



Impact of geopolitical risk on firm financial fragility: International evidence from listed companies

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ABSTRACT

In this study, we investigate the impact of geopolitical risks on financial fragility of firms across 40 countries in the period from 1990 to 2022. The Altman Z-Score is used as an indicator of financial fragility, while the Geopolitical Risk Index is employed as a measure of geopolitical risk. The analysis includes firm-specific indicators and macroeconomic factors from a novel panel dataset. We use panel fixed-effect estimation method and employ system GMM for robustness check. We also examine the relationship according to three different income level groups of countries. The results reveal that geopolitical risks significantly increase the financial fragility of firms, and this effect is stronger in upper middle-income countries. Along with macroeconomic environment and firm characteristics, firms' heightened sensitivity to geopolitical instability emphasizes the essential role of geopolitical stability in maintaining firm financial health.

1. Introduction

Companies which are financially fragile and potentially default on their debts may have severe social and economic consequences (Cao et al., 2022). While a financially weak company may struggle to earn enough money to cover its bills, this may lead to defaults (Pindado et al., 2008). In our increasingly globalized and interconnected world, geopolitical events can rapidly spread through markets and adversely affect global financial stability. In this context, various stakeholders—including but not limited to policymakers, managers, auditors, analysts, and investors—need to have a comprehensive understanding of how company-specific and broader economic factors, particularly geopolitical risks, affect the financial health of companies.

Geopolitical events such as wars between nations, acts of terrorism, and domestic tensions are associated with significant repercussions. Termed as geopolitical risks, these incidents can disrupt markets and national economies. Some of the notable instances of geopolitical risks include the September 11 terrorist attack, Russia's war against Ukraine, the US-China trade war, Brexit, and the threats posed by North Korea. These events are challenging for firms, institutional investors, and individual savers alike. The profound impact of geopolitical risks on

economics makes those risks an important object of study in finance and economic research. For instance, based on country data, Caldara and Iacoviello (2022) created a risk index, namely Geopolitical Risk (GPR) Index, for 44 countries from different development levels. The process of creating the aforementioned index was largely based on scanning the frequency of words such as “war”, “nuclear threat”, “terrorist attack” in the national media of the relevant country. We conducted this study to examine the impact of geopolitical risks on the financial fragility of companies in those countries. For the analysis, we used yearly balance sheet data of the listed companies, along with basic indicators showing the macroeconomic performance of countries together with the geopolitical risk index. To account for policy uncertainty in firm financial fragility, we incorporated the Economic Policy Uncertainty (EPU) Index developed by Baker et al. (2016) into our model. In this study, following Altman (1968), we define financial fragility as a firm's vulnerability to financial distress or bankruptcy. Furthermore, following the methodology previously proposed by Alfaro et al. (2019), we adopt the Altman Z-score as a composite measure of firm fragility.

Geopolitical risks affect firms' financial fragility through several mechanisms. First, the primary effects of geopolitical risks include increasing uncertainties in the market and delays in the decision

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mechanisms of market-forming agents. According to pecking order theory formulated by Myers & Majluf (1984), this effect may cause delays in consumers' consumption behavior and companies' investment decisions. Second, as argued by Caldara and Iacoviello (2022), significant capital outflows and increases in companies' costs due to losses in purchasing power of national currencies frequently co-occur in periods of high geopolitical risks. Third, there is a general assumption that investments do not go to countries with high geopolitical risks or leave those countries. Finally, an increase in the GPR is strongly associated with increases in credit risk by potentially weakening the debt payment capacity of firms or governments.

In the literature, the GPR was primarily explored from a macroeconomic standpoint, highlighting its influence on various economic factors. To date, empirical research has demonstrated GPR's effects on oil prices (Bouoiyour et al., 2019) and fluctuations in gold prices (Gkillas et al., 2020). Previous studies also examined GPR's association with the likelihood of future recessions (Clance et al., 2019) and its implications for business cycles (Fernández-Villaverde et al., 2011). Specific focus was on exploring how GPR affects macroeconomic indicators like economic growth (Bloom, 2009; Soybilgen et al., 2019) and international trade (Gupta et al., 2019). In addition, several recent studies examined GPR's impact on newer financial markets, including cryptocurrencies (Al Mamun et al., 2020; Aysan et al., 2019) and the stock market (Salisu et al., 2022).

Furthermore, there is also a growing literature analyzing GPR from a firm-level perspective. For instance, Alsagr and Almazor's (2020) showed that stability and profitability in the banking sector are negatively affected by geopolitical risks, thereby leading to high costs for businesses in need of funds. As demonstrated by Caldara and Iacoviello (2022), this situation in the banking sector means less capacity utilization and profitability for non-financial companies, particularly those operating in the manufacturing field. Several previous studies also examined the effects of GPR on mergers and acquisitions (Shen et al., 2021), research and development (Jia et al., 2022; Pan, 2018), corporate finance (Khoo & Cheung, 2021), and firm value (Pringpong et al., 2023).

However, available research on the impact of geopolitical risk on firm financial fragility remains scarce. While several studies examined how geopolitical risk can affect corporate finance, investment decisions, firm valuation and stock returns, there is a clear lack of direct research on the impact of GPR on firm financial fragility. Another limitation of previous studies is that most of them focused on the relationships within individual countries, rather than on an international scale. To fill this gap in the literature, in the present study, we analyze how geopolitical risk affects firm resilience or financial fragility as measured by Altman Z-score. To this end, we use a comprehensive dataset of approximately 32,000 firms' balance sheets from 40 countries covering the period from 1990 to 2022. We also use macroeconomic indicators of these countries and the innovative GPR index developed by Caldara and Iacoviello (2022) as a measure of geopolitical risk.

We investigate the impact of GPR on firm financial fragility using panel fixed effect estimation method and analyze how this relationship varies across countries with different levels of income. The results reveal that increasing GPR significantly increases firm financial fragility. The observed trend is consistent with previous studies' finding the negative effect of GPR on firm value (Pringpong et al., 2023) and the negative effect of GPR on stock prices (Fiorillo et al., 2024). Furthermore, our analysis of the impact of GPR on firm financial fragility across countries according to different levels of income reveals that its negative impact is most pronounced in upper middle-income countries, moderate in developed countries, and insignificant in lower middle-income countries.

