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ESG Performance and Stock Market Responses to Geopolitical Turmoil: evidence from the Russia-Ukraine War

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Abstract

Since the Paris Agreement of 2015, firms have been asked to enhance their commitment to ethical, environmental, and social responsibility by many different stakeholders. This movement seeks, alongside minimum required financial returns, positive contributions to the planet and society as a whole. However, these types of practices and investments are threatened by increased geopolitical risks, such as the invasion of Ukraine by Russia, given the interconnectedness between political events and responsible investing. In this paper, we analyze a large worldwide cross-section of stock price reactions to the Ukraine-Russia conflict, specifically differentiating companies by country, industry, and ESG characteristics. By employing an event study methodology approach on more than 17 thousand firms, the empirical analysis unveils, on average, a negative stock market reaction in the days around the event. Nonetheless, different patterns of stock market response are identified, most of which are country-sector specific. We also demonstrate that ESG performance seems to be a moderating factor, as firms with higher industry-adjusted ESG scores obtain less negative CARs.

Keywords: Event Study, ESG, Russia-Ukraine Conflict, Stock Market Performance
JEL codes: F51; G14; G15; G32.

*Corresponding author. E-mail: simone.boccaletti@unimib.it, paolo.maranzano@unimib.it, c.morelli12@campus.unimib.it, elisa.ossola@unimib.it. Research paper developed within the MUSA – Multilayered Urban Sustainability Action – project, funded by the European Union – NextGenerationEU, under the National Recovery and Resilience Plan (NRRP) Mission 4 Component 2 Investment Line 1.5: Strengthening of research structures and creation of R&D "innovation ecosystems", set up of "territorial leaders in R&D - project code: ECS 000037. – We are grateful to the participants at the IWEEE 2024, CefES Conference 2024, IC CGRM 2024.

1. Introduction

In recent years, Environmental, Social, and Governance (ESG) investments have emerged as a pivotal and guiding force in redirecting financial investment towards sustainable activities. While the focus on sustainable investment dates back to the early 2000s, after the Paris Agreement of 2015, investors started to heavily prioritize sustainability practices in companies' evaluation, and firms have been compelled to reassess and enhance their commitment to ethical, environmental, and social responsibility. This movement seeks beside minimum required financial returns, positive contributions to the planet and society as a whole.

In this new framework, the invasion of Ukraine by Russia has originated an in-depth debate on the interconnectedness between political events and responsible investing. The energy markets and raw materials markets have been the two main sectors affected by this event, given the global increase in electricity and raw materials. How investments in the energy and ecological transition could reduce the risks arising from these geopolitical events remains the main question that policymakers are trying to answer. From this perspective, the conflict has triggered increased awareness of the relationship between political events, social stability, and the ethical considerations embedded in investment decisions.

Immediately after the invasion, stock markets all around the globe reacted instantaneously and suffered large losses, even more serious because the economic system had not fully recovered from the COVID-19 outbreak. Moreover, western countries immediately started to put in place sanctions against the Russian economy, with some heterogeneity in the nature and target of the action: for instance, on February 27th, the EU and US targeted Russian airlines (e.g., banning aircraft from their airspace) and banks (e.g., blocking access to the SWIFT paying system). Another important sanction was the block of fuel export, and to restrict imports, to hinder economic activity within Russia's borders. Also the vast majority of large and listed companies started to disinvest and suspend their activity in the Russian market. Furthermore, with regard to the OECD's 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 invasion on sectors at worldwide level showed a diverse range of outcomes. For example, considering the energy sector, the conflict had two major effects: first, it accelerated the investment in renewable energies, especially in Europe, to overcome the increase in the cost of fossil fuels; secondly, some countries decided to re-open coal mines and plants, generating great controversies regarding their protection of the environment.

This paper aims to analyze the effect of the invasion of Ukraine on several stock markets at the worldwide level, considering sustainability performance at the company level, in turn, proxied by ESG ratings. We aim to answer the two following research questions:

1. How did the invasion affect company stock returns?
2. What were the main drivers of stock market reactions at the company level?

To answer the first research question, we employ an Event Study (ES) methodology to a sample of listed firms around the world. In particular, we apply a set of cross-sectionally adjusted and not-adjusted test statistics relying on either a parametric or non-parametric specification to

check whether the event had a significant impact on stock markets. The use of multiple adjusted tests follows the analysis provided by Pelagatti and Maranzano (2021), which argue that when considering strongly correlated time series a cross-correlation adjustment is necessary to preserve consistent test size and power. Also, many test statistics present very similar statistical performances, making it difficult a singular choice of tests. For this reason, as a byproduct of the analysis, we propose a rule-of-thumb based on a majority vote approach (see Section 10.1 of Hastie, Tibshirani, & Friedman, 2017) to decide whether the event generated a significant effect or not. By using a majority rule, we are able to identify in which scenarios (i.e., country, sector, and sustainability levels and their pair combinations) the event hit the most. Indeed, we apply the ES approach at the country, industry, and sustainability levels. In addition, to take into account the different layers of specificity, we consider the pair combinations of country, industry, and sustainability level.

To tackle the second research question, we study the determinants of the Cumulative Abnormal Returns (CARs), around the event date. We investigate the relationship between the CARs and a set of companies' financial information, to understand if market reactions were driven by firms' characteristics, including sustainability performance. To the best of our knowledge, the only paper considering ESG performances, and the invasion of Ukraine in an ES setting is the one by Tsang et al. (2024), in which authors find mild evidence of superior stock market performance by companies with higher ESG scores. However, while that paper focuses only on the top 100 companies of the S&P 500 index, we provide a broader study by considering a global approach, developing a thorough country-sector analysis, and delving into the determinants of the CARs at the company level. Moreover, we also compute several statistical tests rather than focusing on standard t-statistics, accounting for the different types of concerns regarding assumptions on stock returns.

Our results can be summarized as follows. First, even if the adverse consequences of the invasion were pervasive, we provide evidence of limited significant effect and also important heterogeneity across countries and sectors. Specifically, implementing the ES methodology over several frameworks, defined at country, industry, and sustainability levels, allows us to identify at which level the Ukraine invasion hit the most. Second, we show that larger firms and firms with lower debt-to-capital ratios were able to withstand the negative effect of the invasion on the event date and on the day after the invasion. Lastly, companies with better sustainability performance were able to dampen the potentially negative effects of the invasion with respect to companies with low levels of sustainability.

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 and the analysis of the determinants. Finally, Section 5 concludes.

2. Background and related literature

War has always caught the interest of academics willing to study the effect of armed conflicts on the economy and financial markets. As argued by Schneider and Troeger (2006), the potential impacts of conflicts on the financial market are heterogeneous and depend on the

severity of the conflict and how economic agents can anticipate cooperative and conflictive events.

Since 2022, the academic literature has offered a growing number of papers that aim to analyze the impact of the Russia-Ukraine conflict on the stock market. Considering the returns of the global stock market indices, several papers found evidence of heterogeneous effects of the Russian invasion on the financial markets in different countries, according to the geographic proximity to the war zone, the market efficiency, the level of globalization, and the economic relationship and dependence with Russia and Ukraine (see, for example, Boubaker et al., 2022; Boungou and Yatié, 2022; Ferrandez Serrano and Angosto Fernandez, 2022; Yousaf et al., 2022; Kumari et al., 2023; Obi et al., 2023; Assaf et al., 2023; Diaconasu et al., 2023; Granàt et al., 2023; Tsang et al., 2024).

Moreover, Sun and Zhang (2023), Abbassi et al. (2023), and Ahmed et al. (2023) confirm these results by providing firm-level analysis respectively using a sample of global, European, and G7 firms and then adding a more accurate analysis of the effects by country and by sector.

Other research focuses 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 considering Indian firms from different sectors. Keles (2023) provides evidence of a significant adverse reaction of the Turkish stock exchange, which started before the official war announcement, whereas Kamal et al. (2023) finds 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 industry globally and at the European level, while Martins et al. (2023a) consider the world's largest insurance firms. Moreover, Pandey and Kumar (2023) and Le et al. (2023) focus respectively on tourism companies and airline companies, while Yudaruddin et al. (2023) reveal a significant negative impact of the invasion on the global consumer staples market.

Many other papers have focused on the energy sector. For instance, Diaconasu et al. (2023) provide evidence of the increase in oil price at the beginning of the war, Mohammed et al. (2023) show that renewable energy markets have a positive and significant effect, and 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, we assist with an increase in energy price and volatility. Consequently, companies operating in the energy sector have recorded significant changes in financial returns (Nerlinger and Utz, 2022; Febriandika et al., 2023), as well as the stock market indices related to the same industry (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' choices and therefore the impact on firms' market value finding controversial results. Indeed, according to Tee et al. (2023) and Nicolau et al. (2024), companies benefited from these decisions, while Ayoub and Qadan (2023) and French et al. (2023) show that firms involved in these actions present significant reductions in stock prices.

Also, the implementation of sanctions and political actions against Russian institutions and companies are closely linked to ESG topics. To the best of our knowledge, only a few papers study the reaction of the market in this geopolitical turmoil scenario with a specific focus on sustainable practices.

