significant level

Table 4. EGARCH Regression Result

Index	Variables	Coefficient	Standard Error	Z-Statistic	Probability
CWI	GSVI	-0.000235	8.98E-05	2.614949	0.0089***
	C	-0.009662	0.003620	-2.668821	0.0076***
FWI	GSVI	-0.000326	0.000148	2.194924	0.0282**
	C	0.006135	0.004802	-1.277616	0.2014
GWI	GSVI	0.000422	0.000130	3.252042	0.0011***
	C	-0.009472	0.005249	-1.804469	0.0712*
JWI	GSVI	-0.000180	0.000102	-1.760627	0.1783
	C	0.001779	0.002814	0.632466	0.5271
UKWI	GSVI	-0.000195	0.000111	1.759678	0.0785*
	C	-0.005262	0.003740	-1.406667	0.1595
USAWI	GSVI	0.000539	0.000263	2.046219	0.4207
	C	-0.014385	0.005799	-2.480619	0.0131**
IWI	GSVI	-0.000144	0.000155	-0.931738	0.3515
	C	0.003203	0.004500	0.711741	0.4766

Note: ***, ** and * denotes 1%, 5% and 10% significant level

Tables 4 and 5 report the E-GARCH estimation model, first table 4 represents the direct impact of the GSVI on the volatility of the index returns, which illustrates that the news of the Russian-Ukrainian war has a negative significant impact on the index return of 4 countries from the G7 (CWI, FWI, GWI and UKWI), while JWI, USAWI and IWI are not affected by the war news.

The term α from relation 10 explains how conflict-related news volume influences future index return volatility. A positive value indicates a positive correlation between past and present return variances of the indices FWI, GWI and UKWI. The volatility increases with the increases in the variance shock's magnitude. The phrase $\boldsymbol{\delta}$ reveals the conflict-induced shock's nature and effect on the index return volatility. When a value is negative, it shows leverage. This means that bad news will have a greater impact on causing instability than good news of the same strength (FWI, GWI, UKWI and IWI). A negative and statistically significant beta coefficient reveals a counterintuitive relationship: investments with lower returns tend to experience more dramatic fluctuations in value compared to investments with higher returns of the same amount. (FWI, GWI and IWI) (Table 5).
From the aforementioned discussion we should accept the first hypothesis states that ***there is a negative impact of Ukraine war on stock market volatility in the G7 countries.***

Table 5. E-GARCH Coefficient

Index	**Coefficient**			
	α_0	α	δ	β
CWI	-1.085098***	0.813208	-0.385911	-0.759350
FWI	-5.218307***	0.235606**	-0.906135***	-0.286292***
GWI	-4.948738*	0.137873**	-0.582204**	-0.352411***
JWI	-0.840774***	-0.767506***	-0.177609	0.805034***
UKWI	-2.924683	0.333147**	-0.587994**	0.604451
USAWI	-5.323371**	-0.317108	-0.680888	0.217911
IWI	-13.04145***	-0.643835	-0.215659***	-0.750278***

Note: ***, ** and * denotes 1%, 5% and 10% significant level

Table 6. ARCH LM Results

Index	F-statistic	Probability
CWI	0.074111	0.7866
FWI	0.312009	0.5790
GWI	0.448172	0.5063
JWI	0.535145	0.4679
UKWI	0.467864	0.4972
USAWI	0.055737	0.8143
IWI	0.248560	0.6203

Note: ***, ** and * denotes 1%, 5% and 10% significant level

The ARCH LM test was conducted in table 6. The results indicate that the estimated model doesn't suffer from heteroscedasticity problem as the probabilities are greater than 0.05 so we can't reject the null hypothesis which states that there is no conditional heteroscedasticity in the data, meaning that the variance of the error term is constant over time. So, we can say that the E-

GARCH model doesn't suffer from conditional heteroscedasticity in the estimated models.

The Granger causality test was used to examine the causal relationships between the variables. There is a unidirectional causal relationship between news and the indices of 3 nations under study, as shown in table 7. We found that GWI stock index GWI had a significance level of 5%, whereas FWI and IWI stock had a significance level of 1% and 10%, respectively. This demonstrated a causal relationship, albeit a short-lived one, between the volatility of stock indexes and the GSVI. The indices and news do not exhibit a unidirectional or bidirectional causal relationship, which validates the findings of Kropiński and Anholcer (2022). Also, JWI, UKWI and USAWI all showed no interactions for return volatility and GSVI, meaning that the intensity of war information doesn't affects return volatility and vice versa.

