THE RELATIONSHIP BETWEEN COST OF EQUITY AND ESG: THE EFFECT OF COVID-19

RUIJIE FAN
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Ruijie Fan

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Dr. Ebenezer Asem Thesis Co-Supervisors University of Lethbridge Lethbridge, Alberta	Associate Professor	Ph.D.
Dr. Gloria Tian Thesis Co-Supervisors University of Lethbridge Calgary, Alberta	Associate Professor	Ph.D.
Dr. Yutao Li Thesis Examination Committee Member University of Lethbridge Calgary, Alberta	Associate Professor	Ph.D.
Dr. David Xiang Thesis Examination Committee Member Newcastle University Newcastle upon Tyne	Senior Lecturer	Ph.D.
Craig Wilson External Examiner University of Saskatchewan Saskatoon, Saskatchewan	Professor	Ph.D.
Luis Escobar Chair, Thesis Examination Committee University of Lethbridge Lethbridge, Alberta	Assistant Professor	Ph.D.

Abstract

Several prior studies report that environmental, social, and governance (ESG) initiatives temper the cost of equity. More recent studies show that COVID-19 increased the cost of equity. It is unclear whether the ESG mitigated the higher cost of capital during the COVID period. I focus on studying this using ESG and basic financial data for the period ranging from 2015 to 2022 based on U.S. and Canadian firms listed on NYSE, AMEX, and NASDAQ. The results show that the increase in the cost of equity during the COVID period concentrates less on firms with high ESG performance scores, suggesting ESG mitigated the increase in the cost of equity. This is consistent with the insurance-like effect of ESG on the cost of capital, cushioning the increase in the cost of capital during uncertain periods. In addition, my study reveals that the amplified ESG benefit in cost of equity reduction can be moderated by levels of industrial GDP growth and the stringency of the COVID-19 government policy.

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List of Abbreviations

ESG: Environmental, Social, and Governance
COE: Cost of Equity

Chapter 1: Introduction

Initially, the COVID-19 pandemic was considered a dangerous threat only to public health. However, its negative impact on the economy was soon felt shortly after lockdowns and other measures were implemented to control the quick spread of the epidemic. The early evidence from U.S. public firms shows that it was more challenging for firms to obtain equity financing with the swift spread of the COVID-19 pandemic. The equity financing cost increased by around 1.72% on average due to the impact of the COVID-19 pandemic (Ke, 2022).

Environmental, Social, and Governance (ESG), as essential criteria in business sustainability, was developed in the 1970s and became more popular in the 21st century. The financial sustainability performance pays off in that ESG is negatively associated with firms' cost of equity (Ng & Rezaee, 2015). This negative relationship suggests that the superior ESG firm performance reduces investors' perceived risk, leading investors to require a lower return (Mio et al., 2023), which implies that adopting the ESG benchmark is helpful for firms' financial survival during unexpected crises such as the COVID-19 pandemic.

The COVID-19 pandemic leads to the uncertainty and lower efficiency in business operation and production (Klimecka-Tatar and Ulewicz, 2021), which increases the risk for investment. This results in an increase in the cost of equity for firms because investors perceive the higher level of risk in investment. However, firms with better ESG performance are less risky than those with worse ESG performance for investors (Mio et al., 2023). That is because prominent ESG performance can help firms avoid the negative impacts on the assets, financial and earnings situation, or reputation of a supervised entity when an uncertain social or environmental event or condition occurs (European Commission, 2020). ESG enhances the firms' ability to keep a sustainable development (Zhou et al., 2022), indicating that the ability to sustain growth over time allows firms to reduce the risk.

There are multiple articles discussing the benefit of ESG (La and Bernini, 2022; Raimo, 2020) but there is a noticeable gap in investigating whether and how ESG reduces cost of equity during the pandemic. Identifying the gap between the firms' ESG performance and the increasing cost of equity due to the COVID-19 pandemic, I am highly motivated to explore how ESG serves as an insurance (Godfrey et al., 2009; Amiraslani et al., 2023) to help firms to help firms obtain the lower cost of equity to survive the crisis.