Considering the period before the war, Fiorillo et al. (2024) investigate the mediating role of the ESG factors in the effect of geopolitical risk on stock price crash risk, examining a sample of global listed companies between 2010-2021. In particular, they observe negative implications to be less severe for high ESG-rated issuers and, specifically, for firms scoring high in the Environmental and Social dimensions. Ricci et al. (2024) found that stock returns of European listed firms with high ESG scores are less affected than their peers during the war escalation and announcements regarding shocks to gas imports from Russia, during the period 2021-2022, especially companies with higher environmental score had higher returns.

Katsampoxakis et al. (2024) focus on the performance of ESG stock indices during periods of crisis and suggest that stock indices of leading ESG companies in North America and Europe constitute a safe investment. Clancey-Shang and Fu (2024) consider a sample of US-listed firms and, using an event-study approach, observe that better ESG performance is associated with lower range volatility of stock returns, during the outbreak of the war. Tang et al. (2024) analyse how the conflict impacted different sectors using a sample consisting of the top 100 companies in the S&P 500 index. Their result unveil that more responsible firms were able to withstand supply chain disruptions from the conflict.

Overall, we have reason to believe that ESG performance play an important role in mitigating the effects of the invasion on a firm's market value. Nevertheless, a comprehensive and detailed study of the phenomenon will certainly be useful and interesting to understand how ESG assessments have helped to alleviate the impact of such a disruptive event, in different countries and in different sectors, observing individual companies listed on the stock exchange.

3. Data and Methods

3.1 Data

We collect daily prices from FACTSET for all listed firms belonging to the main stock exchanges around the worlds (Table 1). We retrieve daily prices for 17,365 companies from July 30, 2021, to February 28, 2022. We retrieved[1] the ESG Rating and Score available on February 24, 2022, i.e., the date of the Russian invasion from MSCI ESG ratings. Sustainability ratings are specialized assessments of companies' performance over several indicators related to sustainable practices broadly defined. ESG ratings from MSCI take the form of a letter, and a number (score) adjusted for the industry in which the firm operates. Henceforth, ESG ratings range between AAA (top class) and CCC (bottom class), and ESG scores range from 0 (worst performance) to 10 (best performance). MSCI provides ESG ratings and scores for about 14,000 worldwide companies. Since ESG ratings are not mandatory, only about 5,600 firms have a rating in our sample, as shown in Table 1.

[1] ESG are typically issued once per year for every company with a variable release date during the year. Henceforth, for some companies, ESG ratings are relatively older (in terms of months) compared to others.

[INSERT TABLE 1 AROUND HERE]

Moreover, we retrieve balance sheet information at the company level. In particular, we consider the companies' size (computed as the natural log of total assets), the interest coverage ratio (defined as the ratio between EBITDA and interest expenses), the debt to total asset ratio (computed as the ratio between total financial debt and total assets), and profitability (ROA, i.e., return on assets). Table 2 shows the descriptive statistics of the sample by sector (based on the North American Industry Classification System, NAICS). The Table also reports the descriptive statistics for the ESG scores collected.

[INSERT TABLE 2 AROUND HERE]

3.2 Empirical strategy

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

$$R_t = a + b' f_t + \epsilon_t \quad (1)$$

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. 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 $AR_t = R_t - [\hat{a} + \hat{b}' f_t]$, where $\hat{a}$ and $\hat{b}$ are estimated from the OLS regression on Eq. (1), using daily returns observed within the estimation window, that is, from August 1st, 2021 to January, 31st, 2022. We implement the Capital Asset Pricing Model (Sharpe, 1964), for which f_t corresponds to the market factor.

We define the event window of the ES around the Russian invasion of Ukraine on February 24th, 2022. The main event window considers five trading days between February 21st, 2022, that is, when news related to the invasion of the Donbass started to spread out, 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 over the event window, we compute the Cumulative Abnormal Returns, defined as $CAR_i = \sum_{t \in \Omega} AR_t$, with *i=1,…,n. T*hen, we average the CAR at country, industry, and at different ESG levels and at their pair combination, obtaining the Cumulative Average Abnormal Returns (CAARs). We also estimate CARs and average CARs on different event windows to provide additional findings and robustness checks.

In our ES setting, we employ several test statistics to infer the effects of the event on the stock market returns. We include the classical tests by Patell (Patell, 1976; Dodd and Warner, 1983) and 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 of returns, thus leading to excessive rejection rates of the tests and thus to weak reliability of the results (Pelagatti and Maranzano, 2021). For this reason, we consider the set of eighteen ES statistics discussed in Pelagatti and Maranzano (2021), including both non-adjusted and cross-

sectional adjusted specifications and parametric and non-parametric statistics based on ranks to account for the potential non-Gaussian distribution of the data. Table 2 provides a summary of the implemented test statistics.

The use of multiple test statistics to decide whether the event generated a statistically significant effect or not on the stock markets poses the issue of deciding which criterion should be adopted for the assessment. To overcome this issue, we propose a rule-of-thumb that relies on a majority vote approach (see Hastie et al., 2017). In particular, at a given significant level $\alpha = 0.05$, we count the number of statistics suggesting for a rejection of the null hypothesis (i.e., no statistically significant effect of the event). We consider the event relevant (i.e., the War in Ukraine generated a market reaction) if the majority of the tests (i.e., 9 or more statistics) reject the null hypothesis.

[INSERT TABLE 3 AROUND HERE]

To answer the second research question, i.e., to study if the stock market reactions to the Russian invasion of Ukraine are heterogeneous across companies, we propose the following cross-sectional specification for $CAR_{i,s,c}$ defined for each company *i*, belonging to industry *s*, and country *c*:

$$CAR_{i,s,c} = \alpha + \beta' X_i + \gamma'_s \boldsymbol{D_s} + \gamma'_c \boldsymbol{D_c} + \gamma'_{s,c} \boldsymbol{D_s D_c} + \epsilon_{i,s,c}, \quad (2)$$

where X_i is the vector of selected company-specific variables described in the previous section, namely, *Size*, *Profitability* (i.e., Return on Assets), the *Debt-to-Asset rati*o, the *Interest Coverage ratio*, and the industry-adjusted ESG score. We also include the following dummy variables defined to the sector (**Ds**), country (**Cs**), and sector-country (***DsCc***) allowing us to capture the sector and country specificity at different levels. 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 and discussion

In this Section, we provide the empirical results by developing an analysis at three layers: country, industry, and ESG. Furthermore, we also provide results considering pairs of layers, namely Country-Sector, Country-ESG, and Sector-ESG. For each analysis, we compute the 18 statistics described in Section 3 on the significance of the CAAR over the event window[2] [-3;+1]. Our discussion, through this Section, is based on the majority rule described in the previous section, i.e., how many tests out of 18 reject the null hypothesis that the CAAR is equal to zero at the significance level of 5%.

4.1 Results at Country, Sector, and ESG levels

[2] We have computed CAAR also on different event windows, namely [-3;0], [-1;0], [0] (i.e., the event date only), and [0;+1]. Extended results are available upon request.

Hereafter, we describe the results collected by performing analysis at country, sector, and ESG levels. For each analysis, we provide plots that figure out the statistical results of the 18 tests. In Appendix A, Tables A.1, A.2, and A.3 provide numerical results at country, sector, and ESG levels, respectively. For completeness, in Appendix B, Figures B.1, B.2, and B.3 show the effective number of statistically significant tests for each of the eighteen statistics used. These plots clearly show that the acceptance or rejection area of the null hypothesis is heterogeneous across the set of statistical tests used. Such evidence might be helpful in supporting the use of majority rules, instead of single tests, in ES when the choice of the proper test statistics is non-obvious.

By focusing on the analysis at the country level, Figures 1 and 2 show the value of the CAAR and the number of statistical significance tests (i.e., p-value lower than 0.05). We observe a predominantly negative impact across most of the countries included in the analysis. However, the negative impact is statistically significant across the several tests in a small selection of European countries, namely, Austria, France, Germany, and the UK. For these countries, we reject the null hypothesis for at least 9 test statistics. Thus, across the European countries, we observe heterogeneity in the reaction to Russia's invasion. Indeed, the Spanish, Italian, Suisse, Danish, and Irish companies featured a negative, but not significant impact. Outside the European continent, the only relevant result is observed for Australian companies, for which the CAARs take negative and strongly statistically significant values. The US Companies experience a negative effect, that is statically significantly different from zero for only 5 over the 18 statistics computed. Furthermore, we observe a slightly positive, but not statistically significant, impact in Japan and the Netherlands.

