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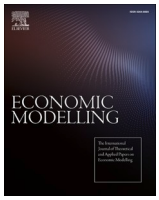

ESG performance and stock market responses to geopolitical turmoil: evidence from the Russia-Ukraine war

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ABSTRACT

In the wake of the 2015 Paris Agreement, an increasing number of stakeholders have called upon companies to demonstrate a greater level of ethical, environmental, and social responsibility. This movement aims to contribute positively to the planet and society as a whole, as well as achieving the minimum required financial returns. However, such practices and investments are being challenged by increased geopolitical risks, such as Russia's invasion of Ukraine. This is because political events can significantly impact the financial markets and responsible investing practices. In this paper, we analyze stock price reactions to the Ukraine-Russia conflict on a global scale, focusing on differentiating between companies by country, industrial sector, and ESG characteristics. Using an event study methodology on over 17,000 firms, the empirical analysis shows that, on average, the stock market reacted negatively in the days surrounding the event. However, distinct patterns of stock market reaction are evident, most of which were country- and sector-specific. Furthermore, the results suggest that ESG performance acts as a moderating factor: firms with higher sector-adjusted ESG scores exhibit less negative CARs.

1. Introduction

In recent years, Environmental, Social, and Governance (ESG) considerations have emerged as a pivotal and guiding force in redirecting financial investment towards sustainable activities. Although the focus on sustainable investing dates back to the early 2000s, it was not until the 2015 Paris Agreement that investors started to place significant weight on sustainability practices when assessing companies. This has encouraged many companies to reconsider their approach to issues of ethics, the environment and social responsibility. This movement aims to go beyond the minimum financial returns required, and to make a positive contribution to the planet and society as a whole, and it has permeated financial markets under many different perspectives (Rau and Yu, 2024).

The Russian invasion of Ukraine has prompted a wide-ranging debate on the relationship between political events and responsible investment. The two main sectors affected by this event are the energy and commodity markets, given the global changes in the demand and supply market structure for electricity and raw materials. Policymakers are primarily attempting to address whether and how investments in the energy and ecological transition can mitigate the risks associated with such events. From this perspective, the conflict has highlighted the connection between political events, social stability, and the ethical implications embedded in investment decisions.

In the immediate aftermath of the Russian invasion, stock markets around the world fell sharply and suddenly. This was exacerbated by the fact that the global economy was still recovering from the effects of the SARS-CoV-2 pandemic. Furthermore, Western countries promptly imposed sanctions against the Russian economy, with varying degrees of severity and differing in nature and scope. For instance, on February 27th, the EU and the US took measures against Russian airlines (e.g., banning aircraft from their airspace) and banks (e.g., blocking access to the SWIFT payment system). Another significant sanction was the ban on fuel exports and the imposition of import restrictions aimed at hampering economic activity within Russia's borders. Additionally, most large, listed companies initiated divestment and suspended their

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activities within the Russian market. With regard to the Organisation for Economic Co-operation and Development's (OECD) Responsible Business Conduct (RBC) principles, *"Russia's war against Ukraine […] has also revealed areas where greater clarity might be needed in how RBC principles and standards can be applied consistently in decision making by both businesses and policymakers, especially in contexts in which conflict or human rights abuses are widespread"* (OECD, 2023).

The impact of the Russian invasion on sectors at a global level was evident in many ways. For example, the energy sector experienced two significant facts. First, the conflict led to a surge in investment in renewable energy sources, particularly in Europe, as a means of mitigating the rising cost of fossil fuels. Second, some countries chose to reopen coal mines and power plants, a decision that triggered major environmental debates.

The study examines the impact of the event on a number of stock markets on a global scale. To gain a deeper understanding of this phenomenon, the research will also consider companies' sustainability performance as proxied by ESG ratings. The study aims to answer the following research questions: first, whether the Russian invasion generated a significant impact on worldwide companies' stock returns; second, to assess which factors were the most relevant in determining the significant influence on the stock market response at company level.

To answer the first research question, we employ an event study (ES) methodology on a sample of listed companies from around the world. Specifically, we use a set of cross-sectionally adjusted and unadjusted test statistics, employing either parametric or non-parametric specifications to determine whether the event had a significant impact on stock markets. Using multiple adjusted tests is consistent with the analysis of Pelagatti and Maranzano (2021), who point out that cross-correlation adjustment is necessary when considering highly correlated time series to ensure consistent test size and power. Moreover, as many test statistics have comparable statistical properties, selecting a single test statistic is challenging. For this reason, as a by-product of the analysis, we propose a rule-of-thumb based on a majority voting approach (see Hastie et al., 2017, Section 10.1) to decide whether the event produced a significant effect or not. By applying a majority rule, we are able to identify which scenarios (i.e., country, sector, and sustainability levels and their pair combinations) are most affected by the event. The ES approach is indeed applied at the country, sector, and sustainability dimensions. Furthermore, we consider the pair combinations of country, sector, and sustainability level to account for the different degrees of specificity.

To address the second research question, we examine the factors influencing the Cumulative Abnormal Returns (CARs) in the period around the event date. This investigation aims to determine whether there is a correlation between the CARs and a number of financial information of the companies, and whether the market reactions were influenced by the characteristics of the companies in question, including their sustainability performance. To the best of our knowledge, the only paper that considers ESG performance and the Russian invasion of Ukraine in an ES setting is the one by Tsang et al. (2024). The authors find evidence suggesting that companies with higher ESG scores exhibit superior stock market performance. However, while they focus exclusively on the top 100 companies in the S&P 500 index, our study has a broader scope. Indeed, we adopt a global perspective, conduct a comprehensive country-sector analysis, and examine the factors influencing the CARs at the company level. Furthermore, in addition to standard t-statistics, we employ a range of statistical tests, accounting for the various concerns pertaining to assumptions about stock returns.

Our findings can be summarized as follows. First, despite the pervasive nature of the negative consequences of the offensive, our findings suggest that the impacts were limited and significant, with notable heterogeneity observed across countries and sectors. In particular, applying ES methodology across multiple frameworks defined at country, sector, and sustainability levels enables the most relevant level of impact of the event studied to be identified. Secondly, we show that larger companies and those with lower debt ratios were able to resist the negative impact of Russian invasion on the stock markets. Finally, we find that companies with superior sustainability ratings, particularly for environmental performance, were better able to mitigate potentially negative effects than those with minimal sustainability.

Our paper makes several contributions to the academic literature on the impact of the invasion on financial markets. Firstly, the large size of the sample and the level of granularity of the analysis (i.e., at sector and country levels) enable us to identify the characteristics and mechanisms through which the event had its greatest impact. These are more exhaustive and general than the impact occurred on a restricted but economically relevant sample of companies (see, for example, Tsang et al., 2024) or on global market indicators (Granàt et al., 2023). Secondly, we detect the main determinants of stock market reactions, focusing on ESG performance. Our findings show that the potential negative effects of the invasion at company levels is reduced by firms' environmental performance. Eventually, we also consider the fact that event study statistics may exhibit different statistical properties. Indeed, in the common framework of ES, researchers only rely on the well-established statistics (e.g, Patell and BMP) ignoring their potential drawback as well as the existence of more robust statistics (see, for example, Obi et al., 2023; Granàt et al., 2023) Conversely, this abundance of available statistics raises an issue concerning the selection of the most suitable specifications for the specific case under study. In light of the issue, we propose a rule-of-thumb approach –based on consensus of the test statistics (i.e., the majority rule) – to identify the significance of the event in the stock market. In particular, we evaluate how many statistics reject the null hypothesis of no impact of the considered event, allowing to characterize and to compare markets according to the degree of consensus of statistics across countries, industries, and ESG performance.

The rest of the paper is organized as follows. Section 2 revises the academic literature relevant to the paper; Section 3 describes the sample and outlines the empirical strategy. Section 4 gathers the empirical results from the event study. Section 5 presents the analysis of the relevant factors at company levels. Section 6 proposes a discussion and implications of the empirical results. Finally, Section 7 concludes.

2. Background and related literature

The impact of armed conflicts on the economies and financial markets has long been a topic of interest to academics. As Schneider and Troeger (2006) observe, the impact of conflicts on financial markets is manifold and depends on the severity of the conflict and the ability of economic agents to predict cooperative and conflictive events.

Since 2022, a growing body of academic literature has attempted to analyze the impact of the Russia–Ukraine conflict on the stock market. By examining the returns of global stock market indices, several studies have identified the heterogeneous effects of the Russian invasion on the financial markets of different countries. These effects have been found to vary according to geographical proximity to the war zone (e.g., Boungou and Yatié, 2022; Yousaf et al., 2022), market efficiency (Granàt et al., 2023), the level of globalization (e.g., Boubaker et al., 2022; Assaf et al., 2023; Kumari et al., 2023; Obi et al., 2023), and the economic relationship with, and dependence on, Russia and Ukraine (see, for example, Ferrandez Serrano and Angosto Fernandez, 2022; Diaconasu et al., 2023). Among others, Yousaf et al. (2022) show that while on aggregate a significant and negative impact of the war can be identified European and Asian countries (e.g., France, Germany, Italy, Spain, India, Japan) were particularly and adversely affected. Moreover, Sun and Zhang (2023), Abbassi et al. (2023), and Ahmed et al. (2023) corroborate these findings through firm-level analysis, based on samples of global, European, and G7 firms, respectively. They also provide a more detailed analysis of the effects by country and by sector. Other studies focus on specific countries. For example, Pandey et al. (2023) and Saini et al. (2023) show a negative impact of the war on the Indian financial market

by examining Indian firms across different sectors. Keles (2023) provides evidence of a significant adverse reaction of the Turkish stock market, that began prior to the official announcement of war. In contrast, Kamal et al. (2023) find a negative impact on Australian firms.

Delving deep into the impact of the conflict on specific sectors, Boubaker et al. (2023) and Martins et al. (2023b) analyze the market reactions of the banking sector at the global and European level, while Martins et al. (2023a) consider the world's largest insurance companies. Moreover, Pandey and Kumar (2023) and Le et al. (2023) focus on tourism companies and airline companies respectively, while Yudaruddin et al. (2023) show a significant negative impact of the offensive on the global consumer staples market. Many other papers focus on the energy sector. For instance, Diaconasu et al. (2023) provide evidence of an increase in the oil price at the beginning of the war, Mohammed et al. (2023) show that renewable energy markets have a positive and significant effect, while Si Mohammed et al. (2023) find that natural gas and clean energy prices are less affected than traditional energy and metals markets. Aloui et al. (2023) describe the significant impact of the ongoing Russia–Ukraine conflict on the energy commodity markets. Overall, this has contributed to an increase in energy prices and volatility. Consequently, companies operating in the energy sector have experienced significant changes in financial returns (Nerlinger and Utz, 2022; Febriandika et al., 2023), as well as the stock market indices related to the same sector (Umar et al., 2022; Saad, 2023; Du et al., 2022).

In such a delicate political context, many countries and companies have taken a stand adopting sanctions policies toward Russia. Some interesting studies show how these decisions have influenced investors' decisions and thus the impact on the market value of companies, finding controversial results. Indeed, according to Tee et al. (2023) and Nicolau et al. (2024), companies have benefited from these decisions, while Ayoub and Qadan (2023) and French et al. (2023) show that firms involved in these actions have experienced significant stock price declines. Sanctions and political actions implemented against Russian institutions and companies are also closely linked to ESG issues. To the best of our knowledge, few papers have examined the market reactions in a scenario of geopolitical turmoil with a specific focus on sustainable practices.

