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The influence of information asymmetry and climate risk on the nexus between ESG and idiosyncratic risk

Master's thesis in Industrial Economics and Technology Management
Supervisor: Maria Lavrutich
Co-supervisor: Rita Pimentel
June 2021

Master's thesis

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Abstract

This thesis examines the influence of information asymmetry and climate risk on the relationship between ESG and idiosyncratic risk. Using a comprehensive data set of 4,886 firms from 2008 to 2018, we find that ESG is negatively associated with idiosyncratic risk. A regional segmentation shows that the relationship is negative and significant at the 0.1% level in North America and Asia-Pacific, whereas no significant association is found in Europe and Japan. We show that the risk-reducing effect of ESG is mainly concentrated in low-performing ESG firms by employing a semiparametric model as well as splitting the entire sample into a low- and high-ESG subsample. Moreover, we investigate whether decreased information asymmetry is a channel through which ESG decreases idiosyncratic risk. We find that information asymmetry has a significant mediating effect on the ESG-risk relationship in North America and Asia-Pacific, while no significance is found in Europe and Japan. Furthermore, we investigate how a market-based measure of climate risk affects the association between ESG and idiosyncratic risk. We show that better ESG performance reduces idiosyncratic risk to a greater extent in times of increased climate risk, although this effect is not statistically significant across all regions. The moderating effect of climate risk is most evident when climate news with negative sentiment is considered. Overall, our findings contribute to the growing literature on the ESG-risk relationship by corroborating two factors that influence this relationship.

Sammendrag

Denne studien undersøker hvordan asymmetrisk informasjon og klimarisiko påvirker forholdet mellom ESG og selskapsspesifikk risiko. Vi bruker et omfattende datasett bestående av 4,886 selskaper i perioden fra 2008 til 2018 og finner at ESG har en negativ innvirkning på selskapsspesifikk risiko. En regional segmentering viser at forholdet er negativt og signifikant på 0.1% nivået i Nord-Amerika og Asia-Stillehavsregionen. I Europa og Japan finner vi ikke en signifikant assosiasjon mellom ESG og selskapsspesifikk risiko. Vi viser at den risikoreduserende effekten fra ESG er mest fremtredende i lavtscorende ESG-selskaper ved å bruke en semiparametrisk modell, i tillegg til å dele datasettet i høyt- og lavtscorende ESG-selskaper. Videre undersøker vi om ESG reduserer selskapsspesifikk risiko gjennom en reduksjon i asymmetrisk informasjon. I Nord-Amerika og Asia-Stillehavsregionen finner vi at asymmetrisk informasjon har en signifikant mediator-effekt på forholdet mellom ESG og risiko, mens mediator-effekten i Europa og Japan ikke er signifikant. Videre studerer vi hvordan en markedsbasert indikator for klimarisiko påvirker forholdet mellom ESG og selskapsspesifikk risiko. Vi finner at bedre ESG-prestasjon reduserer selskapsspesifikk risiko i større grad under perioder med økt klimarisiko, selv om effekten ikke er signifikant i alle regioner. Den påvirkende kraften fra klimarisiko er mest fremtredende når en tar hensyn til klimarelaterte nyheter med negativt sentiment. Våre funn føyer seg til den voksende litteraturen på forholdet mellom ESG og risiko ved å introdusere to faktorer som påvirker dette forholdet.

Preface

This thesis completes our Master of Science (MSc) degree in Industrial Economics and Technology Management at the Norwegian University of Science and Technology (NTNU). The thesis is written independently by Øyvind Larsen, Jacob Rise and Magnus Kjærstad Wetjen from January to June 2021.

Our motivation to write this thesis was divided into two pieces. First, our interest in ESG and sustainable investing was sparked while writing our project thesis on the topic of green bonds in the fall of 2020. A successful and exciting project thesis naturally lead to a growing interest within the field that we wanted to further investigate in our Master's thesis. Second, the growing attention towards ESG in the last decade presented itself as a "hot topic" that is likely to give valuable experience for our later working careers.

We want to extend our sincere thanks to our main supervisor Maria Lavrutich for excellent guidance in academic writing, fruitful discussions, valuable insights through her expertise in empirical finance and feedback throughout the entire period. We would also like to thank Rita Pimentel for helpful feedback, help with the methodology and expertise in modeling using R language.

Contents

List of Figures

List of Tables

Abbreviations

AUM	Assets Under Management
CR	Climate Risk
CRNEG	Climate Risk Negative sentiment
CSP	Corporate Social Performance
CSR	Corporate Social Responsibility
ESG	Environmental, Social and Governance
ETF	Exchange Traded Fund
FE	Fixed Effects
GHG	Green House Gas
IA	Information Asymmetry
IV	Idiosyncratic Volatility
MSCI	Morgan Stanley Capital International
RE	Random Effects
SRI	Social Responsible Investing
TR	Thomson Reuters

1 | Introduction

The fight against global warming has turned out to be one of the biggest challenges of our time. The levels of greenhouse gases (GHG) are now higher than ever, and biodiversity is constantly decreasing (Nunez, 2019). As the earth's temperature is rising, international agreements such as The Paris Agreement (United Nations, 2015) and The EU Green Deal (European Commission, 2019) have been put in place to fight global warming. The EU Green Deal outlines an extensive budget required to reach net-zero carbon emission by 2050, fueling companies to invest more in Environmental, Social and Governance (ESG) policies.

However, the firm's motivation and financial incentives behind these investments are not fully understood. From the perspective of shareholder theory, the firm's goal is to maximize the value for its shareholders, implying that ESG-investments are expected to create shareholder value. Classical financial theory suggests that this can be achieved by increasing the return or decreasing the risk for the shareholders. The impact of ESG on return has gained substantial recognition in financial literature (Ng and Rezaee, 2015; Lins et al., 2017; Khan, 2019; Huynh and Xia, 2020), and there is compelling evidence of a positive relationship between ESG and return. However, the ESG-risk aspect has received less attention in the literature, although theoretical and empirical arguments have been made to support the hypothesis of a negative relationship (El Ghoul et al., 2011; Mishra and Modi, 2013; Sassen et al., 2016; Utz, 2018; Dumitrescu and Zakriya, 2021).

In this thesis, we focus on the relationship between ESG and idiosyncratic risk. Idiosyncratic risk refers to the firm-specific risks that are inherent to an individual asset. Idiosyncratic risk is in general diversifiable by holding multiple assets in a portfolio and should not be priced according to the capital asset pricing model (Sharpe, 1964). However, retail investors tend to hold under-diversified portfolios (Goetzmann and Kumar, 2008). In addition, Merton (1987) shows that securities with higher idiosyncratic risk should earn higher expected returns in markets with incomplete information. Hence, idiosyncratic risk is an important aspect to consider. Existing literature generally supports the notion of a negative relationship between ESG and idiosyncratic risk (El Ghoul et al., 2011; Mishra and Modi, 2013; Sassen et al., 2016; Utz, 2018; Dumitrescu and Zakriya, 2021). However, these findings are not entirely consistent across different regions and time periods. In order to better understand these inconsistencies, it is essential to understand *how* ESG affects idiosyncratic risk. The aforementioned literature and supplementary studies within the field provide strong arguments as to why ESG could reduce firm risk. However, to the best of our knowledge, it has not been empirically studied which factors that influence the ESG-risk relationship.

One potential explanation for why better ESG performance decreases idiosyncratic risk could be that higher ESG performance decreases information asymmetry (IA). Dumitrescu and Zakriya (2021) states that ESG could reduce firm risk by decreasing the likelihood of managerial hoarding of bad news that results in stock price crashes. Similarly, Utz (2018) argues that high levels of ESG decrease firm risk by limiting managers' concealment of firm-specific information. The relationship between information asymmetry and risk is well studied in financial literature, and current findings support the hypothesis that lower information asymmetry decreases stock volatility (Zhang, 2006; Rajgopal and Venkatachalam, 2011; Lambertides and Mazouz, 2013). In addition, existing literature finds that higher ESG is related to decreased information asymmetry (Clarkson et al., 2008; Cho et al., 2013). Based on these theoretical and empirical findings, we hypothesize that information asymmetry is a channel through which ESG reduces idiosyncratic risk.

A second explanation is that high ESG performers are less risky because they are less exposed to climate risk. According to a report by S&P Global, "80 percent of the world's largest companies are reporting exposure to physical or market transition risks associated with climate change" (Mattison and Mints, 2019). ESG is intuitively linked with climate change through its Environmental pillar (E), which measures how the firm reduces its carbon footprint through improved resource use, supply chain and innovations (Thomson Reuters, 2017). Thus, corporate investments in ESG could be interpreted as a preparation for a low-carbon economy, possibly indicating that high-performing ESG firms are less exposed to climate risk. Sharfman and Fernando (2008) supports the view of ESG as a protection against climate risk, positing that improved environmental risk management lowers the market's risk perception of the firm. Along the same line, Engle et al. (2020) uses E-scores to model individual firms' climate risk exposure and finds that this approach yields portfolios that perform well in hedging climate risk. This finding suggests that high-performing ESG firms are less exposed to climate risk. Furthermore, Krueger et al. (2020) highlights the growing importance of climate risk in financial markets, finding that investors believe that climate risks have already begun to materialize and have financial implications for their portfolios. The aforementioned findings suggest that financial markets recognize climate risk and that high-performing ESG firms are less exposed to climate risk. This gives strong reason to suspect that high-performing ESG companies are perceived as less risky in times of high climate risk. Although some would consider climate risk to be a systematic risk factor, the findings of Engle et al. (2020) suggest that climate risk is diversifiable and thus a firm-specific risk that depends on the individual firm's climate efforts. Based on this, we hypothesize that better ESG performance reduces idiosyncratic risk to a greater extent in times of increased climate risk.

This thesis aims to fill the knowledge gap related to the ESG-risk nexus by examining whether information asymmetry and climate risk affect the relationship between ESG and idiosyncratic risk. First, we employ a fixed effects (FE) panel regression with a comprehensive sample of 4,886 firms from 2008 to 2018 to test if ESG is associated with idiosyncratic risk after controlling for variables that are known to be associated with idiosyncratic risk. Time-fixed effects are used to account for yearly variations in market volatility. Additionally, firm-fixed effects are included to control for heterogeneity in time-invariant firm characteristics such as country, industry, management and listings. The results from this regression show that ESG is negatively associated with idiosyncratic risk and that this effect is statistically significant at the 0.1% level.

Second, we estimate the regression model separately on regional subsamples (North America, Asia-Pacific, Europe and Japan) to investigate regional differences. Our results show that ESG is negatively associated with idiosyncratic risk in North America and Asia-Pacific, whereas no evidence of a significant relationship is found in Europe or Japan. This indicates that ESG decreases idiosyncratic risk heterogeneously across regions. To further explore the regional differences, we estimate a semiparametric model to examine how the shape of the ESG-risk relationship varies across regions. The results from the semiparametric model show that the risk-reducing effect of ESG is most prominent for low-performing ESG firms. We confirm this result by splitting the data set into low- and high-performing ESG firms, showing that a negative association between ESG and idiosyncratic risk is only found for low ESG performers. This could help to explain the lack of significant association between ESG and idiosyncratic risk in Europe and Japan, as these are the two regions with the highest ESG scores.

Third, we examine whether decreased information asymmetry is a channel through which ESG decreases idiosyncratic risk. We use a mediation approach to determine whether ESG affects information asymmetry, which in turn influences idiosyncratic risk. Our results show that ESG is negatively associated with information asymmetry in North America and Asia-Pacific, the same regions where ESG and idiosyncratic risk are negatively associated. Furthermore, the mediating effect of information asymmetry on the ESG-risk relationship is significant at the 1% level. This confirms that information asymmetry is a channel through which ESG affects risk in North America and Asia-Pacific. In Europe and Japan, we can not find a significant relationship between ESG and information asymmetry. For the same regions, no significant relationship between ESG and idiosyncratic risk is found. Based on the fact that these regions have the highest ESG scores, a potential explanation is that the negative effect of ESG on risk is not detected because they have already benefited from a reduction in information asymmetry through their past ESG development.

Finally, we examine whether climate risk affects the strength of the ESG-risk relationship. We perform a moderation analysis to determine whether better ESG performance reduces idiosyncratic risk to a greater extent in times of increased climate risk. Our results show that climate risk has a moderating effect on the ESG-risk relationship in Europe that is statistically significant at the 1% level. The negative coefficient of the interaction term implies that firms' ESG efforts are most rewarded in times of increased climate risk. Moreover, this indicates that periods of high climate risk can create a significant risk-reducing effect of ESG in Europe, where ESG is not significantly related to risk in itself.

Overall, our results show that decreased information asymmetry is a channel through which ESG reduces idiosyncratic risk in North America and Asia-Pacific. Furthermore, we show that the risk-reducing effect of ESG in Europe is more pronounced in times of increased climate risk. These findings show that both information asymmetry and climate risk are important factors to consider in the ESG-risk nexus. Moreover, our results could indicate that information asymmetry mostly influences the ESG-risk relationship in the regions with lower ESG scores, whereas climate risk is an important factor to consider in the regions with higher ESG scores. Our findings are robust to alternative idiosyncratic risk measures, alternative fixed effects model specifications and when excluding highly regulated industries.

Our thesis contributes to financial literature in several ways. First, it contributes to the growing body of research on the nexus between ESG and risk (Lioui, 2018; Maiti, 2020) and, more specifically idiosyncratic risk (Ferreira and Laux, 2007; Ng and Rezaee, 2015; Becchetti et al., 2015; Utz, 2018). Compared to previous studies on the ESG-risk relationship within Europe (Sassen et al., 2016) and United States (Kyaw, 2020), we utilize a more comprehensive data set. Moreover, we expand the literature on the ESG-risk relationship by taking the novel approach of examining two factors that influence the relationship. Second, our finding that information asymmetry is a channel through which ESG decreases risk consolidates the literature that relates ESG with information asymmetry (Clarkson et al., 2008; Cho et al., 2013) and the literature that relates information asymmetry to risk (Zhang, 2006; Rajgopal and Venkatachalam, 2011; Lambertides and Mazouz, 2013). Finally, we contribute to the growing literature on climate risk (Jo and Na, 2012; Krueger et al., 2020; Hoepner et al., 2020) and its relationship with ESG (Engle et al., 2020; Huynh and Xia, 2020).