Table 7: Granger Causality Results

Null Hypothesis	F-statistic	Probability	Causality direction
GSVI does not Granger Cause CWI	2.51612	0.7193	No causality
CWI does not Granger Cause GSVI	0.02973	0.8638	No causality
GSVI does not Granger Cause FWI	1.64715	0.0056	Unidirectional
FWI does not Granger Cause GSVI	0.23265	0.6318	No causality
GSVI does not Granger Cause GWI	4.63928	0.0364	Unidirectional
GWI does not Granger Cause GSVI	0.80568	0.3740	No causality
GSVI does not Granger Cause JWI	0.29930	0.5869	No causality
JWI does not Granger Cause GSVI	2.16750	0.1476	No causality
GSVI does not Granger Cause UKWI	0.17067	0.6814	No causality

UKWI does not Granger Cause GSVI	0.81933	0.3700	No causality
GSVI does not Granger Cause USAWI	1.23658	0.2718	No causality
USAWI does not Granger Cause GSVI	1.16510	0.2859	No causality
GSVI does not Granger Cause IWI	3.2E-06	0.0986	Unidirectional
IWX does not Granger Cause GSVI	0.00611	0.9380	No causality

Note: ***, ** and * denotes 1%, 5% and 10% significant level.

The time series were tested for cointegration using Johansen's test (MacKinnon et al., 1999). The null hypothesis is accepted when a critical value at 1%, 5%, or 10% is greater than the trace and Max-Eigen statistics value, and vice versa (MacKinnon et al., 1999). For the equation, cointegration exists if the null hypothesis is rejected.

To find out if there is a long-term association between the indices and GSVI, we performed a cointegration test. The optimal lags were ascertained by utilizing the Hannan-Quinn criterion (HQ), Akaike Information Criterion (AIC), and Schwarz Information Criterion (SC) with the lowest values (Ahmed et al., 2022). The number of lags was chosen based on the significant data at the 5% level and the final prediction criterion value (table 8). The analysis's findings show that, over the time period under investigation, there was a link between the indices and GSVI (Kropiński & Anholcer, 2022).

The results of the cointegration tests are presented in Table 9, which shows that, at a significance level of 1% and 5%, the maximum Eigenvalue and trace statistics were higher than the critical value. Our conclusion that the variables are in long-term equilibrium is based on the cointegration of the indices and GSVI at a significance level of 1% and 5%. This finding shows that the alternative is admissible, in contrast to the null hypothesis, which states that cointegration cannot be denied.

From the aforementioned discussion we should accept the second hypothesis states that: ***there is long-term impact of Ukraine war on stock market volatility.***

Table 8: VAR lag order selection criteria

Index	Lag	Log L	LR	FPE	AIC	SC	HQ
CWI	1	-105.3510	27.38481	0.35494*	4.639623*	4.873523*	4.728015*
FWI	1	-104.3588	8.237742	0.375579*	4.696119*	4.932308*	4.784998
GWI	1	-86.95012	26.42616*	0.179051*	3.955324*	4.191513*	4.044204*
JWI	1	-100.8840	21.05586*	0.323955*	4.548257*	4.784446*	4.637136*
UKWI	1	-73.51476	25.59886*	0.101084*	3.383607*	3.619796*	3.472486*
USAWI	1	-92.50075	27.95867*	0.226755*	4.191521*	4.427710*	4.280401*
IWI	1	-78.28574	36.63706*	0.123838*	3.586627*	3.822816*	3.675507*

Table 9: Johansen co-integration test

Unrestricted Cointegration Rank Test (Trace)

	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
CWI and GSVI	None *	0.330913	26.66699	15.49471	0.0007
	At most 1 *	0.123219	6.574924	3.841466	0.0103
FWI and GSVI	None *	0.398443	37.14333	15.49471	0.0000
	At most 1 *	0.221038	12.23989	3.841466	0.0005
GWI and GSVI	None *	0.407786	36.26293	15.49471	0.0000
	At most 1 *	0.194404	10.59246	3.841466	0.0011
JWI and GSVI	None *	0.421389	36.67381	15.49471	0.0000
	At most 1 *	0.182350	9.864717	3.841466	0.0017
UKWI and GSVI	None *	0.353395	30.89461	15.49471	0.0001
	At most 1 *	0.176740	9.529648	3.841466	0.0020
USAWI and GSVI	None *	0.452723	41.60491	15.49471	0.0000
	At most 1 *	0.218296	12.06768	3.841466	0.0005
IWI and GSVI	None *	0.406324	32.60386	15.49471	0.0001
	At most 1 *	0.134081	7.054216	3.841466	0.0079