Fiorillo et al. (2024) investigate the mediating role of the ESG factors in the effect of geopolitical risk on the risk of stock price crashes, examining a sample of listed global companies between 2010 and 2021. In particular, they observe that the negative impact is less severe for issuers with high ESG rates, especially for firms with high scores on the environmental and social dimensions. Ricci et al. (2024) find that the stock returns of European listed firms with high ESG scores are less affected than those of their peers during the escalation of the war and the announcement of gas import shocks from Russia in 2021–2022. Companies with higher environmental scores have higher returns. Katsampoxakis et al. (2024) examine the performance of ESG stock indices during periods of crisis and suggest that stock indices of leading ESG companies in North America and Europe represent safe investments. Clancey-Shang and Fu (2024), using an event-study approach, consider a sample of US-listed firms and find that better ESG performance is associated with lower range volatility of stock returns, during the outbreak of the war. Tsang et al. (2024) analyze the impact of the conflict on different sectors using a sample consisting of the top 100 companies in the S&P 500 index. They find that more responsible firms were able to withstand the supply chain disruptions caused by the conflict. Alnafrah (2024) shows that non-ESG committed companies have been more vulnerable to geopolitical risk with respect to ESG-committed firms between 2021 and 2024. In light of the literature, it is reasonable to argue that ESG performance plays an important role in reducing the exposure of companies to both internal and external market events, such as the Russian invasion of Ukraine, preserving their market value (see Section 2.3 of Fiorillo et al., 2024). Nevertheless, a comprehensive and detailed study of this phenomenon would undoubtedly be beneficial in clarifying how ESG assessments have mitigated the impact of such a disruptive event in different countries and across economic sectors, particularly with regard to individual listed companies.

3. Data and methods

3.1. Data

The dataset includes the daily prices of all firms listed on the main stock exchanges around the world, as shown in Table A.1 in Appendix A. These prices are collected from FACTSET. The dataset comprises daily prices for listed companies from July 30, 2021, to February 28, 2022, as well as the daily prices of the main stock exchange market index for each country. Companies with missing values during the specified period, and those with a constant price, which leading to a zero return, have been excluded from the sample. The final sample consists of 17,635 companies.[1]

We retrieved the ESG rating and score available on February 24, 2022 (i.e., the starting date of the Russian military invasion) from MSCI ESG ratings.[2] Sustainability ratings are a form of specialized assessment that evaluates a company's performance based on a set of indicators related to sustainable practices, which are broadly defined. MSCI ESG ratings are expressed as a letter grade and a numerical score adjusted for the sector in which the firm operates. Consequently, ESG ratings range from AAA (the highest level of performance) to CCC (the lowest level of performance), while ESG scores range from 0 (the worst performance) to 10 (the best performance). MSCI provides ESG ratings and scores for approximately 14,000 companies worldwide. As ESG ratings are not mandatory, only around 5600 companies (i.e., 33 % of those in the sample) have a rating, as shown in Table A.1. On average, ESG scores are available for 32 % of companies by country. The US is the largest market in the sample, representing around 26 % of listed companies and around 43 % of available ESG scores. Japan has the second largest representation of companies, but ESG coverage in Japan (20 %) is below average. The listed companies are heterogeneous by country, including those accounting for less than 1 % of observations (i.e., Austria, Ireland, the Netherlands, New Zealand, and Portugal). In terms of ESG availability, Switzerland, Ireland, and the Netherlands appear to be the countries where ESG reporting is available for more than 55 % of companies listed on their respective stock markets. Conversely, Greece has the lowest availability rate of ESG data (8 %).

3.2. Empirical strategy

Let R_t be the observed return for company i (with $i = 1,\ldots,n$) at time t (with $t = 1, \ldots, T$). In the estimation phase, we assume independence across the companies. Thus, we model the returns of company i using the following firm-specific linear factor model:

$$R_t = a + b'f_t + \epsilon_t \tag{1}$$

where a is the firm-specific constant coefficient, f_t is a vector of K observable factors common to every company in a given stock market, b is the vector that collects the firm-specific factor loadings, and ϵ_t is the error term with classic assumptions.

[1] Since companies are listed on stock exchanges in more than one country, our time series are unavailable on non-weekend public holidays according to the national holidays celebrated in each country. To control for non-weekend public holidays, if there are no observations on a given day for all companies listed in the same country, the price from the previous day is used instead. According to this methodology, financial returns are set to zero when the stock exchange is closed.

[2] ESG ratings are usually issued once a year for each company, with a variable release date. Therefore, ESG ratings can be relatively older (in terms of months) from one company to another.

To study the stock-price reactions to the Russia-Ukraine war, we compute the sequence of abnormal returns AR_t for each company i, i.e., the residual of returns regressed on the constant and K factors, and defined as $AR_t = R_t - \left[\widehat{a} + \widehat{b}' f_t\right]$, where $\widehat{a}$ and $\widehat{b}$ are estimated from the OLS regression on Eq. (1), using daily returns observed within the estimation window, that is, from August 3rd, 2021 to January 31st, 2022. We implement the Capital Asset Pricing Model (Sharpe, 1964), for which the observable systematic factor f_t corresponds to the excess return on the value-weighted market portfolio over the risk-free rate (see, e.g., Ramelli et al., 2021).

We adopt a short-run perspective about the event's impact on the considered markets; specifically, we define the event window for the ES as the days immediately following or preceding February 24th, 2022. The main event window comprises the five trading days between February 21st, 2022, when news of the Russian invasion of the Donbass began to circulate, and February 25th, 2022. Therefore, the main event window Ω for our analysis is $[-3; +1]$, effectively observing one week of the trading days. As we are interested in the overall effect of the event window, we compute the Cumulative Abnormal Returns (CARs), defined as $CAR_i = \sum_{t\in\Omega} AR_t$, with $= 1,\ldots,n$. We then compute the average of the CARs at country, sector, and different ESG levels and as well as at their combinations, to obtain the Cumulative Average Abnormal Returns (CAARs). We also estimate CARs and average CARs over different event windows to provide additional insights and robustness checks. Table A.2 in Appendix A presents summary statistics for the CARs calculated over several event windows: (i) the $[-3; +1]$ event window; (ii) the event windows including the three and one days before the event (i.e. $[-3; 0]$ and $[-1; 0]$, respectively); (iii) the day of the event (i.e. CAR at [0]); (iv) the event window including the day after the event (i.e. [0,+1]). On average, the CARs across the different event windows are negative. However, we observe that the negative sign changes when we consider the event window including the day after the event.

In our ES setting, we use a set of eighteen event study test statistics to infer the impact of the event on the stock market returns. These include the classical tests by Patell (Patell, 1976; Dodd and Warner, 1983), as well as the BMP (Boehmer and Poulsen, 1991; Sanders and Robins, 1991). However, it is worth noting that commonly applied ES statistics do not account for the cross-sectional dependence in returns and are based on the assumption that data are Gaussian. Recently, Pelagatti and Maranzano (2021) showed that even weak cross-correlation can strongly bias the results from ES statistics, characterized by high rejection rates, and thus unreliable estimates. Accordingly, we consider an extended set of ES test statistics, including both unadjusted and cross-sectionally adjusted specifications, as well as contrasting parametric and non-parametric rank-based statistics to account for the potential non-Gaussian distribution of the data. Table 1 summarizes the eighteen test statistics employed in the empirical analysis. We kindly refer the reader to the paper by Pelagatti and Maranzano (2021) for a comprehensive discussion about definitions and statistical properties of the test statistics, as well as for an overview related to the issues of cross-correlation and non-Gaussianity in event studies.

Using multiple test statistics to determine whether an event has had a statistically significant impact on the stock market poses the challenge of selecting an appropriate assessment criterion. To address this challenge, we propose a heuristic rule based on a majority vote approach (see Hastie et al., 2017). Specifically, at a given level of statistical significance $= 0.05$, we count the number of statistics indicating the rejection of the null hypothesis (i.e., the presence of a statistically significant effect of the event). We consider the event to be relevant -(i.e., the War in Ukraine generated a market reaction) if the majority of the tests reject the null hypothesis (i.e., if it is rejected by at least nine statistics). We believe that this consensus strategy is supported by the presence of heterogeneity in the statistical features embedded in the selected statistics. Notably, the combination of parametric and distribution-free estimators, as well as adjusted and unadjusted cross-sectional methods, encompasses a broad spectrum of empirical scenarios (e.g., heterogeneity in distribution shapes at the country or sector level or varying degrees of correlation between stocks) that a single statistic might not capture. In any case, some of the statistics on the list are inherently more robust (e.g., rank-based statistics), so they should be given greater attention and credibility.

Table 1
Overview of the statistical tests.

		Specification	
		Parametric	**Non-parametric**
Cross-sectional	**Not-Adjusted**	t_{CS}	$CumRank_Z$
		t_{CD}	Z_{grank}
		t_{SKEW}	
		Z_{PAT}	
		Z_{BMP}	
	Adjusted	$Z_{PAT,adj}$	T_{grank}
		$Z_{BMP,adj}$	$Z_{grank,adj}$
			$CumRank$
			$CumRank_{mod}$
			$CumRank_T$
			$CumRank_{Z,adj}$
			P_1
			P_2
			$CorradoTukey_{adj}$

Note: The table summarizes the test statistics discussed in Pelagatti and Maranzano (2021) in order to test for the statistical significance of the CARs. We distinguish cross-sectional adjusted and not-adjusted tests and parametric and non-parametric tests. For the parametric test statistics, we compute the cross-sectional t-test (t_{cs}), the test statistic based on the cross-sectional variance of the average abnormal returns (t_{CD}), and the test linked to the skewness of the cumulative average abnormal returns (t_{SKEW}). We implement both the non-adjusted and adjusted Pattel's Z statistics (Z_{PAT} and $Z_{PAT,adj}$), and the BMP statistics (Z_{BMP} and $Z_{BMP,adj}$). Considering the non-parametric tests, we focus on rank-based non-parametric statistics both adjusted and not adjusted. Furthermore, we compute the Campbell and Wasley (1992) statistics ($CumRank$, $CumRank_{mod}$, $CumRank_{Zadj}$), and the adjusted statistics for small sample $CumRank_T$. Following Corrado (2011), we also compute the cumulative rank statistics (Z_{grank}, $Z_{grank,adj}$). Finally, we also perform the non-parametric cross--dependence adjusted P_1 and P_2 tests, and the $CorradoTukey_{adj}$ statistics introduced by Pelagatti and Maranzano (2021).