Our contribution to the literature is two-fold. First, our study investigates the impact of geopolitical risk on firm fragility on a global scale using a large novel panel dataset. Second, we analyze the impact of GPR for each income level category of countries separately and compare the results.

The remainder of this paper is structured as follows. Section 2 briefly reviews the literature on geopolitical risks and firm financial fragility. In Section 3, we present our data and model, while, in Section 4, we report our estimation results. Finally, Section 5 concludes.

2. Literature review

Previous research on the concept of firm financial fragility has identified a variety of influencing factors, ranging from internal governance to broader economic conditions. For instance, Lee and Yeh (2004) and Farag and Mallin (2017) explored the impact of governance structures, board diversity, ownership patterns, and the presence of female executives on financial stability. These aspects of corporate governance play a crucial role in determining firms' resilience to external shocks, including geopolitical risks. Another topic of extensive research is the interconnectedness between firm financial health and broader economic indicators. For instance, Tinoco and Wilson (2013), Batuo et al. (2018), and Chletsos and Sintos (2021) examined the relationship between macroeconomic factors such as growth rate, financial development, liberalization, and employment with corporate financial health. In addition, previous studies also focused on the role of financial ratios in estimating corporate bankruptcy and assessing financial strength. For instance, while Amoa-Gyarteng (2019) highlighted the importance of liquidity, profitability, leverage, and efficiency ratios in determining corporate financial health, Alfaro et al. (2019) investigated how firm size correlates with financial fragility, particularly in the context of market and exchange rate fluctuations.

External factors that are typically beyond companies' control are always a risk factor. Among various external influences, an important factor is geopolitical risks such as conflicts, terrorism, ethnic unrest, and civil unrest, all of which often include country risks. The effects of these and similar developments, which are perceived as geopolitical risks, can occur on both regional and global levels. Available studies linking financial activities with geopolitical risks draw attention to disputes and political instability between states. Diversity of the studies is important in terms of showing the scope of the impact of geopolitical risks on finance. For example, Agoraki et al. (2022), Alqahtani et al. (2022), and Hoque and Zaidi (2020) examined the impact of geopolitical risks on stock market performance. Furthermore, Balcilar et al. (2018) explored the impact of geopolitical risks on the stock market volatility. Among other related studies, Antonakakis et al. (2017), Kumar et al. (2021) and Smales (2021) investigated the relationship between geopolitical risks and oil returns and volatilities. Furthermore, Alqahtani and Klein (2021) and Bouoiyour et al. (2019) examined the correlation between geopolitical risks and oil prices. In addition, tourism listed company stocks, service demand and supply relationship were examined by Balli et al. (2019), Gozgor et al. (2022), Jiang et al. (2022), and Lee et al. (2021). On top of that, there is also extensive research on the impact of GPR on overall economic growth (e.g., Adedoyin et al., 2022; Ghosh, 2022; Soybilgen et al., 2019).

Overall, the intersection of geopolitical risks and firm financial fragility is an expansive and dynamic field of study that reflects the complexities of global economic interactions. For instance, in a study on how national income, inflation, mutual values of national currencies, and securities interact with geopolitical risks in a very large group of 172 countries, Glick and Taylor (2010) documented the devastating effects of these risks. Moreover, Qin et al. (2020) and Zhang et al. (2023) highlighted how stock and bond markets are affected by geopolitical risks (see also Glick & Taylor, 2010). Interestingly, however, Qin et al. (2020) and Zhang et al. (2023) emphasized that precious metals such as gold and silver differ positively in terms of resistance to the negative effects of geopolitical risks.

While Das et al. (2019) drew attention to the effects of geopolitical risks on the stock market, the authors also highlighted the difficulty of making reliable inferences about geopolitical risks for parts of the dataset that contain outliers. Accordingly, Das et al. (2019) stressed that,

in the case of extreme values, uncertainty indicators rather than geopolitical risks are compatible with making more meaningful inferences. Another implication of Das et al.'s (2019) study concerns cyclical developments. Specifically, the authors highlighted the need to examine the effects of geopolitical risks in different conjectural conditions such as expansion, contraction or recession periods. Furthermore, Balcilar et al. (2018) found that geopolitical risks in BRICS countries do not significantly affect possible gains from the stock market. However, the authors also observed that volatility in these countries was significantly affected by geopolitical risks. In another relevant study, Balcilar et al. (2018) emphasized that volatility and geopolitical risks affect basic economic transactions such as consumption, production, commercial transactions and investment, along with changing financial conditions. In addition, several studies also explored the impact of geopolitical risks on renewable energy (Su et al., 2021), the impact of GPR on crypto currencies (Aysan et al., 2019), the impact of GPR on technology transfer and real investments (Nguyen et al., 2022), the impact of GPR on international trade (Gupta et al., 2019; Williams, 2014), as well as the relationship between GPR and economic sustainability (Nguyen et al., 2023).

Furthermore, several previous studies examined the impact of geopolitical risks on company investments. For instance, recent studies revealed that, in periods of high geopolitical risks, company investments tend to slow down (Le & Tran, 2021; Wang et al., 2023). In addition, as highlighted by researchers, geopolitical risks are effective in companies' tendency to avoid risk not only in investment decisions, but also in all other decisions of companies. An important aspect to note here is that companies' financial decisions, such as their borrowing behavior, are also affected by the aforementioned trend. As argued by Khoo and Cheung (2021), in an environment where geopolitical risks increase, companies tend to reduce their financial liabilities. In addition, companies' reactions to geopolitical risks are not limited to investment and borrowing decisions, but also include liquidity management. For example, Lee and Wang (2021) and Wang et al. (2021) observed that companies strengthen their cash positions in an environment where geopolitical risks increase. Furthermore, there is also evidence to suggest that companies do not avoid geopolitical risks only by maintaining a high cash position and low liability tendencies. In addition to these decisions aimed at reducing risks, strategic merger and acquisition behaviors are also preferred as a method (e.g., Shen et al., 2021; see also Borthwick et al., 2020 for a consolidation of these hedging methods).