[INSERT FIGURE 1 AROUND HERE]

[INSERT FIGURE 2 AROUND HERE]

Figure 3 provides the results aggregated at the sector level, showing a negative average response. In particular, the largest effect is found in the "Mining, Quarrying and Oil and Gas extraction", for which the estimated CAAR is -2.3%. This result, even if it is weakly statistically significant across the proposed statistics, confirms the relevant role of the energy markets and raw materials markets concerning Russia's war against Ukraine, as also pointed out in Aloui et al. (2023). Companies in the "Construction" sector are featured by a negative and significant impact, that could be affected by the negative impact from the energy industry. We also observe a negative effect (larger than -1%) in "Administrative and Support Waste Management" and "Agriculture, Forestry, Fishing and Hunting", both industries related to green and sustainable activities. Furthermore, a negative impact of the event concern also the companies included in the "Information" sector. Looking at the significance of these effects, the sector for which the number of tests showing significant results is the highest in the "Finance and Insurance", with a negative CAAR (-0.7%), with 11 tests out of 18 showing a p-value lower than 0.05. This result could reflect the increasing perceived industry risk since most banks and financial institutions may have faced an increase in the interest rate risk, together with borrowers' increased credit risk, and thereby potential losses on investments. The negative impact in "Administrative and

Support and Waste Management" and "Information" are also significant (i.e., more than nine tests are statistically rejected).

[INSERT FIGURE 3 AROUND HERE]

Figure 4 shows the results grouped by ESG scores. From the analysis, the most significant negative and statistically impact is on unrated companies (no rating). Thus, the companies for which the ESG scores is missing, due to the lack of non-financial disclosed information, seems to featured losses of about 1.5%. The missing information on ESG seems to have a crucial role in this study (see, for example, the discussion in Sahin et al., 2022). For the companies where ESG scores are available, only the top scorers (AAA-rated) companies feature a negative and statistically significant impact. For other classes – i.e., from AA to CCC – CAARs are not statistically different from zero, thus there is no evidence of the effect of the event studied.

[INSERT FIGURE 4 AROUND HERE]

4.2 Results at country-sector level

Table 4 provides the CAAR by each pair of countries and sectors included in our sample. This analysis captures some of the specific patterns that the aggregated picture shown in Section 4.1 was not supplying. In particular, this analysis allows us to observe which industries mainly drove the impact of Russia's invasion in each country. We observe indeed heterogeneous effects. Generally speaking, the vast majority of country-sector pairs show a negative response to the invasion. If there is some positive magnitude in the CAARs, they are always not statistically significant. Some of the most negative responses at the country level can be traced to specific pairs. For example, the negative response for Austria is mainly explained by the negative impact featured by the companies belonging in the "Transporting and Warehousing" sector (-7.8%). In the UK, the negative response instead is driven by the "Manufacturing" sector (-2.6%), and by the "Wholesale Trade sector" (-3.3%). The negative response in Germany is driven by the "Accommodation and Food Services" (-4.3%). In France, the sectors that were hit the most are the "Health Care and Social Assistance" (-7.9%) and the "Professional, Scientific and Technical services" (-2.4%). We also observe that for the countries for which the impact is not statically significant (see Figure 2), there is not any significant impact across the industries. Focusing on Australia, for which the event has a large negative impact at the country level, this is mainly driven by the companies belonging to the "Manufacturing", "Information", and "Professional, Scientific, and Technical Services" industries.

[INSERT TABLE 4 AROUND HERE]

From the other perspective, the analysis gives some other insights. For the "Mining, Quarrying and Oil and Gas extraction sector", which on aggregate had the largest negative CAAR, no significant results are found when considering also the country level. The strong statistical effect shown in Figure 3, for the "Information" sector is only observed in Australia. In addition, for some sectors that on aggregate the CAAR is statistically not different from zero, we get different results at the country and sector pairs. This happens, for example, for the "Manufacturing sector", significant for the UK (-2.6%) and Australia (-5.5%), and the "Transporting and Warehousing" sector in Austria (-7.8%). Finally, we observe that the results for "Finance and Insurance" is mainly driven by companies in Hong Kong, not reflecting the strongest significance obtained in the analysis in Figure 3,.

4.3 Results at Country and ESG level

Table 5 reports the results considering the pair country-ESG level. For the AAA rated companies, we get *less* significant results than at the aggregate level. This could be due to a drop in the number of observations that the analysis at this level entails. Moreover, we note that for AA-rated companies in Austria, we get a strong significant drop of -3.2%. Then, we also get a positive and large effect (+5.3%) for B-rated companies in Germany. We cannot conclude on strong evidence of the results distinguishing more sustainable and less sustainable companies. However, we observe that also in this analysis a strong negative impact for the no-rated companies is evident. Indeed, the negative results on unrated firms obtained at an aggregate level (see Figure 4) are somehow confirmed for most of the countries, with high significance mainly in Australia, Austria, France, Germany, and the UK.

[INSERT TABLE 5 AROUND HERE]

4.4 Results at ESG and sector level

Table 6 shows 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. Here, both positive and negative impacts are estimated, however, their statistical significance is low (i.e., less than 14 statistics are significant over the 18 tests). In particular, the AA-rated companies in the "Arts, Entertainment and Recreation" sector, and the BB-rated companies in the "Health Care and Social Assistance" sector gain two large positive responses (i.e., +6.4% and + 6.7%, respectively). Henceforth, as in the case of the Country-ESG level characteristics, no clear differences in the response of more sustainable companies concerning less sustainable companies could be identified. For the companies with missing ESG scores the results shown in Figure 3 are mainly driven by the negative impacts for the industries that show a large negative magnitude effect in Figure 2, i.e., "Construction", "Finance and Insurance", "Information" and "Administrative and Support and Waste Management" sectors.

[INSERT TABLE 6 AROUND HERE]

4.5 Determinant of the responses at the company level

Table 7 shows the output of the estimation of Eq. (2) for different 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 on 13,372 observations, including the full sample and excluding the ESG score. Specifications (6)-(10) introduce the ESG score, and thus the analysis is performed on the subsample including only companies for which the sustainability information is available (i.e., 4,628 companies). All specifications include country dummies, sector dummies, and the interaction country times sector dummies, including all the possible layers - studied in the previous event study analysis.

From specifications (1)-(5) of the estimated loadings for the companies' characteristics are not constant throughout the event windows considered: some of the characteristics have been able to reduce or magnify the impact of the invasion on different dates. Specifically, *Profitability* and the *Interest Coverage ratio* positively affects CARs during the days before the invasion. On the other hand, *Size* positively affects the CARs the day of the event and the day after. Moreover, the coefficient of the *Debt-to-Asset ratio* is negative and statistically significant in the [-1;+1] time

horizon (i.e., specifications 3-5). Introducing the ESG score in specifications (6)-(10) is relevant and interesting. Indeed, we observe that sustainability levels positively affect CARs at the company level for any event window considered. Henceforth, at the company level, better sustainability performances seem to be able to reduce the potential negative impact of the invasion of Ukraine by Russia. In other words, higher sustainability scores are associated with higher CARs.

5. Conclusion

In this paper, we showed that the stock market reaction to the invasion of Ukraine by Russia are highly heterogeneous with regard to different layers of specificity stemming from country and sectoral characteristics, as well as companies' performance in sustainable practices. In an event study framework, we used a variety of test statistics that directly take into account the statistical properties of stock market returns, that is the potential violation of the normality assumption and the strong cross-sectional dependence. Our results highlight that, while the event had an overall negative impact on most of the countries, country-sector specificities are relevant in explaining stock market reaction to the increase in geopolitical risks. Moreover, we have also found evidence related to a positive effect (and thus, a mitigating effect) of ESG performance on cumulative abnormal returns, which further recognizes the positive role of sustainable investment in this new era of high geopolitical uncertainty.

Our study also highlights the importance of evaluating sustainable practices on two fronts: a broader assessment of companies' sustainability performance within an international and evolving context, and a more granular examination that recognizes how the same event (in our case, an increase in the geopolitical turmoil from the Russia-Ukraine conflict) may affect various contexts (such as different countries or sectors) in different ways.

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Declarations

- Conflict of interest/Competing interests: The authors have no competing interests to declare that are relevant to the content of this article.
- Data availability and codes: 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, all the scripts and the data not covered by non-disclosure agreements will be made available for the public on a dedicated GitHub at the end of the peer-review process.
- Figures: All images included in the paper were created by the authors and do not require any publication permission.