To address the second research question - namely, whether stock market reactions to the Russian invasion of Ukraine vary across companies - we propose examining the role of several potential firm-specific determinants of the observed CARs. In particular, we are interested in studying the correlation between the CARs and financial information extracted from the balance sheets of the companies to understand whether market reactions were influenced by the firms' characteristics and by their sustainability performance. Let $CAR_{i,s,c}$ be the cumulated abnormal return during the $[-3; 1]$ event window for company i, belonging to sector s, and country c, we estimate OLS the following cross-sectional regression model

$$CAR_{i,s,c} = \alpha + \beta' X_i + \gamma_s' D_s + \gamma_c' D_c + \gamma_{s,c}' D_s \times D_c + \epsilon_{i,s,c}, \quad (2)$$

where X_i is the vector of selected company-specific variables, namely, *Size*, (natural logarithm of total assets) *Leverage (the debt-to asset ratio)*, *Profitability (the ROA)*, Tobin's Q and the sector-adjusted ESG score. These variables reflect fundamental aspects of firm performance and risk. Smaller firms often yield higher returns due to their greater growth potential and risk premiums. Leverage affects financial stability, while profitability signals operational efficiency and long-term value creation, which often attracts new investors. The Tobin's Q indicates market expectations versus asset replacement cost—higher values may suggest overvaluation or strong growth prospects. Lastly, strong environmental scores can enhance a firm's reputation, reduce its overall risk and attract ESG-focused capital. All variables are winsorized at the 1 % level and

standardized. Table A.2 in Appendix A reports descriptive statistics (prior to the standardization) of all the variables used in the analysis and Table A.3 in Appendix A shows the correlation matrix. In addition to the main covariates, we include the fixed-effect dummy variables according to the sector (D_s), the country (D_c), and the interaction between sector and country ($D_s \times D_c$) allowing us to capture the sector and country specificity across different dimensions. The regression is estimated through OLS and run on different event windows to understand the possible heterogeneous effect of the specific companies' characteristics in different periods.

4. Results of the event study

This section presents the empirical results of the analysis carried out at three layers: country, sector, and ESG. Additionally, we present results for combinations of two layers: country-sector, country-ESG, and sector-ESG. To assess the significance of the CAAR over the event window, we compute the eighteen statistics described in Table 1 for each layer and pairwise combination.[3] The event window is defined as [−3; +1] around the date of the event (i.e., February 24th, 2022). The following section is based on the majority rule outlined in the previous section, specifically the number of tests out of eighteen that reject the null hypothesis that the CAAR is equal to zero at the 5 % significance level. Accordingly, with a slight abuse of notation, we conclude that the effect of the event is statistically significant if more than nine out of eighteen test statistics reject the null hypothesis of no effect. Conversely, the event is deemed not to be significant if fewer than nine tests reject the null hypothesis.

4.1. Results at country, sector, and ESG levels

Hereafter, we describe the results collected by conducting analysis at country, sector, and ESG levels. For each analysis, we provide plots illustrating the statistical results of the ES statistics. In Appendix A, Tables A.4, A.5, and A.6 provide sample descriptive statistics and summary results of the tests at country, sector, and ESG levels, respectively. For completeness, in Appendix B, Figures B.1-B.6 show the effective number of statistically significant tests for each of the eighteen statistics used by country, sector, ESG, and at the combination levels, respectively. These plots clearly show that the rejection rate of the null hypothesis varies across the set of considered statistics. This evidence could support the use of majority rules, instead of single tests, in ES when choosing the proper test statistics is difficult.

Focusing on the analysis at the country level, Figs. 1 and 2 show the CAAR values and the number of statistically significant tests (i.e., p-value below 0.05). A predominantly negative impact is observed in all countries, except for the US, which has a positive but statistically insignificant CAAR. Looking at the negative impact, we observe heterogeneous results across countries. Notably, some European countries exhibit a strong and significant impact. In particular, the impact is highly statistically significant in a few countries: Austria, France, and Great Britain reject the null hypothesis that the CAAR is equal to zero for more than twelve test statistics. This result is confirmed when only the adjusted test statistics are considered (see Table A.4). In Italy, the test statistic is rejected for at least nine test statistics. Outside Europe, the only relevant result is observed for Australian companies, for which the CAARs are negative and statistically significant values for most of the statistics. A slightly positive but statistically not significant effect in Japan and the Netherlands.

Therefore, not all countries show clear evidence of a negative impact. In fact, Greece, Japan, Norway, Sweden, and, perhaps most notably, the United States and Canada, demonstrate few, if any, strong negative effects. This pattern suggests that geographic, economic, and institutional factors play a buffering role. Countries with limited direct trade or financial exposure to Russia and Ukraine, or those with greater macroeconomic resilience, may be better positioned to withstand the secondary effects of the invasion. Earlier academic studies in the United States have pointed out that the invasion affected US-listed foreign firms and domestic firms differently, which could help to explain there has been no significant impact on this country (Clancey-Shang and Fu, 2023).

Fig. 3 and Table A.5 show the aggregated results at the sector level, indicating a negative average response. In particular, the largest and most statistically significant effects are found in activities relating to sustainability. Specifically, the largest negative effect (−2.1 %) is found in the "Agriculture, forestry, fishing and hunting" sector, for which we collect eight out of eighteen reject test statistics for the null hypothesis of no effect. We also observe a negative and significant impact on companies belonging to the sectors "Construction" (−1.9 %), "Mining, quarrying, and oil and gas extraction" (−1.7 %), and "Administrative and support service activities" (−1.6 %). This could be due to the relevant role of energy and raw material markets in relation to Russia's war against Ukraine, as discussed in Aloui et al. (2023). Some effects are also observed in the sectors that indirectly received a crucial role in the energy market during this event, e.g. "Accommodation and food service", "Manufacturing" and "Retail trade", for which we get negative CAAR and a statistically significant result on six out of eighteen statistics. Focusing on the statistical tests, the adjusted test statistics do not reject zero effects in all sectors, except for 'Agriculture, forestry, fishing and hunting'. There is also a negative CAAR (−1.7 %), with six tests showing a p-value lower than 0.05, in 'Financial intermediation'. This result may reflect an increase in the perceived risk of the sector, as most banks and financial institutions may have faced an increase in interest rate risk, together with an increase in the credit risk of borrowers, and thus potential losses on investments. Finally, we also observe a positive effect for companies belonging to the "Utilities" sector, but its significance is only registered for one test statistic.

Considering the results in Fig. 4 and Table A.6, the analysis shows that unrated companies (no ESG rating) experience the most significant negative impact, with a number of notable results. For instance, companies with missing ESG scores due to a lack of disclosed non-financial information appear to be associated with a loss of around 2 %. Missing ESG information appears to play a crucial role in this study (see, e.g., the discussion in Sahin et al., 2022). For companies with available ESG scores, the impact is negative, greater than 1 %, and not rejected for 33 % of the statistics for the highest scorers (AAA-rated companies). For other ratings - i.e. from AA to CCC - the CAARs show smaller effects that are not statistically different from zero, i.e. there is no evidence of the effect of the event under review.

4.2. Results at country-sector level

Table 2 shows the CAAR for each pair of countries and sectors in our sample. This analysis reveals specific patterns not evident in the aggregate picture presented in Section 4.1. In particular, it allows us to identify the sectors that were the main drivers of the impact of the Russian invasion in each country. In general, heterogeneous effects are evident; however, the vast majority of country-sector pairs show a negative response. Any positive magnitudes in the CAARs are statistically not significant. Some of the most negative responses at the country level can be traced back to specific pairs. For instance, the negative response for Austria is primarily due to the negative impact of enterprises belonging to the "Finance and Insurance" (−6.4 %) and 'Manufacturing' sectors. In France, the sectors that explain its highly significant negative CAAR are mainly driven by agriculture and manufacturing. In Great Britain, however, the negative response is driven by several sectors with a negative and statistically significant

[3] As described in the previous section, we have also computed the CAAR on different event windows, namely [-3; 0], [-1; 0], [0], and [0; +1]. Extended results are available upon request.

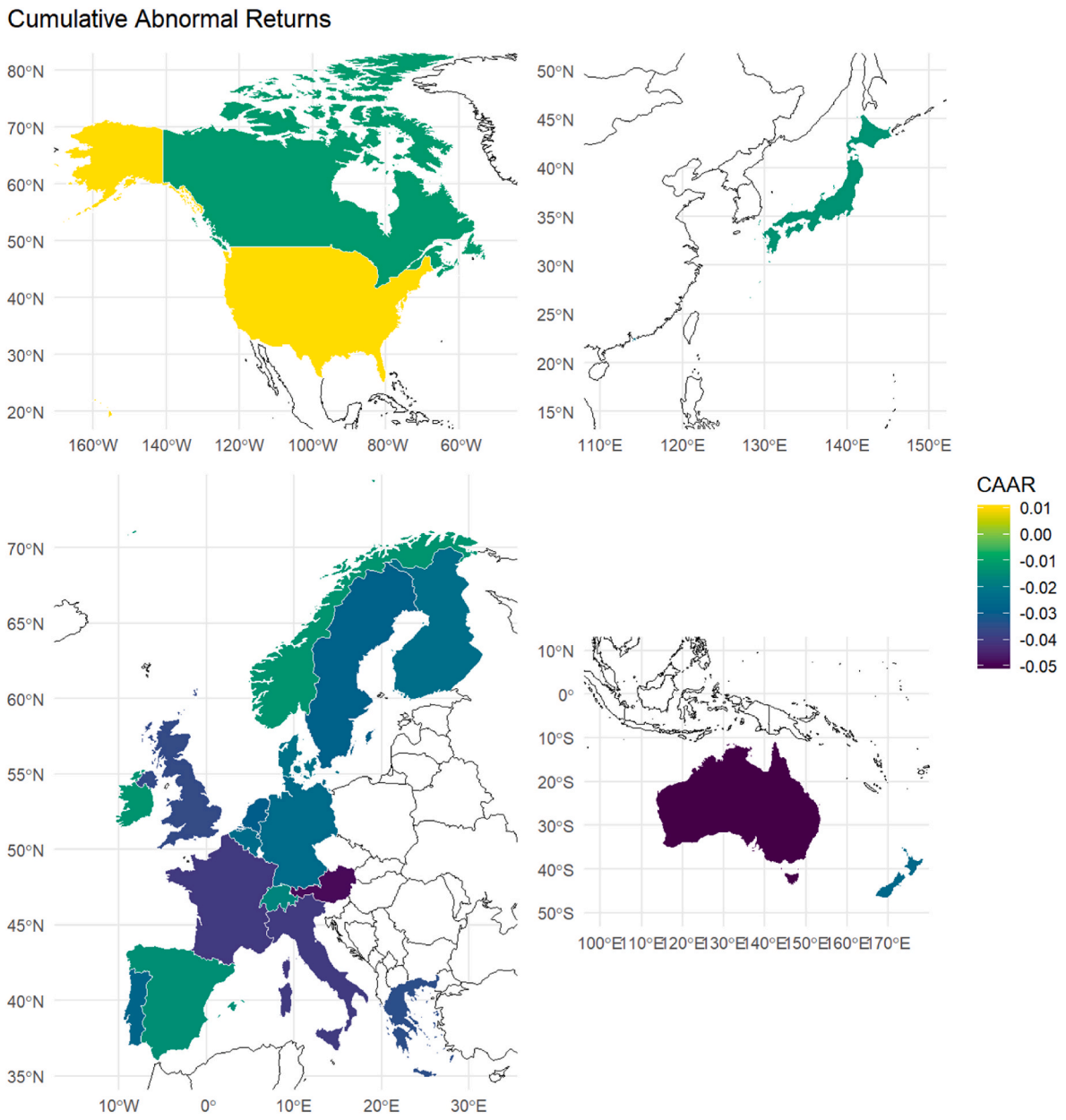

Fig. 1. Map of CAAR by country
Note: This map shows the intensity of stock market reactions to the Russian invasion at the country level, measured by the CAAR.

impact of around −4 % or more (e.g. for the enterprises in the "Health and care and social assistance"' sector). Focusing on Australia, for which the event has a large negative impact at the country level, this is mainly driven by companies belonging to the "Accommodation and food service", "Manufacturing" and "Utilities" sectors. In the case of Japan and the Netherlands, we observe a large number of positive but statistically insignificant impacts across activities, in line with the results in Fig. 2.