Another salient aspect focused on in the literature is the relationship between macroeconomic variables and geopolitical risks. For instance, in an important studies on the relationships between real outputs, insurance activities, and geopolitical risks for BRICS countries, Lee and Lee (2020) showed that micro-scale companies are negatively affected by geopolitical risks, while basic macroeconomic variables such as growth rates are negatively affected by geopolitical risks. Industrial differences were also pointed out in the context of geopolitical risks. In other words, whether each industry should be examined separately remains a question extensively discussed in the literature. A prominent industry in this respect is the tourism industry, as this sector is based on human mobility. Tourism industry is considered as a sector that is most vulnerable to geopolitical fluctuations (e.g., Akadiri et al., 2020; Demir et al., 2020; Tiwari et al., 2019).

In more recent studies, new dimensions to the understanding of geopolitical risks and firm financial fragility have been introduced. For instance, Murinde et al. (2022) explored how fin-tech platforms adapt their risk models to account for geopolitical uncertainties, integrating political risk assessment into their financial algorithms. In addition, previous studies also examined the shifting dynamics of international trade triggered by geopolitical tensions. Meanwhile, Williams (2014) provided an insightful analysis of how trade wars and protectionist policies, which frequently stem from geopolitical disputes, reshape global supply chains and adversely affect corporate financial strategies.

Furthermore, research on geopolitical risks has expanded to explore

the relationship between environmental, social, governance factors and GPR. For instance, Saharti et al. (2024) pointed out that environmental, social, and governance-related factors can be meaningfully used by companies to overcome the challenges of geopolitical risks and that it is possible to make more accurate investment decisions by using these factors in an environment with high geopolitical risks. In addition to the examination of environmental, social and governance factors to mitigate the effects of geopolitical risks, the role of technological developments also came to the fore in the literature. For example, Unger and Hassani (2023) showed that applications such as artificial intelligence or blockchain, which are among the most important technological developments in recent years, can be effectively used by companies to reduce the negative effects of geopolitical risks.

3. Data and empirical model

The dataset used in the present study covers the period from 1990 to 2022 and includes publicly traded firm data from 40 countries at different stages of their economic development. Using this comprehensive dataset ensured a robust and thorough analysis. Financial data for publicly listed companies, providing a detailed insight into firm-specific financial metrics such as leverage ratios, profitability indicators, liquidity ratios, and firm size, were sourced from the Thomson Reuters Eikon database. These data formed the backbone of the study.

In addition to company financials, macroeconomic variables were extracted from the World Bank's World Development Indicators. These indicators, including GDP growth rates, inflation rates, trade as a percentage of GDP, and real effective exchange rates, provided the macroeconomic backdrop against which the firm-level analysis was conducted. In addition to macroeconomic variables, we also added Economic Policy Uncertainty (EPU) index for controlling its impact on Altman Z-score developed by Baker et al. (2016). Finally, we also incorporated the Geopolitical Risk Index (GPRIND) developed by Caldara and Iacoviello (2022), which offers a quantifiable measure of geopolitical tensions impacting each country included in the study. They created GPRIND by using frequently used words related to geopolitical and international political tensions. The frequency of those words was determined using the text-search algorithm applied to analyze 11 leading newspaper in selected countries. For construction of the index, certain words such as *conflict*, *army*, *geopolitics*, *nuclear*, *invasion*, *terrorist attack*, and so forth were critical. The GPRIND was considered crucial for assessing the intensity and nature of geopolitical risks affecting the countries in the dataset.

The dataset is winsorized to eliminate outliers, specifically truncating data below the 1st percentile and above the 99th percentile. The final sample consisted of a total of 32,125 firms with 330,166 firm-year observations, covering the period of 1990–2022 from 40 countries. This process ensured that the analysis was not skewed by extreme values. Summary statistics, including mean, standard deviation, and range of the variables are reported in Table 1.

3.1. Selection of variables

Following Alfaro et al. (2019), we used Altman Z-score as explanatory variable in our models. This score is a widely accepted and effective instrument used to predict financial fragility. In the last five decades, this score has been extensively used and remains as an established method to evaluate a company's business performance. By using various financial ratios including liquidity, profitability, solvency and efficiency, the model determines a company's financial health and probability of experiencing financial fragility or bankruptcy. The analysis of Altman's Z-score bankruptcy prediction model in an international context indicated that the model performs reasonably well for most countries, with a prediction accuracy level reaching 75%. In some countries, the model performed remarkably well, with accuracy levels exceeding 90% (Altman et al., 2014).

Table 1
Summary statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
Measure of firm financial fragility					
AltmanZS	437,056	4.22	6.21	−12.72	56.76
Measures of firms' specific variables					
CapitalExp	563,669	8.29	2.61	0.91	14.39
CurrentRatio	591,302	2.62	3.67	0.08	42.56
Size	626,632	11.83	2.13	5.51	17.32
Leverage	625,477	1.36	2.23	−8.49	20.08
ROE	556,990	0.55	36.64	−298.76	119.29
Measure of geopolitical risks					
GPRIND	1452	0.21	0.3	0.003	4.68
Measure of policy uncertainty					
EPU	522	128.636	75.63579	27.0009	669.01
Measures of macroeconomic variables					
ExcRate	1158	680.98	3138.05	0.00002	23271.21
Inflation	1348	10.54	135.28	−4.01	7481.66
Growth	1402	3.57	3.64	−29.1	18.28
Openness	1397	67.18	67.97	13.75	442.62

The main objective of the present study is to evaluate the impact of geopolitical risk on firm fragility. Geopolitical risk reflects uncertainties arising from political, economic, and social factors (Caldara & Iacoviello, 2022). We used the geopolitical risk index developed by Caldara and Iacoviello (2022) to quantify and model potential effects of geopolitical events on companies' activities and financial performance. Considering that the reflections of geopolitical risks on the financial fragility of companies are becoming increasingly important so we included these risks in the analysis process.