In my study, with the sample of public-traded firms in the North American market (from 2015 to 2022), I examined the relationship between the cost of equity and ESG by exploring whether ESG reduced the cost of equity more during the COVID-19 pandemic. I also investigated the ESG benefit for firms by industry during the pandemic. Additionally, I compared the benefit of ESG for firms under different levels of stringency in COVID-19 government policy.

Regarding my research questions, I hypothesize firms associated with higher ESG scores could benefit from lower cost during the COVID-19 pandemic due to the insurance mechanism (Godfrey et al., 2009; Amiraslani et al., 2023). The insurance mechanism allows the ESG to have a better pay-off in the drop of the cost of equity when the COVID-19 pandemic destroyed the business by reducing the perceived risk from investors. Based on the insurance mechanism, I also hypothesize that the ESG insurance-like benefit is amplified for firms with negative industrial GDP growth and firms under stringent COVID-19 government policy. Negative industrial GDP growth and stringent COVID-19 government policies reflect the difficulty for the firms to survive during the COVID-19 pandemic. The ESG insurance pay-off is higher when the circumstance worsens because ESG signals promising sustainable growth with resilience (Yi, 2020) against the increasing risk during the COVID-19 pandemic.

Based on the results, I find that firms with greater overall ESG performance obtain the lower cost of equity. Environmental, Social, and Governance pillars, also tempers the firms' equity financing cost respectively. Moderated by the industry, the E and G benefit in the cost of equity reduction is amplified for those firms that experienced negative industrial GDP growth during the COVID-19 shock. Regarding the COVID-19 government policy, the E and S benefit in reducing firms' cost of equity is pronounced for firms under more stringent pandemic government measures. These confirm that the insurance mechanism of ESG effectively mitigates the expected risk for investors during the COVID-19 pandemic (Amiraslani, 2023; Godfrey et al., 2009).

To sum up, the COVID-19 pandemic is initially viewed as a problem in the medical field, then in the field of finance the study of the relationship between the COVID-19 pandemic and the economy arises during the epidemic period when the economic downturn became obvious. Yet, financial experts mainly focus on the benefit of ESG, thus leaving room for delving into the ways ESG reduces cost of equity during the pandemic. Therefore, there is a certain potential for further research in this neglected area. Findings to address the neglected area can provide insights for firms, investors, and policy-makers. The four sections in the following literature review will briefly overview the core concepts, summarize what have been found in the previous research and clarify the relevance to my topic of study.

Chapter 2: Literature Review

2.1 Cost of Equity and COVID-19 Pandemic

Cost of equity (COE) is defined as the return shareholders expect on their investment in a firm to compensate for the risk of investing in the firm. It is also an essential benchmark for both businesses and investors. COE is frequently used as the internal rate or the discount rate to determine the valuation of the firms based on the cash flow method (Mio, 2023). The review section 2.1 provides a summary of the existing academic work on the correlation between the cost of equity and the COVID-19 pandemic. Specifically, this section explores the critical academic findings about COE during the COVID-19 pandemic and the models for estimating the cost of equity.

In the past few years, the financial markets have gone through significant fluctuations, including but not only limited to the 2008 Great Financial Crisis, the deteriorative impacts of climate change, and the recent COVID-19 pandemic (Dmuchowski et al., 2023). The COVID-19 bothered the daily operations in education, recreation, business, and other fields from the beginning of 2020. It first started as a health crisis but soon deteriorated into a full-scale economic crisis with significant economic and social impact (Goodell, 2020). To verify and quantify the economic impact of the COVID-19 pandemic, Ke (2022) examined whether and how the COVID-19 pandemic influences companies' cost of equity, and the findings confirm that the U.S. public firms suffer from 172 basis-points increase on average in the cost of equity. In addition, firms with greater COVID-19 exposure suffer from the higher cost of equity (Ke, 2022).

