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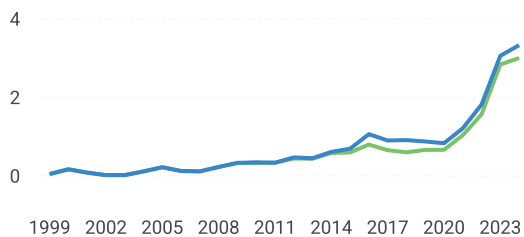
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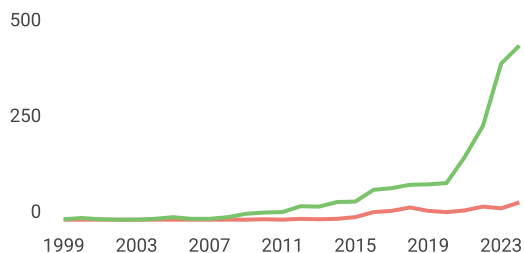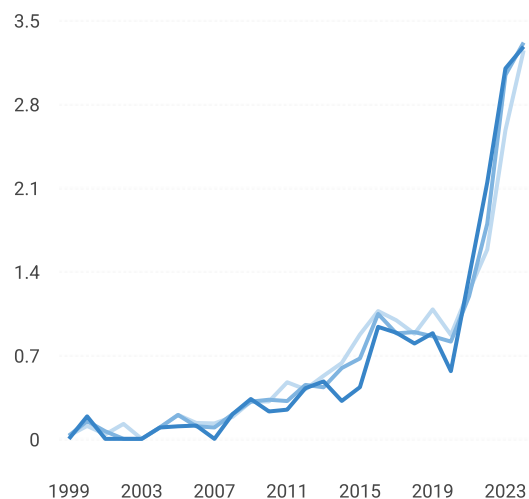

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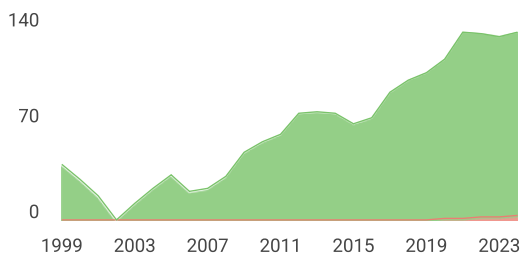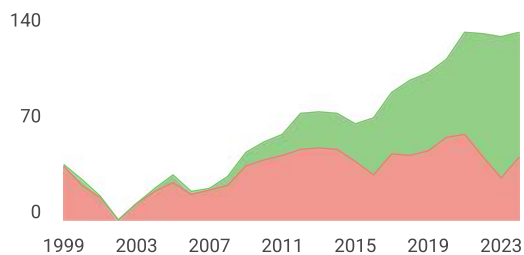

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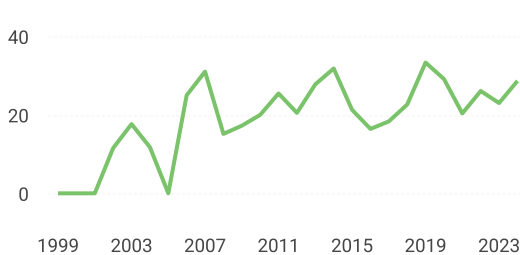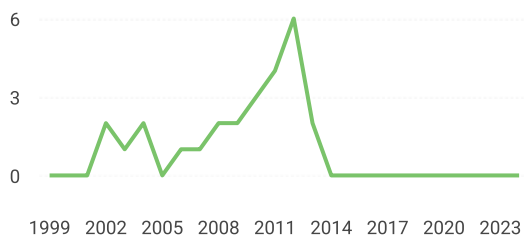**Citable documents** ● **Non-citable documents** ●

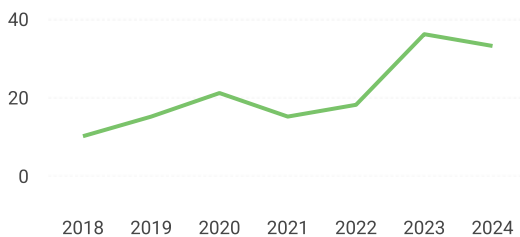**Cited documents** ● **Uncited documents** ●

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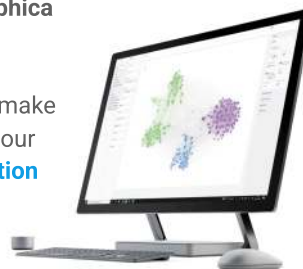← Show this widget in your own website

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Impact of the Russia–Ukraine War: evidence from G20 countries

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School of Business and Management, Universitas Kristen Petra, Surabaya, Indonesia

Abstract

Purpose – This paper aims to investigate the impact of geopolitical events of the Russia–Ukraine conflict on the stock market volatility of G20 countries. Furthermore, the paper also investigates the possible reasons for any similarities or differences in the results of the three sectors.

Design/methodology/approach – This paper measures the impact of the stock market sectoral index price (SIP) by using the daily closing price as a dependent variable. In addition, this study uses three independent variables: geopolitical risk (GPR), commodity price (CP) and foreign exchange rate (FER). Seventeen countries from the G20 are analyzed using a daily timeframe from September 2021 to August 2022 (before and during the Russian invasion).

Findings – The results revealed that FER, CP and GPR all affect SIP, but the level of significance and positive/negative signs vary in all three sectors. The positive FER affects SIP in all sectors, while the negative CP and GPR significantly impact SIP in the energy and transportation sectors.

Research limitations/implications – This study's research model is more suited for transportation and energy than consumer goods. Future researchers can enhance the research model for the consumer goods sector by incorporating additional variables to understand their relationship with SIP better.

Originality/value – This study explores the impact of the Russia–Ukraine conflict on the stock market in G20 countries, focusing on the top three most affected sectors.