Capital expenditure (CapitalExp) represents the company's investment. While a higher level of capital expenditure might indicate a company's commitment to expansion and innovation, it can also pose financial risks if not managed properly (Le & Tran, 2021). Current ratio is one of the other variables used in estimation model, because it measures a company's ability to cover its short-term liabilities with its short-term assets. Furthermore, a high current ratio suggests financial stability, while a very high ratio might indicate inefficient use of resources (Lee & Wang, 2021). Return on equity (ROE) is a key indicator of a company's profitability used in this study. Consistently high ROE suggests effective use of equity capital, while a declining trend might signal challenges in generating returns (Alfaro et al., 2019).

As argued by Asis et al. (2021), corporate leverage and firm size can impact financial fragility. Size, which is frequently measured by total assets, can reflect a company's scale and market presence. While larger firms might have more resources, they could also face challenges related to operational complexity and management efficiency. Leverage reflects the extent to which a company relies on debt rather than equity to fund its activities. While moderate leverage can amplify returns, excessive leverage was previously found to increase the risk of financial distress, especially if economic conditions deteriorate (Alfaro et al., 2019; Asis et al., 2021).

Besides, we used Inflation, GDP Growth (Growth), Trade% of GDP (Openness), and Exchange Rate (ExcRate) variables as macroeconomic controls in the analysis. Inflation, GDP growth, and trade dynamics can influence a company's financial health, while the exchange rate reflects currency movements that impact international business operations (Gupta et al., 2019). Along with the aforementioned macro variables, there are also other factors affecting financial fragility of firms. One of these factors is Economic Policy Uncertainty (EPU) (Phan et al., 2021; Alam et al., 2023). For that reason, the EPU index developed by Baker et al. (2016) was added to our model and its impact on financial fragility was estimated.

3.2. Summary statistics

Table 1 provides (shows) a summary of the descriptive statistics. As

can be seen in Table 1, average Altman Z-score is 4.18, which corresponds to "B" letter grade rating. Next, standard deviation of this variable is 6, so variation in firm financial fragility appears to be quite high. Mean of geopolitical risk index (GPRIND) is 0.22 and its standard deviation is 0.22, which suggests that, in our sample, geopolitical risk does not vary much across countries. Firm-specific variables indicate moderate variation across firm year observations (except for return on equity which has a high variation).

Table 2 provides the correlation matrix of variables. Based on the correlation coefficients of the variables, we rule out collinearity, concluding that our model does not suffer from multicollinearity.

3.3. Empirical model

In order to examine the impact of geopolitical risk on firm financial fragility, we employ the following model (See Eq. (1)):

$$\text{AltmanZS}_{i,t} = a_0 + \gamma_i + \delta_t + b_1 \text{GPRIND}_{i,t} + b_2 X_{i,t} + b_3 Z_{c,t} + \varepsilon_{it} \quad (1)$$

In this model, the Altman Z-Score serves as the dependent variable, representing firm financial fragility. Independent variables include firm-specific factors ($X_{i,t}$: capital expenditure, current ratio, firm size, leverage, return on equity), country-specific macroeconomic variables ($Z_{c,t}$: inflation, GDP growth, trade volume, real exchange rate), and the Geopolitical Risk Index. Firm-fixed effects (γ_i) account for unchanging individual firm characteristics across time, thus mitigating the risk of omitted variable bias; finally, (δ_t) represents the year fixed effects.

The regression model is specified in a progressive manner, starting with a baseline model analyzing the impact of firm-specific variables on firm financial fragility, followed by extended models incorporating the Geopolitical Risk Index and macroeconomic controls. To account for the endogeneity problem, first, we use lagged values in estimations and second, we employ the System GMM method.

4. Estimation results

We report the estimation results of four models obtained from Eq. (1) in Table 3. The findings from the models are quite similar. Specifically, the results indicate that higher capital expenditure (CapitalExp), current ratio (CurrentRatio), and return on equity (ROE) are linked to higher Altman-Z scores. These results are also consistent with previous research (Platt & Platt, 2002; Powell et al., 2023). By contrast, larger firm size (Size) and higher leverage (Leverage) were previously found to be associated with lower Altman-Z scores (Demirgüç-Kunt & Maksimovic, 1998; Fama & French, 2002). These findings are also consistent with the findings of previous studies (e.g., Assadian & Ford, 1997; Tinoco & Wilson, 2013; Fiorillo et al., 2024) showing that larger firms and more leveraged firms are financially more fragile.

Geopolitical risk index (GPRIND), which is focal point of the present investigation, is introduced in Model II and in subsequent models, displaying significant negative coefficients ranging from −1.4 to −1.15. Specifically, the GPR coefficient of −1.412 suggests that a one standard-deviation (0.3 unit) increase in GPR is associated with 10.03% decrease in Altman Z-score from its mean.¹ The coefficient of GPR is −1.412 (see Table 3), indicating that a one-unit increase in GPR is associated with a 1.4 point decrease in Altman Z-score. This relationship indicates that elevated levels of geopolitical risk correspond to lower Altman-Z scores. This finding is congruent with previous research that highlighted the detrimental effects of geopolitical uncertainty on firm performance.

¹ The coefficient of GPR is −1.412 in Table 3, indicating that a one-unit increase in GPR is associated with a 1.412 point decrease in Altman Z-score. Considering that the standard deviation of GPR is 0.3 and mean of Altman Z-score is 4.22 (see Table 3), the percentage change in Altman Z score with increase of one-standard-deviation increase in GPR can be calculated as follows: $(-1.412 \times 0.3)/4.22 = -10.03\%$.

Table 2
Correlation matrix.