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

	Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
CWI and GSVI	None *	0.330913	20.09207	14.26460	0.0054
	At most 1 *	0.123219	6.574924	3.841466	0.0103
FWI and GSVI	None *	0.398443	24.90344	14.26460	0.0007
	At most 1 *	0.221038	12.23989	3.841466	0.0005
GWI and GSVI	None *	0.407786	25.67047	14.26460	0.0005
	At most 1 *	0.194404	10.59246	3.841466	0.0011
JWI and GSVI	None *	0.421389	26.80910	14.26460	0.0003
	At most 1 *	0.182350	9.864717	3.841466	0.0017
UKWI and GSVI	None *	0.353395	21.36496	14.26460	0.0032
	At most 1 *	0.176740	9.529648	3.841466	0.0020
USAWI and GSVI	None *	0.452723	29.53722	14.26460	0.0001
	At most 1 *	0.218296	12.06768	3.841466	0.0005
IWI and GSVI	None *	0.406324	25.54964	14.26460	0.0006
	At most 1 *	0.134081	7.054216	3.841466	0.0079

Discussion

The current study used the EGARCH (Exponential Generalized Autoregressive Conditional Heteroskedasticity) model to examine how the war in Ukraine affected stock market volatility in the G7 nations. The study's conclusions offer insightful information about the dynamics of stock market volatility during a time of geopolitical unrest and how it affects global markets. The confrontation between Russia and Ukraine began when news of Russian troop advancement and subsequent bombs caused market volatility to increase. First, the findings showed that the G7 countries' stock market volatility was significantly impacted by the conflict in Ukraine. This result is consistent with earlier studies that showed how financial markets are sensitive to geopolitical and political developments (see for example: Boubaker et.al 2022; Ahmed, et.al 2023; Brune, et.al 2015, Assaf, et.al 2023). Stock markets saw greater volatility as a result of the war in Ukraine, which raised risk and

uncertainty. This volatility was a reflection of investors' cautious behavior and their responses to the changing geopolitical environment.

The current research volatility dynamics confirms that some markets responded faster than others, as mentioned by Yousaf et al. (2022a). The study finds that the Group of Seven was greatly affected by the repercussions of this war, and the countries most affected were Britain, France, Germany and Canada. After the conflict, there was a swift and intense reaction on the stock markets in France, German, Italy and Britain, which revealed considerable volatility followed by a stabilizing phase. Positive post-event results were noted as investor confidence rose, assuming NATO would not directly interfere in the crisis (Kumari et al., 2023). This finding is consistent with Neely's (2022) conclusions that the extent of economic collaboration and the proximity of a war affect markets. The markets that were farther distant had far less volatility. The Russia-Ukraine crisis has had a detrimental effect on financial markets globally, with European markets experiencing significant declines and other countries exhibiting less significant reactions. Also, (Ahmed, et.al 2023) confirmed the same conclusion using different methodology. More specifically, this research employed event study to detect the negative abnormal returns around the war date. They confirmed the significant abnormal returns around the event date in the European countries. In contrary to the previous discussion, (Izzeldin, et.al 2023; Kumari, et.al 2023) confirmed that the Russian-Ukrainian war is not as bad as it was during the Great Financial Crisis or the Covid-19 pandemic. This is explained by the market's belief that the battle wouldn't last very long.

Our results suggest that the war between Russia and Ukraine had a negative effect on stock markets globally. The regional research showed that other markets reacted far less, even though European markets in particular declined. Chortane and Pandey (2022) saw a similar but more pronounced pattern in the way the currencies of the Pacific, Africa and Middle East behaved in relation to the US dollar following the commencement of the invasion of Ukraine. Regardless of location, the research data also showed a noticeably reduced volatility in larger marketplaces. During the studied time, there was a decrease in market volatility in the US, Japan, and Canada, which supports the findings of Abbassi et al. (2023). One probable cause could be the sanctions that NATO countries placed on Russia and the response that Moscow gave.

The degree to which the markets reacted to bad news, sanctions, and official measures differed after the war-related collapse of stock market indices. Early in March was when volatility peaked. France, Germany, the United Kingdom, and Italy attained their peak volatility values on March 9, 2022, with Russia exhibiting the most volatility. The most volatility was

observed in 21 of the countries under analysis between March 2 and March 16, 2022. Most markets showed a trend toward reduced volatility after this high. The differing reactions observed in developed markets over time and in different quantities suggest that their economic ties with the belligerent nations may have had an impact. Asset prices responded immediately to the battle, with the availability of more information, the markets corrected, reflecting the responses observed during the COVID-19 pandemic's initial wave (Zheng et al., 2021).