Keywords Russia–Ukraine conflict, Stock market volatility, Sectoral indices, G20

Paper type Research paper

1. Introduction

Political disorders have multidimensional impacts on all economies around the world. The ongoing Russia–Ukraine conflict has led to many disruptions, changes and uncertainties in the world, with no exception to the global economy. The Group of 20 countries, abbreviated as G20, has accounted for 80% of the world's trading activities (Zhao *et al.*, 2021; Kumar *et al.*, 2023). According to World Federation of Exchanges 2019 data, the total market capitalization of G20 was nearly US$90tn (G20 Insights, 2021). Extreme events such as the Russia–Ukraine war undoubtedly threaten the world's market condition, as evidenced by abnormal activities in the stock market. The IDX composite depreciated by 1.48% on the day of the Russian invasion of Ukraine, while the Nikkei and Nasdaq declined by 1.81% and 2.57%, respectively. (CNN Indonesia, 2022). Stock prices represent expectations for the listed companies' future and financial position (Nuhiu *et al.*, 2022; Aliu *et al.*, 2022). Wars result in irreversible damage to people, property and the economy, as recorded in world history. But in the case of the conflict between Russia and Ukraine, savagery repeats itself, with innocent children and other victims. Since the end of the Second World War, the Russia–Ukraine conflict has been regarded as one of the most critical military confrontations (Aliu *et al.*, 2023a, 2023b). Since Russian forces seized Ukrainian land, the world economy's prognosis

has worsened (Cohen, 2022). The hostilities between Ukraine and Russia have had a huge overall impact. The conflict in Ukraine increased global inflation by 3% in 2022 and 2% in 2023. This would amount to a loss of $1tn in global GDP by 2023 (Kumar *et al.*, 2023).

Trade embargoes, war sanctions and other war-related consequences have significantly disrupted the global commodity supply chain, impacting economic conditions in various countries. Additionally, geopolitical risk should be considered, as it impacts the financial market (Umar *et al.*, 2022). The FER movement significantly impacts the stock performance of companies listed on stock exchanges, as G20 countries account for 80% of world trade (Zhao *et al.*, 2021).

Since Russia invaded Ukraine, NATO has imposed unprecedented economic and political sanctions on Russia, particularly in response to its actions (NATO, 2022). Russia's position as the third-largest producer of oil worldwide (Statista, 2022a) tremendously affected the oil supply for the global energy industry. NATO sanctions halted Russia from exporting its oil, causing a market supply fall despite the increasing demand. The global oil price surged to $123.7 per barrel in March 2022, causing significant disruptions to the global energy industry. Consequently, the increase in world oil prices would also affect the transportation sector, which relies on oil for fuel.

Russia dominates oil exports and is the world's largest wheat exporter (OEC, 2024). On the other hand, Ukraine is the fourth largest exporter of wheat worldwide (Statista, 2022b). Russia and Ukraine, responsible for 28% of the world's wheat exports, could disrupt the global wheat supply if their exports cease (Glauben *et al.*, 2022). During the ongoing war with Russia, the Ukrainian temporarily banned the export of wheat and other staples to meet the country's food needs (ABC News, 2022). In addition, Russia had blocked Ukraine ships carrying grain exports from leaving the Black Sea, threatening worldwide food security. However, a successful negotiation between the two countries has resumed Black Sea grain shipment (DW, 2022). Wheat prices reached an all-time high of $14.25 per bushel in March 2022 due to an inadequate supply and high demand (Investing.com, 2022a). The high wheat price is expected to significantly impact the primary consumer goods sector, particularly for companies producing noodles, breads and biscuits.

This study analyses whether geopolitical risk (Umar *et al.*, 2022), foreign exchange rate (Aliu *et al.*, 2022) and commodity price (Nuru and Gereziher, 2021) affect stock market sectoral indices during the Russia–Ukraine conflict in G20 countries, mainly focusing on the energy, transportation and primary consumer goods sectors. These sectors are the subject of this research as they are the most impacted sectors by the ongoing conflict. This study examines the relationship between variables before and during the Russia and Ukraine wars in three sectors to investigate market trends and changes. It examines similarities and differences in the relationship between variables and sectoral indices. The study aims to provide in-depth insights into how independent variables affect dependent variables in each sector rather than the general stock market. It also explores sectoral indexes to investigate sectoral changes and risk behavior during turmoil events. The results can serve as a reference for future geopolitical events. Another purpose of this study is for investors, and the study helps investors because of the high uncertainty. Investors need as much data and information as possible to make the best decision to get the desired return. Therefore, the paper contributes to the fast-emerging literature on the impact of the Russian–Ukrainian War on economic and financial outcomes.

As a novelty in this study and research gap, the authors use G20 countries, focusing on the top three most affected sectors. The Russia–Ukraine conflict disrupted commodity prices, equities markets, geopolitical risk and exchange rates, causing a global financial system cardiac arrest. The Ukrainian conflict, which has had terrible economic repercussions,

is at its height as this story is being written. Investors, particularly from G20 countries, were concerned about the potential spread of violence to other nations. Standing on the identified problem and the context of the before and ongoing war, the following question was asked:

RQ1. What is the impact of GPR, CP, and FER on G-20 countries' stock market SIP before and during the Russia–Ukraine war?

Panel data analysis and tests were utilized to address the issues. Relevant literature is reviewed, and hypotheses regarding the relationship between them are explained in Section 2. Furthermore, Section 3 explains the sample, measurement and research model. Section 4 discusses the research results, while Section 5 discusses the conclusions and limitations.

2. Literature review and hypothesis development

The Russian invasion of Ukraine created numerous uncertainties in global trade and deteriorated international supply. Presently, Russia and Ukraine are significant players in international trade, affecting geopolitical risk (GPR), commodity price (CP) and foreign exchange rate (FER). This conflict will heavily influence the European continent while reshaping the global economy (Prohorovs, 2022). Various studies highlight that war has a negative effect on capital markets (Choudhry, 2010; Hudson and Urquhart, 2015; Schneider and Troeger, 2006). However, the effects of geopolitical may vary from country to country (Kumar *et al.*, 2023). The interconnectedness of global financial markets diminishes diversification benefits while easily transmitting problems from one country to another (Batten *et al.*, 2022). Those phenomena can be explained using the Adaptive Market Hypothesis (AMH) theory.