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Tables

Table 1: Sample by market indexes

Country	Country code	Index	Num. of Companies	Share (to total sample)	Num. of available ESG scores	Share (to total avaiable)	Availability rate
Australia	AU	S&P ASX 200 Index	1.188	*6.84%*	254	*4.50%*	*21%*
Austria	AT	ATX Index	56	*0.32%*	26	*0.46%*	*46%*
Belgium	BE	BEL 20 Index	115	*0.66%*	45	*0.80%*	*39%*
Canada	CA	S&P/TSX Index	1.501	*8.64%*	250	*4.43%*	*17%*
Denmark	DK	OMX Copenhagen 20 Index	127	*0.73%*	35	*0.62%*	*28%*
Finland	FI	OMX Helsinki Index	163	*0.94%*	41	*0.73%*	*25%*
France	FR	CAC 40 Index	634	*3.65%*	134	*2.37%*	*21%*
Germany	DE	DAX Index	643	*3.70%*	161	*2.85%*	*25%*
Greece	GR	Athens Stock Exchange Large Cap Index	128	*0.74%*	10	*0.18%*	*8%*
Hong Kong	HK	Hanf Seng Index	1000	*5.76%*	176	*3.12%*	*18%*
Ireland	IE	ISEQ All-Share	23	*0.13%*	13	*0.23%*	*57%*
Italy	IT	FTSE MIB Index	352	*2.03%*	90	*1.59%*	*26%*
Japan	JP	NIKKEI 225	3.729	*21.47%*	1116	*19.77%*	*30%*
Netherlands	NL	AEX Index	94	*0.54%*	54	*0.96%*	*57%*
New Zealand	NZ	S&P/NZX 50	96	*0.55%*	46	*0.81%*	*48%*
Norway	NO	OSE ALL SHARE Index	259	*1.49%*	57	*1.01%*	*22%*
Portugal	PT	PSI 20 Index	34	*0.20%*	12	*0.21%*	*35%*
Singapore	SG	Straits Times Index STI	412	*2.37%*	68	*1.20%*	*17%*
Spain	ES	Ibex 35 Index	178	*1.03%*	66	*1.17%*	*37%*
Sweden	SE	OMX Stockholm 30 Index	740	*4.26%*	110	*1.95%*	*15%*

Switzerland	CH	SPI SWISS Performance Index	210	*1.21%*	121	*2.14%*	*58%*
USA	US	S&P 500	4.535	*26.12%*	2.417	*42.81%*	*53%*
United Kingdom	UK	FTSE 100 Index	1.148	*6.61%*	344	*6.09%*	*30%*
Total			*17365*	*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 2: Summary statistics

	Size		Interest coverage ratio		Debt-to-capital ratio		ROA		Industry Adjusted ESG score	
Industry	Mean	*Std.Dev.*	Mean	*Std.Dev.*	Mean	*Std.Dev.*	Mean	*Std.Dev.*	Mean	*Std.Dev.*
Accommodation and Food Services	5.98	*1.96*	12.75	*106.94*	0.45	*0.31*	1.07	*11.65*	4.21	*2.08*
Administrative and Support and Waste Management and Remediation Services	5.58	*2.17*	40.78	*139.63*	0.29	*0.26*	1.86	*21.93*	5.49	*2.09*
Agriculture, Forestry, Fishing and Hunting	4.96	*2.30*	12.21	*152.19*	0.33	*0.36*	-13.66	*33.08*	5.92	*1.93*
Arts, Entertainment, and Recreation	5.71	*1.95*	15.53	*113.81*	0.37	*0.30*	-3.97	*21.17*	5.40	*2.23*
Construction	6.59	*2.02*	38.58	*115.77*	0.26	*0.22*	2.57	*12.55*	5.52	*1.97*
Educational Services	4.96	*1.90*	78.53	*176.43*	0.30	*0.31*	1.67	*18.36*	5.14	*2.60*
Finance and Insurance	6.67	*2.47*	14.59	*130.77*	0.36	*0.30*	0.02	*20.92*	4.56	*2.24*
Health Care and Social Assistance	5.91	*2.18*	-10.07	*123.60*	0.38	*0.33*	-5.92	*31.43*	6.34	*1.64*
Information	5.20	*2.58*	13.97	*164.93*	0.28	*0.31*	-7.66	*32.62*	5.55	*2.07*
Management of Companies and Enterprises	5.10	*1.88*	4.11	*52.85*	0.45	*0.57*	-6.70	*15.97*	5.07	*0.85*
Manufacturing	5.84	*2.32*	21.93	*154.24*	0.26	*0.27*	-5.75	*32.61*	5.44	*2.12*
Mining, Quarrying, and Oil and Gas Extraction	4.62	*2.66*	-71.21	*183.43*	0.22	*0.39*	-15.52	*47.90*	5.08	*2.06*
Other Services (except Public Administration)	5.64	*1.75*	29.60	*110.86*	0.34	*0.25*	3.18	*12.01*	5.76	*1.78*
Professional, Scientific, and Technical Services	4.88	*2.08*	46.61	*199.71*	0.24	*0.29*	-5.79	*32.19*	5.37	*2.12*
Real Estate and Rental and Leasing	6.86	*2.01*	13.74	*75.80*	0.41	*0.25*	2.86	*11.98*	4.78	*2.38*
Retail Trade	6.29	*2.13*	44.97	*131.08*	0.33	*0.25*	3.16	*16.95*	5.58	*1.84*
Transportation and Warehousing	7.36	*2.06*	23.27	*84.91*	0.36	*0.23*	4.51	*14.53*	5.50	*2.13*
Utilities	8.01	*2.52*	2.14	*88.79*	0.37	*0.24*	1.21	*16.15*	6.22	*1.74*
Wholesale Trade	5.89	*1.93*	53.03	*141.54*	0.23	*0.20*	3.31	*18.91*	5.90	*2.10*
Full sample	*5.85*	*2.41*	*17.07*	*152.03*	*0.29*	*0.29*	*-3.95*	*30.02*	*5.36*	*2.13*

Note: The table shows the descriptive statistics of the variables involved in the analysis. Specifically, the table displays the mean and the standard deviation (in italic), by industry. All variables are winsorized at the first percentile and the 99th percentile.

Table 3: Overview of the statistical tests

		Specification	
		Parametric	**Non-parametric**
Cross-sectional	**Not-Adjusted**	t_{CS} t_{CD} t_{SKEW} Z_{PAT} Z_{BMP}	$CumRank_Z$ Z_{grank}
	Adjusted	$Z_{PAT,adj}$ $Z_{BMP,adj}$	T_{grank} $Z_{grank,adj}$ $CumRank$ $CumRank_{mod}$ $CumRank_T$ $CumRank_{Z,adj}$ 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 statistically 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-Wasley (1992) statistics ($CumRank, CumRank_Z$). 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 $CorradoTukey_{adj}$ statistic.

Table 4: Results from the analysis at the country-sector level

Country\Sector	Accomodation 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	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
AU	-0.020	-0.031	-0.017	0.028	-0.030	-0.078	-0.004	-0.012	-0.053++		-0.055+++	-0.052	-0.055	-0.057++	-0.021++	-0.023	-0.014	0.025	-0.051
AT	-0.091				-0.016		-0.009		-0.017		0.009	-0.038			0.031		-0.078+++	0.019	-0.127
BE		-0.039	0.038		0.003		0.021		0.024		0.015		0.019	-0.056	-0.005	-0.033	-0.023		-0.006
CA	0.015	-0.024	0.041	-0.031	-0.001	-0.082	-0.010	-0.011	0.021		-0.016	-0.016	-0.016	-0.022	-0.005	-0.004	-0.007	-0.030	-0.019
DK		-0.006	0.017	0.010	-0.004		0.004				-0.020	0.066		-0.023	-0.055	-0.093	0.025	0.073	0.006
FI	-0.007	-0.015			-0.024		-0.007	-0.030	0.030		-0.014	-0.001	-0.031	-0.016	-0.014	-0.006	0.028	-0.013	-0.045
FR	0.081	-0.024	-0.077	0.003	-0.019	-0.129	0.007	-0.079++	0.008		-0.002	0.075	0.001	-0.024+	-0.020	-0.026	0.006	-0.001	-0.005
DE	-0.043+	0.004	0.020		-0.006	0.033	-0.013	-0.020	-0.002	-0,019	-0.011	0.022	-0.002	-0.020	0.001	-0.018	-0.020	0.001	-0.004
GR	0.015		-0.008	-0.006	-0.046		0.035	-0.023	-0.044		-0.029	0.006		-0.009	-0.017	0.004	0.010	-0.025	0.015
HK	0.005	0.010	0.039	0.027	-0.018+	0.002	-0.016+	-0.011	-0.021	-0,026	0.002	-0.015	-0.052	0.024	0.002	0.012	-0.001	-0.020	0.003
IE	-0.051		-0.009		0.013		-0.014		0.005		0.002	0.166		0.039	-0.050		-0.020		0.055
IT	0-047	-0.020	-0.024	0.005	0.010	-0.106	-0.006	-0.023	-0.021		0.005	0.027	-0.012	-0.033	-0.013	0.070	-0.017		0.036
JP	0.006	0.004	0.004	0.021	-0.006	-0.002	-0.003	-0.004		-0,026	0.004	0.031	-0.005	-0.001	-0.007+	-0.005	-0.004	-0.008	0.002
NL	0.020	0.024		-0.014	0.011		-0.011	-0.034	-0.018		-0.006	-0.009		-0,001	0.017	-0.021	0.008	0.084	-0.019
NZ	0.003	-0.126	-0.018			-0.027	0.009	-0.028	0.011		0.004	-0.044		-0,264	0.005	-0.038	0.016	-0.025	-0.011
NO		-0.009	0.011	0.058	0.029	-0.025	-0.001		0.029		-0.002	0.008		-0,02	-0.014	-0.032	-0.037	0.025	0.006
PT	-0.369			0.024	0.020		0.033		-0.004		-0.018	0.009		-0.054		-0.007	0.017	0.016	
SG	0.019	-0.039	0.016	0.004	0.011	-0.134	-0.006	-0.031	0.025	0.006	-0.002	0.014	-0.014	-0.014	-0.013	-0.010	0.008	0.085	0.007
ES	-0.019	-0.034	-0.015		0.010		0.001	-0.035	-0.019		0.005	-0.013		-0.020	0.005	-0.026	0.025	-0.007	-0.019
SE	0.042	-0.013	-0.066	-0.019	-0.012	0.009	-0.006	-0.027	-0.005		-0.016	0.018	0.005	-0.016		-0.009	0.017	0.003	-0.021
CH		0.024		-0.023	-0.002		0.001	0.024	0.020	-0.005	-0.002			-0.010	0.009	0.013	-0.027	-0.023	0.013
US	-0.004	0.006	0.017	-0.002	-0.011	-0.033	0.002	-0.012	0.006	-0.020	0.005	-0.024	-0.027	-0.006	-0.004	-0.006	-0.015	0.002	0.006
UK	-0.013	-0.020	-0.003	-0.018	-0.010	0.032		0.007	-0.018		-0,026++	-0.015	-0.019	0.001	0.005	0.017	-0.024	0.010	-0.033+

Note: The table reports the estimated CAAR by applying the event study methodology at the country-sector level. +++, ++, and + indicate that the estimate is significantly different from zero at 5% for 9-10, 11-14, and 15-18 test statistics listed in Table 3.