The "Agriculture, forestry, fishing, and hunting" sector is confirmed as the most affected sector across countries, with statistically significant results in France, Italy, and New Zealand. Contrary to expectations, no significant results are found when also looking at the country level for the "Mining, Quarrying and Oil and Gas extraction sector" sector, which had a large negative CAAR overall (−1.7 % in Table A.5). Given the importance of fossil fuel markets to the conflict—especially in the context of sanctions, supply disruptions, and shifts in energy flows—this absence of significant impact is surprising. In fact, it may suggest that firms operating in this sector were already priced in geopolitical risks or possessed structural buffers. The large negative effect shown in Fig. 3 for the "Finance and Insurance" sector is observed and statistically significant for around 50 % of the countries in the sample. A similar effect is also observed in 35 % of countries for enterprises in the 'Manufacturing' sector. Thus, these sectors appear to be the ones for which the event is systematically distributed across countries. The frequent statistical significance observed in the manufacturing sector likely reflects its exposure to global value chain disruptions. The war has created logistical bottlenecks, raised the cost of raw materials, and increased geopolitical uncertainty—all of which disproportionately affect manufacturing-intensive firms reliant on cross-border operations. Meanwhile, the finance sector appears to be sensitive to the reconfiguration of international capital flows, heightened risk premiums, and potential sanctions or exposure to Russian assets. The prevalence of significant results in these sectors highlights how systemic and globally interconnected areas of economic activity are particularly vulnerable to large-scale geopolitical events. Lastly, the U.S. case is intriguing: while some sectors show

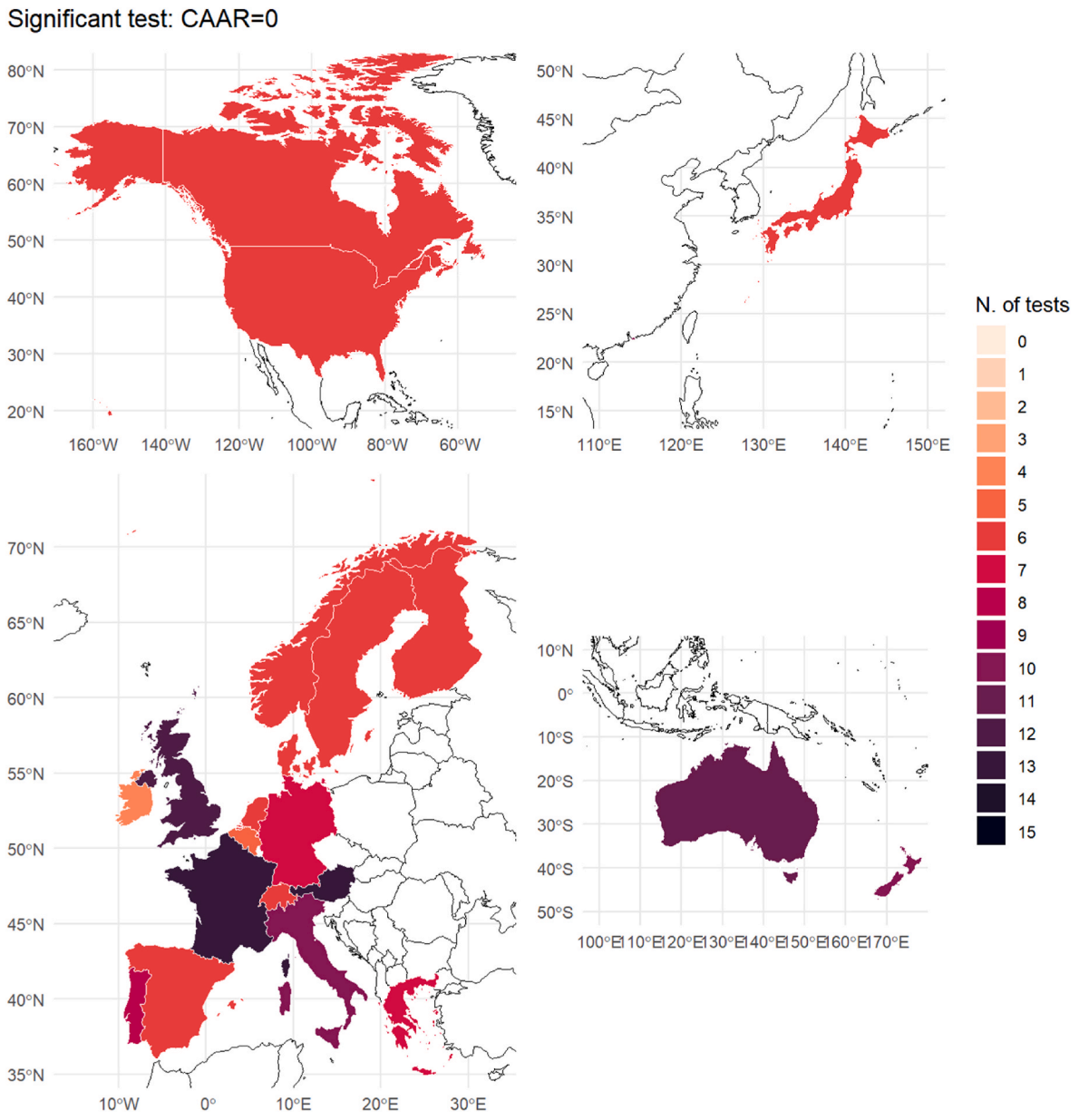

Fig. 2. Map of the number of significant tests
Note: This map shows, at the country level, the number of tests from Table 1 that reject the null hypothesis of CAAR being not statistically different from zero (i.e., the p-value is lower than 5 %).

positive market responses, the number of significant results never exceeds eight in any one sector. This suggests a potentially fragmented or modestly beneficial effect.

4.3. Results at country and ESG level

Table 3 shows the results at the country-ESG level. The results of Fig. 4 are also confirmed by this analysis. As in the previous analysis, we observe a strong negative effect for the unrated companies. Looking at the EU countries, we find a strong negative significant effect for the no-rated companies in Austria, France, and Italy. This highlights that, even when the sample includes countries with the same disclosure requirements, the effects at the firm level may differ. Focusing on non-EU countries, we observe negative effects for unrated companies in Australia, Great Britain, and Hong Kong. For the latter, the negative impact is mainly explained by the AAA-rated companies (see Fig. 4). We do not observe any other strong impact for AAA-rated companies in the other countries. This could be due to the reduced number of observations that the analysis at this level entails. This analysis shows that ESG metrics only explain the impact of the Russian invasion in certain countries. Indeed, for 13 out of 23 countries in the sample, the results at the ESG level are not statistically significant. Finally, we do find no strong evidence that the results discriminate between more and less sustainable companies.

4.4. Results at ESG and sector level

Table 4 shows the results at the sector ESG level. We observe the heterogeneous response of different pairs of sustainability and sector levels to the Russian invasion of Ukraine. Both positive and negative impacts are estimated. However, we only find negative and low statistical significance (i.e., less than ten statistics are significant over the eighteen tests) for unrated companies belonging to the “Construction” and “Finance and Insurance" sectors. Thus, as in the case of the country-

Fig. 3. CAAR and number of statistically significant test statistics by sector
Note: The figure shows, at the sector level, the size of CAAR and the number of tests from Table 1 that reject the null hypothesis of CAAR being not statistically different from zero (i.e., the p-value is lower than 5 %).

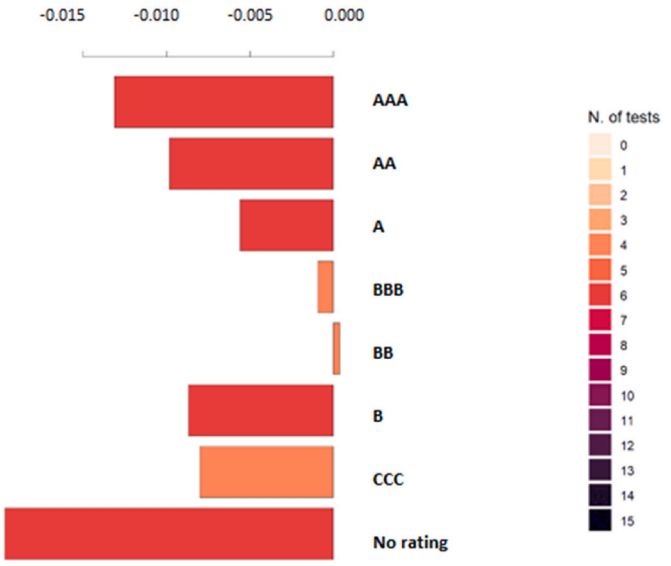

Fig. 4. CAAR and number of statistically significant test statistics by ESG rating and availability of rating
Note: The figure shows, at the ESG rating, the size of CAAR and the number of tests from Table 1 that reject the null hypothesis of CAAR being not statistically different from zero (i.e., the p-value is lower than 5 %).

ESG level characteristics, no clear differences in the response of more sustainable companies compared to less sustainable companies could be identified. Nevertheless, the impact on unrated companies is still evident.

In Hong Kong, the role of ESG ratings adds another layer to the interpretation. In this context, the significant effects among firms with ESG scores are concentrated in four sectors, i.e., “Real Estate and Rental and Leasing ”; “Transportation and Warehousing”; “Construction”; and “Finance and Insurance". This may reflect heightened sensitivity among ESG-rated firms to investor sentiment and geopolitical instability. Alternatively, it could suggest that ESG transparency itself acts as a conduit for market reactions, with firms that are more transparent about their governance and sustainability practices becoming focal points for portfolio reallocation in periods of uncertainty. A different dynamic is observed in France and the United Kingdom, where the results appear to be predominantly driven by firms without ESG ratings. This asymmetry suggests that the limited sustainability disclosure may correlate with higher perceived risk or lower investor confidence in times of geopolitical stress. It may also reflect the structural characteristics of these firms themselves, such as smaller size, lower international diversification, or weaker governance standards, which amplify their vulnerability in the absence of ESG signaling.

5. Channels at company level

Table 5 shows the results of estimating Eq. (2) for various event windows, namely, [−3; 1] (the main event window), [−3; 0], [−1; 0], [0] (i.e., the event date only), and [0; +1]. Specifications (1)–(5) are estimated using 14,896 observations, which include the full sample but exclude the ESG score. Specifications (6) to (10) and (11) to (15) introduce the ESG score and the E, S, and G pillars, respectively; therefore the analysis is performed on the subsample that includes only companies for which the sustainability information is available. All specifications include country and sector dummies, as well as the interaction term between-country and sector, including all the possible layers - studied in the previous event study analysis.