2.1 Adaptive market hypothesis theory

The Adaptive Market Hypothesis (AMH) theory is a theory developed by Andrew W. Lo (2004), which combines the established Fama's Efficient Market Hypothesis (EMH) theory with concepts of behavioral finance. EMH argues that investors make rational investment decisions, and share prices reflect all available information. In an efficient market, efficiency is classified into three levels - weak, semi-strong and strong. On the contrary, behavioral finance believes that EMH cannot explain why market efficiency has altered over time and that stock market anomalies remain unanswered (Peon *et al.*, 2019). Behavioral finance argues that psychological and emotional outcomes influence investors. Hence, investors behave differently under different circumstances in the market. This argument can explain that investors sometimes behave irrationally, which causes a sudden rise and fall in the market (Zahera and Bansal, 2018). Most researchers agree that EMH has to be calibrated based on fluctuating market conditions (Priscilla *et al.*, 2022), and AMH fills this gap by combining both EMH and behavioral finance theories. According to AMH, people are mainly rational when making investment decisions. Still, they sometimes can overreact and become irrational in response to heightened market volatility, such as the conditions of the Russian–Ukraine war.

2.2 Market sectoral index price, foreign exchange rate, commodity price, geopolitical risk

To understand how the Russia–Ukraine conflict affects the stock market volatility, sectoral indices of the three industries were used. The positive feedback hypothesis suggests that increased market volatility correlates with investors' expectations of negative returns, leading to a decline in stock prices. (Bekiros *et al.*, 2017). The positive feedback hypothesis theory's impact on aggregate stock indices is influenced by the Russia–Ukraine conflict, as some sectors remain unaffected. Using individual sectoral indices can unmask heterogeneity

hidden in an aggregate stock index. Therefore, more in-depth insight can be gained regarding the cause-and-effect relationship between the Russia–Ukraine conflict and the three most affected sectors (Hamdi *et al.*, 2019).

The foreign exchange rate (FER) is the value of a national currency against other currencies. The exchange rate facilitates international trade as the bridge between countries in the international market for goods and services. A low exchange rate benefits import-oriented nations as it reduces the cost of production, while it is adverse for export-oriented countries (Verma and Bansal, 2021). Some claim that exchange rate fluctuations may reduce global commerce volume as risk-averse traders shift their capital toward less hazardous trading obligations. Another argument suggests that higher risk implies higher returns and increases risk due to exchange rate fluctuations, thereby increasing international trade volume. Nevertheless, according to research, a stable and competitive exchange rate helps spur economic growth and increase the profitability of tradable sectors (Guzman *et al.*, 2018).

The changes in the international commodity price (CP) significantly impact the countries that produce such commodities. Developing countries heavily rely on commodity production and exports to achieve economic growth (Nuru and Gereziher, 2021). Thus, the economic performance of countries that heavily depend on commodity production is more vulnerable as the commodity international market price gets more volatile. This study uses daily historical data on worldwide crude oil and wheat prices. These commodities are used because of their extreme volatility during the Russia–Ukraine war due to Russia's and Ukraine's position as the top producers of those commodities.

Geopolitical risk refers to the potential impact of unfavorable geopolitical events, such as wars, terrorist attacks and state conflicts, on international relations. Uncertainty brought on by military and political tensions can increase geopolitical risk, disrupting economic activity and household income (Chiang, 2021). In a moment of uncertainty, investors undoubtedly react by withdrawing their investments in high-risk assets and switching to a more liquid asset by saving money in the bank. Lower spending leads to lower economic development. Hence, a change in geopolitical risk can lead to a change in the global economic condition. The GPR index, developed by Caldara and Iacoviello, measures geopolitical risks and adverse events based on newspaper articles about geopolitical tensions. High geopolitical risk was observed during the Korean War, the Cuban Missile Crisis, post 9/11 and the recent Russian invasion of Ukraine. (Caldara and Iacoviello, 2022).

2.3 Control variables: inflation, interest rate, gross domestic product

The control variables are essential variables that act as predictors and response variables. This study is done by controlling some variables that might affect the dependent variables, such as inflation, interest rate and gross domestic product. Inflation measures the rate of increase in prices of goods and services in an economy. The government often raises interest rates to combat high inflation, causing consumers to shift to bank savings instead of purchasing goods and services (Ibrahim *et al.*, 2022). Inflation expectations increase, leading to higher future dividends and potentially causing stock price rises (Eldomiaty *et al.*, 2020). Inflation is also correlated with geopolitical risk. The growing cost of food is due to concerns about a worldwide food emergency, as Russia is known as the "breadbasket of Europe" (Sohag *et al.*, 2022).

Many studies conclude a negative relationship between interest rates and stock returns (Eldomiaty *et al.*, 2020; Verma and Bansal, 2021). A rise in interest rates leads to consumers saving money in risk-free investments, resulting in decreased trading volume in the stock market. Higher interest rates increase business borrowing costs, limiting credit and expansion, resulting in slower growth and decreased share price.

GDP is a critical macroeconomic indicator that measures a country's wealth by analyzing the utilization of national resources over a year (Oliinyk and Kozmenko, 2019). A country's GDP growth rate indicates economic growth, with a positive relationship between GDP and the stock market in emerging and developed economies (Verma and Bansal, 2021). This demonstrates how important GDP is in driving the development of a country's stock market.

2.4 Hypotheses development: foreign exchange rate and stock market sectoral index

Based on the AMH theory, each country's market efficiency in reacting to the exchange rate's volatility may differ. It may change over time according to the movement of the exchange rate. The stability of the exchange rate facilitates international trade, yet the Russian–Ukraine conflict caused instability, which heavily affected international trade. G20 countries accounted for 80% of the world's trading activities (Zhao et al., 2021). Hence, the exchange rate volatility can cause a significant change in international trade activities. Some countries rely more on their international trade activities, which would be tremendously affected by the volatility in exchange rates, while others may not. Countries relying on export-import revenues may be more sensitive to exchange rate movement. Hence, market efficiency may strengthen in these countries. Moreover, each country's investors may react differently to the crisis according to their personalities and emotions. Nonetheless, it is without doubt that the volatility of the foreign exchange rates plays a vital role in the stock market's volatility.