	AltmanZS	Cap.Exp	Cur.Rat.	Size	Leverage	ROE	Inflation	Growth	Openness	ExcRate	GPRIND	EPU
AltmanZS	1.00											
Cap.Exp	−0.08 ^a	1.00										
Cur.Rat.	0.52 ^a	−0.19 ^a	1.00									
Size	−0.13 ^a	0.79 ^a	−0.19 ^a	1.00								
Leverage	−0.21 ^a	0.09 ^a	−0.2 ^a	0.14 ^a	1.00							
ROE	0.12 ^a	0.21 ^a	−0.06 ^a	0.22 ^a	−0.12 ^a	1.00						
Inflation	−0.01 ^a	0.02 ^a	−0.01 ^a	0.01 ^a	−0.004 ^a	0.004 ^a	1.00					
Growth	0.07 ^a	0.01 ^a	−0.01 ^a	−0.04 ^a	−0.03 ^a	0.09 ^a	−0.08 ^a	1.00				
Openness	−0.03 ^a	−0.08 ^a	0.01 ^a	−0.01 ^a	−0.04 ^a	0.01 ^a	−0.04 ^a	−0.02 ^a	1.00			
ExcRate	−0.01 ^a	−0.11 ^a	−0.01 ^a	−0.12 ^a	0.01 ^a	0.04 ^a	−0.01 ^a	0.13 ^a	0.12 ^a	1.00		
GPRIND	0.05 ^a	0.12 ^a	−0.03 ^a	0.14 ^a	0.01 ^a	0.03 ^a	−0.02 ^a	0.01 ^a	−0.25 ^a	−0.14 ^a	1.00	
EPU	0.02 ^a	0.09 ^a	0.02 ^a	0.12 ^a	−0.04 ^a	−0.03 ^a	−0.03 ^a	−0.26 ^a	0.16 ^a	−0.03 ^a	0.43 ^a	1.00

* $p < 0.10$, ** $p < 0.05$.

^a $p < 0.01$.

Table 3
Baseline regressions.

	I	II	III	IV
GPRIND		−1.412 ^a (0.088)	−1.398 ^a (0.093)	−1.148 ^a (0.115)
CapitalExp	0.170 ^a (0.012)	0.168 ^a (0.012)	0.164 ^a (0.012)	0.159 ^a (0.016)
CurrentRatio	0.884 ^a (0.015)	0.883 ^a (0.015)	0.884 ^a (0.015)	0.969 ^a (0.019)
Size	−0.680 ^a (0.029)	−0.654 ^a (0.029)	−0.631 ^a (0.029)	−0.640 ^a (0.039)
Leverage	−0.192 ^a (0.008)	−0.191 ^a (0.008)	−0.193 ^a (0.008)	−0.195 ^a (0.009)
ROE	0.026 ^a (0.001)	0.025 ^a (0.001)	0.025 ^a (0.001)	0.026 ^a (0.001)
Inflation			0.0001 (0.0001)	0.0001 (0.0001)
Growth			0.042 ^a (0.004)	0.055 ^a (0.006)
Openness			−0.001 (0.001)	−0.022 ^a (0.003)
ExcRate			−0.00004 (0.00003)	0.0002 (0.0003)
EPU				−0.003 ^a (0.0002)
Constant	8.719 ^a (0.294)	8.979 ^a (0.292)	8.661 ^a (0.307)	9.787 ^a (0.452)
OBS	330166	330166	325320	230015
Adjusted R ²	0.242	0.243	0.243	0.252

Standard errors in parentheses.

* $p < 0.10$, ** $p < 0.05$.

^a $p < 0.01$.

While, to the best of our knowledge, none of the previous research directly examined the relationship between firm financial fragility and geopolitical risk index, there were studies on the relationship between stock return, firm value, corporate performance and geopolitical risk. Our results are largely consistent with the findings previously reported by Hoque and Zaidi (2020) Pringpong et al. (2023), and Fiorillo et al. (2024). Interestingly, the negative impact of a one unit increase in the standard deviation of the GPR on firm financial fragility (about 10.03% decrease from the average value of the Altman Z-score) is close to the results reported by Pringpong et al. (2023), namely the negative impact of the GPR on firm value (7.8% decrease from the average value of Tobin's Q).

Moreover, our analysis incorporates macroeconomic variables—specifically, inflation (Inflation), GDP growth (Growth), trade openness (Openness), and exchange rate (ExcRate)—in Model III, while Economic Policy Uncertainty (EPU) Index is also added in Model IV. The results reveal that GDP growth exhibits a significant positive coefficient in both models, suggesting a direct relationship between robust economic growth and higher Altman-Z scores. Conversely, we observed that

trade openness is associated with a significant negative coefficient in Model IV, implying that increased trade openness may adversely affect the Altman-Z score (Rodrik, 1998). Of note, neither inflation nor exchange rate demonstrates significant coefficients across the models. The inclusion of the economic policy uncertainty index in Model IV reveals a significant negative coefficient, suggesting that increased economic policy uncertainty leads to lower Altman-Z scores (see also Baker et al., 2016). When we add EPU² and other macroeconomic variables to Model II, the coefficient of the GPRIND remains negative and significant in Model IV. Taken together, the findings presented in Table 3 indicate the substantial impact of firm-specific factors, geopolitical risk, and broader macroeconomic conditions on the Altman-Z score, while controlling for firm and year fixed effects. The results of this analysis indicate the need to consider both internal and external influences when evaluating firm performance, thereby contributing valuable insights to the discourse on financial health assessment in an increasingly complex economic landscape.

In Table 3, all variables in the models are contemporaneous, which may lead to endogeneity problems. To overcome the possible endogeneity problem estimation results with lagged values of explanatory variables are presented in Table 4. A comparison of the results in Tables 3 and 4 reveals that, while the signs and significance levels of firm-specific variables' coefficients do not change, magnitude does change. These findings are in line with previous research that shows that increased liquidity, profitability and reduced leverage are indicators of stronger financial performance. (Altman et al., 2014). With regard to the focal point of the study (GPRIND), our findings indicate that an increase in geopolitical risk is associated with a significant decline in the Altman-Z score, with coefficients ranging from −0.80 to −1.28. These results are consistent with the results in Table 3; yet, the absolute values of coefficients decrease.