The remainder of the thesis is organized as follows. Chapter 2 presents the history of ESG and the ESG framework. Chapter 3 gives an overview of the relevant literature to explain the relationship between ESG and risk, followed by the rationale behind our hypotheses. Chapter 4 explains the methods used to test our hypotheses. Chapter 5 contains an overview of the variable selection, data cleaning process and descriptive statistics for the final data set. Chapter 6 presents and discusses the results. Finally, Chapter 7 concludes the thesis.

2 | Background

2.1 A brief history of ESG

Social responsibility as a concept started to gain attention in the latter half of the 19th century when the first wealth management set restrictions on investments within the "sin-industries" tobacco, alcohol and weapons (Roselle, 2016). This development was the beginning of what is known as Social Responsible Investing (SRI), and it has been an important part of external stakeholder management since the 19th century. During the 1950s, Patrick Murphy outlined the concept named Corporate Social Responsibility (CSR) (Carroll, 2009). The concept of CSR is often referred to as the idea that businesses have certain social responsibilities towards themselves, shareholders and society (Smith, 2003; Siegel and Vitaliano, 2007). As investments and attention towards social responsibility increased, the importance of the environment aspect became evident through various agreements; The Kyoto Protocol (United Nations, 1998), The Copenhagen Accord (United Nations, 2010), The Carbon Pollution Emission Scheme Act (The Parliament of Australia, 2010), and The Paris Agreement (United Nations, 2015).

ESG as a concept was first introduced by the European Union's "Who Cares Wins" report in 2004 (The Global Compact, 2004). The overall goals of the report were to build a stronger financial market that made information more transparent and contributed to sustainable development. The report highlighted "recommendations by the financial industry to better integrate environmental, social and governance issues in analysis, asset management and securities brokerage" (The Global Compact, 2004). Differentiated from CSR, ESG is a more extensive terminology that incorporates corporate governance explicitly, while CSR includes governance issues indirectly as they relate to environmental and social considerations (Gillan et al., 2021). Where CSR traditionally has referred to the companies' strategy and moral, ESG has become a more quantifiable reporting framework used by investors and institutions (Eccles et al., 2020; Engle et al., 2020). As ESG performance began to materialize (Krueger et al., 2020) and investors started to consider it as an intangible asset (Gangi et al., 2020), the demand for ESG data increased (Eccles et al., 2020). Figure 2.1 illustrates the growing number of Exchange Traded Funds (ETFs) and assets under management (AUM) that are tracking the Morgan Stanley Capital International (MSCI) ESG Indexes. The figure indicates a sharp increase in the number of ETFs from 2018. Furthermore, AUM has almost doubled from 2019 to Q3'20. The increasing number of ETFs and AUM demonstrates that investors are investing more in ESG related instruments and that the selection of ESG ETFs is getting more comprehensive.

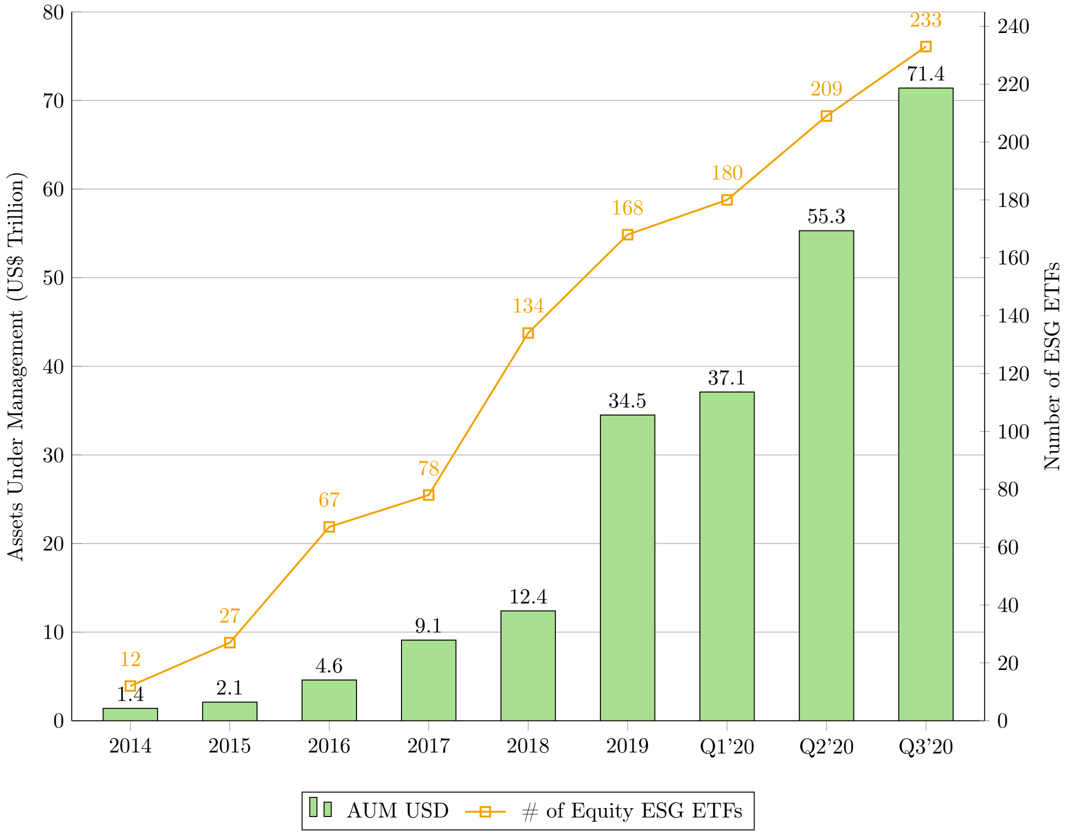

Figure 2.1: Assets Under Management in ETFs tracking MSCI ESG Indexes and number of equity ESG ETFs. Source: MSCI.

2.2 ESG framework

Thomson Reuters (TR) has one of the most comprehensive ESG databases with coverage on more than 8,000 companies (Thomson Reuters, 2017). Figure 2.2 shows that the total number of companies with ESG data has more than tripled in the last ten years. The database is continuously updated every second week with 400 ESG metrics available in assessment. Replacing the old ASSET4 ratings, TR publishes an overall ESG score for each company every year. The ESG score is based on three pillar scores and ten underlying categories with individual weighting, displayed in Table 2.1.[1] The environmental pillar measures how the firm reduces its carbon footprint through improved resource use, supply chain and innovations. The social pillar relates to how the firm takes care of its workforce, human rights and community while maintaining safety in the production process. The governance pillar measures how the firm controls and maintains a healthy management structure, communicates clearly to shareholders and integrates a good CSR strategy. Each category is weighted by the number of indicators relative to the total number of indicators. The final ESG Score is a weighted performance in each category compared to industry peers. The score is on a scale from 0-100 and is grouped by grade ranging from D- to A+.

[1]More information about Thomson Reuters' ESG score calculation methodology can be found at: https://www.esade.edu/itemsweb/biblioteca/bbdd/inbbdd/archivos/Thomson_Reuters_ESG_Scores.pdf.

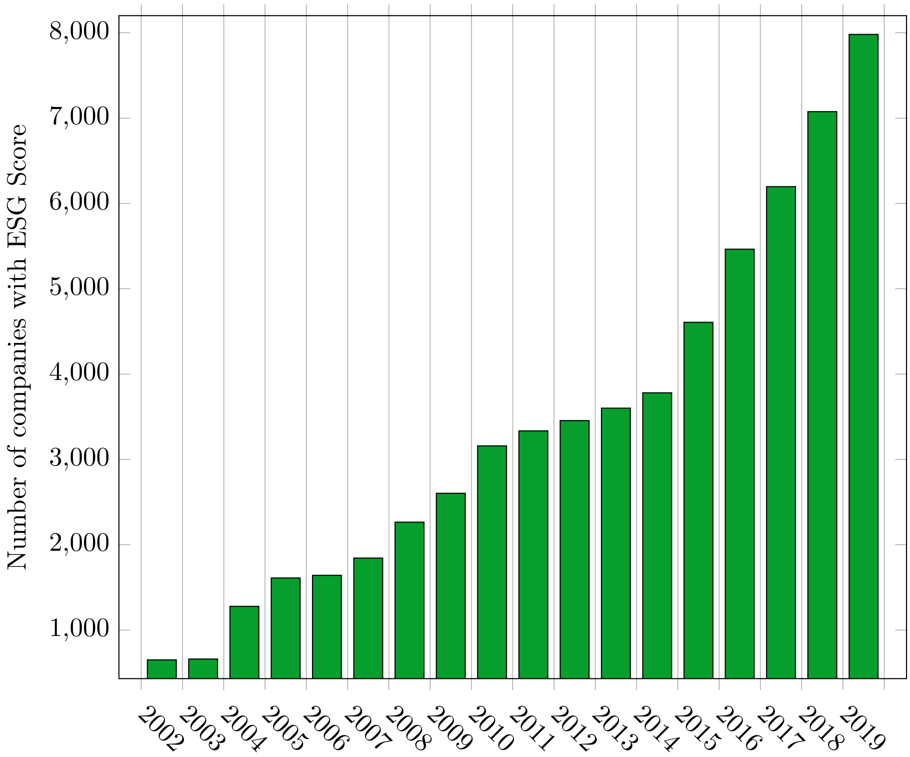

Figure 2.2: The number of companies that are included in Thomson Reuters ESG database. Source: TR.

Table 2.1: Thomson Reuters ESG score categories and their individual weights. Source: TR.

Pillar	Category	Indicators in Scoring	Weights
Environmental	Resource Use	20	11 %
	Emissions	22	12 %
	Innovation	19	11 %
Social	Workforce	29	16 %
	Human Rights	8	4.5 %
	Community	14	8 %
	Product Responsibility	12	7 %
Governance	Management	34	19 %
	Shareholders	12	7 %
	CSR Strategy	8	4.5 %
TOTAL		178	100 %

3 | Literature Review

In recent years, investors have started to incorporate ESG criteria into their investment strategy. In an investment decision, volatility is one of the most important characteristics to consider, and it is often used as a crude measure of risk in theoretical studies (Sharpe, 1964; Black and Scholes, 1972) and empirical research (Pindyck, 1984; Poterba and Summers, 1986). Section 3.1 gives an introduction to how previous literature relates systematic and idiosyncratic risk to ESG. Section 3.2 and 3.3 review existing evidence that corroborates our hypothesis that information asymmetry and climate risk affect the ESG-risk relationship.

3.1 Relationship between ESG and risk

Financial literature has established several links between ESG and the different components of risk. One stream of literature focuses on the relationship between ESG and systematic risk. Systematic risk refers to macroeconomic risks inherent to the entire market or segments therein and can not be diversified. Some studies have examined whether ESG is a systematic risk factor that should be included in Fama-French three- or five-factor models (Lioui, 2018; Maiti, 2020; West and Polychronopoulos, 2020). In this stream of literature, Lioui (2018) examines the relationship between ESG and systematic risk by studying the existence of a systematic ESG risk factor. The paper proposes an ESG risk factor that consists of going long in a portfolio with low ESG strengths and high ESG concerns (LH) and going short in a portfolio with high strengths and low concerns (HL).[2] The findings show that firms with a positive loading on this factor will see their anomalous returns reduced, and thus the market price of ESG risk is negative and significant. Using a similar approach, Maiti (2020) finds that ESG as a risk factor is statistically significant at the 5% level and that a pricing model with ESG factors outperforms the Fama-French three-factor model. However, Arnott et al. (2019) proclaims that over 400 factors have been "discovered" in top-tier academic journals by 2018. Building on this, West and Polychronopoulos (2020) suggests that the criteria used by Lioui (2018) and Maiti (2020) for determining whether something is a risk factor are too lenient. In line with the research of Beck et al. (2016), they put forward three critical requirements for something to be considered a risk factor: (i) It should be grounded in a long and deep academic literature, (ii) it should be robust across definitions and (iii) it should be robust across geographies. They find that ESG does not satisfy either of the three criteria and thus conclude that ESG is not a risk factor. Based on this, we do not consider ESG a systematic risk factor, and thus we focus on the relationship between ESG and idiosyncratic risk.

A different stream of literature focuses on the relationship between ESG and idiosyncratic risk. Kyaw (2020) finds that US firms with higher environmental ratings have significantly lower idiosyncratic stock volatility. Similarly, Ferreira and Laux (2007) confirms that there is a relationship between ESG and idiosyncratic risk by showing that higher corporate governance reduces idiosyncratic risk. Further, Sassen et al. (2016) also concludes that higher levels of ESG decrease idiosyncratic risk using a sample of European firms. Additionally, they find that only the environmental and social dimensions of ESG have a significant and unidirectional impact on idiosyncratic risk. In contrast to Ferreira and Laux (2007), their results show that the corporate governance

[2] MSCI provide close to 70 ESG strengths and concern indicators. Each indicator is given a binary score indicating the presence of a strength or concern (Lioui, 2018).

dimension of ESG is not significantly related to idiosyncratic risk, and the relationship between idiosyncratic risk and corporate governance is bidirectional. Utz (2018) uses a global sample to examine whether ESG affects idiosyncratic risk. The paper finds that ESG significantly decreases idiosyncratic risk in Europe, the US, Asia-Pacific and Japan. However, the ESG-risk relationship is not consistently significant across all regions depending on the model definition. These findings indicate that there are regional variations in the ESG-risk relationship. The study also concludes that there is a non-linear relationship between ESG and idiosyncratic risk and that there exists an optimal level of ESG. Utz (2018) bases this on two explanations: (i) There could be an over-investment in ESG since costly ESG projects could compete with critical marketing instruments such as advertising or R&D; (ii) ESG could be seen as a risk-mitigating investment that protects against stock price crash risk. West and Polychronopoulos (2020) later adds to the latter explanation by finding that ESG portfolios tend to exhibit low-volatility characteristics, strengthening the argument of ESG as a risk mitigation strategy.

Contrary to the aforementioned findings, Ng and Rezaee (2015) finds that the sum of ESG strengths and concerns is positively associated with idiosyncratic volatility and that this association is stronger for firms with high sustainability disclosure. Similarly, Becchetti et al. (2015) finds that idiosyncratic volatility increases with net CSR strengths minus CSR concerns. However, both studies use the sum of ESG strengths and concerns rather than the ESG score itself, and this measurement does not take into account the relative importance of each strength and concern. A company with several minuscule strengths and one paramount concern would wrongfully be categorized as a high-scoring ESG company, which could lead to bias in their results. Consequently, Nofsinger et al. (2019) criticizes the "net-method" of Ng and Rezaee (2015) and Becchetti et al. (2015) based on the argument that a firm with weaknesses in one ESG pillar will spend resources to generate strengths in the same pillar to disguise the weakness. Therefore, we argue that using the ESG score yields more robust results than the "net-method".