Exchange rates and stock prices tend to move in the same direction, where local currency depreciation makes local firms more competitive (Singhal et al., 2019). Hung (2020) also agreed that domestic currency depreciation increases local enterprises' competitiveness. Therefore, international trade makes exports more affordable, increasing income and rising stock prices. When the exchange rate is high, more money is obtained upon conversion. This stimulates foreign investment, which raises stock values and vice versa (Verma and Bansal, 2021).

The Russia–Ukraine war has influenced the aggressive movement of the exchange rate. The Russian government's request for oil payments to be made in rubles has strengthened the Russian ruble's position. Even though it has lesser significance than the USD or euro. This eventually led to a revaluation of the Russian ruble. Research has indicated that the Russian Ruble had a substantial impact on the devaluation of the euro and the revaluation of the US Dollar (Aliu et al., 2022). This shows that the Russia–Ukraine war affects the movement of hard currencies, which creates a domino effect on international trade and, finally, stock prices.

Hypotheses are conducted separately for all three sectors to give a more in-depth insight into how independence affects the dependent variable. However, an additional hypothesis to test the effect on the three sectors simultaneously is conducted as an additional comparison:

H1a. Foreign exchange rate has an impact on stock market energy sectoral index.

H1b. Foreign exchange rate has an impact on stock market transportation sectoral index.

H1c. Foreign exchange rate has an impact on stock market consumer goods sectoral index.

H1d. Foreign exchange rate has an impact on all three sectors' sectoral index.

2.5 Hypotheses development: commodity price and stock market sectoral index

Based on the AMH theory, countries relying more on commodity exports may react more aggressively toward volatility in commodity prices, indicating stronger market efficiency. Previous studies have shown significant volatility transmission from commodities to stock markets (Shabbir *et al.*, 2020). Due to the conflict between Russia and Ukraine, the commodity market experienced significant turmoil. This is because both countries have roles as significant exporters of several commodities, such as oil and wheat.

Russia has substantial surplus capacity for its oil production, which may even get larger as Russia keeps expanding its pipeline network, providing much room for exports (Vatansever, 2017). As of 2022, Russia is the third-largest producer of oil (Statista, 2022c). Yet, Russia has received sanctions from NATO, the European Union and many other countries, restricting their export activities. Supply chains were disrupted, and oil prices hiked to a record high level. Several previous studies were done on the impact of oil on stock returns, yet the results were mixed. Some studies have shown that stock market declines follow increasing oil prices, while others have said otherwise or even have no relationship between the two variables (Amin and Mollick, 2022). This aligns with the concepts of AMH. Market efficiency varies between countries and can change over time. It is shown by the differing results of the previous studies from different observation periods. This study looks at the relationship between oil prices and the stock market, particularly in the energy and transportation sectors.

Moreover, Russia and Ukraine are the 1st and 4th most prominent exporters of wheat, respectively (Statista, 2022a). During the war, Russian and Ukrainian bans on wheat exports led to an all-time high in wheat prices (Investing.com, 2022b). Increased production in other countries can somewhat offset a reduction in exports, but rising carbon emissions may worsen global food security (Carriquiry *et al.*, 2022). Wheat scarcity and global food instability may discourage investors from stocks in the primary consumer goods industry. This study examines the relationship between wheat prices and the stock market, particularly in the consumer goods industry:

H2a. Oil price has an impact on the stock market energy sectoral index.

H2b. Oil price has an impact on stock market transportation sectoral index.

H2c. Wheat price has an impact on stock market consumer goods sectoral index.

H2d. Oil and wheat price has an impact on all three sectors' sectoral index.

2.6 Hypotheses development: geopolitical risk and stock market sectoral index

Due to the ongoing war tensions between Russia and Ukraine, uncertainty increases market volatility. A study reveals that geopolitical risk's impact varies across countries, suggesting that the USA and Indonesia may react differently to specific geopolitical events (Balcilar *et al.*, 2018). Hence, the impact of a geopolitical risk may differ between countries, where some experience a higher impact than others. The AMH theory suggests that market efficiency varies across countries, and investors' reactions may differ based on their psychological behavior.

Additionally, increased economic and political unpredictability can impede economic activity, worsening future cash flows and lowering stock prices (Chiang, 2021). Volatility shocks, partially driven by geopolitical tensions, are transmitted into the stock market from the uncertainty in export trades and foreign direct investment (Balcilar *et al.*, 2018). Lower investment is predicted by higher geopolitical risk, with businesses exposed to overall geopolitical risk suffering the most (Caldara and Iacoviello, 2022). During crises, aggregate stock market indices may not accurately reflect the impact of the crisis on a specific

industry. Consequently, the surge of stock prices in one industry can offset the downfall of another. Thus, industry-specific analysis is the best way to measure the volume of impact of geopolitical risk, which can be measured using sectoral indices.

This study investigates geopolitical risk's impact on stock markets, particularly in the energy, transportation and consumer goods sectors and explores potential reasons behind these differences:

H3a. Geopolitical risk has an impact on stock market energy sectoral index.

H3b. Geopolitical risk has an impact on stock market transportation sectoral index.

H3c. Geopolitical risk has an impact on stock market consumer goods sectoral index.

H3d. Geopolitical risk has an impact on all three sectors' sectoral index.

Based on the various studies and elaboration, the following research model is developed as the basis of this study and illustrated in Figure 1.