Furthermore, in Table 4, we report the results of our analysis of macroeconomic variables, including inflation, GDP growth (Growth), trade openness (Openness), and exchange rate (ExcRate), which are integrated into Models III–IV. When we take lagged values of the variables, inflation and exchange rate become significant. The results indicate that inflation and GDP growth positively affect the Altman-Z score. Conversely, trade openness is associated with a significant negative impact in Model IV. The exchange rate exhibits a complex relationship, showing a significant positive influence in Model III; however, significant negative effect is observed in Model IV. These mixed findings may suggest that the effects of macroeconomic factors on firm financial

² The observations of EPU variable are limited to 19 countries. The dataset used in the present study covers 40 countries. In fact, when we use EPU data, the number of observations dramatically decreases, so this weakens the estimation. For that reason, the EPU variable is not added to the analysis conducted for country groups with different income levels.

Table 4

Robustness Tests: Lagged independent variables.

	I	II	III	IV
L.GPRIND		−1.28 ^c (0.11)	−1.24 ^c (0.12)	−0.80 ^c (0.13)
L.CapitalExp	0.03 ^b (0.01)	0.03 ^b (0.01)	0.03 ^b (0.01)	0.02 (0.02)
L.CurrentRatio	0.35 ^c (0.01)	0.35 ^c (0.01)	0.35 ^c (0.01)	0.38 ^c (0.01)
L.Size	−1.04 ^c (0.03)	−1.02 ^c (0.03)	−1.01 ^c (0.03)	−1.15 ^c (0.04)
L.Leverage	−0.09 ^c (0.01)	−0.08 ^c (0.01)	−0.08 ^c (0.01)	−0.08 ^c (0.01)
L.ROE	0.02 ^c (0.001)	0.02 ^c (0.001)	0.02 ^c (0.001)	0.02 ^c (0.001)
L.Inflation			0.001 ^a (0.0004)	0.001 ^b (0.0004)
L.Growth			0.02 ^c (0.005)	0.04 ^c (0.007)
L.Openness			−0.0001 (0.001)	−0.02 ^c (0.002)
L.ExcRate			0.0001 ^b (0.00003)	−0.001 ^c (0.0004)
L.EPU				−0.003 ^c (0.0003)
Constant	14.34 ^c (0.31)	14.61 ^c (0.31)	14.40 ^c (0.32)	17.04 ^c (0.46)
OBS	315417	315417	314064	222944
Adjusted R ²	0.143	0.139	0.141	0.142

Standard errors in parentheses.

^a $p < 0.10$.^b $p < 0.05$.^c $p < 0.01$.

fragility vary by the inclusion of other variables (see also [Asimakopoulou et al., 2009](#); [Mazzeu et al., 2019](#)).

In addition, Model IV includes the Economic Policy Uncertainty (EPU) index, which reveals a significant negative effect on the Altman-Z score. This aligns with the findings previously reported by [Arouri et al. \(2016\)](#), who argue that uncertainty in economic policy can adversely impact firm financial performance. The rigorous inclusion of both year and firm fixed effects in the analysis effectively controls for unobserved time-specific and firm-specific factors that may influence the Altman-Z score. Therefore, the results of our comprehensive analysis robustly underscore the critical interplay of firm-specific, geopolitical, and macroeconomic factors in evaluating firm financial fragility.

To account for the endogeneity problem, we also estimate the models using the system GMM developed by [Arellano and Bond \(1991\)](#), [Arellano and Bover \(1995\)](#), and [Blundell and Bond \(1998\)](#). The results of system GMM estimation are summarized in [Table 5](#).

The lagged Altman Z-score (L.AltmanZ) consistently has positive and statistically significant coefficient across all models, indicating a notable persistence in financial fragility over time (cf. [Wruck, 1990](#)). The coefficients of capital expenditure, size and leverage are negative and significant, suggesting that a greater capital expenditure, a larger firm size and leverage lead to lower Altman Z-scores, reflecting elevated financial fragility. By contrast, the coefficients of current ratio and ROE are positive and significant, signifying that enhanced liquidity and profitability are associated with reduced financial fragility. These results are consistent with the results of [Altman, Iwanicz-Drozowska, et al. \(2017\)](#).

In Model II, geopolitical risk index (GPRIND) reveals negative and significant coefficient, indicating that an increased geopolitical risk is linked to greater financial fragility (see also [Caldara & Iacoviello, 2018](#)). This trend is upheld in both Models III and IV where the analysis further incorporates macroeconomic variables. The coefficient of GDP growth is positive and significant, suggesting that economic growth is inversely associated with financial fragility, which is consistent with the results previously reported by [Tinoco and Wilson \(2013\)](#). Conversely, trade openness displays negative and significant coefficient, implying that

Table 5

Addressing endogeneity: System GMM.

	I	II	III	IV
L. AltmanZ	0.382 ^c (0.017)	0.366 ^c (0.016)	0.34 ^c (0.016)	0.323 ^c (0.019)
GPRIND		−0.772 ^c (0.059)	−0.546 ^c (0.062)	−0.266 ^c (0.067)
CapitalExp	−0.033 ^c (0.012)	−0.031 ^b (0.012)	−0.025 ^b (0.012)	−0.016 (0.016)
CurrentRatio	0.81 ^c (0.020)	0.808 ^c (0.02)	0.805 ^c (0.019)	0.878 ^c (0.025)
Size	−1.059 ^c (0.059)	−1.057 ^c (0.058)	−1.07 ^c (0.059)	−1.081 ^c (0.073)
Leverage	−0.104 ^c (0.01)	−0.104 ^c (0.01)	−0.106 ^b (0.01)	−0.106 ^c (0.012)
ROE	0.019 ^c (0.001)	0.019 ^c (0.001)	0.018 ^c (0.001)	0.019 ^c (0.001)
Inflation			−0.0002 ^a (0.0001)	0.0001 (0.0001)
Growth			0.051 ^c (0.002)	0.063 ^c (0.003)
Openness			−0.016 ^c (0.001)	−0.06 ^c (0.002)
ExcRate			−0.0001 (0.00004)	−0.001 ^b (0.0004)
EPU				−0.002 ^c (0.0002)
AR(2) p-value	0.194	0.270	0.457	0.894
Hansen test	0.980	0.898	0.734	0.316
Prob.				
OBS	263090	263090	258835	184096

Standard errors in parentheses.