To summarize, existing literature that studies the relationship between ESG and risk suggests that ESG is negatively associated with idiosyncratic risk. However, current findings are not entirely consistent across regions and time. This thesis aims to better understand these inconsistencies and investigate two factors that affect the relationship between ESG and idiosyncratic risk. We extend the literature on the ESG-risk relationship by investigating whether the relationship is affected by: (i) information asymmetry and (ii) climate risk. In what follows, we focus on the literature for each of the two factors more closely.

3.2 ESG and information asymmetry

The value of data has rapidly increased in the last decades as the world is getting more connected and the speed of the internet is increasing. In 2017, The Economist stated, "data is the new oil", indicating that the market value of data had surpassed oil as the most valuable resource in the world (The Economist, 2017). The value of accurate and correct information is crucial for an investor in the process of executing a trade, making information asymmetry an obstacle in the efficient market hypothesis (Berk and DeMarzo, 2013). Following this hypothesis, all investors should theoretically trade on equal information, and new information should be absorbed more or less instantly, limiting the price fluctuation to a minimum. There exists a stream of literature studying the relationship between information asymmetry and stock volatility (Zhang, 2006; Rajgopal and Venkatachalam, 2011; Lambertides and Mazouz, 2013). The findings generally support the hypothesis that lower information asymmetry decreases stock volatility. Specifically, Zhang (2006) finds that greater information asymmetry leads to increased short-term volatility following both good and bad news. Adding to this, Rajgopal and Venkatachalam (2011) finds a relationship between increasing stock volatility and deteriorating financial reporting quality. Further strengthening this argument, Lambertides and Mazouz (2013) finds that the informational efficiency from the mandatory International Financial Reporting Standard (IFRS) accounting scheme leads to lower stock volatility for adopting firms and improved stability in financial markets.

At the same time, there exist studies relating ESG performance to information asymmetry. Clarkson et al. (2008) finds that environmental performance and environmental disclosures are positively associated. Moreover, Cho, Lee and Pfeiffer (2013) find that CSR performance and reduced information asymmetry are linked through increased information disclosure and that the increased transparency leads to lower information asymmetry. The paper highlights that bad performers' motives for disclosing information are to defend their bad performance, while good performers disclose information to highlight good performance.

More recent literature connects ESG performance directly to risk reduction through better information flow. Dumitrescu and Zakriya (2021) states that ESG reduces firm risk by decreasing the likelihood of managerial hoarding of bad news that results in stock price crashes. Similarly, Utz (2018) argues that high levels of ESG decrease firm risk by limiting managers' concealment of firm-specific information. The aforementioned papers provide evidence that better ESG performance reduces information asymmetry. Combined with the established link between information asymmetry and idiosyncratic risk, this warrants the following novel hypothesis:

Hypothesis 1: *Better ESG performance reduces idiosyncratic risk through decreased information asymmetry.*

3.3 ESG and climate risk

The collective goal of reducing GHG emissions has led to a global increase in corporate environmental activities (Ghisellini et al., 2016). The ten largest polluting countries contribute with almost two-thirds of the world's GHG emissions (Nejat et al., 2015), leaving the lion's share of the responsibility to the most industrialized countries in reaching the EU's Green Deal. In a survey of institutional investors, Krueger et al. (2020) finds that investors believe that climate risks have already begun to materialize and that these risks have financial implications for their portfolios. The paper categorizes climate risk into physical, regulatory and technological climate risk. Physical climate risk is related to adverse physical impacts from climate change, such as extreme weather, floods, droughts, and sea-level rise. Regulatory climate risk concerns changes in regulations and policies to shift the economy away from carbon-intensive assets. Technological climate risk involves climate-related technological disruption. Their survey highlights that institutional investors view the effects of regulatory and technological risks as more important than physical risks.

Corporate investments in ESG could be interpreted as a preparation for a low-carbon economy, possibly indicating that high ESG firms are better hedged against climate risks. Sharfman and Fernando (2008) supports the view of ESG as a protection against climate risk, positing that improved environmental risk management lowers the market's perception of the firm's risk. They find that improved environmental risk management is negatively associated with the cost of capital, which is shown to be positively related with idiosyncratic risk.[3] Adding to this, Krueger et al. (2020) finds ESG oriented companies to be more climate aware and to have an active approach to reduce climate risk. Further supporting the importance of climate risk in the ESG-risk relationship, Hoepner et al. (2020) finds that the ESG engagement is most effective in lowering downside risk when climate change topics are addressed. Engle et al. (2020) quantifies the perceived climate risk of investors by measuring the amount of climate-related news, and uses ESG scores to model firms' climate risk exposure. The paper finds that this approach yields portfolios that perform well in hedging innovations in climate risk both in and out of sample. Using the same climate risk measure, Huynh and Xia (2020) finds that investors are willing to pay higher prices for bonds issued by high ESG firms in times of high climate risk.

[3] Merton (1987) shows that cost of capital increases with idiosyncratic risk in capital markets with incomplete information. This finding is later empirically confirmed by several studies (Fu, 2009; Bozhkov et al., 2020).

The aforementioned studies provide both theoretical arguments and empirical findings to support the hypothesis that high ESG firms are better hedged against climate risk. Given the growing awareness of climate risk, this gives reason to believe that high ESG firms are less risky because they are less exposed to climate risk. Although climate risk could be considered a systematic risk, the findings of Engle et al. (2020) suggest that climate risk is diversifiable and thus a firm-specific risk that depends on the individual firm's climate efforts. Based on this, we suggest that the relationship between ESG and idiosyncratic risk is strengthened in times of increased climate risk. Hence, the following novel hypothesis is proposed:

Hypothesis 2: *Better ESG performance reduces idiosyncratic risk to a greater extent in times of increased climate risk.*

To summarize, the relationship between ESG and idiosyncratic risk has received some attention in existing literature, and current findings indicate that ESG reduces idiosyncratic risk. Through a comprehensive review of existing literature on the nexus between ESG and risk, we have identified two underlying explanations to why ESG decreases idiosyncratic risk. We hypothesize that the ESG-risk relationship is affected by: (i) information asymmetry and (ii) climate risk. Although these aspects do not encompass all of the arguments for why ESG decreases firm risk, we view information asymmetry and climate risk as two integral factors to consider in the ESG-risk relationship. Table 3.1 shows an overview of financial literature that has investigated the relationship between ESG and idiosyncratic risk, information asymmetry or climate risk. To the best of our knowledge, the ESG-risk relationship has not been studied in conjunction with information asymmetry and climate risk. Consequently, our novel contribution to financial literature is to shed light on how the relationship between ESG and idiosyncratic risk depends on information asymmetry and climate risk.

Table 3.1: Overview of financial literature that has investigated the relationship between ESG and idiosyncratic risk, information asymmetry or climate risk.

Author	Kyaw	Ferreira and Laux	Sassen et al.	Utz	Ng and Razaee	Becchetti et al.	Cho et al.	Dumitrescu and Zakriya	Sharfman and Fernando	Krueger et al.	Hoepner et al.	Engle et al.	Our thesis
Year	*(2020)*	*(2007)*	*(2016)*	*(2018)*	*(2015)*	*(2015)*	*(2013)*	*(2021)*	*(2008)*	*(2020)*	*(2020)*	*(2020)*	*(2021)*
ESG	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Related to													
Idiosyncratic risk	✓	✓	✓	✓	✓	✓		✓					✓
Information asymmetry							✓						✓
Climate risk									✓	✓	✓	✓	✓

4 | Methodology

This Chapter includes supporting literature on the framework and models used to investigate the relationship between ESG and idiosyncratic risk. It consists of three parts that explain the methodological decisions in this thesis. Section 4.1 gives an overview of the regression methodology used to determine the association between ESG and idiosyncratic risk. Section 4.2 explains how we apply mediation analysis to determine if decreased information asymmetry is a channel through which ESG decreases risk. Lastly, Section 4.3 gives an overview of how we use moderation analysis to investigate if climate risk affects the relationship between ESG and risk.

4.1 Model definition

Panel data, or *longitudinal data*, embody data that varies across time and space (Brooks, 2014). Our thesis investigates firm characteristics over time and attempts to explain how these characteristics affect idiosyncratic risk. The main advantages of panel data are, according to Brooks (2014), that it allows for more complex problem solutions while maintaining higher degrees of freedom.

Fixed effects panel regression model

To determine the relationship between ESG and idiosyncratic risk, measured as the idiosyncratic stock volatility (IV), we estimate the following fixed effects panel regression model

$$IV_{i,t} = \beta_1 ESG_{i,t} + \gamma X_{i,t} + \mu_i + \lambda_t + \epsilon_{i,t}, \tag{4.1}$$

where $IV_{i,t}$ is the idiosyncratic risk of firm i in year t. $ESG_{i,t}$ is the ESG-score for firm i in year t. γ is a vector of control variable coefficients, and $X_{i,t}$ is a vector of control variables, which is detailed in Section 5.1.3. $\epsilon_{i,t}$ is the error term. μ_i is the firm-fixed effects, which can vary for each firm in the sample and accounts for unobserved time-invariant differences across companies, such as country, industry, management and listings. λ_t is the time-fixed effects, which can vary for each time step in the sample and captures unobserved differences across time, such as yearly variations in market volatility. Adding both firm- and time-fixed effects is a common panel data modeling technique in financial literature to account for firm- and time-variant heterogeneity in the panel data sample (Flannery and Hankins, 2013; Sassen et al., 2016; Kyaw, 2020).

An alternative to the FE model in Equation (4.1) is the random effects (RE) model. However, an assumption of the RE model is that any unobserved omitted variables are uncorrelated with all the independent variables. Many of our independent variables are likely distributed differently across regions, industries and time periods, meaning that there may exist correlations between the independent variables and the unobservable heterogeneity in our sample. One example is that the independent variable leverage ratio is likely to correlate with the unobserved variable organizational culture (Arosa et al., 2014). If any of the independent variables are correlated with any unobserved omitted variables, the RE model would be biased, and the FE model should be chosen. The Hausman test can be conducted to determine whether FE or RE is the most suitable model (Hausman, 1978). The test determines if the assumption of no correlation between independent variables and the random variable estimator in the RE model should be rejected or not. If the null hypothesis of uncorrelated error terms is rejected, a RE model would be biased and can not be used. We confirm that the null is rejected by conducting a Hausman test; therefore, we use the FE model.

Semiparametric model

Semiparametric regression is considered a bridge between the more renowned parametric and non-parametric regression models. In statistics, semiparametric models are used in a range of fields and problems, e.g. Bayesian models, Expectation-Maximization and Markov Chain Monte Carlo (Ruppert et al., 2009). Semiparametric models use a parametric approach where it is suitable while using a non-parametric approach elsewhere, which gives advantageous flexibility. This approach is particularly useful if there is reason to believe that the relationship in the regression model changes across time or space. The semiparametric model allows us to investigate if the relationship between ESG and IV changes behavior depending on whether we look at, e.g. high or low levels of ESG. More details behind the semiparametric model are presented in Appendix A.

4.2 Mediation analysis

Mediation analysis attempts to explain the mechanism or process that results in a relationship between an independent and dependent variable by including a mediating variable. We hypothesize that information asymmetry is a channel through which ESG affects risk. The approach of simply adding information asymmetry as a control variable in a panel regression would not reveal how IA affects the ESG-IV relationship. Consequently, mediation analysis appears suitable to test *Hypothesis 1*: Better ESG performance reduces idiosyncratic risk through decreased information asymmetry. We follow the methodology introduced by Baron and Kenny (1986), which has later been used in several financial studies (Pham, 2019; Wu and Lai, 2020; Francis et al., 2021).

The mediation analysis is conducted in three steps. First, the dependent variable IV is regressed on the independent variable ESG by estimating the regression in Equation (4.1). If there exists a relationship between ESG and idiosyncratic risk, the second step is to regress the independent variable (ESG) on the mediating variable (information asymmetry). The following regression is estimated

$$IA_{i,t} = \beta_2 ESG_{i,t} + \gamma X_{i,t} + \delta_i + \theta_t + \epsilon_{i,t}, \tag{4.2}$$

where $IA_{i,t}$ is the measure of information asymmetry for firm i in year t. If β_2 is significant, there exists a relationship between information asymmetry and ESG. Lastly, the dependent variable IV is regressed on both the independent variable ESG and the mediating variable IA

$$IV_{i,t} = \beta_3 ESG_{i,t} + \beta_4 IA_{i,t} + \gamma X_{i,t} + \delta_i + \theta_t + \epsilon_{i,t}. \tag{4.3}$$

If β_4 is significant, then there is a significant relationship between IV and IA. Moreover, if the coefficient β_3 is smaller in absolute value compared to β_1 in Equation (4.1), then the strength of the relationship between ESG and idiosyncratic risk is reduced when the mediating variable information asymmetry is included. A reduction in β_3 implies that the relationship between ESG and IV is not purely causal and that ESG influences the mediating variable IA, which in turn influences IV. The mediating role of IA is illustrated in Figure 4.1. The relative size and significance between the coefficients β_3 and β_1 gives us information about how much of the influence of ESG on idiosyncratic risk actually goes through the mediating variable information asymmetry. Complete mediation occurs when the mediating variable accounts for all the relationship between ESG and IV, meaning that the coefficient β_3 is is no longer significant with the inclusion of the mediating variable IA. Another way of interpreting complete mediation is that ESG only affects IV through the path 'ab' in Figure 4.1. Partial mediation occurs when the mediating variable accounts for some, but not all the effect of ESG on IV, meaning that the coefficient β_3 is still significant but smaller in absolute value compared to β_1. Consequently, ESG affects IV both through the path 'ab' and the path 'c' in Figure 4.1. Path 'ab' is often referred to as the indirect effect, whereas path 'c' is the direct effect. The total effect of ESG on IV is the sum of the two paths.

We use Sobel's test (Sobel, 1982) to determine whether the mediation effect is significant. It tests whether the relationship between the dependent and independent variables is significantly reduced when the mediating variable is included. In other words, it tests whether the coefficient β_3 in Equation (4.3) is significantly different from β_1 in Equation (4.1). Sobel's test assumes that the sample is normally distributed, which lowers the test's statistical power in small sample sizes. However, this is not a concern as our sample contains 27,064 firm-year observations.