3. Data and methodology

3.1 Data

A daily time frame of February 24, 2022–August 31, 2022 is used to investigate the strength of the relationship between variables during the ongoing Russia–Ukraine conflict. The discussion analysis section uses an additional time frame from September 1st, 2021 to February 23rd, 2022. The analysis aims to compare the strength of the relationship between variables. Variables, not daily data, are converted into daily data before being processed further with the other variables. The population of this research study is 20 member countries of G20, 365 days from September 2021 to August 2022. The G20 is an international forum comprised of 19 nations plus the European Union (EU) and serves as a stand-in for
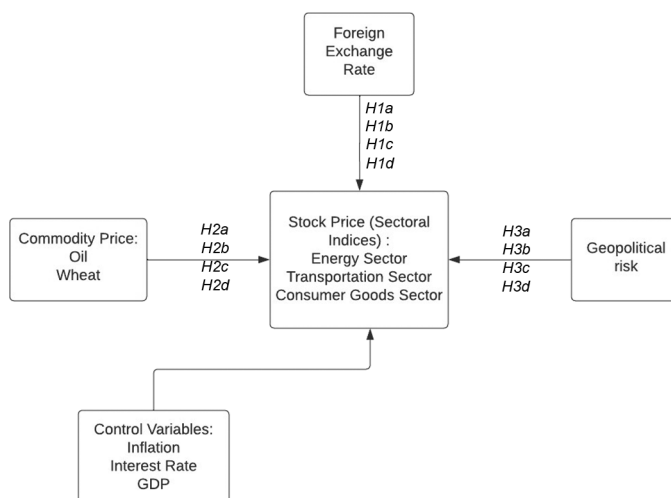
Notes: Figure 1 displays the research model, which is the relationship between foreign exchange rate (FER), commodity (oil and wheat) price (CP), and geopolitical risk (GPR) with stock price
Source: Author's own creation

the global economy for all practical purposes. Based on the population, a non-probability sampling technique based on relevant criteria is used to pick out samples. To this study, these sampling criteria are applied:

- Countries listed as members of G20.
- Countries with complete data sets of all variables tested, including the data of energy, transportation and consumer goods sectoral indices (or equivalent sectors) for September 2021–August 2022. (Table 1)

3.2 Methodology

This research examines the relationship between foreign exchange rate (FER), commodity (oil and wheat) price (CP) and geopolitical risk (GPR) with stock price. In addition, the research was conducted in the energy, transportation and consumer goods sectors. Inflation, interest rate and GDP are used as control variables. Analysis was conducted separately for each of the three sectors, and similarities or differences in the results of the three sectors are discussed further. Following the research model in Figure 1, a panel data analysis was used for the hypothesis stated earlier, formulated as below:

$$SIP_{i,t} = \alpha + \beta_1 FER_{i,t} + \beta_2 CP_{i,t} + \beta_3 GPR_{i,t} + \beta_4 INFLATION_{i,t} + \beta_5 INTEREST_{i,t}$$

$$+ \beta_6 GDP_{i,t} + \varepsilon_{i,t}$$

$SIP_{i,t}$ = sectoral indices price of country i in time t;
$FER_{i,t}$ = foreign exchange rate of country i in time t;
$CP_{i,t}$ = commodity price of country i in time t;
$GPR_{i,t}$ = geopolitical risk index of country i in time t;
$INFLATION_{i,t}$ = rate of inflation of country i in time t;
$INTEREST_{i,t}$ = interest rate of country i in time t;
$GDP_{i,t}$ = gross domestic product of country i in time t;
$\varepsilon_{i,t}$ = error of country i in time t;
α = constant; and β_{1-6}: regression coefficient of each variable.

This study uses the heteroskedasticity-corrected approach on panel data consisting of 17 cross-sectional units with 62 time periods during the Russia–Ukraine conflict. It also

Sampling criteria	Sample size
Countries listed as members of the G20	20
Countries with complete data sets of all variables tested, including the data of energy, transportation and consumer goods sectoral indices (or equivalent sectors) for the period of September 2021–August 2022.	(3)
Countries with a sufficient data set	*17*

Notes: Table 1 displays the sampling criteria of this research. Accordingly, the unit analysis for this research is a total of 2,125 country-days observed, derived from 17 country members of G20 and 125 trading days as balanced data containing all relevant information of every variable used from the 365 days from September 1, 2021–August 31, 2022
Source: Authors' own creation

Table 1.
Sampling criteria

conducts additional discussion analysis testing with 63 time periods before and after the conflict and compares the results.

4. Research result and analysis

4.1 Descriptive statistics

Descriptive statistics computed each variable's mean, median, minimum, maximum and standard deviation. Tables (2–4) portray each element for energy, transportation and primary consumer goods sectors.

The minimum SIP value of the energy and transportation sector for is from September 1, 2021, which is the very start of the observation period. This shows that the energy and transportation sectors grew amidst the Russia–Ukraine conflict. Meanwhile, the minimum value of the consumer goods sector is from March 8, 2022, 1.5 weeks after the Russian

Variable	Mean	Median	Minimum	Maximum	SD
Energy sector					
SIP	2.15	2.39	−1.28	4.02	1.29
GPR	2.16	2.16	1.60	2.72	0.211
CP (oil)	1.95	1.96	1.82	2.09	0.0713
FER	−1.25	−1.15	−4.18	0.141	1.13
Inflation	0.0445	0.0230	0.000397	0.318	0.0695
InterestRate	0.0237	0.00992	−0.000397	0.276	0.0421
GDP	0.0174	0.0163	−0.0163	0.0536	0.0124
Transportation sector					
SIP	2.01	2.12	−1.13	3.99	1.31
GPR	2.16	2.16	1.60	2.72	0.211
CP (oil)	1.95	1.96	1.82	2.09	0.0713
FER	−1.25	−1.15	−4.18	0.141	1.13
Inflation	0.0445	0.0230	0.000397	0.318	0.0695
InterestRate	0.0237	0.00992	−0.000397	0.276	0.0421
GDP	0.0174	0.0163	−0.0163	0.0536	0.0124
Primary consumer goods sector					
SIP	1.93	2.26	−1.36	4.00	1.35
GPR	2.16	2.16	1.60	2.72	0.211
CP (wheat)	2.93	2.90	2.83	3.15	0.0715
FER	−1.25	−1.15	−4.18	0.141	1.13
Inflation	0.0445	0.0230	0.000397	0.318	0.0695
InterestRate	0.0237	0.00992	−0.000397	0.276	0.0421
GDP	0.0174	0.0163	−0.0163	0.0536	0.0124