^a $p < 0.10$.^b $p < 0.05$.^c $p < 0.01$.

increased trade openness coincides with elevated financial distress (cf. [Rodrik, 1998](#)). Moreover, we observe that exchange rate has negative and significant coefficient in Model IV, indicating that currency depreciation is linked to increased financial fragility, as also discussed by [Baggs et al. \(2009\)](#). In addition, the economic policy uncertainty index introduced in Model IV exhibits negative and significant coefficient, suggesting that higher levels of EPU are associated with greater financial distress (cf. [Baker et al., 2016](#)). Overall, the results of the GMM estimation clearly demonstrate that all firm-specific factors, geopolitical risks, macroeconomic conditions, and economic policy uncertainty play significant role in financial fragility.

4.1. Estimation results according to different income level groups

To further examine the impact of GPR on firm fragility, we estimated the model for countries grouped by income level. The results are summarized in [Table 6](#). According to results there is no significant impact of GPR on firm fragility in lower middle-income level countries. On the other hand, in upper-middle and high income countries, geopolitical risk has significant and negative impact on firm financial fragility.

The results obtained for firm-specific variables are similar to those reported in previous results, except capital expenditures. These findings align with established literature, which suggests that liquidity, profitability, and lower leverage are critical indicators of improved financial performance ([Altman, Sabato, & Wilson, 2017](#); [Delen et al., 2013](#)). Conversely, the impact of capital expenditure on Altman Z-score varied across different income groups of countries. We may interpret this result with different risk exposures of firms' investments. In the examined period, in high income countries, capital expenditures reduced the fragility, while, in upper middle-income countries, these expenditures increased it. In our further analyses, we explored the impact of macroeconomic variables which exhibited varying effects across different country groups. Of note, inflation was found to have a significant negative impact in the lower-middle income country group, while it was

Table 6
Subsample analysis.

	World	Lower-Middle	Upper-Middle	High
L.GPRIND	−1.24 ^c (0.11)	−0.19 (0.61)	−2.88 ^c (0.25)	−0.54 ^c (0.12)
L.CapitalExp	0.03 ^b (0.01)	0.01 (0.02)	−0.04 ^b (0.02)	0.08 ^c (0.02)
L.CurrentRatio	0.35 ^c (0.01)	0.23 ^c (0.03)	0.50 ^c (0.02)	0.31 ^c (0.01)
L.Size	−1.01 ^c (0.03)	−0.58 ^c (0.12)	−1.53 ^c (0.06)	−0.92 ^c (0.04)
L.Leverage	−0.08 ^c (0.01)	−0.11 ^c (0.01)	−0.07 ^c (0.02)	−0.08 ^c (0.01)
L.ROE	0.021 ^c (0.001)	0.02 ^c (0.002)	0.03 ^c (0.001)	0.02 ^c (0.001)
L.Inflaiton	0.001 ^a (0.001)	−0.044 ^c (0.007)	0.0003 (0.0005)	0.02 ^a (0.01)
L.Growth	0.02 ^c (0.01)	0.06 ^c (0.01)	0.03 ^c (0.01)	0.01 (0.01)
L.Openness	−0.0001 (0.001)	0.004 (0.003)	0.02 ^c (0.002)	0.006 ^c (0.001)
L.ExcRate	0.0001 ^b (0.00003)	−0.0001 ^b (0.00003)	0.0003 (0.0004)	−0.003 ^c (0.0002)
Constant	14.40 ^c (0.32)	10.02 ^c (1.26)	21.81 ^c (0.63)	12.45 ^c (0.41)
OBS	314064	31100	88221	194743
Adjusted R ²	0.152	0.193	0.082	0.186

Standard errors in parentheses.

^a $p < 0.10$.

^b $p < 0.05$.

^c $p < 0.01$.

associated with a significant positive impact in high income country group. GDP growth revealed a significant positive effect in lower, and upper-middle income country groups, yet remained insignificant in the high income country group. Trade openness showed a significant positive impact in both the upper-middle and high income country groups, whereas the exchange rate presented a significant negative influence in lower- and high income country groups. These mixed results suggest that the effects of macroeconomic factors on firm financial health are contingent upon the specific context of each country group and the level of economic development. The observed variability underscores the importance of considering regional economic conditions when evaluating the financial metrics of firms (Akbar et al., 2013; Zeitun et al., 2007).

The effect of the GPRIND on the Altman Z-score was insignificant in lower middle-income countries, where most of the data were from India. This result may be explained by the findings previously reported by Balcilar et al. (2018) who showed India to be the most resilient BRICS country in terms of stock market stability under geopolitical stress. This resilience was previously attributed to strong domestic demand and significant capital inflows fueled by the boom in the IT sector (see Henkel, 2012).

Furthermore, upper middle-income countries manifested a substantial sensitivity to geopolitical risks, as indicated by the significant coefficient of −2.88 in Column (3). This corresponds to an approximately 20% decrease in the Altman Z score from its mean for every one standard-deviation escalation in the Geopolitical Risk Index (0.3 unit). High sensitivity of firms in these countries to geopolitical risks indicates that geopolitical stability is extremely important for firms in these countries. This heightened sensitivity could be attributed to various factors, including a substantial dependence on foreign capital for investments, with heightened instability dissuading potential investors (Bruno & Shin, 2015). In addition, considering that the production and consumption activities in these countries are closely linked to consumer confidence, when geopolitical risk is high, economic activities may shrink and firm fragility may increase. Furthermore, the consequences of geopolitical uncertainties can be exacerbated by potential governmental interventions in the economies of upper middle-income

countries.