The results of this study's cointegration test show a sustained correlation between the G7 indices and the war's informational content. This outcome is consistent with the findings of earlier research by Tajuddin et al. (2009), Guo et al. (2021), and Abdelbaki (2013), which also discovered evidence of a long-term correlation between stock market behavior and geopolitical events like war. Tajaddini et al. (2009) looked into how stock market returns in the Middle East and North Africa were affected by political risk, such as wars and conflicts. They discovered a sustained correlation between political risk and stock market returns, indicating that developments in geopolitics might have a long-lasting impact on the financial system. Abdelbaki (2013) investigated how stock market volatility in the Middle East and North Africa region was affected by geopolitical events like conflicts and terrorist attacks. The findings demonstrated the enduring impact of geopolitical events on financial markets by demonstrating a long-term correlation between stock market volatility and these events.

The present study's findings are consistent with those of previous earlier research, which supports the idea that geopolitical events—including wars—can have a long-lasting effect on the dynamics of the stock market. The enduring correlation shown between G7 indices and the informational content of the war implies that investors and market players respond to geopolitical uncertainty and conflicts not just in the near term but also in the long run.

Conclusions

Current research investigates the impact of the information content of Ukraine-Russia war on the volatility of the indices of G7 countries. This study contributed many dimensions to the literature on volatilities of market indices and their react to information content of Ukraine war. More specifically, throughout the time under analysis, stock markets experienced negative reactions due to political, economic, and financial volatility, as well as geographical proximity and sanctions placed on Russia. A further layer of shock to the capital markets was brought about by the Russia-Ukraine conflict, which occurred as the world was beginning to recover from the COVID-19 pandemic. By examining the effects of the war on volatility in the G7

countries, current research filled a gap in the literature by doing a volatility study to determine its impact on stock markets. The war caused negative shocks to the most of the examined stock indices. The findings enable the comparison of the volatility observed during the conflict with earlier political or comparable events that impacted the global economy and particular regions. Global long-term economic growth is impacted by military events. Since World War II, military conflicts have had a substantial impact on all political and military developments. In light of the uncertainty surrounding the Russia-Ukraine conflict, this study has ramifications for governments, investment funds, analysts, shareholders, and capital markets regulators. All parties involved are interested in understanding dynamics to make informed investment decisions.

First of all, for regulators and legislators in charge of preserving financial stability, the results have consequences. Financial market stability and operation may be jeopardized by geopolitical developments. The monitoring and management of possible disruptions resulting from geopolitical tensions require policymakers to be alert and proactive. A market's overall stability and stock market volatility can be lessened by implementing effective rules and regulatory frameworks. Second, Events in the geopolitical arena have a big impact on investor mood and market dynamics. Market volatility may rise as investors modify their trading tactics and portfolios in reaction to shifting geopolitical dynamics, owing to the elevated level of uncertainty and risk linked with conflicts. Comprehending the influence of geopolitical developments on investor mood can yield significant understanding of market trends and patterns. Third, the results underscore the significance of taking geopolitical developments into account when devising methods for risk mitigation and making investing choices. Conflicts and tensions on the geopolitical front can have a big impact on stock market volatility and raise risk levels. It is imperative that investors and financial institutions possess awareness of these potential hazards and integrate them into their investment plans and risk management frameworks. Fourth, the research highlights how intertwined the world's financial markets are. Events related to geopolitics in one area, like the conflict in Ukraine, might affect financial markets in other nations. It is imperative for investors and governments to acknowledge the possibility of contagion and spillover risks that may arise from geopolitical events and devise suitable strategies to alleviate these risks.

Factors such as stop importing gas and oil from Russia, particularly to France, German, Italy and UK may have influenced all the financial markets reactions especially capital market. These actions may account for the volatility observed in the nations enforcing the sanctions. We set these theories

aside for further investigation. We suggest conducting additional research on a differentiated examination of sectoral indices, taking into account the post-conflict appreciation of certain sectors, such as the energy industry.
There was not a lot of literature accessible for reference because the war had only recently ended. Nevertheless, our results should be consistent with recent research. Given that the military events of 2022 are a continuation of those of 2014, comparing the volatility of these two eras should provide valuable insights.

The uncertainty surrounding the conflict between Russia and Ukraine is the main source of the study limitations. It's possible that errors and a lack of information affected the outcomes. Future research directions are presented by the lack of explanations for the unusual behavior of various markets, including those in Canada, Japan, and the US. During the examined period, some volatility that had an impact on specific markets emerged as a result of the actions, penalties, and countermeasures taken by NATO members or belligerent governments. Last but not least, a variety of control variables—aspects that may have significant consequences—influence how news and particular keywords perform.

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