Notes: Table 2 displays the descriptive statistics summary. Accordingly, the dependent variable sectoral index price (SIP) has a minimum of −1.28, −1.13 and −1.36 in the energy, transportation and primary consumer goods sectors. These minimum values are all from Indonesia, as Indonesia has the smallest SIP value when converted to USD. GPR has a minimum value of 1.60 on December 29, 2021, and a maximum value of 2.72 on March 2, 2022, implying the peak of geopolitical risk is several days after the Russia invasion of Ukraine. Oil price has a minimum value of 1.82 on December 1, 2021 and a maximum value of 2.09 on March 8, 2022. Wheat price has a minimum value of 2.83 on September 13, 2021 and a maximum value of 3.15 on March 7, 2022. This information implies that oil and wheat prices peaked around ten days after the invasion. The foreign exchange rate (FER) has a minimum value of −4.18 from Indonesia and a maximum value of 0.141 from the United Kingdom. Inflation, interest rate and GDP all have very low standard deviations, possibly because they are converted into daily data with smaller values to be compared from one country to another
Source: GRETL Software output

Variable	Variance inflation factors (VIF)
Collinearity test	
FER	1.081
CP (oil)	1.029
CP (wheat)	1.413
GPR	1.037
Inflation	2.510
InterestRate	2.607
GDP	1.040

Heteroskedasticity (white's test)	Energy sector	Transportation sector	Consumer goods sector
p-value	0.000000	0.000000	0.000000

Panel specification diagnostics	Energy sector	Transportation sector	Consumer goods sector
Fixed effect estimator	0	0	0
	(Fixed)	(Fixed)	(Fixed)
Breusch–Pagan test	0	0	0
	(Random)	(Random)	(Random)
Hausman test	0.359781	0.0603603	0.983007
	(Random)	(Fixed)	(Random)

Notes: Table 3 displays the data testing specification. Accordingly, the dataset has no collinearity problem as all variables' VIF value is below 10. On the other hand, the heteroskedasticity test identifies a problem with the dataset as the *p*-value is below 10%. Moreover, panel specification diagnostics illustrates differing results between the three sectors. To these different results and the heteroskedasticity problem, the best method to produce the best output and compare the apple-to-apple sectors is determined using a heteroskedasticity corrected model
Source: GRETL Software output

Table 3.
Data testing specification

Indicators	Coefficient	Std. error	*t-ratio*	*p-value*
Constant	5.88132	0.336142	17.50	<0.0001***
FER	1.08268	0.00578227	187.2	<0.0001***
CP (oil)	−1.07964	0.163520	−6.602	<0.0001***
GPR	−0.164765	0.0391294	−4.211	<0.0001***
Inflation	0.541084	0.0564717	9.582	<0.0001***
Interest rate	−1.16182	0.113595	−10.23	<0.0001***
GDP	12.0624	0.606590	19.89	<0.0001***
R-squared		0.977333	F(6, 1037)	7452.182
Adjusted R-squared		0.977202	*p-value* (F)	0.000000

Notes: Table 4 displays the energy sector heteroskedasticity corrected result summary. all independent variables, namely foreign exchange rate (FER), commodity price (CP) and geopolitical risk (GPR), significantly influence sectoral index price (SIP). FER shows a positive effect, whereas CP and GPR show negative effects toward SIP
Source: GRETL Software output

Table 4.
Energy sector heteroskedasticity corrected result summary

invasion of Ukraine on February 24th. This shows that the consumer goods sector experienced a drop in the weeks following the invasion. On the other hand, SIP maximum values come from the UK, not its position as the country with the highest SIP value when converted to USD. The highest SIP value is 4.02 on June 8, 2022, for the energy sector and

January 5, 2022, for the transportation sector. Finally, January 19, 2022, for the consumer goods sector. The peak of SIPs varies, with the energy sector peaking before geopolitical conflict and vice versa for other sectors.

4.2 Panel data model estimation method
After conducting the descriptive statistics of the data set, the data set was tested for collinearity, heteroskedasticity and panel specification diagnostics. Data testing operated for a total of three times for each of the three sectors.

4.3 Hypothesis test
In this research, all models are tested using a heteroskedasticity-corrected model. Data testing is conducted separately per sector. The hypothesis is accepted or rejected according to how the independent variables affect the dependent variable during the Russia–Ukraine conflict.

4.4 Energy sector
The hypothesis result for the energy sector can be illustrated in Table 5. All hypotheses are accepted because all independent variables, namely foreign exchange rate (FER), commodity price (CP), and geopolitical risk (GPR), significantly influence sectoral index price (SIP).

4.5 Transportation sector
From the hypothesis testing in Table 6, the hypothesis results and conclusion can be illustrated in Table 7. Two hypotheses are accepted, which are that FER and GPR significantly influence SIP during the conflict.

4.6 Consumer goods sector
From the hypothesis testing in Table 8, the hypothesis results and conclusion can be illustrated in Table 9. Only one hypothesis is accepted, which is that FER and GPR significantly influence SIP during the conflict.

4.7 All sectors combined
Testing of the model for all three sectors combined serves as a comparison for the results of each sector. Based on the result summary, all three hypotheses are accepted. FER affects SIP in a positive way and the other way around for both CP and GPR. A hypothesis summary is formed as below. (Tables 10–11)

Hypothesis	Independent	Dependent	Hypothesis	Result	Decision
1a	FER	SIP	Significant influence	Positive significant	Accepted
2a	CP (oil)	SIP	Significant influence	Negative significant	Accepted
3a	GPR	SIP	Significant influence	Negative significant	Accepted

Note: Table 5 displays the energy sector hypothesis testing result
Source: Authors' own creation

Table 5.
Energy sector
hypothesis testing
result

Indicators	Coefficient	Std. error	t-ratio	p-value
Constant	2.78732	0.221699	12.57	<0.0001***
FER	1,02368	0.00554057	184.8	<0.0001***
CP (oil)	0.153236	0.109081	1.405	0.1604
GPR	−0.0408569	0.0219813	−1.859	0.0634*
Inflation	1.14024	0.133956	8.512	<0.0001***
InterestRate	−0.469342	0.164259	−2.857	0.0044***
GDP	17.3345	0.757002	22.90	<0.0001***
R-squared		0.988265	F(6, 1037)	14554.86
Adjusted R-squared		0.988197	p-value (F)	0.000000