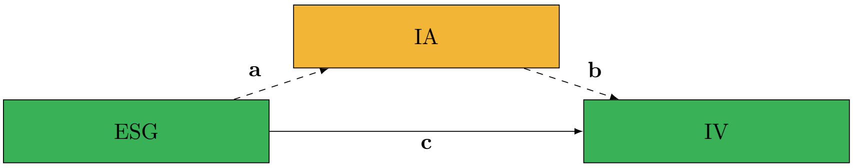

Figure 4.1: Mediating role of information asymmetry (IA) in the relationship between ESG and idiosyncratic risk (IV).

4.3 Moderation analysis

Moderation analysis, or interaction effects, is used to understand how *moderators* affect the relationship between two or more variables. *Moderation* is the resulting effect that the moderator has on the relationship in question. As we want to examine how climate risk affects the relationship between ESG and idiosyncratic risk, moderation analysis appears suitable to test *Hypothesis 2*: Better ESG performance reduces idiosyncratic risk to a greater extent in times of increased climate risk. To incorporate moderation analysis into our model, we augment Equation (4.1) to include the interaction between ESG and climate risk

$$IV_{i,t} = \beta_1 ESG_{i,t} + \alpha_1 (ESG_{i,t} \times M_t) + \alpha_2 M_t + \gamma X_{i,t} + \delta_i + \theta_t + \epsilon_{i,t}, \tag{4.4}$$

where M_t is the climate risk in year t. $ESG_{i,t} \times M_t$ is the *interaction term*. If α_1 is statistically significant, the conclusion is that climate risk is a moderating factor that affects the relationship between ESG and idiosyncratic risk. Figure 4.2 illustrates the moderating role of climate risk in the ESG-IV relationship.

To interpret the size of the moderation effect it is common to investigate the change in R^2 with and without the moderating factors included (Aiken et al., 1991; Aguinis et al., 2005; Dawson, 2014). This relationship is referred to as f^2

$$f^2 = \frac{R_2^2 - R_1^2}{1 - R_2^2}, \tag{4.5}$$

where R_2^2 and R_1^2 is the variance explained by the model with and without moderating factors respectively.

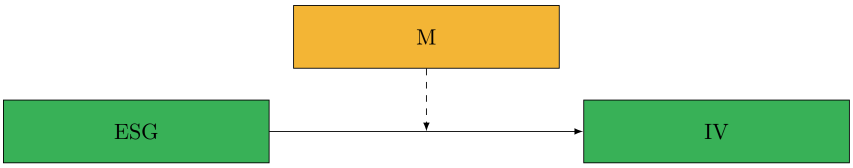

Figure 4.2: Moderating role of climate risk (M) in the relationship between ESG and idiosyncratic risk (IV).

5 | Data Description

Our initial sample consists of 8,269 listed firms from 2002 to 2019. The data is collected from Thomson Reuters Eikon during April 2021. Section 5.1 presents the dependent-, independent- and control variables in our data set. Section 5.2 describes the data cleaning process, starting from the initial data set and all the refinement steps towards our final data set. Section 5.3 summarizes the final data set which is used in our model.

5.1 Variable selection

5.1.1 Dependent variable

In line with previous literature (Zhang, 2006; Bali et al., 2012; Bessembinder and Zhang, 2013), we estimate the dependent variable idiosyncratic risk as the annualized standard deviation of the residuals from the Fama-French-Carhart four-factor model[4](Carhart, 1997)

$$R_{i,d} - R_{f,i,d} = \alpha_i + \beta_{i,M}(R_{Mkt,i,d} - R_{f,d}) + \beta_{i,S}SMB_{i,d} + \beta_{i,H}HML_{i,d} + \beta_{i,R}WML_{i,d} + \epsilon_{i,d}, \quad (5.1)$$

where $R_{i,d}$ is the daily return for company i on day d, $R_{f,i,d}$ is the daily risk-free rate of return, $R_{Mkt,i,d}$ is the daily return of the value-weighted market portfolio, $SMB_{i,d}$ is the size factor, measured as the daily return spread of small minus large stocks. The value factor, $HML_{i,d}$, is the daily return spread of cheap minus expensive stocks. $WML_{i,d}$, also called the momentum factor, is the daily return spread of winners minus losers.[5] Note that the market and factor returns depend on the region of company i. The regions are divided into North America, Europe, Asia-pacific (ex. Japan) and Japan. The error term $\epsilon_{i,d}$ represents the idiosyncratic return that is independent of the market and factor returns. The Fama-French-Carhart four-factor model is estimated individually for each company i for each year t. Idiosyncratic risk for company i in year t, $IV_{i,t}$, is measured as the annualized standard deviation of $\epsilon_{i,d}$

$$\sigma^2_{\epsilon,i,t} = Var(\epsilon_{i,d}), \qquad d \in t \quad (5.2)$$

$$IV_{i,t} = \sqrt{\sigma^2_{\epsilon,i,t} \times T_{i,t}}, \quad (5.3)$$

where $T_{i,t}$ is the number of trading days for company i in year t.

[4]We also verify the robustness of our results by extracting idiosyncratic risk from the Fama-French three-factor model (Fama and French, 1993), five-factor model (Fama and French, 2015) and six-factor model (Fama and French, 2018).

[5]The daily factor returns are obtained from Kenneth R. French's website: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/index.html.

5.1.2 Independent variables

We have three types of independent variables in our model, (i) ESG score (ESG), (ii) information asymmetry (IA) and (iii) climate risk (CR and $CRNEG$). The ESG score of a firm is extracted from Thomson Reuters ASSET4.

As a measure for IA, we use the bid-ask spread, in line with previous literature (Kanagaretnam et al., 2007; Cho et al., 2013; Siew et al., 2016). The bid-ask spread is measured as the difference between the daily bid and ask price at close relative to the closing ask price. As the observations in our panel data are of annual frequency, we take the yearly average of the daily bid-ask spread.

Our proxies for climate risk are adopted from the work of Engle et al. (2020).[6] They construct two measures of climate risk. The first one, CR, is measured as the "cosine similarity" between the "term frequency-inverse document frequency" in the Wall Street Journal and in a climate change vocabulary based on 19 climate change papers (Engle et al., 2020). The second measure, $CRNEG$, is measured as the share of all news articles from Crimson Hexagon that are both related to "climate change" and that have been assigned to the "negative sentiment" category. Crimson Hexagon is a global database with over one trillion news articles. Both measures are provided at a monthly frequency. Similar to information asymmetry, we use the average value of the 12 monthly observations to annualize the climate risk variable.

5.1.3 Control variables

The control variables used in this thesis are based on existing literature covered in Chapter 3 and summarized in Table 5.1. As larger and more established firms tend to be more stable and less risky (Kyaw, 2020), we control for $SIZE$ as well as their ability to undertake new investments, measured by the market-to-book ratio (MTB). Further, we account for the effect leverage (LEV) and cash flow ($CAFL$) have on the firm's ability to manage its long-term liabilities and payables. Higher trading volume increases stock liquidity (LIQ) and has been argued to have a positive association with stock volatility (Skinner, 1989; Chen et al., 2001). Moreover, the firm's profitability is accounted for by the annualized stock return (RET). Finally, the age of the firm (AGE) is included as the last control variable. In addition to time-varying firm-specific characteristics, we include firm-fixed effects to control for heterogeneity in time-invariant firm characteristics such as country, industry, management and listing. Time-fixed effects are added to account for yearly variations in market volatility. All variables are explained in detail in Appendix B.1.

[6] The data used to measure climate risk is publicly available at Stefano Giglio's website: https://sites.google.com/view/stefanogiglio/data-code.

Table 5.1: Summary of control variables used in previous literature that studies the relationship between ESG/CSR and different aspects of risk. A detailed explanation of all variables is found in Table B.1 in the Appendix.

Author	Kyaw	Sharfman and Fernando	Becchetti et al.	Dumitrescu and Zakriya	Albuquerque et al.	Ng and Razaee	Utz	Engle et al.	Maiti	Ng and Razaee	Ferreira and Laux	Lioui	Cho et al.	Madhavan et al.	Gangi et al.	Pedersen et al.	Sassen et al.	Our thesis
Year	*(2020)*	*(2008)*	*(2015)*	*(2021)*	*(2019)*	*(2020)*	*(2018)*	*(2020)*	*(2020)*	*(2015)*	*(2007)*	*(2018)*	*(2013)*	*(2021)*	*(2020)*	*(2020)*	*(2016)*	*(2021)*
Independent variables																		
ESG	✓			✓		✓		✓	✓	✓		✓		✓	✓	✓	✓	✓
CSR			✓	✓	✓		✓						✓		✓			
Risk proxy																		
Idiosyncratic risk	✓	✓	✓			✓	✓			✓	✓		✓		✓		✓	✓
Systematic risk					✓							✓		✓		✓	✓	
Total risk								✓	✓				✓		✓		✓	
Crash risk				✓			✓											
Control variables																		
Size	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Leverage	✓	✓	✓	✓	✓	✓	✓			✓	✓		✓		✓		✓	✓
Liquidity	✓									✓							✓	✓
Market-to-Book	✓			✓		✓	✓	✓	✓	✓	✓	✓				✓	✓	✓
Cash Flow	✓	✓			✓					✓		✓						✓
Return	✓	✓	✓	✓	✓	✓	✓			✓	✓		✓	✓			✓	✓
Age	✓					✓					✓							✓

5.2 Data cleaning process

We restrict the initial data set to only include firms that have at least one year of ESG data in the time frame spanning from 01/01/2002 to 31/12/2019. This time frame provides the maximum amount of available data, given that Thomson Reuters Eikon's ESG history dates back to 2002 (Thomson Reuters, 2017). The initial data set includes 148,842 firm-year observations. The stock data is then used in combination with the factor return data to calculate the annualized idiosyncratic volatility as described in Section 5.1.1. We require a minimum of one financial quarter of stock data to estimate the idiosyncratic risk. Missing observations of IV and ESG are then removed. Subsequently, we discard missing observations of IA, CR and $CRNEG$. The climate risk data is only available from 2008 to 2018, meaning that all observations before and after this time frame are removed. Further, we remove observations with missing control variables to ensure a complete data set. We then discard faulty observations where the firm age is less than zero or implausibly high (more than 2000 years). We also remove faulty observations with infinite liquidity and negative bid-ask spreads, most likely caused by very few shares outstanding. Finally, we restrict the data set to only include observations of idiosyncratic risk that are within the 1% and 99% quantile, i.e. removing the outliers with idiosyncratic volatility less than 4% and more than 900%. In addition, we restrict the data set to exclude observations of MTB above the 99% quantile as we have some obvious outliers in our data set. After removing the outliers, the median MTB changes from 1.77 to 1.76, while the maximum MTB changes from 895.23 to 23.98. Finally, all independent and control variables are standardized to enable comparison of their estimated regression coefficients. The final data set comprises 4,886 unique firms and 27,064 firm-year observations. Figure 5.1 summarizes the data refinement process. The most significant reduction in the number of observations stems from missing ESG scores.

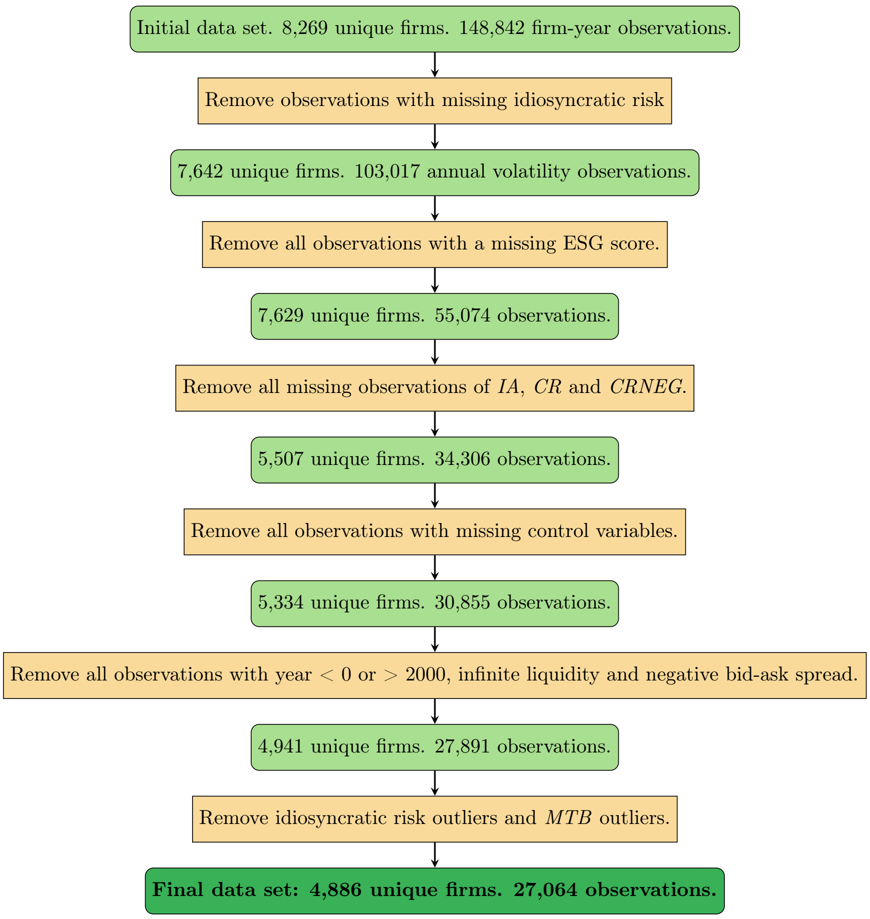

Figure 5.1: Illustration of the data cleaning process from the initial to the final sample. Each intermediate refinement process is shown in light orange, whereas the temporary samples is shown in light green.

5.3 Final data set

Our final data set consists of 4,886 unique firms and 27,064 firm-year observations. The data set has broad geographical coverage, with the USA having just below one-third of the total observations, while Japan is the second largest. Following Fama and French (2012), we consider Japan as a separate region from Asia. Panel A in Table 5.2 shows the geographical segmentation by country, whereas Panel B shows the regional segmentation. North America is the region with the most observations, caused mainly by the USA and Canada. Asia-Pacific is the second largest region by observations, where the top three countries Australia, Hong Kong and Taiwan make up 52% of the regional observations. The United Kingdom is together with France and Switzerland the three largest countries by observations in Europe, adding up to 56% of the observations in Europe.