Specifications (1) to (5) show that loadings for *Size* and Leverage are constantly significant throughout the considered event windows, whereas coefficients for Tobin’s Q and Profitability are only significant in certain event windows. Specifically, the positive beta coefficient for Size indicates that larger firms are associated with “less-negative” market reactions. Larger firms are generally better able to withstand geopolitical shocks than smaller firms due to their ability to diversify their investments, to redirect capital and to access to different markets. The negative coefficient of Leverage is always statistically significant at the 1 % level, indicating that firms with relatively high debt-to-asset ratio are perceived as riskier during geopolitical conflicts, resulting in lower CAR (see Tosun et al., 2024 for similar results). Profitability also seems to affect CAR positively, albeit only in the event windows [−3; +1], [−3; 0] and [−1; 0]. Given that geopolitical risks and events typically reduce firm profitability (see, e.g., Reyad et al., 2024), our analysis unveils that higher profitability allows firms to withstand the negative consequences of the Russian invasion of Ukraine.

The introduction of the ESG score in specifications (6) to (10) is both relevant and interesting. Indeed, we observe that a higher level of sustainability has a positive effect on CARs at firm level before and after the event (i.e., specifications 6, 7, and 10). The results that include each pillar in the three metrics are of interest. The environmental pillar plays a crucial role in all event windows considered, except for the date of the event. Instead, the social pillar appears to be a positive and highly significant driver for the pre-event windows. Therefore, at the company level, better sustainability performance (specifically, better environmental performance) seems to be able to reduce the potential negative impact of Russia’s invasion of Ukraine. This finding aligns with existing

Table 2
Results from the analysis at the country-sector level.

	Accommodation and Food Services	Administrative and Support and Waste Management and Remediation Services	Agriculture, Forestry, Fishing and Hunting	Arts, Entertainment, and Recreation	Construction	Educational Services	Finance and Insurance	Health Care and Social Assistance	Information
Australia	−0.104++	−0.045	−0.021	−0.067++	−0.034	−0.084	−0.021	−0.012	−0.057+
Austria	−0.021				−0.035		−0.064++		−0.031
Belgium		−0.04	0.038		−0.013		−0.004		−0.03+
Canada	0.002	−0.039	−0.042	−0.028	0.013	−0.007	−0.011	−0.012	−0.028
Denmark		−0.058	0.016	0.022	−0.019		−0.036++		0.011
Finland	−0.006	−0.012			−0.021		−0.02	−0.03	−0.015
France	−0.02	−0.033	−0.087++	−0.006	−0.031	−0.131	−0.048++	0	−0.041+
Germany	−0.044+	0.005	−0.009	−0.026	0.006	0.033	−0.038+++	−0.03	−0.035++
Great Britain	−0.024+	−0.041++	−0.031	−0.046	−0.03	−0.041++	−0.043+++	−0.051++	−0.038++
Greece	0.015		−0.001	−0.068	−0.045		−0.032	−0.024	−0.061
Hong Kong	−0.01	0.008	−0.039	−0.002	−0.035++	−0.071	−0.032+++	−0.006	−0.03
Ireland	0.043		0.002		−0.023		−0.045+		0.003
Italy	0.009	−0.062++	−0.053+++	−0.03	−0.069++	−0.106	−0.058+++	−0.037	−0.042++
Japan	−0.022	−0.008	−0.01	−0.021	−0.013	−0.017	−0.031	0.006	0.001
Netherlands	−0.053	−0.053		−0.032	−0.055+		−0.04	0.056	−0.055
New Zealand	−0.017	−0.126	−0.037++			−0.004	−0.052+++	0.011	−0.026
Norway		0.027	−0.023	−0.007	−0.005	−0.054	−0.023		−0.025
Portugal	−0.021			0.007	−0.055		−0.13		−0.053+
Singapore	−0.029	−0.032	−0.005	−0.02	−0.01	0.023	−0.021+	−0.043++	−0.02
Spain	−0.007	−0.025	0.013		−0.008		−0.015	−0.06	−0.005
Sweden	−0.035	−0.016	−0.051	−0.014	−0.021	−0.005	−0.03	−0.028	−0.026
Switzerland		−0.027		−0.127	−0.013		−0.034++	0.004	−0.063
US	−0.009	−0.001	0.028	0.004	−0.007	0.036	0.006	0.016	0.016

	Management of Companies and Enterprises	Manufacturing	Mining, Quarrying, and Oil and Gas Extraction	Other Services (except Public Administration)	Professional, Scientific, and Technical Services	Real Estate and Rental and Leasing	Retail Trade	Transportation and Warehousing	Utilities	Wholesale Trade
Australia		−0.063+++	−0.055	−0.04	−0.067+	−0.026	−0.045	−0.017	−0.085++	−0.052+
Austria		−0.041+++	−0.168			−0.028		−0.064	0.017	−0.127
Belgium		−0.06++		−0.018	−0.062+++	0.04	−0.008	0.051		0.007
Canada		−0.013	−0.009	0.001	0.011	−0.002	−0.011	−0.005	0.007	−0.027
Denmark		−0.02	−0.028		−0.014	−0.055	−0.079	−0.026	0.158	−0.015
Finland		−0.028	−0.001	−0.031	−0.017	−0.007	−0.014	−0.039	−0.158	−0.08++
France		−0.049+++	0.049	−0.018	−0.032	−0.028	−0.047+++	−0.011	0.013	−0.044++
Germany	−0.019	−0.03	0.023	0.005	−0.019	0.005	−0.021	−0.052+	−0.016	−0.012
Great Britain		−0.049++	−0.013	−0.025	−0.031	−0.01	−0.041+++	−0.029	0.014	−0.043++
Greece		−0.032	−0.036		−0.004	−0.019	−0.041	−0.042	−0.018	−0.044
Hong Kong	−0.047	−0.023+	−0.007	−0.031	−0.024	−0.021++	−0.023	−0.048+++	−0.035	0.006
Ireland		0.008	0.169		0.038	−0.043		−0.029		−0.115
Italy		−0.04++	−0.041	−0.011	−0.062+++	0.002	−0.046	−0.008	0.022	−0.008
Japan	−0.005	−0.018	0.017	−0.016	0.002	−0.02	−0.012	−0.021	−0.002	−0.01
Netherlands		−0.021	−0.041		−0.001	−0.019	−0.054	−0.042	−0.076	−0.005
New Zealand		−0.027	0.056		−0.049	−0.023	−0.005	−0.015	−0.024	−0.006
Norway		−0.012	0.032		−0.012	−0.014	−0.023	−0.011	−0.005	−0.037
Portugal		−0.039++	−0.032		−0.002		−0.029	−0.088	0.027	
Singapore	0.06	−0.007	−0.031	0.005	−0.021	−0.028	−0.019	−0.007	−0.015	−0.028
Spain		−0.008	−0.02		−0.046+	−0.043+++	−0.071	0.001	0.032	−0.049++
Sweden		−0.028	−0.031	0.065	−0.033	−0.041	−0.027	−0.038	−0.008	−0.065
Switzerland	0.017	−0.008			0.017	−0.004	−0.032	−0.022	0	−0.007
US	−0.031	0.011	0.034	−0.003	0.019	0.013	0.009	0.007	0.031	−0.003

Note: The table reports the estimated CAAR by applying the event study methodology at the country-sector level. Each column represents a specific sector, while each row corresponds to a specific country. Blank cells indicate a lack of observation for the corresponding country-sector combination. The estimates are evaluated using the majority vote approach described in Section 3.2. Statistically significant at the 5 % level is denoted as follows: +++ indicates significance in 15–18 of the test statistics from Table 1; ++ in 11–14 test statistics; and + in 9–10 test statistics.

Table 3
Results from the analysis at country-ESG level.

	AAA	AA	A	BBB	BB	B	CCC	no rating
Australia	0.021	−0.035	−0.043	−0.036	−0.02	−0.061+	0.066	−0.056++
Austria	−0.049	−0.103+++	−0.047	−0.031			−0.021	−0.036++
Belgium	−0.033	−0.02	0.033	0.004	−0.02	−0.003		−0.04+
Canada	0.016	0.002	0.009	0.006	0.008	0.011	−0.01	−0.015
Denmark	0.056	−0.012	0.01	−0.005	−0.028			−0.031
Finland	−0.05	−0.014	−0.005	−0.026	−0.039			−0.023
France	−0.047	−0.02	−0.002	−0.038	−0.021	−0.024		−0.046+++
Germany	−0.039+	−0.028	−0.022	−0.011	0.004	0.01	−0.002	−0.027+
Great Britain	−0.014	−0.02	−0.017	−0.022	−0.012	−0.147++	−0.089	−0.041++
Greece		−0.064		−0.024	−0.03			−0.035
Hong Kong	−0.074+++	−0.053++	−0.027	−0.041++	−0.036++	−0.036++	−0.049++	−0.02+
Ireland	−0.039	−0.017	−0.068	−0.01	−0.068++	−0.03		0.016
Italy	−0.038	−0.018	−0.029	−0.035	−0.044	−0.03		−0.043+++
Japan	−0.016	−0.026	−0.023	−0.018	−0.013	−0.016	−0.023	−0.011
Netherlands	−0.019	−0.053	−0.05	−0.017	−0.044			−0.013
New Zealand	−0.036	−0.017	−0.036+	−0.019	−0.038	−0.024		−0.026+
Norway	−0.009	−0.017	0.002	0.022	−0.001	0.034		−0.016
Portugal	0.056	−0.055++	−0.069+++	0.015		−0.055		−0.016
Singapore	−0.023	−0.048++	−0.015	−0.013	−0.014	−0.03+	0.011	−0.016+
Spain	−0.006	−0.023	0.013	−0.004	−0.04	−0.027	0.003	−0.018
Sweden	−0.015	−0.017	−0.02	−0.029	−0.024	0.054		−0.03
Switzerland	−0.011	−0.006	−0.008	−0.008	−0.017	−0.032		−0.026
US	0.016	0.027	0.014	0.017	0.016	0.005	0.019	0.006

Note: The table reports the estimated CAAR by applying the event study methodology at the country-ESG level. Each column represents a specific ESG rating class, while each row corresponds to a specific country. Blank cells indicate a lack of observation for the corresponding country-ESG combination. The estimates are evaluated using the majority vote approach described in Section 3.2. Statistically significant at the 5 % level is denoted as follows: +++ indicates significance in 15–18 of the test statistics from Table 1; ++ in 11–14 test statistics; and + in 9–10 test statistics.

Table 4
Results from the analysis at the sector-ESG level.