The risk-reward theory by Markowitz (1952) can interpret Ke's finding that the COVID-19 contributes to more expensive equity financing. Markowitz (1952) proposed that the higher risk is associated with higher return. The increasing risk is grounded in the crisis that the COVID-19 pandemic makes people sick, thus directly preventing employees from production (Bloom et al., 2023). In addition, the regulation to stop the spread of the COVID-19 pandemic further restricts production efficiency (de Vries et al., 2021). During the COVID-19 pandemic, the increasing production inefficiency and the uncertainty about the future have signalled higher risk for investors. The investors deserve compensation for a higher return as they undertake more risk. This forces investors to request a higher return, leading to the higher cost of equity for firms.

Ke's finding can be also justified from another angel: perspective of behavioural finance. The COVID-19 is considered a dangerous threat to health threatening both the physical and mental health of people globally (Arslan et al., 2021). The mental influence associated with coronavirus disease can contribute to anxiety, pessimism, and fear, leading to negative sentiment. Investigating the daily announcements selected from the Wall Street Journal column, Tetlock (2007) explores the relationship between the stock market and public sentiment. The findings show that higher pessimism forecasts downward pressure on market price (Tetlock, 2007). Similarly, Berinato (2017) claim that air pollution brings down the stock market due to the negative sentiment impact. The negative sentiment increases investors' demand for a higher return than a fair return. This evidence shows that negative sentiment from investors caused by COVID-19 is an alternative interpretation of the increasing cost of equity during the pandemic.

Different methodologies have been used to estimate the cost of equity. The classic models are the Capital Asset Pricing Model (Sharpe, 1964), the Fama-French Three-Factor Model (Fama and French, 1993), and the Fama-French & Carhart Four-Factor Model (Carhart, 1997). For example, Kostin, Runge, and Mamedova (2022) selected the Fama-French Three-Factor Model to examine energy-sector companies during the COVID-19 pandemic. These traditional models seek to utilize historical data to estimate the cost of equity. According to the existing literature, alternative models have been used to estimate the cost of equity based on forecasting financials on analyst earnings forecast data (Gebhardtetal, 2001; Thomas, 2001; Ohlson and Jeutterner, 2005; Easton, 2004). These four estimates require forecast growth rate and forecast earnings to measure the cost of equity. Given that the COVID-19 pandemic is a new issue that human beings have never experienced in the history, the present models may not be appropriate for estimating the cost of equity in this different situation. The present models for estimating the cost of equity in this different situation may be questioned in terms of which is the most appropriate one to analyze the issue. And within the Academy of Finance, there has yet to be a consensus regarding the best estimate. Among the existing literature, traditional approaches to estimating the cost of equity are applied in the most recent research. For example, the Capital Asset Pricing Model developed in 1964 by Sharpe has been used to calculate the cost of equity based on evidence from China (Chen et al., 2023).

In terms of the control variables in the model that estimates the cost of equity, the relevant literature suggests incorporating the essential firm characteristic variables as control variables in the financial models (Ke, 2022; Chen et al., 2023). These control variables include firm size, growth rate, leverage, book-to-market ratio (B2M), idiosyncratic volatility, earnings volatility, firm beta, and momentum (e.g., Ke, 2022; Chen et al., 2023). These variables provide insights into constructing the baseline model in my research on the relationship between the cost of equity and the COVID-19 pandemic.