Table 5.2: Geographical segmentation of observations and firms in the final sample. Panel A shows the 14 countries with the most firm observations, with the remaining 29 countries grouped in "Other". Panel B shows the regional segmentation.

Panel A: Countries	Observations	Firms
USA	8,634	2,022
Japan	3,422	420
United Kingdom	2,075	294
Australia	1,767	302
Canada	1,336	218
Hong Kong	1,309	210
Taiwan	926	135
South Korea	821	126
China	744	251
France	720	99
India	600	105
Switzerland	480	66
Singapore	346	41
Malaysia	325	53
Other	3,557	544
Total	27,064	4,886

Panel B: Region	Observations	Firms
North America	10,136	2,264
Asia-Pacific	7,647	1,374
Europe	5,859	828
Japan	3,422	420
Total	27,064	4,886

The segmentation of industries is based on Thomson Reuters' classification of economic sectors, and is illustrated in Table 5.3. It shows that *Industrials*, *Consumer Cyclicals* and *Financials* together make up 46% of the total data set. *Industrials* typically include firms within construction, industrial goods and transportation, while *Consumer Cyclicals* include industries like automobile, textile, household goods, consumer services and retailers. *Financials* include industries like banking and investment services, financial technology (Fintech) and insurance.

Table 5.3: Industry segmentation of observations and firms in the final sample.

Industry	Observations	Firms
Industrials	4,430	775
Financials	3,987	734
Consumer Cyclicals	3,974	707
Technology	3,218	602
Basic Materials	2,872	450
Consumer Non-Cyclical	2,048	352
Energy	1,800	301
Real Estate	1,747	339
Healthcare	1,725	432
Utilities	1,196	181
Academic & Educational Services	68	13
Total	27,064	4,886

Descriptive statistics for the data set are presented in Table 5.4, and points to a rather large range between min (11.12) and max (97.74) values for *IV*. Similarly, the ESG score is almost distributed across the full span from 0 to 100. Table 5.5 shows the correlation between all of the variables in the data set. It shows that *CR* and *CRNEG* have a correlation of 0.46, which demonstrates that the negative sentiment of climate news is different from the general climate news variable. Moreover, *SIZE* is the variable that is most correlated with *ESG*. Finally, *ESG* is negatively correlated with *IV*.

Table 5.4: Descriptive statistics before standardizing

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
IV	27,064	31.025	14.540	11.121	20.580	37.528	97.740
ESG	27,064	42.514	20.574	0.847	25.908	58.027	95.176
IA	27,064	0.003	0.009	0.000	0.001	0.003	1.098
CR	27,064	0.007	0.001	0.005	0.006	0.008	0.008
CRNEG	27,064	0.002	0.001	0.001	0.001	0.002	0.005
SIZE	27,064	22.521	1.765	14.875	21.393	23.562	29.020
LEV	27,064	0.243	0.238	0.000	0.047	0.378	0.997
LIQ	27,064	0.003	0.004	0.000	0.001	0.003	0.173
MTB	27,064	2.670	2.811	0.053	1.079	3.150	23.985
CAFL	27,064	0.073	0.143	−14.581	0.033	0.117	1.219
RET	27,064	0.142	0.494	−0.997	−0.110	0.311	17.743
AGE	27,064	3.128	0.982	0.000	2.485	3.892	5.303

Table 5.5: Pearson correlation matrix for all variables.

	IV	ESG	IA	CR	CRNEG	SIZE	LEV	LIQ	MTB	CAFL	RET	AGE
IV	1.00											
ESG	-0.16	1.00										
IA	0.16	-0.11	1.00									
CR	0.05	0.00	0.00	1.00								
CRNEG	0.30	-0.01	0.03	0.46	1.00							
SIZE	-0.18	0.46	-0.21	0.06	0.08	1.00						
LEV	0.02	0.08	0.01	0.00	-0.02	0.41	1.00					
LIQ	0.11	-0.03	-0.05	0.00	0.06	0.00	0.05	1.00				
MTB	0.00	-0.02	-0.01	0.00	-0.02	-0.12	-0.09	-0.02	1.00			
CAFL	-0.10	0.07	-0.01	0.02	0.01	-0.01	-0.14	-0.03	0.12	1.00		
RET	0.00	-0.04	-0.01	0.11	-0.12	-0.08	-0.12	-0.02	0.06	0.09	1.00	
AGE	-0.12	0.19	-0.03	0.02	0.03	0.13	0.01	0.04	-0.05	0.03	-0.04	1.00

6 Results and Discussion

This Chapter is structured as follows. Section 6.1 presents empirical evidence on the relationship between ESG and idiosyncratic risk. Section 6.2 investigates regional variations in the relationship between ESG and idiosyncratic risk. The results from the semiparametric model are also presented. Section 6.3 presents the results from the mediation analysis, where we investigate if decreased information asymmetry is a channel through which ESG affects idiosyncratic risk. Section 6.4 presents results from the moderation analysis, where we examine if ESG has a heterogeneous effect on idiosyncratic risk that depends on climate risk. Finally, Section 6.5 presents various robustness checks to validate our results.

6.1 Relationship between ESG and idiosyncratic risk

We investigate the relationship between ESG and idiosyncratic risk by estimating the panel regression in Equation (4.1). Table 6.1 displays the results from the regression. The results show that ESG is negatively associated with IV and that this effect is statistically significant at the 0.1% level. The estimated coefficient is -0.649, indicating that a one standard deviation increase in the ESG score is associated with a 0.649 percentage point decrease in IV on average. The R^2 of 0.442 means that the explanatory variables explain almost half of the variation in IV. Our finding of a negative relationship between ESG and idiosyncratic risk is consistent with previous studies (Mishra and Modi, 2013; Sassen et al., 2016; Utz, 2018; Kyaw, 2020).

With regards to the control variables, Table 6.1 shows that $SIZE$ is negatively associated with idiosyncratic risk, indicating that larger firms have lower idiosyncratic risk. This is in line with previous literature (e.g Sassen et al., 2016). Higher leverage, LEV, should intuitively lead to more financial distress and thus higher firm risk, which is confirmed by the positive relationship with idiosyncratic risk. Moreover, stock liquidity, LIQ, is also positively associated with idiosyncratic risk, suggesting that firms that are traded more frequently on stock exchanges are perceived as more risky. The positive relationship between stock liquidity and volatility is well documented in financial literature (e.g. Andersen, 1996). The market-to-book ratio, MTB, is often used as a measure to split between value and growth companies. Previous findings on the relationship between MTB and idiosyncratic risk are inconsistent (Ferreira and Laux, 2007; Jo and Na, 2012; Utz, 2018). Our finding of a negative association with idiosyncratic risk indicates that value companies experience lower risk compared to growth companies which tend to have lower MTB ratios. Firms with higher cash flows, $CAFL$, have higher creditworthiness, which leads to a negative association with idiosyncratic risk. The annual stock return of a firm, RET, is positively associated with idiosyncratic risk. However, existing empirical evidence yields ambiguous results on the relationship between stock return and idiosyncratic risk. Some studies have found evidence of a positive, negative and non-significant relationship (Bozhkov et al., 2020). AGE is positively associated with idiosyncratic risk. Previous literature provides ambiguous conclusions on the relationship between age and idiosyncratic risk, as both positive (Ferreira and Laux, 2007) and negative (Kyaw, 2020; Ng and Rezaee, 2020) associations have been found.

Table 6.1: Association between idiosyncratic risk and ESG for the complete sample.

	IV
ESG	-0.649^{***}
	(0.149)
SIZE	-4.820^{***}
	(0.406)
LEV	1.247^{***}
	(0.215)
LIQ	0.815^{***}
	(0.063)
MTB	-0.969^{***}
	(0.108)
CAFL	-0.519^{***}
	(0.065)
RET	0.623^{***}
	(0.059)
AGE	0.691^{*}
	(0.299)
Observations	27,064
R^2	0.442
Adjusted R^2	0.318
Note:	*p<0.05; **p<0.01; ***p<0.001

6.2 Regional variations in the ESG-risk relationship

As existing evidence on the ESG-risk relationship is not entirely consistent across regions, we estimate the fixed effects panel regression on regional subsamples. Columns (1) through (4) in Table 6.2 show the results from estimating Equation (4.1) separately for each region. Columns (1) and (2) show that ESG is negatively associated with idiosyncratic risk in North America and Asia-Pacific and that this effect is significant at the 0.1% level. These findings are in line with previous literature investigating ESG and idiosyncratic risk in regional samples (Utz, 2018; Kyaw, 2020). Further, Columns (3) and (4) in Table 6.2 show no significant association between ESG and idiosyncratic risk in Europe and Japan. The control variables *LEV, LIQ, CAFL* and *RET* that are statistically significant are consistent across all regions. However, the sign of the estimated coefficient for *AGE* and *MTB* differs for Japan. Previous findings on the relationship between *IV* and both *AGE* (Ferreira and Laux, 2007; Ng and Rezaee, 2020; Kyaw, 2020) and *MTB* (Ferreira and Laux, 2007; Utz, 2018; Jo and Na, 2012) are ambiguous. Overall, the control variables are relatively consistent across regions. However, our results indicate that the effect of ESG on idiosyncratic risk is heterogeneous across regions.

Table 6.2: Association between idiosyncratic risk and ESG for regional subsamples.

	IV			
	North America	Asia-Pacific	Europe	Japan
	(1)	(2)	(3)	(4)
ESG	−1.017***	−1.072***	0.389	0.393
	(0.265)	(0.261)	(0.331)	(0.353)
SIZE	−2.977***	−5.625***	−6.637***	2.476
	(0.675)	(0.719)	(0.876)	(1.606)
LEV	1.400***	1.237***	0.650	1.628*
	(0.419)	(0.371)	(0.396)	(0.681)
LIQ	0.357**	1.005***	0.795***	0.393**
	(0.121)	(0.093)	(0.200)	(0.139)
MTB	−0.602***	−1.328***	−1.055***	2.384***
	(0.159)	(0.237)	(0.219)	(0.634)
CAFL	−0.102	−1.298***	−1.947***	−2.072**
	(0.077)	(0.157)	(0.210)	(0.630)
RET	0.029	1.439***	0.217	1.083***
	(0.105)	(0.099)	(0.130)	(0.192)
AGE	−0.507	1.688**	2.989***	−2.632**
	(0.466)	(0.628)	(0.649)	(0.823)
Observations	10,136	7,647	5,859	3,422
R^2	0.472	0.383	0.482	0.525
Adjusted R^2	0.319	0.246	0.395	0.456

Note: *p<0.05; **p<0.01; ***p<0.001

To further explore the regional differences, we estimate a semiparametric model inspired by Wu and Lai (2020) and Baltagi and Li (2002) to examine how the shape of the ESG-risk relationship varies across regions. We fit a semiparametric model using spatial predictive methods where two separate functions are run simultaneously to determine the average variable importance.[7] Figure 6.1 illustrates the non-linear relationship between ESG and idiosyncratic risk for each region. The dark green line represents the semiparametric estimate of the relationship between *ESG* and *IV*, while the light green area is the 95% confidence interval. The confidence interval is notably larger for ESG scores in the range of 0-20 and 80-100, which yields more uncertain results. Few firm-year observations in this range likely cause this effect. Therefore, we only interpret the more reliable range of ESG scores between 20 to 80. The results indicate that the effect of ESG on idiosyncratic risk is not purely linear. In North America, the risk-reducing benefit of ESG is mainly concentrated in companies with an ESG score between 20 and 40, whereas the slope is relatively flat for ESG scores between 40 and 80. Similarly, the relationship between ESG and risk in Europe is negative and close to linear for ESG scores between 20 and 50, while the effect flattens out for higher ESG scores. The Asia-Pacific shows a negative but diminishing effect of ESG on idiosyncratic risk for increased ESG scores. The non-linear relationship in Japan shows a rather flat development and a small risk reduction in the ESG score range of 20 to 80.

[7] See Rupert et al. (2009) and Appendix A for a more detailed overview of semiparametric and spatial predictive models.

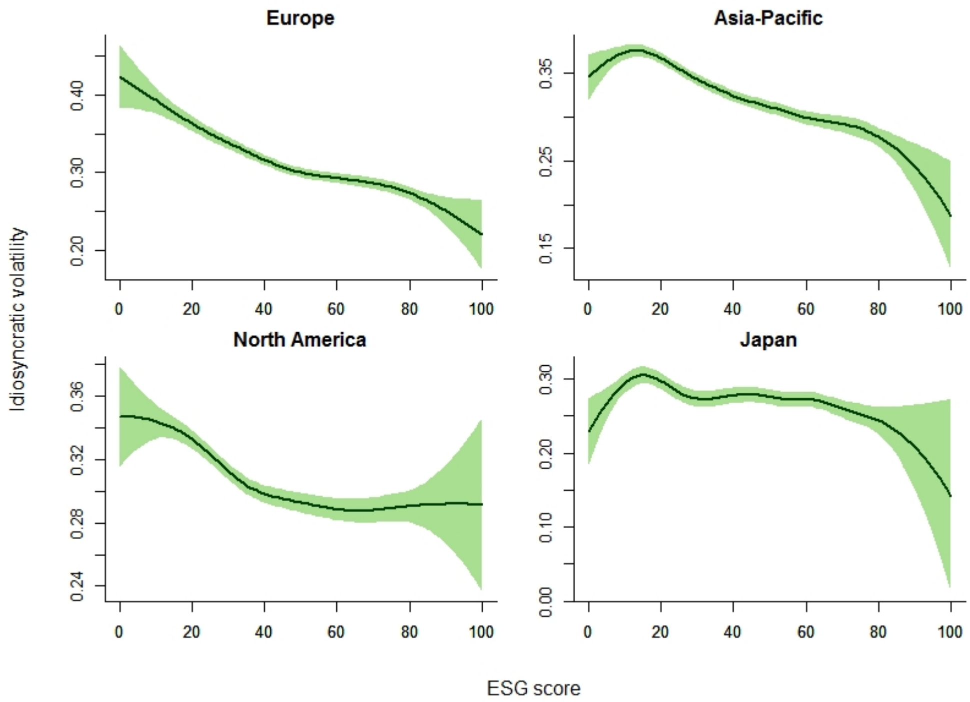

Figure 6.1: Non-linear relationship between ESG and idiosyncratic risk estimated from a semi-parametric model on regional subsamples.