Table 5: Results from the analysis at country-ESG level

Country\ ESG Rating	AAA	AA	A	BBB	BB	B	CCC	no rating
AU	-0.014	0.004	0.003	-0.016	-0.005	0.021	0.010	-0.056++
AT	-0.0400+	-0.032++	-0.004	-0.015			-0.091	-0.036++
BE	0.006	0.002	-0.010	-0.006	0.021	0.001		-0.040
CA	0.034	0.009	0.007	-0.005	-0.003	0.016	-0.003	-0.020
DK	0.006	0.010	-0.012	0.026	0.066			-0.022
FI	-0.002	-0.007	-0.013	-0.058	-0.012			0.005
FR	-0.008	0.006	-0.008	0.002	0.015	-0.007		-0.037++
DE	-0.007	-0.002	-0.006	-0.010	-0.024	0.053++	-0.024	-0.021++
GR		0.002		0.017	0.018			-0.029
HK	0.016	0.031	-0.015	0.005	-0.006	-0.011	0.001	-0.010+
IE	-0.017	0.011	0.055	-0.016	-0-024	-0.015		0-014
IT	0.013	-0.001	-0.011	0.,001	-0.006	0.000		-0.024
JP	-0.001	0.005	-0.003	0.001	-0.001	0.001	0.006	0.013
NL	0.019	0.013	0.002	-0.018	-0.056			0.014
NZ	-0.012	0.009	-0.001	-0.012	-0-009	-0.010		0.009
NO	-0.006	-0.001	-0.030	0.026	-0.033	0-015		0.005
PT	-0.012	-0.018	0.022	0.008		-0.028		-0.068
SG	-0.013	-0.017	0.000	-0.011	-0.002	-0.021	-0.118	-0.025
ES	0.000	-0.002	0.008	0.011	0.002	-0.004	0.056	-0.002
SE	0.001	-0.001	-0.006	-0.005	0.025	0.013		-0.012
CH	0.003	-0.011	0.002	0.005	-0.001	0.008		0.001
US	-0.015	0.001	-0.002	0.001	-0.006	0.003	-0.013	-0.001
UK	0.010	0.004	0.005	-0.017	-0.002	0.010	-0.006	-0.029++

Note: The table reports the estimated CAAR by applying the event study methodology at the country-ESG level. +++, ++, and + indicate that the estimate is significantly different from zero at 5% for 9-10, 11-14, and 15-18 test statistics listed in Table 3.

Table 6: Results from the analysis at the sector-ESG level

Sector/ESG ratings	AAA	AA	A	BBB	BB	B	CCC	no rating
Accommodation and Food Services		-0.013	-0.015	0.003	-0.005	0.010	0.001	0.008
Administrative and Support and Waste Management and Remediation Services		-0.004	-0.008	-0.001	-0.007	0.003	-0.022	-0.022++
Agriculture, Forestry, Fishing and Hunting	0.060	0.017	0.007	-0.020	0.020			-0.023
Arts, Entertainment, and Recreation	0.023	0.064++	-0.034++	-0.001	-0.002	0.020	0.030	-0.017
Construction	-0.014	-0.010	0.006	-0.006	0.004	-0.008	-0.078	-0.014++
Educational Services	0.001	-0.036	-0.027	0.024	0.003	-0.568	-0.073	-0.006
Finance and Insurance	-0.004	0.006	-0.003	0.002	-0.001	0.003	0.003	-0.012++
Health Care and Social Assistance		0.014	-0-007	0.008	0.067+	0.002	0.007	-0.003
Information	0.016	-0.003	0.003	-0.010	-0.007	0.024+	0.014	-0.015+
Management of Companies and Enterprises				0.013	0.002			-0.006
Manufacturing	-0.011	-0.004	0.000	0.004	-0.001	-0.007	-0.013	0.001
Mining, Quarrying, and Oil and Gas Extraction	-0.014	0.003	-0.002	0.000	0.019	-0.022	-0.042	-0.028
Other Services (except Public Administration)	0.006	0.034	0.032	0.002	0.018	-0.047		-0.001
Professional, Scientific, and Technical Services	0.028	0.001	-0.002	0.002	-0.002	0.013	0.037	-0.008
Real Estate and Rental and Leasing	-0.019	-0.002	0.009	0.007	-0.019	0.014+	-0-007	-0.003
Retail Trade	0.005	0.000	0.000	-0.008	-0-001	0.006		0.007
Transportation and Warehousing	0.003	0.005	0.002	0.013	-0.005	0.011	0.020	-0.005
Utilities	-0.007	-0.011	-0.003	-0.006	-0-013	0.015	-0.079	0.002
Wholesale Trade	-0.006	-0.006	0.000	-0.015	-0.006	-0.011	-0.002	0.007

Note: The table reports the estimated CAAR by applying the event study methodology at the sector-ESG level. +++, ++, and + indicate that the estimate is significantly different from zero at 5% for 9-10, 11-14, and 15-18 test statistics listed in Table 3.

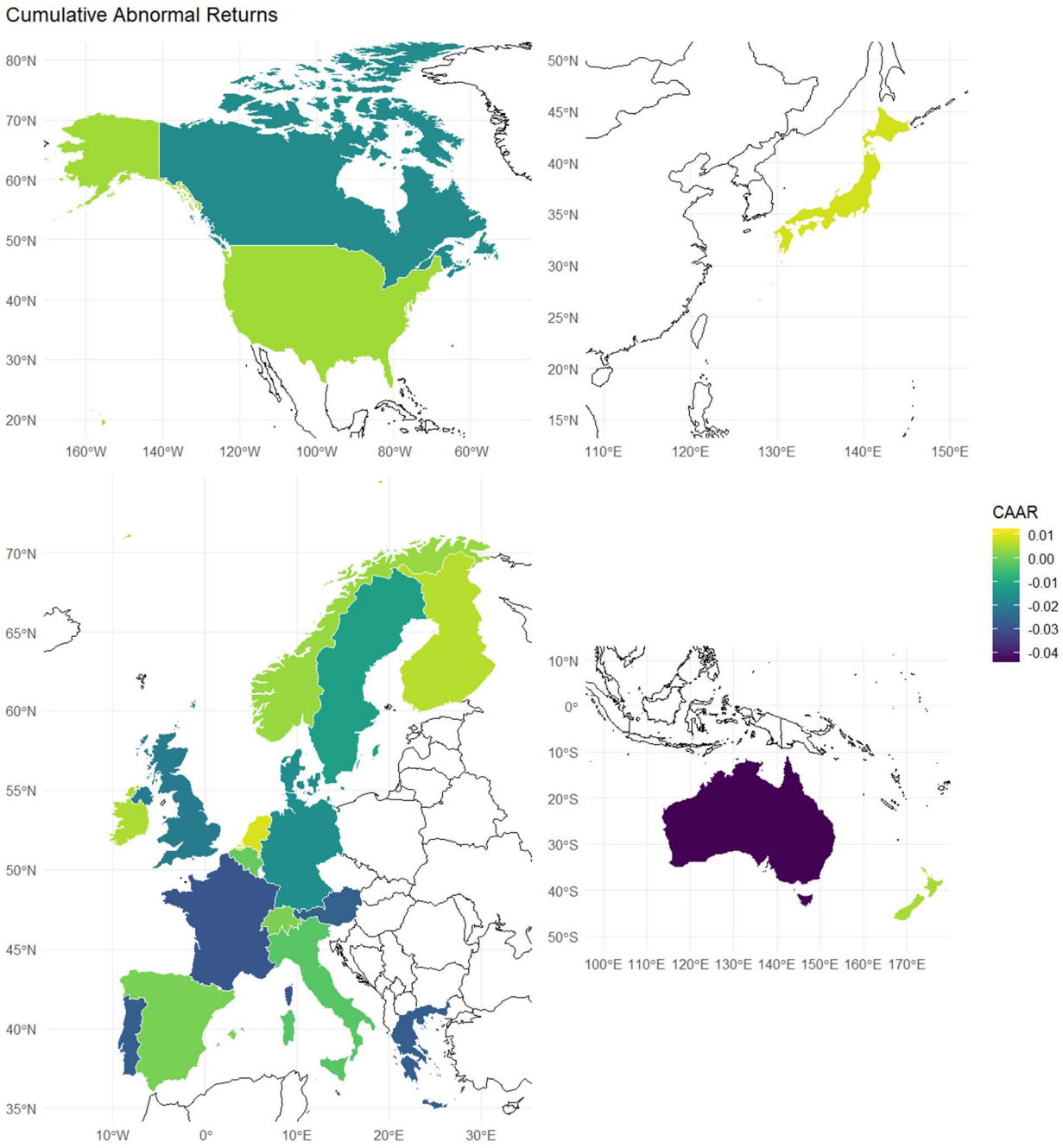
Table 7: Estimation results of the analysis on the CAR at the company level