To sum up, Ke (2022) reports the early evidence on how the COVID-19 pandemic damaged the economy by causing a higher cost of equity for firms. Additionally, his research provides insights into the firm-specific characteristics that may influence the cost of equity. Regarding my study, I cover the full 3 years of the pandemic to construct evidence which shows the adverse effect of COVID-19 in the long-run perspective. Although I replicate the control variables from

Ke (2022), I use the Fama-Freach Carhart Four Factors model to estimate the cost of equity, which demonstrates how the business suffers from COVID under a different model. However, the main contribution of my study concentrates on the risk-mitigation benefit for the increased cost of equity during the COVID-19 pandemic due to ESG-insurance/protection benefit. Ke (2022) provides me with an appealing structure to incorporate the ESG-related factors in the regression model to make a contribution to fill the gap between ESG benefits during the COVID period and the cost of equity.

2.2 Cost of Equity and ESG

The report titled "Who Cares Wins – Connecting Financial Markets to a Changing World" written by the United Nations Global Compact (UNGC), first introduced the concept of Environmental, Social, and Corporate Governance (ESG) in 2004. The initiative regarding the promotion of ESG helped develop the collaborative awareness of the financial organizations to incorporate the ESG criteria into decision-making regarding asset management, stock brokerage services, and related research activities (IFC, 2004). The establishment and development of ESG helps recognize and incorporate ESG considerations in the financial market. In recent years, the financial world has increasingly emphasized Environmental, Social, and Governance (ESG) performance. This focus on sustainability and ethical practices has raised questions about how these factors interact with traditional financial metrics, particularly the cost of equity. The identified trend revealed by the existing literature also shows the increasing interest in sustainability (e.g. ESG) from the stakeholders (Al-Hiyari & Kolsi, 2021; Khan et al., 2016).

Before the investigation of the ESG benefit during pandemic, most papers claimed that ESG played an essential role in reducing the cost of equity capital (e.g., La and Bernini, 2022; Raimo, 2020). Most studies on ESG investigate the firms' total ESG performance, focusing on firm-level analysis. Looking into the joint effect of firm ESG performance, Tang (2022) concludes that companies effectively addressing ESG concerns enhance their capacity/ability to resolve the information asymmetry between shareholders and companies. This conclusion indicates how ESG helps lead to a reduction in the costs associated with equity financing. By exploring each pillar of ESG individually, Temiz (2022) reveals the relationship between environmental performance and cost of capital. The finding proves the reducing effect of firms' environmental performance on their cost of equity capital. Similarly, the studies focusing on firms' social performance (Chouaibi & Zouari, 2022) and governance performance (Friedrich & Schmidt, 2022) also confirm the positive impact (benefit) of the ESG practice, which means that firms can take advantage of the ESG performance. These findings suggest that companies benefit from the total ESG performance and each ESG pillar.

Various theories can interpret why ESG pays off for those firms with better ESG performance. For example, stakeholder theory (Freeman et al., 2010), social responsibility investment theory (Sparkes & Cowton, 2004), and triple bottom line (TBL) theory (Elkington, 1997), highlighted the prospects of the future of sustainability from different point of view, which implies that firms' ESG performance can be potentially beneficial to those firms contribute to sustainable development. Stakeholder theory articulates that all stakeholders' (owners, employees, communities, government etc.) interests should be taken into consideration when a decision is made. Social responsibility investment theory highlights that investment should not only generate financial returns, but it should also contribute positively to the society. Triple bottom line theory argues that profit, people, and planet are three key areas for firms to focus for their sustainable development.

With respect to equity reduction, different theories related to sustainability can explain the benefits of taking ESG into consideration. Based on the risk-reward theory, the ESG benefits can be interpreted from the relationship between risk and return (Markowitz, 1952) in my thesis. Section 2.1 has already discussed the increase in risk which is caused by the COVID-19 pandemic. The subsequent higher perceived risk forces investors to require a higher rate of investment return, resulting in a higher equity cost for firms. However, the effective utilities of ESG performance can temper the investors' perceived risk, resulting in a lower expected return demanded by the investors (Mio et al., 2023). The core motivation for socially responsible investors to favour ESG firms comes from the belief that better non-financial performance in sustainability contributes to better financial performance (Chatterji et al., 2009). Superior expected ESG performance is more likely to prevent the firm from falling into a risk crisis. A variety of risks, such as political, market, societal, and technical risks, can be reduced by extraordinary ESG firm performance (Schaltegger et al., 2012). Sustainable practice creates insurance-like protection for firms (Godfrey et al., 2009; Amiraslani et al., 2023), especially the ESG practice, which can serve as insurance against legal threats for firms (Koh, 2014).