The semiparametric model indicates that the risk-reducing effect of ESG is most prominent for low ESG scores between 20 to 50. To further investigate this, we split the complete sample in two by the median ESG score (40.8), one group high performers and one low. Equation (4.1) is now estimated separately on the low and high ESG sample. The result from this regression is shown in Table C.1 in the Appendix. For the low ESG sample, there is a negative association between ESG and idiosyncratic risk that is significant at the 1% level. For the high ESG sample, no significant relationship between ESG and idiosyncratic risk is found. These results confirm that the risk-reducing effect of ESG is mainly concentrated in low ESG firms. Figure 6.2 shows the distribution of ESG scores for each of the regions. The box plot divides the data into four sections that contain 25% of the data in each sample. The thick vertical line shows the median ESG score for each region, and the box illustrates the interquartile range (25-75% quantile). The whiskers extend to the lowest and highest score, excluding outliers. Outliers are defined as lying 1.5 times the interquartile range outside of the box. Figure 6.2 illustrates that the median ESG score in our sample is highest in Europe and Japan. The higher ESG scores could explain the lack of a significant association between idiosyncratic risk and ESG in Europe and Japan, as the risk-reducing effect of ESG is mainly concentrated in low ESG firms.

Our findings of a significant association between ESG and idiosyncratic risk in North America and Asia-Pacific are in line with previous literature (Utz, 2018; Kyaw, 2020). However, the lack of a significant association between ESG and risk in Europe and Japan is not supported by the results of Sassen et al. (2016) and Utz (2018). The former paper finds a negative and significant association between ESG and risk using a sample of European firms from 2002-2014. The latter finds a negative and significant relationship using a sample of Japanese firms from 2003-2015. Our findings indicate that the negative ESG-risk relationship is concentrated in low ESG firms, and as our data set stretches from 2008 to 2018, a potential explanation could be that some of the risk-reducing effect from ESG has vanished over the last years of growing ESG development in Europe and Japan. To better understand why the effect of ESG on idiosyncratic risk varies across regions, we examine how information asymmetry and climate risk affect the ESG-risk relationship in the following sections.

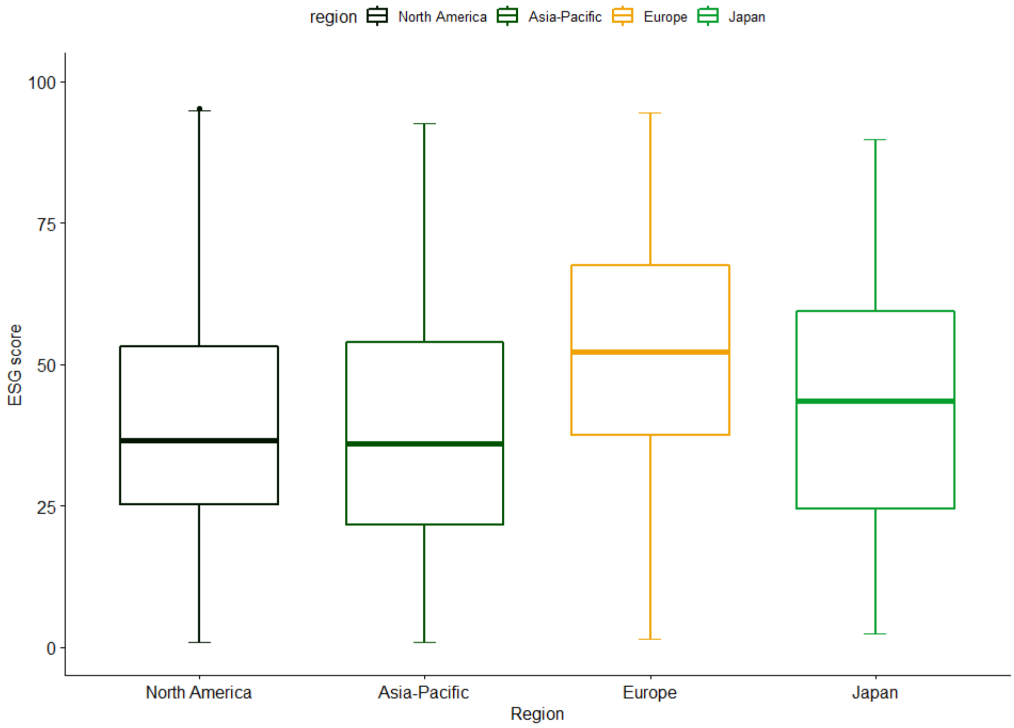

Figure 6.2: Distribution of the ESG scores for regional subsamples, illustrated as box plots.

6.3 Information asymmetry and ESG

In this section, we perform a mediation analysis to determine whether decreased information asymmetry is a channel through which ESG decreases idiosyncratic risk. As described in Section 4.2, the first step is to determine whether there is a significant relationship between the independent variable (ESG) and the dependent variable (idiosyncratic risk). This relationship is significant and was presented in Section 6.1. The second step is to determine whether there is a significant association between the independent variable (ESG) and the mediating variable (information asymmetry). Table 6.3 presents the results from estimating Equation (4.2) where information asymmetry is regressed on ESG. Column (1) indicates that information asymmetry is not significantly associated with ESG when the entire sample is considered. In the complete sample, we do not find evidence to support the hypothesis that decreased information asymmetry is a channel through which ESG decreases risk. However, columns (2) and (3) show that the relationship between ESG and information asymmetry is negative and significant in North America and Asia-Pacific. Columns (3) and (4) show that ESG is not significantly associated with information asymmetry in Europe and Japan. Seen in combination with the results from the previous section, the two regions where ESG and information asymmetry are negatively associated, North America and Asia-Pacific, are the same regions where ESG and idiosyncratic risk are negatively associated. In Europe and Japan, we can not find a significant relationship between ESG and information asymmetry. For the same regions, no significant relationship between ESG and idiosyncratic risk is found. Moreover, Europe and Japan are also the regions with the highest ESG scores. A potential interpretation is that the risk-reducing effect of ESG is not detectable in Europe and Japan because these regions are further ahead in ESG-development and have already benefited from a reduction in information asymmetry through their past ESG efforts.

Table 6.3: Association between information asymmetry and ESG for the complete sample and regional subsamples.

	IA				
	All	North America	Asia-Pacific	Europe	Japan
	(1)	(2)	(3)	(4)	(5)
ESG	-0.010	-0.027^{***}	-0.060^{**}	0.065	-0.004
	(0.016)	(0.006)	(0.019)	(0.066)	(0.005)
SIZE	-0.353^{***}	-0.298^{***}	-0.710^{***}	-0.054	-0.115^{***}
	(0.043)	(0.016)	(0.052)	(0.175)	(0.024)
LEV	0.137^{***}	0.055^{***}	0.142^{***}	0.198^{*}	0.078^{***}
	(0.023)	(0.010)	(0.027)	(0.079)	(0.010)
LIQ	-0.012	-0.009^{**}	-0.015^{*}	-0.020	-0.001
	(0.007)	(0.003)	(0.007)	(0.040)	(0.002)
MTB	-0.029^{*}	-0.024^{***}	-0.081^{***}	-0.002	0.002
	(0.012)	(0.004)	(0.017)	(0.044)	(0.010)
CAFL	-0.041^{***}	-0.038^{***}	-0.065^{***}	-0.013	-0.055^{***}
	(0.007)	(0.002)	(0.011)	(0.042)	(0.010)
RET	0.022^{***}	0.010^{***}	0.046^{***}	0.011	0.012^{***}
	(0.006)	(0.003)	(0.007)	(0.026)	(0.003)
AGE	0.128^{***}	0.053^{***}	0.228^{***}	0.234	-0.052^{***}
	(0.032)	(0.011)	(0.045)	(0.129)	(0.012)
Observations	27,064	10,136	7,647	5,859	3,422
R^2	0.016	0.151	0.110	0.011	0.330
Adjusted R^2	-0.202	-0.095	-0.088	-0.156	0.232
Note:					*p<0.05; **p<0.01; ***p<0.001

The final step in the mediation analysis is to estimate Equation (4.3). Table 6.4 shows the results from this regression. The results show that ESG is significantly associated with information asymmetry and idiosyncratic risk in North America and Asia-Pacific. In Europe and Japan, no significant association is found. Therefore, only the two former regions are included in Table 6.4 for the sake of brevity.[8]

Columns (1) and (3) repeats the baseline results for North America and Asia-Pacific, where idiosyncratic risk is regressed on ESG without including information asymmetry. Column (2) and (4) show the results where information asymmetry is included as mediating variable. Column (2) shows that information asymmetry is positively associated with idiosyncratic risk in North America. Moreover, the magnitude of the ESG coefficient in column (2) is reduced when information asymmetry is added to the regression, indicating that ESG affects risk through decreased information asymmetry. Since the ESG-coefficient is still significant, we have a case of partial mediation. The same effect can be observed for Asia-Pacific in column (4), where the ESG-coefficient is reduced in magnitude when information asymmetry is included. Sobel's test confirms that the mediating effect of information asymmetry on the ESG-risk relationship is significant at the 0.1% and 1% levels for North America and Asia-Pacific, respectively. The aforementioned findings provide compelling evidence to support *Hypothesis 1*: Better ESG performance reduces idiosyncratic risk through decreased information asymmetry.

[8]Europe and Japan are included in Table C.2 in the Appendix. Sobel's test confirms that the mediating effect of information asymmetry on the ESG-risk relationship is not significant for both regions.

Table 6.4: The mediating effect of information asymmetry on the association between ESG and idiosyncratic risk in North America and Asia-Pacific.

	IV			
	North America	North America	Asia-Pacific	Asia-Pacific
	(1)	(2)	(3)	(4)
ESG	-1.017^{***}	-0.920^{***}	-1.072^{***}	-0.991^{***}
	(0.265)	(0.264)	(0.261)	(0.260)
IA		3.572^{***}		1.349^{***}
		(0.465)		(0.176)
SIZE	-2.977^{***}	-1.914^{**}	-5.625^{***}	-4.666^{***}
	(0.675)	(0.687)	(0.719)	(0.726)
LEV	1.400^{***}	1.204^{**}	1.237^{***}	1.045^{**}
	(0.419)	(0.418)	(0.371)	(0.370)
LIQ	0.357^{**}	0.390^{**}	1.005^{***}	1.024^{***}
	(0.121)	(0.121)	(0.093)	(0.093)
MTB	-0.602^{***}	-0.517^{**}	-1.328^{***}	-1.219^{***}
	(0.159)	(0.159)	(0.237)	(0.236)
CAFL	-0.102	0.032	-1.298^{***}	-1.210^{***}
	(0.077)	(0.079)	(0.157)	(0.156)
RET	0.029	-0.005	1.439^{***}	1.377^{***}
	(0.105)	(0.104)	(0.099)	(0.099)
AGE	-0.507	-0.698	1.688^{**}	1.381^{*}
	(0.466)	(0.465)	(0.628)	(0.626)
Observations	10,136	10,136	7,647	7,647
R^2	0.472	0.476	0.383	0.388
Adjusted R^2	0.319	0.324	0.246	0.252
p-value Sobel's test		0.000196		0.002891
Note:			*p<0.05; **p<0.01; ***p<0.001	

6.4 Climate risk and ESG

In this section, we perform a moderation analysis to examine how climate risk affects the association between ESG and idiosyncratic risk. To determine whether the ESG-risk relationship is strengthened in times of increased climate risk, we estimate Equation (4.4) using two different proxies for climate risk.

First, we employ the climate risk measure CR, adopted from Engle et al. (2020). It is measured as the correlation between the text content of The Wall Street Journal and a fixed climate change vocabulary. Table 6.5 shows the moderating effect of CR on the relationship between ESG and idiosyncratic risk. The CR coefficient is positive and significant across all samples, suggesting that the market is more volatile in periods of high climate risk. Moreover, the coefficient estimates are relatively consistent across all samples, indicating that the general climate risk affects all regions equally. Column (1) shows that the moderating effect of climate risk is not significant for the complete sample. With a regional segmentation, we get the same results for North America (2), Asia (3) and Japan (5).

Table 6.5: Moderating effect of CR on the relationship between ESG and idiosyncratic risk.

			IV		
	All	North America	Asia-Pacific	Europe	Japan
	(1)	(2)	(3)	(4)	(5)
ESG	−0.641***	−0.924***	−0.992***	0.470	0.418
	(0.149)	(0.264)	(0.260)	(0.332)	(0.352)
ESG×CR	−0.073	0.065	−0.153	−0.326**	−0.064
	(0.049)	(0.091)	(0.091)	(0.110)	(0.110)
CR	35.957***	35.286***	39.814***	38.468***	33.978***
	(0.474)	(0.847)	(1.110)	(1.003)	(0.988)
IA	0.183**	3.573***	1.352***	−0.106	6.078***
	(0.063)	(0.465)	(0.176)	(0.071)	(1.207)
SIZE	−4.747***	−1.923**	−4.682***	−6.603***	3.177*
	(0.406)	(0.687)	(0.726)	(0.875)	(1.606)
LEV	1.223***	1.201**	1.045**	0.678	1.152
	(0.215)	(0.418)	(0.370)	(0.396)	(0.685)
LIQ	0.817***	0.391**	1.021***	0.794***	0.401**
	(0.063)	(0.121)	(0.093)	(0.200)	(0.139)
MTB	−0.967***	−0.514**	−1.231***	−1.051***	2.357***
	(0.108)	(0.159)	(0.236)	(0.218)	(0.632)
CAFL	−0.511***	0.032	−1.208***	−1.963***	−1.735**
	(0.065)	(0.079)	(0.156)	(0.210)	(0.631)
RET	0.615***	−0.004	1.367***	0.186	1.016***
	(0.059)	(0.104)	(0.099)	(0.131)	(0.192)
AGE	0.681*	−0.711	1.396*	3.092***	−2.305**
	(0.300)	(0.465)	(0.626)	(0.650)	(0.823)
Observations	27,064	10,136	7,647	5,859	3,422
R^2	0.442	0.476	0.389	0.483	0.529
Adjusted R^2	0.318	0.324	0.253	0.396	0.460
f^2	0.0000998	0.0000662	0.0004531	0.0017421	0.0001141
Note:					*p<0.05; **p<0.01; ***p<0.001

However, column (4) shows that climate risk has a significant moderating effect in Europe, as the $ESG \times CR$ coefficient is negative and significant at the 1% level. In Europe, ESG does not provide a significant risk-reducing effect on its own. The effect of ESG on idiosyncratic risk is only significant and negative in times of increased climate risk. The negative moderating effect of CR could indicate that high ESG firms are better protected against the high volatility induced by climate risk. Moreover, f^2 is largest in Europe, further indicating that the moderating effect of climate risk is strongest in Europe. Overall, the results indicate that CR is, in fact, a moderating factor in Europe.