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dependent variable: CAR										
Event window	[-3;1]	[-3;0]	[-1;0]	[0]	[0;+1]	[-3;1]	[-3;0]	[-1;0]	[0]	[0;+1]
Size	0.030	0.023	0.025	0.0983**	0.105**	-0.267***	-0.205***	-0.380***	-0.350***	-0.413***
	(0.051)	(0.049)	(0.044)	(0.0408)	(0.045)	(0.067)	(0.067)	(0.053)	(0.046)	(0.050)
Interest Coverage Ratio	0.001**	0.001***	0.000	0.000106	-0.000	0.002	0.002	0.001	0,000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000117)	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
Debt-to-Asset Ratio	-0.599	-0.536	-1.141***	-1.030***	-1.093***	-1.692***	-1.553***	-0.952*	-1.116***	-1.255***
	(0.511)	(0.478)	(0.372)	(0.354)	(0.415)	(0.635)	(0.592)	(0.514)	(0.373)	(0.445)
Profitability	0.017***	0.017***	0.006**	0.002	0.001	0.009	-0.006	-0.027***	-0.042***	-0.027***
	(0.005)	(0.005)	(0.003)	(0.003)	(0.003)	(0.009)	(0.009)	(0.007)	(0.006)	(0.006)
ESG Score						0.163***	0.154***	0.113**	0.073**	0.082**
						(0.060)	(0.059)	(0.0519)	(0.036)	(0.038)
Constant	-10.320***	-9.862**	-5.124	-2.911**	-3.371***	-11.350**	-13.750***	-9.657	-1.885*	0.509
	(2.977)	(3.914)	(4.870)	(1.395)	(0.999)	(4.889)	(5.036)	(6.365)	(1.043)	(0.887)
Observations	13,372	13,372	13,372	13,372	13,372	4,628	4,628	4,628	4,628	4,628
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country*Sector Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.042	0.052	0.056	0.098	0.084	0.125	0.117	0.170	0.371	0.325

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.

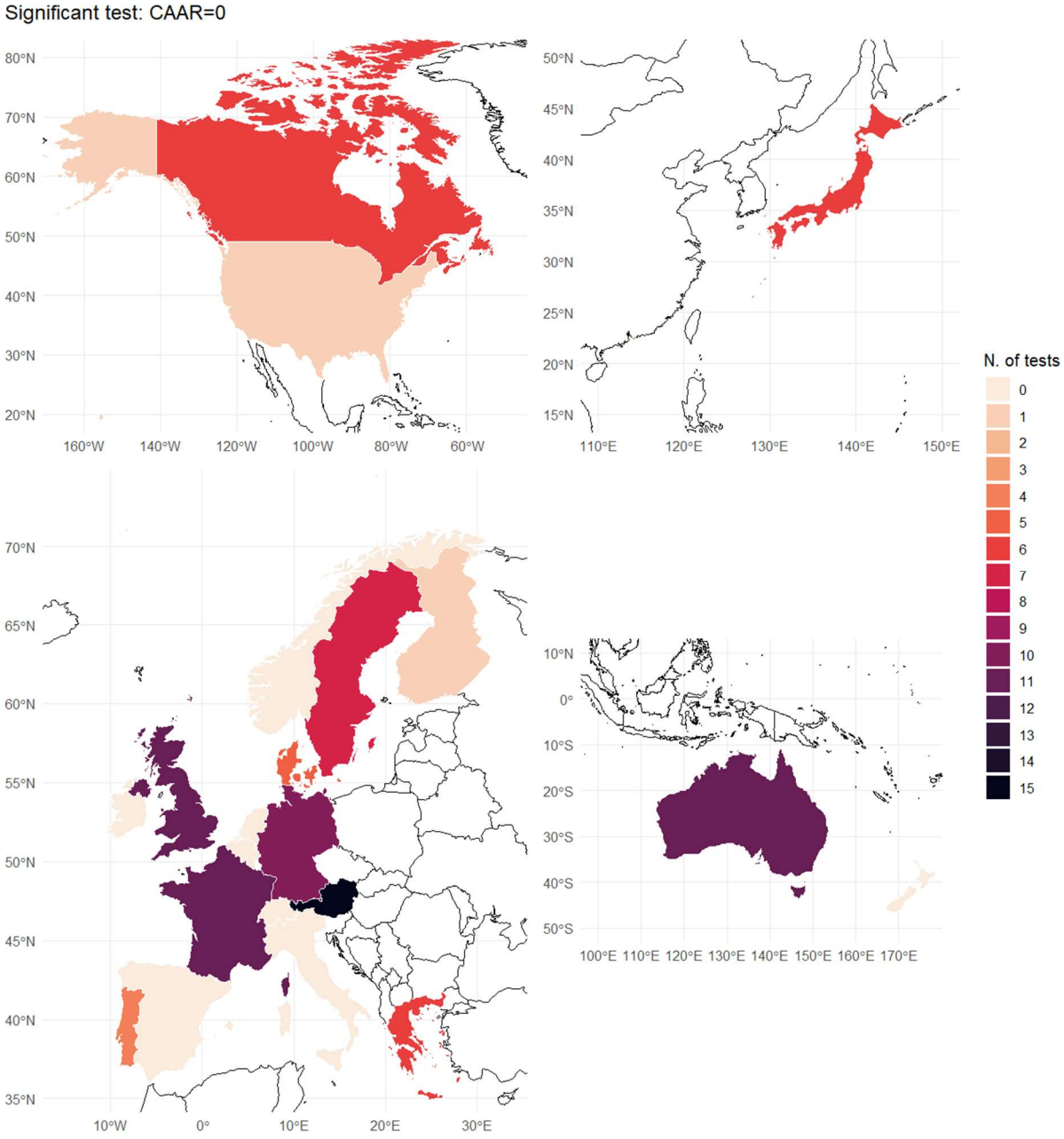
Figures

Figure 1: Map of CAAR by country



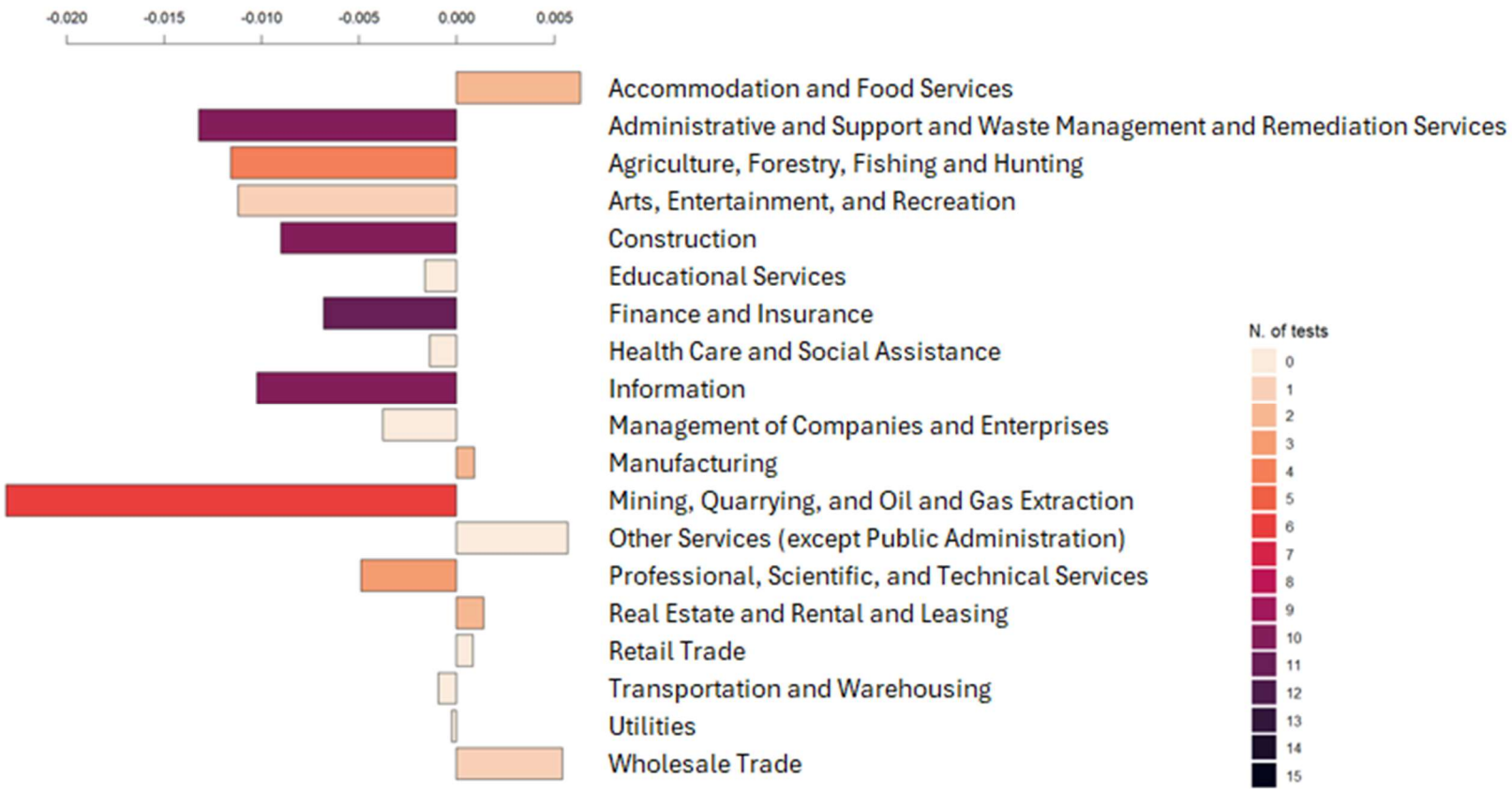
Note: This map shows the intensity of stock market reactions to the invasion of Ukraine by Russia at the country level, measured by the CAAR.