CSR and ESG are all good proxies of the firms' non-financial performance (Lins et al., 2017; Amiraslani et al., 2023). When the systematic level of trust is worse than the expected trust the more trustworthy firms benefit from higher stock returns due to the insurance-like mechanism of CSR (Lins et al., 2017). This implies that firms considered as less risky entities by investors can benefit from the lower cost of equity due to the insurance-like mechanism of ESG during the COVID-19 pandemic when the systematic risk is worse than expected. Given the role that ESG practices serve as a buffer against systematic risks, it is essential to examine how traditional financial models like the Fama-French & Carhart Four-Factor Model quantify these risks and the potential mitigative effects of ESG on the cost of equity. The Fama-French & Carhart Four-Factor Model estimates the cost of equity based on market (market risk), size (small minus big), value (high minus low), and momentum (up minus down). The market factor captures the market risk premium. The size factor assesses the difference between small-cap stocks and large-cap stocks. The value factor quantifies the difference between high BV-to-MV stocks and low BV-to-MV stocks. The momentum factor evaluates the difference between winners (high past returns) and losers. All these factors collectively measure the systematic risk (Bello, 2008). ESG investment offers an opportunity to diminish the systematic risk (Cerqueti, et al., 2021). Furthermore, Responsible/ESG investment serves as the downside protection against ESG-related systematic risk because ESG addresses broader, market-wide issues (Jin, 2018). Other scholars also claimed that ESG investment mitigates the systematic contagion risk (De Bandt and Hartmann, 2015), which limits the propagation of negative externalities generated from one financial institution to others in the market (Cerqueti, et al., 2021).

Although most studies show the consensus that firms' cost of equity can be significantly reduced by their ESG performance (La and Bernini, 2022; Raimo, 2020; Tang, 2022; Temiz, 2022; Chouaibi & Zouari, 2022; Friedrich & Schmidt, 2022; Tanjung, 2023), Priem and Gabellone (2022) do not find evidence to support the ESG benefit that higher ESG scores can significantly reduce the cost of equity for firms.

To sum up, most studies show evidence to support the ESG benefit, but the relationship between the ESG and cost of equity during the pandemic needs to be explored. The benefits of ESG are explained from different perspectives, and risk-reward theory is adopted in my thesis because the risk-reward theory focuses on demonstrating the relationship between risk assessment and expected return, while other theories do not specifically address the risk-return relationship which is the fundamental to understand the change in the cost of equity for firms. The literature review in section 2.2 implies the gap in the ESG benefit of the cost of equity reduction during the pandemic. This motivates me to explore the ESG's potential insurance-protection benefit (Amiraslani et al., 2023; Godfrey et al., 2009; Koh, 2014) explained by risk-reward theory (Markowitz, 1952) during the COVID-19 shock.

2.3 Cost of Equity and Industries

The cost of equity for different industries may differ due to the diverse nature of the sectors with unequable levels of investment risk. This literature review section introduces North American Industry Classification System (NAICS) and U.S. Bureau of Economic Analysis (BEA) -- two reliable sources that can assist research by categorizing industries into groups by industrial definitions and annual GDP growth. The section also highlights the relevant literature with a significant investigation in different sectors and seeks to identify the gap my research needs to address.