	AAA	AA	A	BBB	BB	B	CCC	no rating
Accommodation and Food Services		−0.019	−0.027	−0.015	−0.02	−0.003	−0.027	−0.02+
Administrative and Support and Waste Management and Remediation Services		−0.034	−0.005	−0.023	0.005	−0.01	−0.036	−0.015
Agriculture, Forestry, Fishing and Hunting	0.048	−0.028	−0.027	0	−0.002			−0.024
Arts, Entertainment, and Recreation	−0.064	−0.015	−0.032	−0.008	0.076	0.008	−0.046	−0.025
Construction	−0.01	−0.022	−0.019	−0.014	−0.022	−0.01	0.039	−0.019+
Educational Services	0.053	−0.035	0.07	0.009	0.083	−0.054	0.02	−0.028
Finance and Insurance	−0.041	−0.039	−0.027	−0.016	−0.006	−0.01	−0.003	−0.016+
Health Care and Social Assistance		0.017	0.028	0.048	0.057	0.046	0.08	−0.021
Management of Companies and Enterprises				−0.003	−0.023			−0.02
Manufacturing	−0.01	−0.001	−0.003	0.002	−0.004	−0.022	−0.007	−0.021
Mining, Quarrying, and Oil and Gas Extraction	−0.017	−0.002	0	0.014	0.021	0.015	−0.069	−0.021
Information	−0.003	−0.007	0.008	0.009	0.023	0.017	0.028	−0.024
Other Services (except Public Administration)	−0.015	−0.009	0.001	0.003	0.004	−0.02		−0.019
Professional, Scientific, and Technical Services	0	−0.009	0.009	0.01	0.035	0.019	0.023	−0.015
Real Estate and Rental and Leasing	−0.019	0.003	−0.006	−0.003	−0.013	−0.013	−0.009	−0.011
Retail Trade	−0.032	−0.02	−0.02	0.002	−0.005	−0.006		−0.02
Transportation and Warehousing	−0.015	−0.023	−0.017	−0.007	−0.018	−0.015	−0.073	−0.013
Utilities	0.052	0.019	0.02	0.002	−0.016	−0.004	−0.019	−0.009
Wholesale Trade	−0.027	−0.007	−0.009	−0.005	0.01	−0.02	−0.031	−0.022

Note: The table reports the estimated CAAR by applying the event study methodology at the sector-ESG level. Each column represents a specific ESG rating, while each row corresponds to a specific sector. Blank cells indicate a lack of observation for the corresponding sector-ESG combination. The estimates are evaluated using the majority vote approach described in Section 3.2. Statistically significant at the 5 % level is denoted as follows: +++ indicates significance in 15–18 of the test statistics from Table 1; ++ in 11–14 test statistics; and + in 9–10 test statistics.

literature on sustainability practices and geopolitical risks (e.g., Fiorillo et al., 2024; Ricci et al., 2024).

Lastly, to consider potential additional channels at the company level that might drive companies' CAR, we re-estimate model in Eq. (2) using the full sample (i.e., including firms without an ESG score) and by adding, one at a time, the dividend-per-share, the ratio between tangible assets and total assets and the ratio between short-term debt and long-term debt. Results are collected in Table 6. Dividend-per-share are typically associated with stock returns and market expectations about a company payout policy (see, e.g., Black and Scholes, 1974; Fama and French, 1988). The tangible ratio, defined as tangible assets over total assets, can typically be seen as a proxy of collateral in corporate financing. Lastly, the short-term debt-to-total debt ratio can be seen as an indicator of riskiness: the higher this ratio, the greater the company's obligation to repay or refinance short-term debt, potentially signalling liquidity concerns or heightened financial vulnerability.

Overall, the effect of the dividend per share on the CAR appears to be marginally significant. We found a statistically significant negative result at the 1 % level only on the event date and within the event window [0,+1]. This indicates that firms with a high dividend per share experience more negative CARs, suggesting that, due to heightened geopolitical risks, these firms may fail to meet market expectations regarding their dividend policies. The tangible asset ratio appears to have a small positive effect on the CAR, indicating that more asset-heavy firms are better positioned to cope with the consequences of the Russian invasion. Lastly, the short-term debt ratio seems to have a negative effect

Table 5
Estimation results of the analysis on the CAR at the company level.

Specific.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Event window	[-3; +1]	[-3; 0]	[-1; 0]	[0]	[0; +1]	[-3; +1]	[-3; 0]	[-1; 0]	[0]	[0; +1]
Leverage	−0.0386***	−0.0491***	−0.0461***	−0.0520***	−0.0346***	−0.0528***	−0.0712***	−0.0372**	−0.0367**	−0.0162
	(0.0113)	(0.0107)	(0.0111)	(0.0102)	(0.0109)	(0.0185)	(0.0172)	(0.0173)	(0.0167)	(0.0175)
Tobin's Q	0.00564	−0.0434***	−0.00208	−0.00262	0.0569***	0.0688***	0.0331	0.0341	0.0782***	0.116***
	(0.0124)	(0.0121)	(0.0117)	(0.0109)	(0.0114)	(0.0234)	(0.0227)	(0.0214)	(0.0213)	(0.0213)
Profitability	0.0614***	0.0652***	0.0547***	0.0235*	0.0183	−0.0729*	−0.121***	−0.179***	−0.314***	−0.220***
	(0.0133)	(0.0126)	(0.0133)	(0.0121)	(0.0127)	(0.0434)	(0.0426)	(0.0457)	(0.0472)	(0.0416)
Size	0.0556***	0.0457***	0.0406***	0.0744***	0.0837***	−0.101***	−0.0986***	−0.177***	−0.155***	−0.142***
	(0.0113)	(0.0109)	(0.0111)	(0.0102)	(0.0107)	(0.0238)	(0.0224)	(0.0221)	(0.0211)	(0.0225)
ESG Score						0.0381***	0.0341**	0.0182	0.0198	0.0260*
						(0.0146)	(0.0138)	(0.0140)	(0.0132)	(0.0139)
Country dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Sector dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country x sector dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observation	14,896	14,896	14,896	14,896	14,896	4921	4921	4921	4921	4921
R-squared	0.121	0.146	0.146	0.280	0.222	0.211	0.225	0.257	0.445	0.377
Country dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Specification	(11)	(12)	(13)	(14)	(15)
Event window	[-3; +1]	[-3; 0]	[-1; 0]	[0]	[0; +1]
Leverage	−0.0538***	−0.0717***	−0.0375**	−0.0368**	−0.0170
	(0.0184)	(0.0172)	(0.0172)	(0.0167)	(0.0175)
Tobin's Q	0.0631***	0.0276	0.0293	0.0762***	0.114***
	(0.0232)	(0.0226)	(0.0214)	(0.0213)	(0.0212)
Profitability	−0.0576	−0.109***	−0.167***	−0.311***	−0.214***
	(0.0432)	(0.0422)	(0.0453)	(0.0471)	(0.0415)
Size	−0.121***	−0.118***	−0.196***	−0.162***	−0.147***
	(0.0240)	(0.0228)	(0.0225)	(0.0213)	(0.0224)
Environmental Score	0.0658***	0.0540***	0.0458***	0.0209	0.0318**
	(0.0155)	(0.0147)	(0.0147)	(0.0138)	(0.0145)
Social Score	0.0230*	0.0346***	0.0201*	0.0191*	0.00618
	(0.0122)	(0.0117)	(0.0116)	(0.0110)	(0.0116)
Governance Score	0.0190	0.0159	0.00622	0.0196	0.0228
	(0.0148)	(0.0144)	(0.0145)	(0.0136)	(0.0139)
Country dummies	YES	YES	YES	YES	YES
Sector dummies	YES	YES	YES	YES	YES
Country x sector dummies	YES	YES	YES	YES	YES
Observation	4921	4921	4921	4921	4921
R-squared	0.214	0.228	0.259	0.445	0.377
Country dummies	YES	YES	YES	YES	YES

Note: The table reports the estimation results of Eq. (2) of the cumulative abnormal returns computed on several event windows. All specifications include dummy variables at country and sector levels, and their interaction. Robust standard errors are shown in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1 %, 5 %, and 10 % level, respectively.

on the CAR, but only on the day of the invasion. This aligns with expectations, as firms with higher short-term debt may face difficulties in meeting their obligations due to the increased overall risk.

6. Discussion and implications

Geopolitical shocks on a global scale are a major concern for society as a whole. Such events can have a significant impact on populations and human rights, as well as posing serious risks to companies and participants in financial markets. From a financial market perspective, such events increase economic uncertainty, particularly affecting international firms and those with more irreversible investments. In fact, Wang et al. (2024) document a strong negative correlation between increased geopolitical risk and corporate investment.

The Russian invasion of Ukraine is one of the most significant geopolitical shocks since the Second World War (Boubaker et al., 2023), and has had various implications for the global economy from different perspective, e.g., increased in raw material prices, supply chain disruption, increased financial markets uncertainty, societal turmoil and energy supply disruptions from Russia. In addition, the relationship and interconnectedness among financial markets has changed since the war started (Umar et al., 2022).

Since 2022, many papers have analyzed the impact of the Russian invasion on the global economy and financial markets from different perspectives. Some studies focus on specific sectors, such as banking, energy, or food, while others take a more general approach. Our analysis aims to disentangle the various layers of specificity that a major conflict can involve, particularly with regard to country, sector, and sustainability performance.

Our main finding is that the Russian invasion of Ukraine had heterogeneous and asymmetric economic effects on a global scale. Similar to Yousaf et al. (2022), we showed that not all countries or sectors have been impacted in the same way. Specifically, the absence of significant effects in countries like Canada, Norway, and Japan implies some economies are more insulated, either due to geographic distance, energy independence, or strong institutional frameworks. This asymmetry challenges the concept of uniform global contagion suggesting that risk exposure should be modeled with greater granularity in both macroeconomic and asset-pricing frameworks.

Secondly, our country-sector level results point out that sectoral interconnectedness could magnify vulnerability (see Tsang et al., 2024). The importance of the manufacturing and finance sectors in many countries underscores how global integration creates channels for the rapid transmission of shocks. Manufacturing's exposure to global supply chains and the link between finance and capital flows mean that these sectors respond quickly and visibly to geopolitical instability. In order to

Table 6
Estimation results of the analysis on the CAR at the company level.

Specification	(1)	(2)	(3)	(4)	(5)
Event window:	[-3; +1]	[-3; 0]	[-1; 0]	[0]	[0; +1]
Panel A					
Dividend per share	−0.00552	0.0111	−0.0129**	−0.0228***	−0.0399***
	(0.00694)	(0.00677)	(0.00651)	(0.00666)	(0.00670)
Controls and constant term	YES	YES	YES	YES	YES
Country dummies	YES	YES	YES	YES	YES
Sector dummies	YES	YES	YES	YES	YES
Country x sector dummies	YES	YES	YES	YES	YES
Observation	14,867	14,867	14,867	14,867	14,867
R-squared	0.121	0.147	0.147	0.281	0.223
Panel B					
Tangible assets/Total assets	0.00190	0.0240**	0.0230**	0.0211**	−0.00368
	(0.0109)	(0.0105)	(0.0104)	(0.00974)	(0.0102)
Controls and constant term	YES	YES	YES	YES	YES
Country dummies	YES	YES	YES	YES	YES
Sector dummies	YES	YES	YES	YES	YES
Country x sector dummies	YES	YES	YES	YES	YES
Observation	13,932	13,932	13,932	13,932	13,932
R-squared	0.120	0.145	0.145	0.271	0.214
Panel C					
Short term debt/Total Debt	−0.0137	−0.0110	−0.0228**	−0.0239**	−0.0264***
	(0.0107)	(0.0106)	(0.0105)	(0.00952)	(0.00993)
Controls and constant term	YES	YES	YES	YES	YES
Country dummies	YES	YES	YES	YES	YES
Sector dummies	YES	YES	YES	YES	YES
Country x sector dummies	YES	YES	YES	YES	YES
Observation	13,625	13,625	13,625	13,625	13,625
R-squared	0.126	0.150	0.157	0.294	0.240

Note: The table reports the estimation results of Eq. (2) of the cumulative abnormal returns computed on several event windows. All specifications include control variables (size, leverage, profitability and the Tobin's Q), and dummy variables at country and sector levels, and their interaction. Robust standard errors are shown in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1 %, 5 %, and 10 % level, respectively.

mitigate the impact of such instability, policymakers and firms in these sectors may need to diversify suppliers, stress-test their systems, and strengthen their scenario planning for geopolitical contingencies.