Figure 2: Map of the number of significant tests



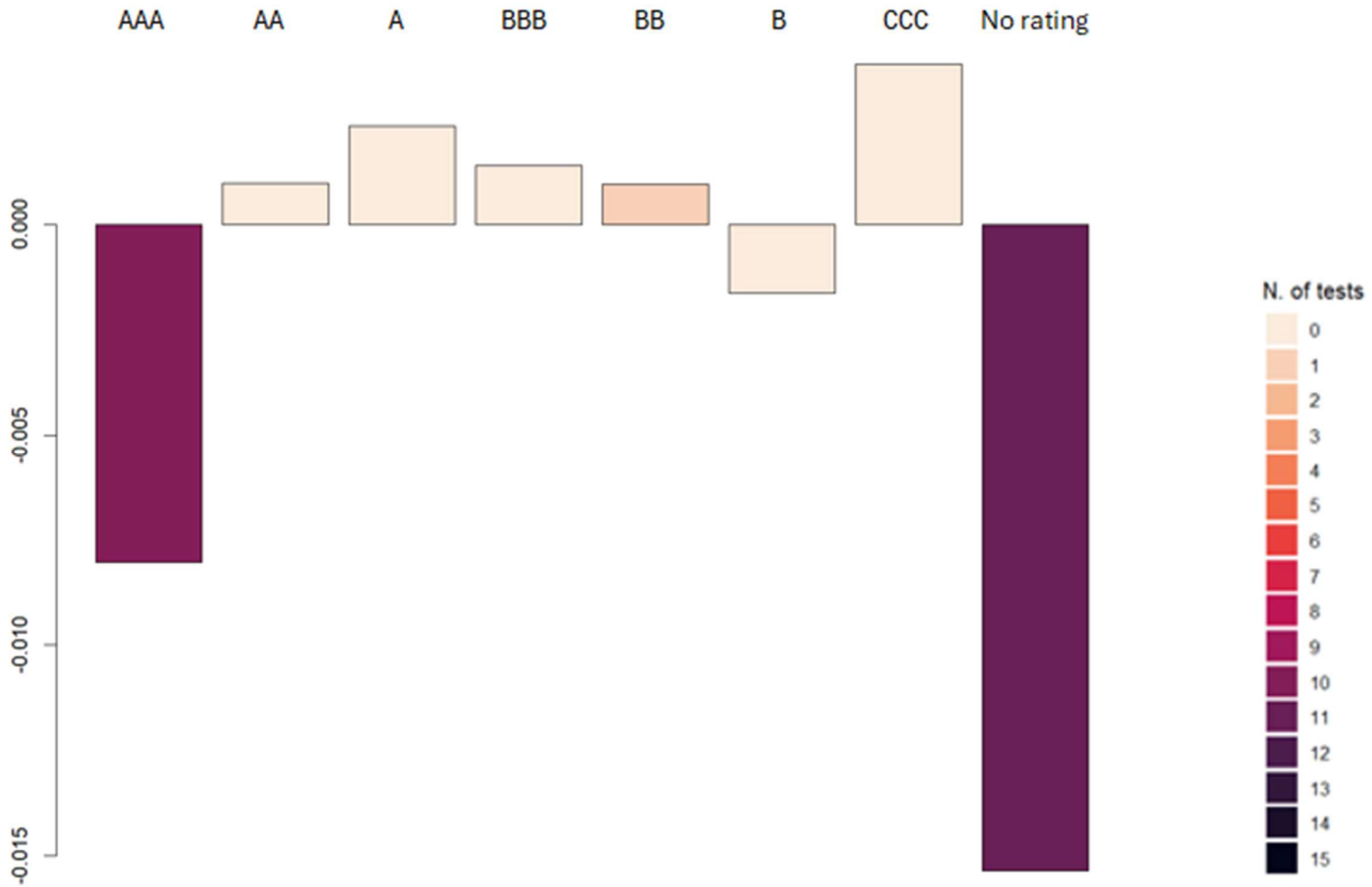
Note: This map shows the number of tests that reject the null hypothesis of CAAR equal to zero, i.e., the p-value is lower than 0.05, at the country level

Figure 3: **CAAR and number of statistically significant test statistics by sector**



Note: This figure shows the value of CAAR, at the sector level. The intensity of the color for each bar reflects the number of tests with a p-value lower than 0.05.

Figure 4: CAAR and number of statistically significant test statistics by ESG rating class and availability of rating



Note: This figure shows the value of CAAR, at ESG level. The intensity of the color for each bar reflects the number of tests with a p-value lower than 0.05.

APPENDIX A

Table A.1: Event study by country

Country of Listing	Number of obs.	CAAR	# of tests showing significant results
AU	1188	-0.044++	11
AT	56	-0.026+++	15
BE	115	-0.001	0
CA	1501	-0.,017	6
DK	127	-0.016	5
FI	163	0.006	1
FR	634	-0:029++	11
DE	643	-0.016+	10
GR	128	-0.027	6
HK	1000	0.013	4
IE	23	0.006	0
IT	352	-0.002	0
JP	3729	0.009	6
NL	94	0.009	0
NZ	96	0.005	0
NO	259	0.004	0
PT	34	-0.027	4
SG	412	-0.021	6
ES	178	0.001	0
SE	740	-0.012	7
CH	210	0.001	0
US	4535	0.005	1
UK	1148	-0.020++	11

Note: The table reports the estimated CAAR by applying the event study methodology at country level. +++, ++, and + indicate that the estimate is significantly different from zero at 5% for 9-10, 11-14, and 15-18 test statistics listed in Table 3. The number of statistics showing significant results are reported. The table also shows the number of observations included in the analysis.

Table A.2: Event study by sector

Sector	Number of obs.	CAAR	# of tests showing significant results
Accommodation and Food Services	327	0.006	2
Administrative and Support and Waste Management and Remediation Services	362	-0.013+	9
Agriculture, Forestry, Fishing and Hunting	140	-0.012	4
Arts, Entertainment, and Recreation	145	-0:011	1
Construction	641	-0.009+	10
Educational Services	75	-0.002	0
Finance and Insurance	2165	-0.007++	11
Health Care and Social Assistance	213	-0.001	0
Information	1727	-0.010+	10
Management of Companies and Enterprises	23	-0.004	0
Manufacturing	5889	0.001	2
Mining, Quarrying, and Oil and Gas Extraction	1573	-0.023	6
Other Services (except Public Administration)	73	0.006	0
Professional, Scientific, and Technical Services	1224	-0.005	3
Real Estate and Rental and Leasing	781	0.001	2
Retail Trade	753	0.001	0
Transportation and Warehousing	405	-0.001	0
Utilities	297	-0.000	0
Wholesale Trade	551	0.005	1

Note: The table reports the estimated CAAR by applying the event study methodology at the industry level. +++, ++, and + indicate that the estimate is significantly different from zero at 5% for 9-10, 11-14, and 15-18 test statistics listed in Table 3. The number of statistics showing significant results are reported. The table also shows the number of observations included in the analysis.

Table A.3: Event study by ESG rating

ESG rating	Number of obs.	CAAR	# of tests showing significant results
AAA	7	-0.008+	10
AA	896	0.001	0
A	1329	0.002	0
BBB	1366	0.001	0
BB	1079	0.001	1
B	673	-0.002	0
CCC	112	0.004	0
No rating	11719	-0.015++	11

Note: The table reports the estimated CAAR by applying the event study methodology at the ESG level. +++, ++, and + indicate that the estimate is significantly different from zero at 5% for 9-10, 11-14, and 15-18 test statistics listed in Table 3. The number of statistics showing significant results are reported. The table also shows the number of observations included in the analysis.