Statistical Agencies of the United States, Canada, and Mexico developed the North American Industry Classification System (NAICS) to provide an industrial definition and framework for analyzing production-related issues (Statistics Canada, 2017). Twenty different categories are defined as (classification code in the brackets): Agriculture, forestry, fishing and hunting (11), Mining, quarrying, and oil and gas extraction (21), Utilities (22), Construction (23), Manufacturing (31-33), Wholesale trade (41), Retail trade (44-45), Transportation and warehousing (48-49), Information and cultural industries (51), Finance and insurance (52), Real estate and rental and leasing (53), Professional, scientific and technical services (54), Management of companies and enterprises (55), Administrative and support, waste management and remediation services (56), Educational services (61), Health care and social assistance (62), Arts, entertainment and recreation (71), Accommodation and food services (72), Other services [except public administration] (81), and Public administration (91). NAICS codes are commonly used in studies on the cost of equity, such as the cost of equity estimation (Cummins and Phillips, 2005) and the relationship between external governance and equity financing (Saadi et al., 2019).

Gross domestic product (GDP) aggregates the total market and monetary value of the final products produced and services provided in a given country during a fiscal year (Van, 2009). Thus, industrial GDP captures the size and the economy's performance by sector since GDP indicates economic well-being (Dynan and Sheiner, 2018). U.S. Bureau of Economic Analysis (BEA) is a platform that provides interactive data for users to understand U.S. economics, including the industry's GDP development. The BEA agency, founded in the 1970s and organized by the U.S. government department, has a good reputation for providing economics-related data. BEA is applicable in my research since around 99 percent of the firms in my study are U.S. firms. In addition, BEA is frequently used in social science studies, and the peer review from academic papers ensures its quality and reliability. BEA data has been used to measure the small business economy (Highfill et al., 2020) and the operations of U.S. Multinational companies (Barefoot and Mataloni, 2011). Thus, BEA constitutes a reasonable source for me to clarify groups based on the industrial GDP change.

The COVID-19 pandemic has affected various industries and sectors. The existing literature has examined many popular industries, such as the food and beverage industry (Raimo et al., 2020) and the regulated energy and infrastructure sector (Singh-K, Singh-A, and Prakash, 2022). Some more complicated studies examine multiple industries, such as natural gas, food, healthcare, software, petroleum, real estate, entertainment, and hospitality sectors (Mazur et al., 2021). The limitations of these studies seem to be that there is a lack of investigation in the insurance mechanism of ESG based on all industries during the pandemic; therefore, there is a great potential for further research in this neglected area.

2.4 Cost of Equity and Government Policy

Government policy is crucial for business development (Schneider, 1998; Matteis et al., 2022). Government policy can be associated with changes in regulation in tax, monetary system, trade, etc., which significantly determines the business operation. Škare and Golja (2014) study the impact of government CSR-supporting policies on economic growth to explore the interplay between government policy and business development.

Recently, OxCGRT has been the primary data source for several studies examining government responses to crises. These studies have reviewed the impact of government responses on volatility and liquidity (Baig et al., 2020; Zaremba et al., 2020, 2021; Zaremba et al., 2021; Bickley et al., 2021), herding behaviour (Kizys et al., 2020) and returns (Ashraf, 2020; Matthias et al., 2021). Oxford COVID-19 Government Response Tracker updated more than 180 countries' government responses to COVID and grouped the responses into three categories: Lockdown Response (Containment and Closure), Economic Response, and Health System Response (Hale et al., 2021). The Lockdown Response (Containment and Closure) includes the indicators for school closing, workplace closing, cancelled public events, restrictions on gathering size, closed public transport, stay-at-home requirements, restrictions on internal movement, and restrictions on international travel.