Thirdly, our event study analysis indicates that, at the time of the invasion—and after controlling for companies' ESG ratings—stronger sustainability performance did not appear to mitigate the immediate market impact. Specifically, there were no significant differences in market reactions between companies with higher and lower ESG ratings. However, examining the specific transmission channels at the firm level, we observed a robust, positive, and statistically significant relationship between environmental performance and CARs. This finding, in line with Fiorillo et al. (2024), suggests that strong environmental performance can play a beneficial role in enhancing firms' resilience over time, potentially offsetting the adverse effects of heightened geopolitical risk.

Lastly, we emphasize once again the importance of the consensus rule-of-thumb used to identify the statistical significance of the event of interest. ES statistics are often constructed under strong assumptions (e.g., gaussianity of the returns) or do not explicitly account for typical empirical issues of financial data (e.g., asymmetry and cross-correlation). However, for many of them, suitable statistical properties can be demonstrated (e.g., exact size and power properties for many rank-based ES statistics). In this context, it becomes difficult to reach an ideal decision and choose a single representative statistic. Therefore, we recommend leveraging the extensive list of available statistical tests as much as possible and evaluating the degree of consistency and agreement in the resulting findings. Nevertheless, it is important to note that this strategy is valid when dealing with heterogeneous statistics that are constructed taking into account the mixed characteristics of the data. In this specific case, we have used adjusted and unadjusted statistics for cross-correlation, but also statistics based on parametric assumptions and other distribution-free statistics.

7. Conclusion

In this paper, we showed that the stock market reaction to the Russian invasion of Ukraine is markedly heterogeneous with respect to a variety of factors, including country and sector characteristics as well as firms' performance in sustainable practices. We focus on a short-term analysis that considers the immediate impact of the military invasion on a large set of worldwide financial and real markets. However, longer-term measurement windows (e.g., 12-month or longer) could also be adopted to capture additional insights of the war effects on stock markets (see, e.g., Kothari and Warner, 2007; Sorescu et al., 2017). Our approach grounds on the perception/assumption that the abnormal/unexpected effect of large-scale and scarcely predictable[4] events like armed conflicts between large sovereign countries are automatically and instantaneously incorporated into the prices in stock markets, which promptly react without delays. In the context, we employed a range of test statistics that directly account for the statistical properties of stock market returns. This approach allows for the potential violation of the normality assumption and the strong cross-sectional dependence to be taken into consideration. Our findings indicate that, while the event had an overall negative impact on most countries, country-sector specificities are relevant in explaining the stock market reaction to the increase in geopolitical risks.

We find that ESG performance has a positive impact on cumulative abnormal returns, underscoring the positive role of sustainable investing in the current era of heightened geopolitical uncertainty. Our study also underscores the need to evaluate corporate sustainability practices from two perspectives: a broad assessment of corporate sustainability performance in an international and evolving context, and a more granular

[4] We avoid using the word 'unpredictable' because in the case of Russia and Ukraine, as highlighted in several studies (see, e.g., Roberts, 2022; Osflaten, 2025), the preconditions for the conflict were well known and long-standing.

analysis that considers the differential impact of a single event (such as an escalation of geopolitical turmoil resulting from the Russia-Ukraine conflict) in different contexts (e.g., different countries or sectors).

Our analysis provides some relevant insights for policymakers. By identifying the sectors in which the impact of the event was more severe, and given the mitigating effects of sustainable practices, policymakers can use the approach presented in the paper to redirect investment in sustainable practices in specific contexts, i.e. specific countries and sectors, to withstand potential geopolitical shocks.

Consent to participate

Not applicable.

Consent to publish

Not applicable.

Ethical approval

Not applicable.

Authors contributions

To be declared at the end of the peer-review process.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Additional Tables

This appendix provide supplementary table. Tables A.1 - A.3 give an overview of the data included in the analysis. Tables A.4 - A.6 provide details on the empirical results described in Section 4.

Table A.1
Distribution of the sample by countris and market indexes

Country	Index	Num. of Companies	Share (to total sample)	Num. of available ESG scores	Share (to total available)	Availability rate
Australia	S&P ASX 200 Index	1188	*6.84 %*	254	*4.50 %*	*21 %*
Austria	ATX Index	56	*0.32 %*	26	*0.46 %*	*46 %*
Belgium	BEL 20 Index	115	*0.66 %*	45	*0.80 %*	*39 %*
Canada	S&P/TSX Index	1501	*8.64 %*	250	*4.43 %*	*17 %*
Denmark	OMX Copenhagen 20 Index	127	*0.73 %*	35	*0.62 %*	*28 %*
Finland	OMX Helsinki Index	163	*0.94 %*	41	*0.73 %*	*25 %*
France	CAC 40 Index	634	*3.65 %*	134	*2.37 %*	*21 %*
Germany	DAX Index	643	*3.70 %*	161	*2.85 %*	*25 %*
Great Britain	FTSE 100 Index	1148	*6.61 %*	344	*6.09 %*	*30 %*
Greece	Athens Stock Exchange Large Cap Index	128	*0.74 %*	10	*0.18 %*	*8 %*
Hong Kong	Hanf Seng Index	1000	*5.76 %*	176	*3.12 %*	*18 %*
Ireland	ISEQ All-Share	23	*0.13 %*	13	*0.23 %*	*57 %*
Italy	FTSE MIB Index	352	*2.03 %*	90	*1.59 %*	*26 %*
Japan	NIKKEI 225	3729	*21.47 %*	1116	*19.77 %*	*30 %*
Netherlands	AEX Index	94	*0.54 %*	54	*0.96 %*	*57 %*
New Zealand	S&P/NZX 50	96	*0.55 %*	46	*0.81 %*	*48 %*
Norway	OSE ALL SHARE Index	259	*1.49 %*	57	*1.01 %*	*22 %*
Portugal	PSI 20 Index	34	*0.20 %*	12	*0.21 %*	*35 %*
Singapore	Straits Times Index STI	412	*2.37 %*	68	*1.20 %*	*17 %*
Spain	Ibex 35 Index	178	*1.03 %*	66	*1.17 %*	*37 %*
Sweden	OMX Stockholm 30 Index	740	*4.26 %*	110	*1.95 %*	*15 %*
Switzerland	SPI SWISS Performance Index	210	*1.21 %*	121	*2.14 %*	*58 %*
US	S&P 500	4535	*26.12 %*	2.417	*42.81 %*	*53 %*
Total		*17,365*	*100 %*	*5646*	*100 %*	*33 %*

Note: The table reports the market indexes and their corresponding country included in the analysis. The table also reports the number of observations available in our database, including information on ESG rating availability. The column "Availability rate" refers to the proportion of ESG score available at country level.

Table A.2
Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
CAR [-3; +1]	14896	−0.014	0.063	−0.237	0.183
CAR [-3; 0]	14896	−0.032	0.062	−0.252	0.145
CAR [-1; 0]	14896	−0.014	0.048	−0.178	0.14
CAR [0]	14896	−0.010	0.045	−0.155	0.133
CAR [0; +1]	14896	0.008	0.052	−0.157	0.184
Leverage	14896	0.238	0.244	0.000	1.391
Tobin's Q	14896	1.993	3.189	0.025	21.228
ROA	14896	−7.376	38.161	−246.482	30.508
Size	14896	5.687	2.400	0.056	12.109
Dividend per Share	14867	0.384	1.057	0.000	8.033
Tangible asset/Total assets	13932	0.865	0.196	0.216	1.000
Short-term debt/Total Debt	13625	0.350	0.305	0.000	1.000
ESG Score	4921	5.310	2.135	0.000	10
Environmental Score	4921	5.129	2.227	0.100	10
Social Score	4921	4.712	1.559	0.800	8.5
Governance Score	4921	5.165	1.335	1.8	7.9

Note: The table shows the descriptive statistics of the variables involved in the analysis. Specifically, the table displays the number of observations, the mean and the standard deviation, and the minimun and maximun values. All variables are winsorized at the first percentile and the 99th percentile.

Table A.3
Pearson correlation matrix

	CAR [-3; +1]	CAR [-3; 0]	CAR [-1; 0]	CAR [0]	CAR [0; +1]	Leverage	Tobin's Q	ROA	Size	Dividend per Share	Tangible asset/Total assets	Short-term debt/ Total Debt	ESG Score	Environmental Score	Social Score	Governance Score
CAR [-3; +1]	1.000															
CAR [-3; 0]	0.833	1.000														
CAR [-1; 0]	0.695	0.843	1.000													
CAR [0]	0.590	0.720	0.831	1.000												
CAR [0; +1]	0.767	0.528	0.636	0.789	1.000											
Leverage	0.009	−0.023	−0.021	0.045	0.069	1.000										
Tobin's Q	0.160	0.120	0.129	0.171	0.207	−0.169	1.000									
ROA	−0.046	−0.078	−0.113	−0.165	−0.116	0.060	0.053	1.000								
Size	−0.077	−0.080	−0.136	−0.107	−0.097	0.268	−0.359	0.172	1.000							
Dividend per Share	−0.014	−0.030	−0.068	−0.089	−0.062	0.091	−0.027	0.130	0.258	1.000						
Tangible asset/ Total assets	−0.083	−0.034	−0.010	−0.074	−0.122	−0.121	−0.050	−0.083	−0.046	0.059	1.000					
Short-term debt/ Total Debt	−0.122	−0.079	−0.057	−0.142	−0.178	−0.339	0.008	−0.014	−0.155	−0.051	0.257	1.000				
ESG Score	−0.017	−0.063	−0.104	−0.125	−0.058	−0.004	0.003	0.073	0.224	0.056	−0.177	−0.112	1.000			
Environmental Score	0.044	0.008	−0.028	−0.039	0.007	0.074	0.006	−0.011	0.267	0.104	−0.155	−0.074	0.340	1.000		
Social Score	0.001	0.013	−0.019	−0.050	−0.053	−0.055	−0.010	0.050	0.120	−0.014	−0.033	0.002	0.549	0.116	1.000	
Governance Score	0.023	−0.044	−0.079	−0.075	0.009	0.036	0.063	0.046	−0.018	0.015	−0.193	−0.232	0.540	0.060	0.014	1.000