Second, we employ the climate risk measure *CRNEG*, also adopted from Engle et al. (2020). This measure is based on over a trillion news articles from 1,000 news outlets, and is measured as the intensity of climate news with negative sentiment. The main difference between *CR* and *CRNEG* is that the latter differentiates between positive and negative climate news in addition to being based on several sources rather than just the Wall Street Journal. Table 6.6 shows the moderating effect of *CRNEG* on the relationship between ESG and idiosyncratic risk. Overall, *CRNEG* has a significant and positive effect on idiosyncratic risk across all regions. This finding again indicates that the market volatility is greater in times of high climate risk. Furthermore, column (1) shows that the interaction term $ESG \times CRNEG$ is negative and significant at the 0.1% level for the full sample. This suggests that *CRNEG* moderates the relationship between ESG and idiosyncratic risk. Moreover, f^2 is larger for *CRNEG* compared to *CR* for all regions, indicating that the moderating effect of climate risk is strongest when considering climate news with a negative sentiment. We can not find a significant moderating effect of *CRNEG* in North America or Japan. Nevertheless, the moderating effect of *CRNEG* is negative and significant in Europe and Asia-Pacific. In Asia-Pacific, high climate risk strengthens the existing ESG-risk relationship. Moreover, periods of high climate risk can create a significant effect of ESG on risk in Europe, where ESG is not significantly related to risk in itself. The aforementioned findings provide evidence to support *Hypothesis 2*: Better ESG performance reduces idiosyncratic risk to a greater extent in times of increased climate risk.

To summarize our results and discussion, our findings indicate that better ESG performance reduces idiosyncratic risk through decreased information asymmetry. This effect is most prominent in the regions with lower ESG scores. This finding consolidates the literature that relates ESG with information asymmetry (Clarkson et al., 2008; Cho et al., 2013) and the literature that relates information asymmetry to risk (Zhang, 2006; Rajgopal and Venkatachalam, 2011; Lambertides and Mazouz, 2013). Furthermore, our results show that better ESG performance reduces idiosyncratic risk to a greater extent in times of increased climate risk. The moderating effect of climate risk is found to be most consistent in the regions with higher ESG scores. This finding adds to the studies on the relationship between ESG performance and climate risk (Engle et al., 2020; Huynh and Xia, 2020).

Table 6.6: Moderating effect of *CRNEG* on the relationship between ESG and idiosyncratic risk.

	IV				
	All	North America	Asia-Pacific	Europe	Japan
	(1)	(2)	(3)	(4)	(5)
ESG	-0.620^{***}	-0.902^{***}	-1.015^{***}	0.626	0.449
	(0.149)	(0.265)	(0.260)	(0.334)	(0.352)
ESG×CRNEG	-0.180^{***}	-0.091	-0.226^{*}	-0.461^{***}	-0.180
	(0.051)	(0.091)	(0.113)	(0.103)	(0.100)
CRNEG	6.662^{***}	6.532^{***}	7.334^{***}	7.287^{***}	6.258^{***}
	(0.088)	(0.156)	(0.205)	(0.192)	(0.182)
IA	0.178^{**}	3.563^{***}	1.363^{***}	-0.131	6.093^{***}
	(0.063)	(0.465)	(0.176)	(0.071)	(1.206)
SIZE	-4.704^{***}	-1.898^{**}	-4.632^{***}	-6.391^{***}	3.125
	(0.406)	(0.687)	(0.726)	(0.876)	(1.605)
LEV	1.223^{***}	1.201^{**}	1.044^{**}	0.636	1.182
	(0.215)	(0.418)	(0.370)	(0.396)	(0.685)
LIQ	0.816^{***}	0.388^{**}	1.024^{***}	0.793^{***}	0.394^{**}
	(0.063)	(0.121)	(0.093)	(0.200)	(0.139)
MTB	-0.965^{***}	-0.519^{**}	-1.222^{***}	-1.031^{***}	2.346^{***}
	(0.108)	(0.159)	(0.236)	(0.218)	(0.631)
CAFL	-0.512^{***}	0.032	-1.209^{***}	-1.980^{***}	-1.753^{**}
	(0.065)	(0.079)	(0.156)	(0.209)	(0.631)
RET	0.616^{***}	-0.004	1.370^{***}	0.211	1.009^{***}
	(0.059)	(0.104)	(0.099)	(0.130)	(0.192)
AGE	0.719^{*}	-0.667	1.418^{*}	3.256^{***}	-2.265^{**}
	(0.300)	(0.466)	(0.626)	(0.651)	(0.823)
Observations	27,064	10,136	7,647	5,859	3,422
R^2	0.442	0.476	0.389	0.484	0.530
Adjusted R^2	0.319	0.324	0.253	0.397	0.461
f^2	0.000564	0.000126	0.000636	0.003961	0.001081

Note: $^{*}p<0.05$; $^{**}p<0.01$; $^{***}p<0.001$

6.5 Robustness checks

The dependent variable *IV* is measured as the standard deviation of the residuals from the fitted Fama-French-Carhart four-factor model (Carhart, 1997), as detailed in Section 5.1.1. To examine the robustness of our results, we employ three additional measures of idiosyncratic risk. Table C.3 in the Appendix reports the results from estimating Equation (4.1) using the standard deviation of the residuals from the fitted Fama-French three-factor model (Fama and French, 1993) as a measure of idiosyncratic risk. Similarly, Tables C.4 and C.5 report the same using the Fama-French five-factor (Fama and French, 2015) and six-factor model (Fama and French, 2018), respectively. Regardless of which factor model is used to define the idiosyncratic risk, the association between ESG and idiosyncratic risk is negative and significant at the 0.1% level in North America and Asia-Pacific. In Europe and Japan, the association is not significant regardless of the idiosyncratic risk definition. This shows that our findings are robust to alternative measures of idiosyncratic risk.

Further, we use a different model specification to examine if this impacts our results. Our initial model includes firm- and year-fixed effects. We add industry-time-fixed effects to account for time-varying characteristics across industries. Table C.6 reports the results from this model specification. Qualitatively, the results do not differ when the model specification is changed. North America and Asia-Pacific are still the only regions where ESG is significantly associated with idiosyncratic risk.

As a final robustness check, we exclude the two sectors *Financials* and *Utilities*. As these sectors are highly regulated, they are sometimes excluded from data samples in empirical studies (Ferreira and Laux, 2007; Ng and Rezaee, 2020; Wu and Lai, 2020). Table C.7 in the Appendix reports the results from fitting the regression in Equation (4.1) when *Financials* and *Utilities* are excluded. The results are consistent with the complete sample, which shows that our results are robust when highly regulated sectors are excluded.

7 | Conclusion

The corporate world is changing, and firms face higher expectations towards their contribution and responsibility in society. The youngest generations have experienced the ongoing fight against climate change from they were born, causing a shift in expectations towards firms' environmental responsibility. The increased focus on ESG-factors could be seen as the corporate world's answer to the growing climate awareness but raises the question of which underlying financial incentives that drive the ESG investments. Existing literature suggests that ESG provides a risk-reducing benefit, as some studies have found a negative relationship between ESG and idiosyncratic risk (El Ghoul et al., 2011; Mishra and Modi, 2013; Sassen et al., 2016; Utz, 2018; Dumitrescu and Zakriya, 2021). However, these findings are not entirely consistent across different regions and time periods. In order to better understand these inconsistencies, it is essential to understand *how* ESG affects idiosyncratic risk. Current literature provides several arguments as to why ESG could reduce firm risk. Nevertheless, to the best of our knowledge, we are the first to empirically study *how* ESG affects idiosyncratic risk. We narrow the knowledge gap related to the ESG-risk nexus by examining whether information asymmetry and climate risk affect this relationship.

To model the relationship between idiosyncratic risk and ESG, we use a fixed effects panel regression model. The model is estimated on a data set from 2008 to 2018 with 27,064 complete observations from 4,886 unique firms, providing a more comprehensive and detailed data set compared to previous related studies. Variables that are known to be associated with idiosyncratic risk are added as controls. Moreover, time-fixed effects are added to account for yearly variations in market volatility, and firm-fixed effects are included to control for heterogeneity in time-invariant firm characteristics such as country, industry, management and listings.

Our results show that the relationship between ESG and idiosyncratic risk is negative and significant at the 0.1% level. Further analysis of regional subsamples shows a regional heterogeneity in the relationship. We find a significant negative relationship in North America and Asia-Pacific but not in Europe and Japan. To further explore these regional differences, we estimate a semiparametric model to examine the shape of the ESG-risk relationship. The results from the semiparametric model indicate that the risk-reducing effect of ESG is most prominent for low performing ESG firms. We find further support for this finding by splitting the full sample into a low- and high ESG sample, showing that ESG is only negatively associated with idiosyncratic risk in the low ESG sample. This could explain why there is no significant association between idiosyncratic risk and ESG in Europe and Japan, as these are the regions with the highest ESG scores.

Further, we perform a mediation analysis to determine whether decreased information asymmetry is a channel through which ESG decreases idiosyncratic risk. Our findings show that ESG is negatively associated with information asymmetry in North America and Asia-Pacific, the same regions where ESG and idiosyncratic risk are negatively associated. Furthermore, our results show that information asymmetry has a significant mediating effect on the ESG-risk relationship in North America and Asia-Pacific. However, in Europe and Japan, the regions where ESG and idiosyncratic risk are not significantly associated, ESG is not significantly associated with information asymmetry either. A possible interpretation is that the risk-reducing effect of ESG is not detectable in Europe and Japan because they are further ahead in ESG-development and have already benefited from a reduction in information asymmetry through their past ESG efforts. Our results confirm that ESG affects risk through decreased information asymmetry, although it does not account for all of the effect from ESG on idiosyncratic risk.

Next, we investigate if increased climate risk strengthens the relationship between ESG and idiosyncratic risk. We take a moderation approach, examining whether a market-based measure of climate risk affects the association between ESG and idiosyncratic risk. We employ two different measures of climate risk adopted from the work of Engle et al. (2020). First, we use a measure of climate risk based on the amount of climate-related news in the Wall Street Journal. Using this measure, we find that climate risk has a significant moderating effect on the ESG-risk relationship in Europe. This suggests that in Europe, ESG does not provide a significant risk-reducing benefit on its own, but the effect of ESG on idiosyncratic risk is significant and negative in times of high climate risk. Second, we employ a measure of climate risk based on the amount of climate-related news with negative sentiment from a global database with over one trillion news articles. We find that climate risk has a significant moderating effect in the complete sample. Moreover, the moderating effect of climate risk is stronger when considering climate news with a negative sentiment. Our findings provide evidence to support the hypothesis that the ESG reduces idiosyncratic risk to a greater extent in times of high climate risk.

Overall, our results indicate that ESG affects risk through decreased information asymmetry mainly in the regions with lower ESG scores. Moreover, increased climate risk strengthens the risk-reducing effect of ESG primarily in the regions with higher ESG scores. Our findings of information asymmetry as a channel through which ESG decreases risk consolidates the literature that relates ESG with information asymmetry (Clarkson et al., 2008; Cho et al., 2013) and the literature that relates information asymmetry to risk (Zhang, 2006; Rajgopal and Venkatachalam, 2011; Lambertides and Mazouz, 2013). Further, our findings of a strengthened relationship between ESG and idiosyncratic risk in times of increased climate risk adds to the work of Engle et al. (2020), finding that better ESG performers have improved financial performance in times of high climate risk.

We have identified several interesting topics for further research that could complement our findings. First, future studies could employ ESG metrics from several providers to improve the robustness of our findings. Second, additional channels through which ESG affects risk could be examined. For example, one channel worth investigating is whether corporate reputation could be a mediating variable that affects the ESG-risk relationship, as it is intuitively linked to the Social pillar of ESG. Moreover, further research could augment the argumentation of channels by discovering other variables that mediate or moderate the relationship. Finally, a modeling framework able to perform mixed data sampling could be applied to utilise more granular frequencies than yearly for several variables.

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A Methodology

Semiparametric Model

Our semiparametric model is based on radial basis functions, and is to be considered as a generalisation of smoothing splines (Ruppert et al., 2009). The underlying model $f(x)$ could be expressed as

$$f(x) = \sum_{j=0}^{m-1} \beta_j x^j + \sum_{k=1}^{K} u_k |x - \kappa_k|^{2m-1}, \qquad m = 1, 2, 3, ... \tag{A.1}$$

with

$$\mathbf{u} \equiv [u_1, ..., u_K]^T \sim N(\mathbf{0}, \sigma_u^2 \mathbf{\Omega}^{-1/2} (\mathbf{\Omega}^{-1/2})^T), \qquad \mathbf{\Omega} \equiv [|\kappa_k - \kappa_{k'}|^{2m-1}]_{1 \leq k, k' \leq K}, \tag{A.2}$$

where the vector of β values make up the regression coefficients and $|x - \kappa_k|$ are a set of spline basis functions that determine the penalty for the number of knots to include in the spline. $\mathbf{u}$ is the random subject intercept with variance σ_u^2. Splines knots κ_j where $j = 1, ..., K$ are the $x's$ where the slops of the curve can change. However, as pointed out by Ruppert et al. (2009), the problem is often simplified with the use of smoothing splines and extended to radial basis functions. As a consequence, the model could be expressed as

$$E(\mathbf{y}|\mathbf{u}) = g(\mathbf{X}\boldsymbol{\beta}|\mathbf{Z}\mathbf{u}), \qquad \mathbf{u} \sim (\mathbf{0}, \mathbf{G}), \tag{A.3}$$

where $\mathbf{y}$ is the vector of responses, $\mathbf{X}$ and $\mathbf{Z}$ are design matrices and $\boldsymbol{\beta}$ and $\mathbf{u}$ are coefficient vectors. In this case, g is a scalar "link" that evaluates the vector arguments. $\mathbf{Zu}$ is the random effect matrix with covariance matrix $\mathbf{G}$ and represent the non-linear effects in the panel data regression that we use. For more supporting literature, see Ruppert et al. (2009) and Wand et al. (2005).

B | Data

Table B.1: Description of all the variables in our data set.