The Oxford COVID-19 dataset reveals how government policy varied from the beginning of 2020 to the end of 2022, which shows how the government implements lockdown, and satisfies the citizens' need for economic and health support. Appropriate restrictions on containment and closure can alleviate potential future risks. It is found that an optimal lockdown can generate a net benefit of up to $653 billion in the U.S. The mortality rate in European Union countries is inversely associated with the number of general hospitals, physicians, and nurses (Mattiuzzi et al., 2021). Dash and Maitra (2020) highlight the importance of understanding the relationship between pandemic uncertainty and investors' sentiment. Government policy in response to the COVID-19 crisis has reduced the death rate, effectively improving the COVID-19 conditions during the pandemic (Dergiades et al., 2020). Thus, the investors' fear and sentiment resulting from COVID-19 can be mitigated. Active government policies seek to alleviate the pandemic-related risk to health and the economy, and this helps dispel the uncertainty brought about by the COVID-19 pandemic and minimize the risk perceived by investors. Government interventions may help dampen the systematic risks associated with the pandemic, which mitigates investors' fear. These suggest that the adverse impact of COVID-19 on firms' cost of equity may be weaker under stricter government policy. This evidence shows how government responses to the spreading of COVID-19 help alleviate future risks and scares.

However, more substantial evidence from the existing literature supports the contrary viewpoint (de Vries et al., 2021; Baig et al., 2021; Li et al., 2023; Kok, 2020). Most studies show that the stringent government policy to control the COVID-19 pandemic damages the economy, leading to a higher risk for investors. During the COVID-19 pandemic, to cope with the health crisis, the local province or state must act or change their regulations to prevent the continuous spread of the virus, which significantly enhances the stringency of the government policy. Stringent and obligatory governmental policies imposed upon firms may significantly constrain their daily operations (de Vries et al., 2021). Such regulatory frameworks can exert negative pressure on the efficiency of production processes within these organizations (de Vries et al., 2021). Baig et al. (2021) explored the U.S. equity market to investigate the impact of COVID-19 from the perspective of micro-infrastructure. They find that stock market volatility and illiquidity increased due to reduced mobility from stringent lockdowns (Baig et al., 2021). Stringent government policies during the pandemic, such as lockdowns, can lead to increased uncertainty in the market. This uncertainty often results in higher market volatility as investors respond to the rapidly changing economic environment. Higher market risk, in turn, increases the cost of equity as investors demand a higher rate of return as compensation for undertaking greater risk. Stringent policies may also lead to market illiquidity as there might be fewer transactions in the market (Baig et al., 2021). An illiquid market can increase the cost of equity because investors might demand a liquidity premium to compensate for the difficulty in buying or selling assets without affecting the price of the assets. The stock market collapsed with dropping stock prices during the pandemic (Li et al., 2023), and the cost of equity increased correspondingly based on the Gordon Growth Model, also known as the Dividend Discounted Model (Gordon, 1959). Another study investigates the short-term trade-off between stringency and economic growth and indirectly infers that the cost of equity can be higher during the pandemic (Kok, 2020). The risk about lower levels of consumption and production can explain the higher cost of equity under stringent policies.

To sum up, it is true that timely government intervention is helpful in minimizing risks and building up investors' confidence in firms. However, strict government policies can lead to a decline in the overall productivity and efficiency levels of the daily operation of firms, which can bring down the financial market. Yet, there is a lack of comprehensive studies revealing the relationship between ESG insurance-like benefits and the cost of equity based on COVID-19 policy stringency. Examining this relationship from the perspective of COVID-19 policy can help fill the research gap.

Chapter 3: Hypothesis Development

3.1 Cost of Equity and ESG

H1: ESG tempers the increase in the cost of equity during the COVID-19 pandemic.