With regard to higher-income countries, we should note the negative impact of GPRIND on the Altman Z score. However, the coefficient of GPRIND in high income countries was considerably higher than the coefficient of GPRIND observed in upper middle-income countries. This difference can be explained by the robust legal frameworks, economic stability, and sophisticated risk management instruments which are superior in higher-income countries. The deviation in the coefficient of GPRIND across different income groups can be further interpreted from the perspective of institutional quality and risk management infrastructure. Lower middle-income countries, which frequently struggle with institutional weaknesses, may exhibit a muted response to geopolitical risks due to limited capacity for effective risk management (Acemoglu et al., 2014). By contrast, high risk sensitivity in upper middle-income countries could be attributed to the complex interplay of global economic dependencies and higher firm financial fragility in the absence of efficient risk mitigation mechanisms. Higher-income countries, which are characterized by stronger institutional frameworks, may demonstrate resilience by quickly adapting to various geopolitical risks and implementing effective risk mitigation strategies, which may result in less negative impact on firm financial fragility.

Our detailed results concerning the impact of geopolitical risk across different income groups provide valuable insights about the complicated relationship between macroeconomic factors, firm-specific dynamics, and geopolitical uncertainties. This results present new evidence for complex mechanisms underlying the observed variations in the coefficients.

Overall, the results in Table 6 reinforce the critical interplay between firm-specific attributes and macroeconomic conditions, highlighting the necessity of nuanced approach for evaluating financial health across different income level of selected countries. In Table 6, geopolitical risks, firm-related factors, and overall economic conditions significantly influence the dependent variable across various country groups. These findings underscore the importance of considering both internal and external factors, along with the level of economic development, in evaluations of companies' financial health and stability.

5. Conclusion

The last several decades have witnessed growth in the number and frequency of geopolitical tensions, which emerge a significant source of systematic risk that businesses have to navigate. While geopolitical risks do not originate from economic factors, such risks can have extensive adverse economic consequences that can become a burden for both firms and investors. In this context, it is essential to gain a comprehensive understanding of economic and financial results of such risks and to explore potential mitigation strategies for both policymakers and practitioners. Accordingly, in this study, we investigated the impact of geopolitical risks on the financial fragility of firms internationally. The analysis of the data from over 32,000 firms across 40 countries from 1990 to 2022 revealed the significant negative effect of GPR on firms' financial fragility—a relationship that was found to persist even after controlling for firm-specific factors and macroeconomic variables. The addition of Economic Policy Uncertainty (EPU) Index further showed that both GPR and policy uncertainty contribute to heightened financial fragility. Consistently with previous research (e.g., Alsagr & Almazor, 2020; Caldara & Iacoviello, 2022), our findings underline the serious sensitivity of businesses to geopolitical instability, emphasizing the essential role of geopolitical stability in sustaining their financial health. We also employed system GMM estimation to address potential endogeneity concerns, and the results confirmed the robustness of our findings across all models. Both contemporaneous and lagged effects of GPR, firm-specific and macroeconomic variables were considered to provide more dynamic understanding of the geopolitical risk-financial fragility relationship.

When investigating the effects according to the country income

levels, we found that the adverse impacts of geopolitical risks are most remarkable in upper middle-income countries. Here, a one-standard-deviation increase in geopolitical risk was found to reduce the firms' Altman Z-scores by approximately 20% of their mean value. This high sensitivity may be attributed to high global economic interdependencies, reliance on foreign capital, and the lack of robust risk-mitigating mechanisms (cf. Bruno & Shin, 2015). On the other hand, in developed countries, the impact is found more moderated. This result could be due to stronger institutional frameworks and effective risk management practices. Meanwhile, we observed no significant effect in lower middle-income countries. The differences of GPRIND coefficient may be explained by differences in institutional quality, risk management infrastructure, and global economic ties.

Empirical findings of this study provide meaningful implications for policymakers, investors, and corporate executives, offering crucial understandings into importance of managing geopolitical risks. A careful monitoring of these risks and establishing early detection mechanisms is critical to proactively manage potential threats. In this regard, investors may consider diversifying their portfolios across various countries to mitigate geopolitical risks. In addition, managers can improve their firms' health by implementing targeted measures that address the financial characteristics of firms under distress. By following diversification strategies and investing in new markets, companies can reduce the adverse effects of geopolitical uncertainties. Similarly, ensuring

robust balance sheet structures with moderate leverage and sufficient liquidity levels can effectively improve firms' resilience to external shocks. Finally, macroeconomic stability is critical for firms' health. In future research, it would be meaningful to explore how different industries and firms' characteristics influence their fragility to geopolitical risks.

CRedit authorship contribution statement

Hüseyin Kaya: designed the model and the computational framework, Formal analysis, wrote the manuscript with input from all authors. **Yasir Küçükşahin:** designed the model and the computational framework, Formal analysis, wrote the manuscript with input from all authors. **Mücahit Çitil:** wrote the manuscript with input from all authors.

Authorship statement

All authors have equally contributed to this paper.

Data availability

Data are available on request.

Appendix

Table A1
Variable Definitions

Variable	Definition
AltmanZS	Altman Z-score, a measure of financial distress risk. Calculated as: $1.2 \times (\text{Working Capital} / \text{Total assets}) + 1.4 \times (\text{Retained Earnings} / \text{Total assets}) + 3.3 \times (\text{Operating Income} / \text{Total assets}) + 0.6 \times (\text{Market Capitalization} / \text{Total liabilities}) + (\text{Net Sales} / \text{Total assets})$
GPRIND	Geopolitical risk index, measuring the level of geopolitical tension. Higher values indicate higher risk.
CapitalExp	Natural logarithm of capital expenditures
CurrentRatio	Current assets divided by current liabilities
Size	Natural logarithm of total assets
Leverage	Total liabilities divided by total equities
ROE	Return on equity, calculated as net income divided by total equity
Inflation	Annual inflation rate (%)
Growth	Annual GDP growth rate (%)
Openness	Trade openness, measured as $(\text{Exports} + \text{Imports}) / \text{GDP}$
EXC	Yearly average value of country's currency to USD
EPU	Economic policy uncertainty index

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