Table A.4
Event study by country

Country	# of observation	CAAR	% of tests showing significant results	% of significant CS adjusted test
Australia	1188	−0.051++	61.11 %	36.36 %
Austria	56	−0.048++	72.22 %	54.55 %
Belgium	115	−0.024	27.78 %	0.00 %
Canada	1501	−0.011	33.33 %	0.00 %
Denmark	127	−0.021	33.33 %	0.00 %
Finland	163	−0.023	33.33 %	0.00 %
France	634	−0.04++	72.22 %	54.55 %
Germany	643	−0.025	38.89 %	9.09 %
Great Britain	1148	−0.036++	66.67 %	45.45 %
Greece	128	−0.035	38.89 %	18.18 %
Hong Kong	1000	−0.023+	55.56 %	36.36 %
Ireland	23	−0.013	22.22 %	0.00 %
Italy	352	−0.04+	55.56 %	27.27 %
Japan	3729	−0.013	33.33 %	0.00 %
Netherlands	94	−0.029	33.33 %	0.00 %
New Zealand	96	−0.025+	55.56 %	36.36 %

(*continued on next page*)

Table A.4 (*continued*)

Country	# of observation	CAAR	% of tests showing significant results	% of significant CS adjusted test
Norway	259	−0.013	33.33 %	0.00 %
Portugal	34	−0.027	44.44 %	27.27 %
Singapore	412	−0.017	33.33 %	0.00 %
Spain	178	−0.014	33.33 %	0.00 %
Sweden	740	−0.029	33.33 %	0.00 %
Switzerland	210	−0.016	33.33 %	0.00 %
US	4535	0.011	33.33 %	0.00 %

Note: The table reports the estimated CAAR by applying the event study methodology at the country level. The estimates are evaluated using the majority vote approach described in Section 3.2. Statistically significant at the 5 % level is denoted as follows: +++ indicates significance in 15–18 of the test statistics from Table 1; ++ in 11–14 test statistics; and + in 9–10 test statistics. The table also reports the percentage of significant results among the 18 tests, the percentage of cross-sectionally (CS) adjusted tests rejecting the null hypothesis, and the number of observations used in the analysis.

Table A.5
Event study by sector

Sector (NAICS classification)	# of observations	CAAR	% of tests showing significant results	% of significant CS adjusted test
Accommodation and Food Services	327	−0.018	33.33 %	0.00 %
Administrative and Support and Waste Management and Remediation Services	362	−0.016	27.78 %	0.00 %
Agriculture, Forestry, Fishing and Hunting	140	−0.021	38.89 %	9.09 %
Arts, Entertainment, and Recreation	145	−0.018	33.33 %	0.00 %
Construction	641	−0.019	33.33 %	0.00 %
Educational Services	75	−0.015	22.22 %	0.00 %
Finance and Insurance	2165	−0.017	27.78 %	0.00 %
Health Care and Social Assistance	213	−0.003	0.00 %	0.00 %
Information	1727	−0.014	33.33 %	0.00 %
Management of Companies and Enterprises	23	−0.019	0.00 %	0.00 %
Manufacturing	5889	−0.016	33.33 %	0.00 %
Mining, Quarrying, and Oil and Gas Extraction	1573	−0.017	33.33 %	0.00 %
Other Services (except Public Administration)	73	−0.013	22.22 %	0.00 %
Professional, Scientific, and Technical Services	1224	−0.009	33.33 %	0.00 %
Real Estate and Rental and Leasing	781	−0.010	33.33 %	0.00 %
Retail Trade	753	−0.016	33.33 %	0.00 %
Transportation and Warehousing	405	−0.015	33.33 %	0.00 %
Utilities	297	0.003	5.56 %	0.00 %
Wholesale Trade	551	−0.018	33.33 %	0.00 %

Note: The table reports the estimated CAAR by applying the event study methodology at the sector level. The estimates are evaluated using the majority vote approach described in Section 3.2. Statistically significant at the 5 % level is denoted as follows: +++ indicates significance in 15–18 of the test statistics from Table 1; ++ in 11–14 test statistics; and + in 9–10 test statistics. The table also reports the percentage of significant results among the 18 tests, the percentage of cross-sectionally (CS) adjusted tests rejecting the null hypothesis, and the number of observations used in the analysis.

Table A.6
Event study by ESG rating

ESG rating	# of observations	CAAR	% of tests showing significant results	% of significant CS adjusted test
AAA	191	−0.013	33.33 %	0.00 %
AA	896	−0.010	33.33 %	0.00 %
A	1329	−0.006	33.33 %	0.00 %
BBB	1366	−0.001	22.22 %	0.00 %
BB	1079	0.000	22.22 %	0.00 %
B	673	−0.009	33.33 %	0.00 %
CCC	112	−0.008	22.22 %	0.00 %
no rating	11719	−0.020	33.33 %	0.00 %

Note: The table reports the estimated CAAR by applying the event study methodology at the ESG rating. The estimates are evaluated using the majority vote approach described in Section 3.2. Statistically significant at the 5 % level is denoted as follows: +++ indicates significance in 15–18 of the test statistics from Table 1; ++ in 11–14 test statistics; and + in 9–10 test statistics. The table also reports the percentage of significant results among the 18 tests, the percentage of cross-sectionally (CS) adjusted tests rejecting the null hypothesis, and the number of observations used in the analysis.

Appendix B

For each empirical exercise implemented in Section 4, this appendix provides plots representing the number of significant results, by the statistics listed in Table 1.

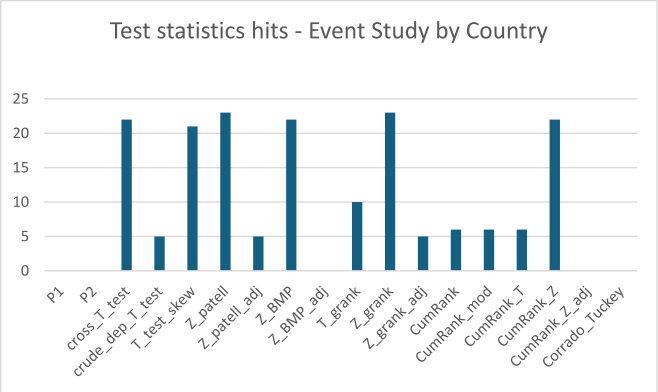

Fig. B.1. Number of significant test statistics for the analysis by country

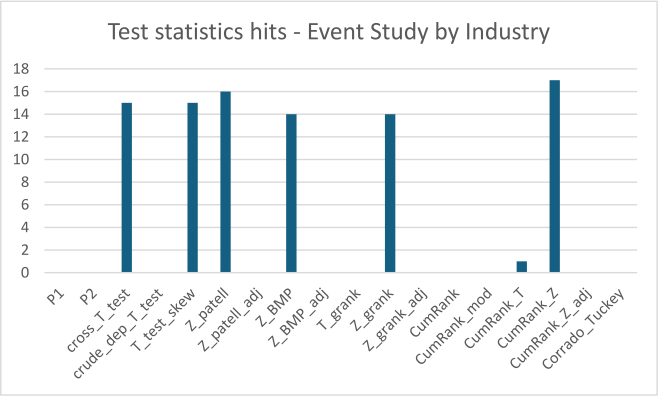

Fig. B.2. Number of significant test statistics for the analysis by sector

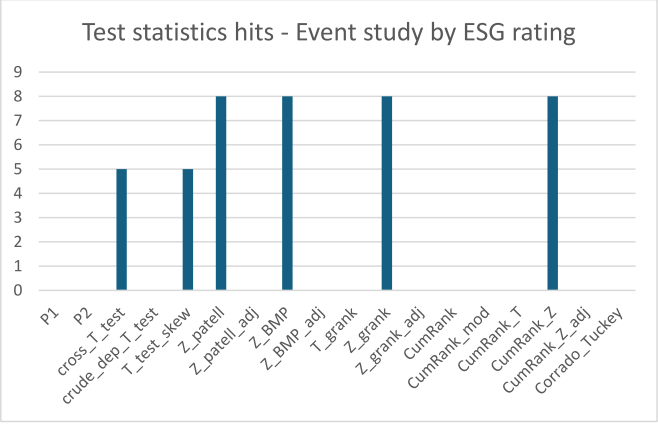

Fig. B.3. Number of significant test statistics for the analysis by ESG ratings

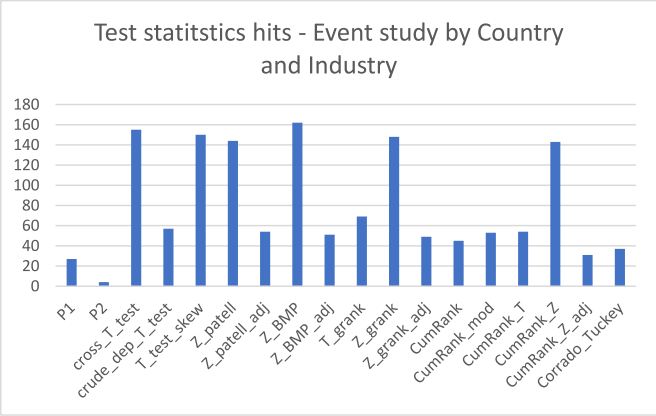

Fig. B.4. Number of significant test statistics for the analysis by country-sector

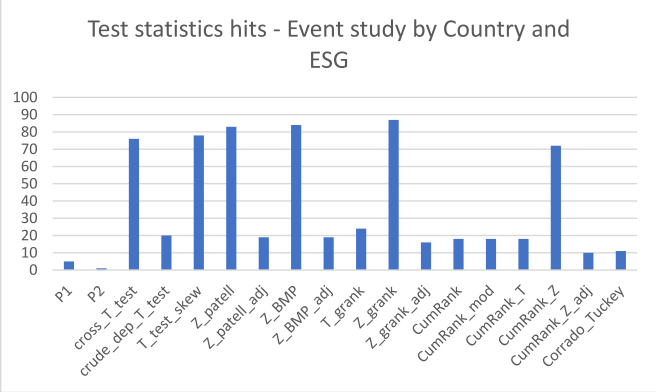

Fig. B.5. Number of significant test statistics for the analysis by country-ESG

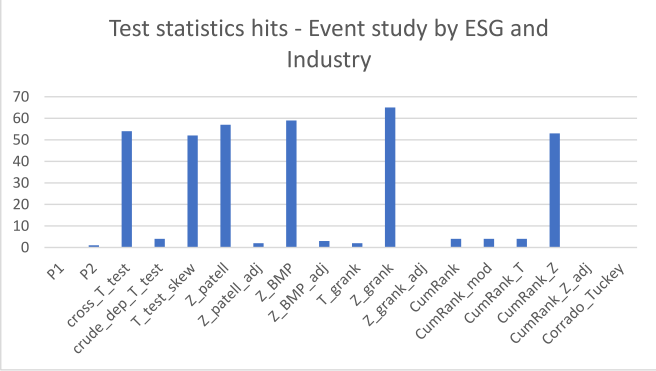

Fig. B.6. Number of significant test statistics for the analysis by ESG-sector

Data availability

All results presented in this paper can be reproduced using the R and Stata 18 software. The codes were developed entirely by the authors. For reproducibility purposes, we refer to Boccaletti, Simone; Maranzano, Paolo; Morelli, Caterina; Ossola, Elisa (2025), "ESG Performance and Stock Market Responses to Geopolitical Turmoil: evidence from the Russia-Ukraine War (Boccaletti, Maranzano, Morelli & Ossola, 2025)", Università Cattolica del Sacro Cuore, V5, https://doi.org/10.17632/tyj4bvwtfn.5.

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