Variable name	**Description**
Industry	TRE classification of companies in 11 economic sector according to their field of business.
Region	The company's region of exchange. Regions included is: Asia-Pacific (ex Japan), Europe, North America and Japan.
YEAR	Which year the firm-observation belongs to.
ESG	The ESG score set by TR based on the company's weighted performance in the underlying pillars and components.
IV	Idiosyncratic risk. Measured as the standard deviation of the residuals from the Fama-French five-factor model.
IA	Information asymmetry. Calculated as the yearly average of the daily bid-ask spread relative to the close price.
CR	Climate risk. Measured as the fraction of the daily Wall Street Journal that is dedicated to climate related topics.
CRNEG	Climate risk. Measured as the amount of climate-related news in Crimson Hexagon with a "negative sentiment".
SIZE	Size of the company. Measured as the natural logarithm of total assets reported.
LEV	Leverage of company. Formula: total debt / (market value of equity + total debt).
LIQ	Stock liquidity. Formula: trading volume / common shares outstanding.
MTB	Market-to-Book ratio. Formula: market capitalization / (total assets - total debt).
CAFL	Cash flow. Formula: cash flow from operations / total assets.
RET	Stock return performance. Calculated as the annual stock return.
AGE	Age of the firm. Measured as the natural logarithm of firm age.

C | Results

Table C.1: Relationship between ESG and idiosyncratic risk for the low and high ESG sample.

	IV	
	Low ESG	High ESG
	(1)	(2)
ESG	−0.931**	−0.059
	(0.335)	(0.241)
SIZE	−5.320***	−4.796***
	(0.569)	(0.671)
LEV	1.202***	1.229***
	(0.321)	(0.324)
LIQ	0.977***	0.464***
	(0.089)	(0.094)
MTB	−1.502***	−0.240
	(0.167)	(0.155)
CAFL	−0.254***	−2.128***
	(0.074)	(0.195)
RET	0.678***	0.618***
	(0.078)	(0.097)
AGE	1.400**	0.319
	(0.476)	(0.430)
Observations	13,532	13,532
R^2	0.408	0.454
Adjusted R^2	0.190	0.322
Note:	*p<0.05; **p<0.01; ***p<0.001	

Table C.2: Mediating effect of information asymmetry on the relationship between ESG and risk for all the regional subsamples.

	IV							
	North America	North America	Asia-Pacific	Asia-Pacific	Europe	Europe	Japan	Japan
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ESG	-1.017^{***}	-0.920^{***}	-1.072^{***}	-0.991^{***}	0.389	0.396	0.393	0.414
	(0.265)	(0.264)	(0.261)	(0.260)	(0.331)	(0.331)	(0.353)	(0.352)
IA		3.572^{***}		1.349^{***}		-0.108		6.056^{***}
		(0.465)		(0.176)		(0.071)		(1.206)
SIZE	-2.977^{***}	-1.914^{**}	-5.625^{***}	-4.666^{***}	-6.637^{***}	-6.642^{***}	2.476	3.174^{*}
	(0.675)	(0.687)	(0.719)	(0.726)	(0.876)	(0.876)	(1.606)	(1.605)
LEV	1.400^{***}	1.204^{**}	1.237^{***}	1.045^{**}	0.650	0.671	1.628^{*}	1.153
	(0.419)	(0.418)	(0.371)	(0.370)	(0.396)	(0.396)	(0.681)	(0.685)
LIQ	0.357^{**}	0.390^{**}	1.005^{***}	1.024^{***}	0.795^{***}	0.793^{***}	0.393^{**}	0.400^{**}
	(0.121)	(0.121)	(0.093)	(0.093)	(0.200)	(0.200)	(0.139)	(0.139)
MTB	-0.602^{***}	-0.517^{**}	-1.328^{***}	-1.219^{***}	-1.055^{***}	-1.055^{***}	2.384^{***}	2.372^{***}
	(0.159)	(0.159)	(0.237)	(0.236)	(0.219)	(0.218)	(0.634)	(0.631)
CAFL	-0.102	0.032	-1.298^{***}	-1.210^{***}	-1.947^{***}	-1.948^{***}	-2.072^{**}	-1.740^{**}
	(0.077)	(0.079)	(0.157)	(0.156)	(0.210)	(0.210)	(0.630)	(0.631)
RET	0.029	-0.005	1.439^{***}	1.377^{***}	0.217	0.218	1.083^{***}	1.011^{***}
	(0.105)	(0.104)	(0.099)	(0.099)	(0.130)	(0.130)	(0.192)	(0.192)
AGE	-0.507	-0.698	1.688^{**}	1.381^{*}	2.989^{***}	3.014^{***}	-2.632^{**}	-2.317^{**}
	(0.466)	(0.465)	(0.628)	(0.626)	(0.649)	(0.650)	(0.823)	(0.822)
Observations	10,136	10,136	7,647	7,647	5,859	5,859	3,422	3,422
R^2	0.472	0.476	0.383	0.388	0.482	0.482	0.525	0.529
Adjusted R^2	0.319	0.324	0.246	0.252	0.395	0.395	0.456	0.460
p-value Sobel's test		0.000196		0.002891		0.408211		0.511231

Note: $^{*}p<0.05$; $^{**}p<0.01$; $^{***}p<0.001$

Table C.3: Relationship between ESG and idiosyncratic risk when idiosyncratic risk is extracted from the Fama-French three-factor model.

	IV from Fama-French three-factor model				
	All	North America	Asia-Pacific	Europe	Japan
	(1)	(2)	(3)	(4)	(5)
ESG	-0.642^{***}	-1.049^{***}	-1.074^{***}	0.418	0.464
	(0.151)	(0.268)	(0.263)	(0.335)	(0.357)
SIZE	-4.766^{***}	-3.031^{***}	-5.548^{***}	-6.505^{***}	2.315
	(0.410)	(0.683)	(0.724)	(0.885)	(1.622)
LEV	1.255^{***}	1.388^{**}	1.240^{***}	0.622	1.692^{*}
	(0.217)	(0.424)	(0.374)	(0.401)	(0.688)
LIQ	0.821^{***}	0.373^{**}	1.006^{***}	0.821^{***}	0.391^{**}
	(0.063)	(0.122)	(0.094)	(0.203)	(0.141)
MTB	-0.971^{***}	-0.616^{***}	-1.333^{***}	-1.047^{***}	2.434^{***}
	(0.109)	(0.161)	(0.239)	(0.221)	(0.640)
CAFL	-0.535^{***}	-0.108	-1.327^{***}	-2.014^{***}	-2.041^{**}
	(0.065)	(0.078)	(0.158)	(0.212)	(0.636)
RET	0.596^{***}	-0.012	1.436^{***}	0.192	1.060^{***}
	(0.060)	(0.106)	(0.100)	(0.132)	(0.194)
AGE	0.772^{*}	-0.478	1.734^{**}	3.076^{***}	-2.470^{**}
	(0.302)	(0.471)	(0.632)	(0.657)	(0.832)
Observations	27,064	10,136	7,647	5,859	3,422
R^2	0.446	0.472	0.384	0.488	0.538
Adjusted R^2	0.323	0.319	0.247	0.401	0.470

Note: $^{*}p<0.05$; $^{**}p<0.01$; $^{***}p<0.001$

Table C.4: Relationship between ESG and idiosyncratic risk when idiosyncratic risk is extracted from the Fama-French five-factor model.

	IV from Fama-French five-factor model				
	All	North America	Asia-Pacific	Europe	Japan
	(1)	(2)	(3)	(4)	(5)
ESG	−0.631***	−1.014***	−1.088***	0.415	0.456
	(0.149)	(0.267)	(0.259)	(0.332)	(0.353)
SIZE	−4.878***	−3.128***	−5.641***	−6.621***	1.983
	(0.406)	(0.680)	(0.715)	(0.878)	(1.605)
LEV	1.342***	1.620***	1.287***	0.668	1.793**
	(0.215)	(0.421)	(0.369)	(0.397)	(0.681)
LIQ	0.804***	0.350**	0.989***	0.824***	0.377**
	(0.063)	(0.122)	(0.093)	(0.201)	(0.139)
MTB	−1.002***	−0.670***	−1.327***	−1.060***	2.340***
	(0.108)	(0.160)	(0.236)	(0.219)	(0.634)
CAFL	−0.534***	−0.112	−1.305***	−1.997***	−2.119***
	(0.065)	(0.078)	(0.156)	(0.210)	(0.630)
RET	0.610***	0.034	1.428***	0.161	0.966***
	(0.059)	(0.105)	(0.098)	(0.131)	(0.192)
AGE	0.734*	−0.385	1.583*	3.146***	−2.735***
	(0.300)	(0.469)	(0.624)	(0.651)	(0.823)
Observations	27,064	10,136	7,647	5,859	3,422
R^2	0.431	0.454	0.378	0.477	0.514
Adjusted R^2	0.306	0.296	0.240	0.389	0.443
Note:					*p<0.05; **p<0.01; ***p<0.001

Table C.5: Relationship between ESG and idiosyncratic risk when idiosyncratic risk is extracted from the Fama-French-Carhart six-factor model.

	IV from Fama-French-Carhart six-factor model				
	All	North America	Asia-Pacific	Europe	Japan
	(1)	(2)	(3)	(4)	(5)
ESG	-0.621^{***}	-0.969^{***}	-1.076^{***}	0.389	0.411
	(0.148)	(0.264)	(0.258)	(0.328)	(0.350)
SIZE	-4.874^{***}	-3.079^{***}	-5.679^{***}	-6.671^{***}	2.148
	(0.402)	(0.672)	(0.711)	(0.869)	(1.592)
LEV	1.308^{***}	1.575^{***}	1.271^{***}	0.664	1.734^{*}
	(0.213)	(0.416)	(0.367)	(0.393)	(0.675)
LIQ	0.795^{***}	0.338^{**}	0.987^{***}	0.795^{***}	0.387^{**}
	(0.062)	(0.120)	(0.092)	(0.199)	(0.138)
MTB	-0.988^{***}	-0.649^{***}	-1.334^{***}	-1.054^{***}	2.286^{***}
	(0.107)	(0.158)	(0.234)	(0.217)	(0.628)
CAFL	-0.521^{***}	-0.105	-1.295^{***}	-1.952^{***}	-2.066^{***}
	(0.064)	(0.077)	(0.155)	(0.208)	(0.625)
RET	0.625^{***}	0.067	1.430^{***}	0.177	0.982^{***}
	(0.059)	(0.104)	(0.098)	(0.129)	(0.190)
AGE	0.700^{*}	-0.440	1.557^{*}	3.031^{***}	-2.635^{**}
	(0.297)	(0.463)	(0.621)	(0.644)	(0.816)
Observations	27,064	10,136	7,647	5,859	3,422
R^2	0.430	0.454	0.377	0.474	0.516
Adjusted R^2	0.304	0.295	0.239	0.385	0.445
Note:					*p<0.05; **p<0.01; ***p<0.001

Table C.6: Relationship between ESG and idiosyncratic risk when industry-year-fixed effects are added to the regression.

	IV				
	All	North America	Asia-Pacific	Europe	Japan
	(1)	(2)	(3)	(4)	(5)
ESG	−0.666***	−0.971***	−1.058***	0.425	0.275
	(0.149)	(0.267)	(0.261)	(0.332)	(0.358)
SIZE	−4.401***	−2.400***	−5.264***	−6.253***	2.095
	(0.409)	(0.690)	(0.725)	(0.893)	(1.628)
LEV	1.204***	1.005*	1.213**	0.641	2.816***
	(0.215)	(0.422)	(0.375)	(0.402)	(0.714)
LIQ	0.799***	0.270*	1.019***	0.804***	0.382**
	(0.062)	(0.121)	(0.093)	(0.200)	(0.140)
MTB	−0.910***	−0.484**	−1.237***	−1.020***	2.283***
	(0.109)	(0.162)	(0.239)	(0.223)	(0.649)
CAFL	−0.446***	−0.055	−1.185***	−1.848***	−1.688**
	(0.064)	(0.077)	(0.157)	(0.214)	(0.636)
RET	0.622***	0.010	1.405***	0.240	1.209***
	(0.060)	(0.109)	(0.102)	(0.135)	(0.201)
AGE	0.680*	−0.558	1.549*	2.882***	−0.768
	(0.299)	(0.468)	(0.629)	(0.656)	(0.856)
Observations	27,064	10,136	7,647	5,859	3,422
R^2	0.454	0.490	0.402	0.500	0.552
Adjusted R^2	0.331	0.335	0.259	0.406	0.471

Note: *p<0.05; **p<0.01; ***p<0.001

Table C.7: Relationship between ESG and idiosyncratic risk when Financials and Utilities are excluded from the sample.

	IV				
	All	North America	Asia-Pacific	Europe	Japan
	(1)	(2)	(3)	(4)	(5)
ESG	-0.648^{***}	-1.205^{***}	-0.770^{*}	0.462	0.246
	(0.167)	(0.298)	(0.301)	(0.371)	(0.357)
SIZE	-5.489^{***}	-2.388^{**}	-6.773^{***}	-7.675^{***}	0.878
	(0.461)	(0.752)	(0.831)	(1.023)	(1.699)
LEV	1.393^{***}	1.145^{*}	1.099^{*}	1.371^{*}	2.271^{**}
	(0.264)	(0.517)	(0.441)	(0.540)	(0.769)
LIQ	0.763^{***}	0.661^{***}	0.774^{***}	0.562^{**}	0.175
	(0.073)	(0.173)	(0.106)	(0.214)	(0.146)
MTB	-0.994^{***}	-0.638^{***}	-1.365^{***}	-1.031^{***}	2.536^{***}
	(0.112)	(0.166)	(0.254)	(0.225)	(0.620)
CAFL	-0.490^{***}	-0.107	-1.216^{***}	-2.140^{***}	-1.619^{**}
	(0.066)	(0.079)	(0.166)	(0.222)	(0.617)
RET	0.671^{***}	0.092	1.402^{***}	0.311^{*}	1.140^{***}
	(0.063)	(0.111)	(0.107)	(0.140)	(0.200)
AGE	1.374^{***}	-0.026	2.657^{***}	4.114^{***}	-1.591
	(0.337)	(0.521)	(0.719)	(0.751)	(0.926)
Observations	21,881	8,121	6,143	4,656	2,961
R^2	0.432	0.457	0.363	0.487	0.540
Adjusted R^2	0.305	0.296	0.220	0.400	0.472
Note:					$^{*}p<0.05$; $^{**}p<0.01$; $^{***}p<0.001$

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