APPENDIX B

Note: The following figures show for each empirical exercise, the number of significant results, by the statistics listed in Table 3.

Figure B.1

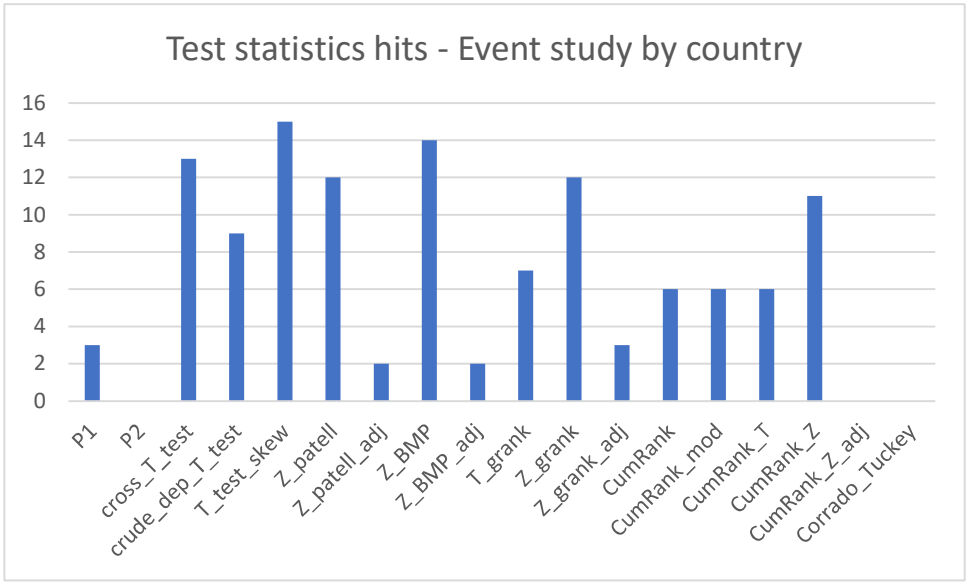


Figure B.2

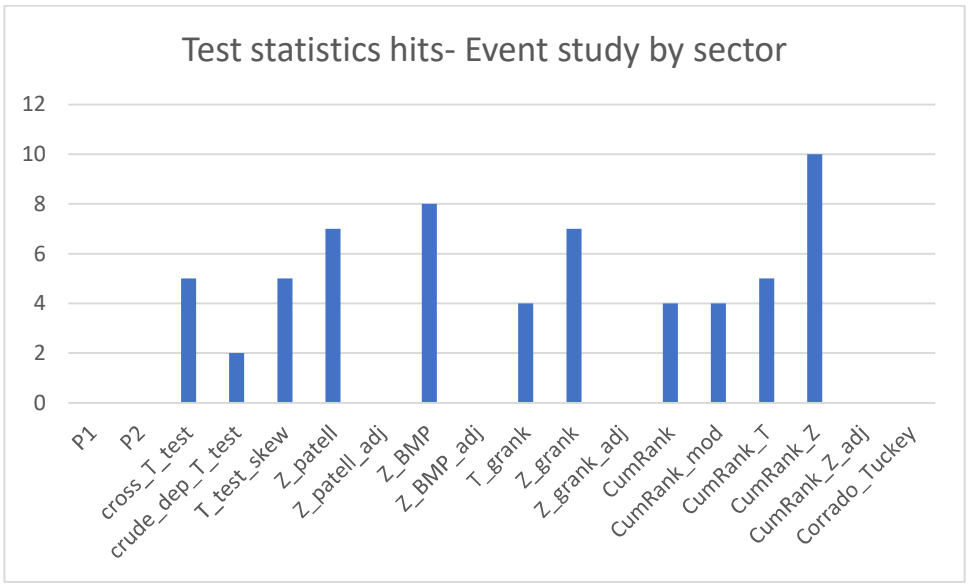


Figure B.3

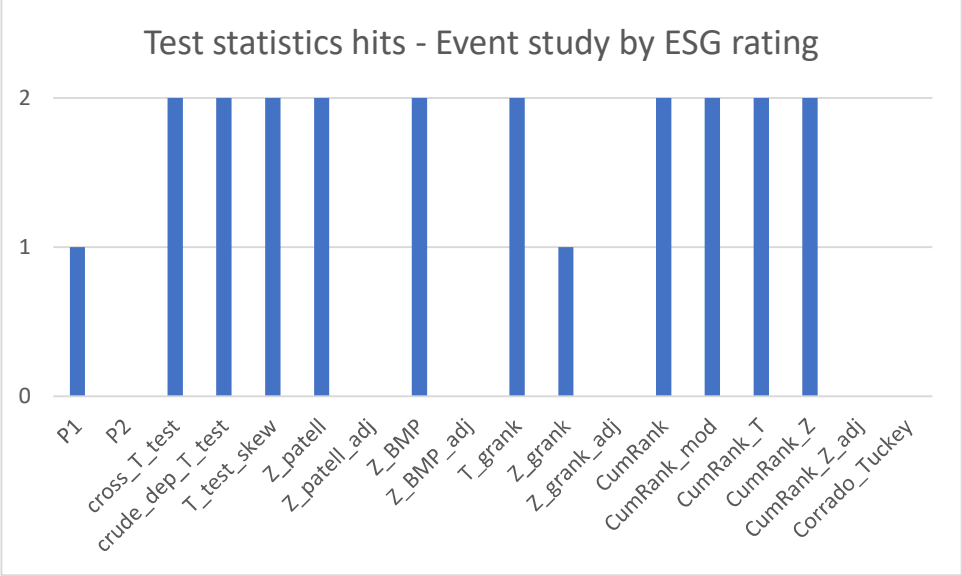


Figure B.4

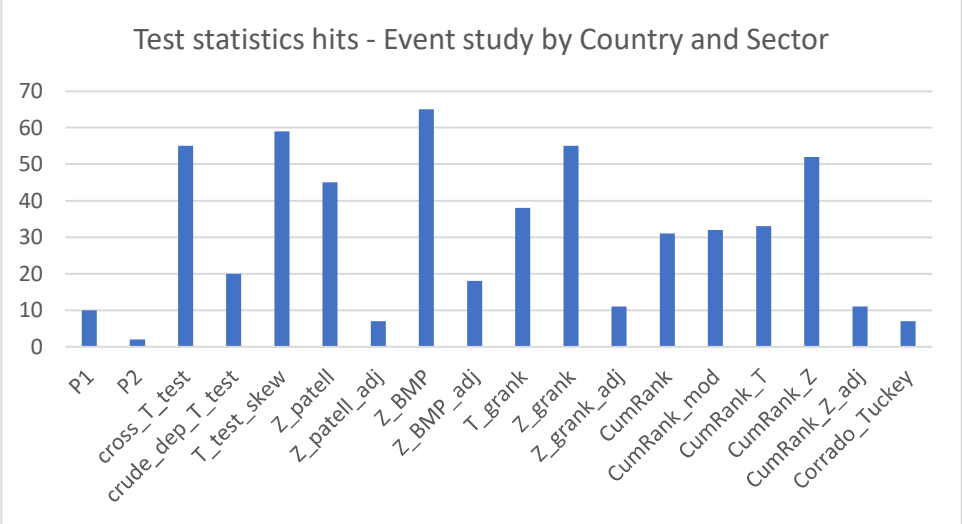


Figure B.5

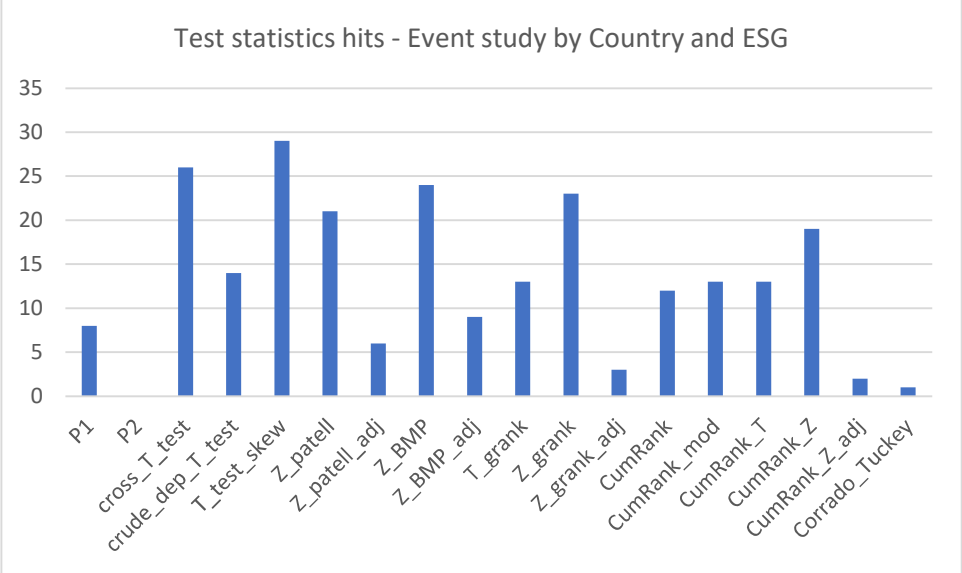


Figure B.6