Table 6.
Transportation sector heteroskedasticity corrected result summary

Notes: Table 6 displays transportation sector heteroskedasticity corrected result summary. The result summary table above indicates that FER and GPR significantly influence SIP during the conflict. CP, however, has an insignificant effect toward SIP which rejects the hypothesis. FER and CP show positive effects toward SIP, while GPR shows a negative effect
Source: GRETL Software output

Hypothesis	Independent	Dependent	Hypothesis	Result	Decision
1b	FER	SIP	Significant influence	Positive significant	Accepted
2b	CP (oil)	SIP	Significant influence	Insignificant influence	Rejected
3b	GPR	SIP	Significant influence	Negative significant	Accepted

Table 7.
Transportation sector hypothesis testing result

Note: Table 7 displays transportation sector hypothesis testing result
Source: Authors' own creation

Indicators	Coefficient	Std. error	t-ratio	p-value
Constant	2.99790	0.872930	3.434	0.0006***
FER	0.847793	0.0240079	35.31	<0.0001***
CP (wheat)	−0.0455397	0.316384	−0.1439	0.8856
GPR	−0.00783247	0.103396	−0.07575	0.9396
Inflation	1.60368	0.227699	7.043	<0.0001***
InterestRate	0.857737	0.256424	3.345	0.0009***
GDP	−4.36863	2.56173	−1.705	0.0884*
R-squared		0.595631	F(6, 1037)	254.5815
Adjusted R-squared		0.593291	p-value (F)	6.3e-200

Table 8.
Consumer goods sector heteroskedasticity corrected result summary

Notes: Table 8 displays consumer goods sector heteroskedasticity corrected result summary. The result summary table above indicates FER is the only independent variable which significantly affects SIP. The conflict insignificantly influences both CP and GPR
Source: GRETL Software output

4.8 Discussion and analysis
The first hypothesis concerns the relationship between foreign exchange rate (FER) and sectoral index price (SIP). All sectors investigated in this study unanimously agree with previous studies. It is shown that the exchange rate and stock price tend to move in the same direction (Singhal *et al.*, 2019; Hung, 2020; Verma and Bansal, 2021). Results from the

energy, transportation and consumer goods sectors show that FER positively influences SIP. This significant relationship is like the one before the Russia–Ukraine conflict began and after it began. Despite FER's significant impact on SIP, the Russia–Ukraine conflict has not altered its positive impact despite significant geopolitical events like it. G20 countries' strong global trade position may cause FER to be a significant variable in their export-import activities, regardless of its volatility.

The second hypothesis examines the influence of commodity prices on SIP, using oil prices for energy and transportation and wheat prices for consumer goods. The result of the second hypothesis varies between sectors. The energy sector results show that the hypothesis is accepted, whereas the hypotheses are rejected for the transportation and consumer goods sectors. Although the energy and transportation sectors both use oil price as one of the variables, they produce different results regarding the effect on SIP. However, previous studies also showed that there had been mixed results and an unstable relationship between oil prices and the stock market (Amin and Mollick, 2022; Tchatoka et al., 2019). The

Hypothesis	Independent	Dependent	Hypothesis	Result	Decision
1c	FER	SIP	Significant influence	Positive significant	Accepted
2c	CP (wheat)	SIP	Significant influence	Insignificant influence	Rejected
3c	GPR	SIP	Significant influence	Insignificant influence	Rejected

Note: Table 9 displays consumer goods sector hypothesis testing result
Source: Authors' own creation

Table 9. Consumer goods sector hypothesis testing result

Indicators	Coefficient	Std. error	t-ratio	p-value
Constant	3.98799	0.119046	33.50	<0.0001***
FER	1.03678	0.00731558	141.7	<0.0001***
CP (oil and wheat)	−0.197552	0.0160050	−12.34	<0.0001***
GPR	−0.170483	0.0489749	−3.481	0.0005***
Inflation	0.967916	0.0675251	14.33	<0.0001***
InterestRate	0.0101551	0.124985	0.08125	0.9352
GDP	9.25988	0.648336	14.28	<0.0001***
R-squared		0.887411	F(6, 3125)	4105.142
Adjusted R-squared		0.887195	p-value (F)	0.000000

Notes: Table 10 displays all sector heteroskedasticity corrected result summary. The result summary table above indicates FER affects SIP in a positive way and the other way around for both CP and GPR
Source: GRETL software output

Table 10. All sectors heteroskedasticity corrected result summary

Hypothesis	Independent	Dependent	Hypothesis	Result	Decision
1d	FER	SIP	Significant influence	Positive significant	Accepted
2d	CP (oil and wheat)	SIP	Significant influence	Negative significant	Accepted
3d	GPR	SIP	Significant influence	Negative significant	Accepted

Note: Table 11 displays all sector hypothesis testing results
Source: Authors' own creation

Table 11. All sectors hypothesis testing result

result of the energy sector aligns with previous studies, which conclude that oil price is negatively correlated with SIP (Singhal *et al.*, 2019; Noor and Dutta, 2017). On the contrary, the result of the transportation sector aligns with other previous studies stating that there is a positive co-movement between oil price and stock price returns (Prabheesh *et al.*, 2020). A possible reason for this might be the higher correlation between oil, the energy sector and the transportation sector. Oil is the main component in energy companies, while it is only used as fuel in transportation companies. Some transportation sub-sectors, such as marine transportation, are fuel-efficient. A study also showed that oil price rises positively affect airline stock returns due to higher economic growth and more demand for air travel (Smyth and Narayan, 2018). Fuel subsidies in some countries allow customers to pay for increased fuel costs, reducing the risk of rising oil prices and maintaining economic activity (Maitra *et al.*, 2021). For this reason, CP affects the energy and the other two sectors differently. As for the consumer goods sector, the Russia–Ukraine conflict also caused CP to influence SIP insignificantly. The consumer goods sector's broad scope may be a contributing factor, as few companies utilize wheat as a raw material for their products.

The third hypothesis looks at the correlation between geopolitical risk (GPR) and SIP. Like the second hypothesis, the result of the third hypothesis varies between sectors. The hypothesis is accepted because GPR negatively influences the energy and transportation sectors. In addition, it also negatively influences the consumer goods sector, albeit insignificantly; hence, the hypothesis is rejected. These findings align with previous studies stating that geopolitical risk and political unpredictability result in negative stock returns (Chiang, 2021; Caldara and Iacoviello, 2022). The most common reason is investors taking their funds out of the stock market amid uncertain conditions. GPR's impact on the consumer goods sector is less significant than other sectors, as these products are essential for human survival. Hence, regardless of geopolitical events, the demands of primary products remain the same.

The combined sectors' results from the three hypotheses all show significant results. FER positively affects SIP, whereas CP and GPR negatively affect SIP. As shown in Table 11, the results of all sectors mostly align with the results of each separate sector in terms of whether the relationships of variables are positive or negative. However, a separate analysis for each sector is still needed. The combined results of all sectors fail to capture the variation in the significance level of each variable in each sector. This can also be verified and analyzed further through Appendix Table A1. It compares how the dependent and control variables influenced the dependent variable before and during the Russia–Ukraine conflict. The effect of GPR is a unique thing to point out because it didn't have any significant influence before the conflict. Still, it significantly negatively influenced the energy and transportation sector during the conflict. GPR also hurts the consumer goods sector, but it is insignificant. The results show that some variables are suitable for long-term observation. The example shown is FER, which has had a significant influence throughout all periods. In addition, GPR is the variable that only matters during a geopolitical event, and its significance is only shown during the Russia–Ukraine conflict.

5. Conclusions

The main objective of this study is to explore the relationship between the market sectoral index price (SIP) and three independent variables. Geopolitical risk (GPR), commodity price (CP) and foreign exchange rate (FER) change over time from before and during the conflict. This research has a variety of findings that contribute to some implications. Stakeholders can use the result of this study to make better decision-making for their own interests. First, FER, CP and GPR indeed influence SIP. However, these influences vary between sectors.

FER significantly impacts all sectors, unlike CP and GPR, allowing investors and policymakers to differentiate which variables to focus on when making investment decisions. Insights into the nature of volatility spillovers during crises and the interconnectedness of markets can be gained by both investors and regulators. The study underscores the importance of monitoring market shock spread and implementing effective risk management strategies to mitigate their impact. Markets gradually stabilize, and investor fear declines after tumultuous periods defined by high levels of uncertainty. Equities, commodities and crypto market investors may find the study's policy implications helpful when investing in volatile circumstances. In such difficult circumstances, investors, policymakers and financial planners must take additional precautions about hedging and investing. Second, the research model of this study is more suited for the transportation and energy sector than the consumer goods sector, as shown by the highest adjusted R-squared value 98.8%. Future researchers can enhance the consumer goods sector research model by incorporating additional variables to better understand their relationship with SIP. Third, while control variables are not the main object of this study, inflation, interest rate and GDP also significantly affect SIP. Future researchers can use this fact to dig deeper into these variables and compare the results of this study with their studies to obtain the best conclusion. Finally, firms of these three most affected sectors can position themselves to manage the volatility of their corporate performance and stock price. Firms can monitor the movement of FER, CP and GPR and accordingly make decisions that best fit the firms' situation.

Furthermore, the findings of this analysis align with the principles of AMH, where market efficiency changes over time due to institutional factors (Shahid *et al.*, 2020). The market becomes more efficient and reacts aggressively to variables' volatilities amid the Russia–Ukraine conflict, further influencing SIP. The appropriateness of the research model can be explained by the differences in the results of the three sectors to each of the sectors. This can be investigated by examining the difference between the adjusted R-squared of the three sectors. The transportation sector has the highest adjusted R-squared value compared to the others, with a value of 98.8%. This means that the variance of SIP in the energy sector is 98.8%, as explained by the variables in this study. The energy sector also has a very high adjusted R-squared value of 97.7%. The consumer goods sector has a relatively moderate value of 59.3%. According to the order, the research model used in this study is most appropriate for the transportation sector. Furthermore, the energy and consumer goods sectors become the next order. A possible reason is that not all companies in the consumer goods sector use wheat as raw materials, which limits wheat's significance in interfering with SIP. Hence, many more variables, including other commodities besides wheat, can affect this sector.

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Appendix

Indicators	Coefficient	Std. error	*t-ratio*	*p-value*
Energy sector				
Before conflict				
FER	1.04569	0.0156604	66.77	<0.0001***
CP (oil)	0.815890	0.301048	2.710	0.0068***
GPR	0.0730438	0.0701071	1.042	0.2977
During conflict				
FER	1.08268	0.00578227	187.2	<0.0001***
CP (oil)	−1.07964	0.163520	−6.602	<0.0001***
GPR	−0.164765	0.0391294	−4.211	<0.0001***
Transportation sector				
Before conflict				
FER	1.02017	0.00571643	178.5	<0.0001***
CP (oil)	0.0566781	0.210860	0.2688	0.7881
GPR	0.0655582	0.0475775	1.378	0.1685
During conflict				
FER	1,02368	0.00554057	184.8	<0.0001***
CP (oil)	0.153236	0.109081	1.405	0.1604
GPR	−0.0408569	0.0219813	−1.859	0.0634*
Consumer goods sector				
Before conflict				
FER	0.788155	0.0338453	23.29	<0.0001***
CP (wheat)	0.945666	1.45855	0.6484	0.5169
GPR	0.0483899	0.158938	0.3045	0.7608
During conflict				
FER	0.847793	0.0240079	35.31	<0.0001***
CP (wheat)	−0.0455397	0.316384	−0.1439	0.8856
GPR	−0.00783247	0.103396	−0.07575	0.9396

Notes: Table A1 displays before and during conflict comparison. The result summary table above indicates FER is the most constant variable as it remains positive and significant toward SIP throughout all periods regardless of the conflict. The significance of CP and GPR toward SIP, on the other hand, changes over time. The most significant change of CP is seen in the energy sector, where its positive significant influence turns into negative once the Russia–Ukraine conflict starts
Source: GRETL software output

Table A1.
Before and during
conflict comparison

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