ESG, which is about the environmental, social, and governance, may affect an entity's financial performance or solvency, sovereign or individual (Li et al., 2021). The formal proposal of ESG was announced in 2004 and has been developed for around 17 years. The practice of ESG principles aligns with the need for sustainable development of the global economy and society (Li et al., 2021). Benchmark analysis discovered that firms' ESG performance lowered their cost of equity (Chen et al., 2023). This finding can be explained with the interpretation of the benefits of ESG. A lot of existing literature highlight the joint effect of environmental pillar performance, social pillar performance, and governance pillar performance. For example, Ng and Rezaee (2015) proposed that the strength of both environmental and governance pillars of sustainability performance imposes a direct effect on financial performance by either reducing environmental liabilities in the case of environmental initiatives or enhancing the effectiveness of corporate governance measures in the case of governance sustainability performance. In addition, ESG can both directly and indirectly lower the cost of equity because ESG performance helps attenuate the market risk and improve equity diversification (Chen et al., 2023). ESG activities could act as a buffer against market shocks, protecting the firm's cost of equity capital from the negative impacts of unexpected risks like those during the COVID-19 pandemic (Mio et al., 2023). Overall, I am interested in evaluating whether the ESG-related performance equip the firms with an insurance-like mechanism to protect their cost of equity capital when the market suffers from higher unexpected risk due to the COVID-19 pandemic.

3.1.1 Cost of Equity and Environmental Performance

H1-(a): Firms with better environmental performance benefit from amplified mitigation of the increase in the cost of equity during the COVID-19 pandemic.

When it comes to environmental performance, companies that excel in this area often find themselves less vulnerable to fines and penalties due to the updated and stricter regulations. The themes that current stakeholders are interested in not only limited to "economic" concerns but also involve "legal" and "environmental" concerns (Fombrun and Foss, 2004). Firms with better Environmental performance usually go beyond the minimum requirement for environmental laws in terms of emission and resource use, etc. The prior study finds that companies associated with poor profiles in the environment pillar raise capital with a higher equity cost (Chava, 2014), which infers that firms with better environmental performance can benefit from the lower cost of equity. The proactive behaviour measured by a firm's active environmental performance reduces regulatory risks, and this serves as a form of "insurance" against future environmental regulation change. The insurance mechanism and resilience can be earned due to the long-term operational efficiencies of environmental stewardship.

3.1.2 Cost of Equity and Social Performance

H1-(b): Firms with better social performance benefit from amplified mitigation of the increase in the cost of equity during the COVID-19 pandemic.

Social performance has the unique advantage of reducing perceived risk by building the firm image with trust through social capital. "Social capital" is a broad concept but can generally be viewed as the propensity of people in the society or community to collaboratively produce socially efficient outcomes (Putnam, 1993; Putnam, 2000). The social capital theory promotes the norms of reciprocity and trustworthiness, which can shape how individuals behave toward each other as members of society (Lins et al., 2017). Trust can be interpreted as the expectation that another person will perform beneficial actions, or at least not detrimentalto us regardless of our capacity to monitor those actions (Gambetta, 1988). There are two ways for firms to obtain trust. External acquired trust, or “Endowed trust” is obtained when firms are physically located in a high-trust district/society (Guiso et al., 2004). Internal trust, defined as "Earned trust" can be obtained if the firm invests in social capital (Amiraslani et al., 2023). Following the prior study (Lins et al., 2017), firms’ social performance can be considered a good proxy for measuring their social capital investment. The stronger practice in the social pillar helps firms gain more social capital by building higher trust among shareholders and stakeholders. Gupta, Rahman, and Shang (2018) highlight the inverse relationship between the cost of equity and the level of social capital investment. Firms with higher social performance are more likely to take human capital, product liability, stakeholder opposition, and social opportunities into consideration (MSCI, 2023). Firms with superior social performance contribute to society and are committed to ethical, sustainable, and socially responsible practices. Human capital development, outstanding product safety and quality, healthy community relationships, and easier access to finance amplify a company’s reputation, building trust between investors/customers and the firm. By being socially responsible for developing social capital, firms also mitigate legal risks, which prevents firms from being violating labour laws.

Thus, investors perceive firms, which invest in social capital, as more trustworthy and less risky. This leads to lower minimum returns for high-CSR firms during the COVID-19 pandemic crisis. Thus, social capital acts as the more effective insurance to protect firms from increasing the cost of equity when trustworthiness is more valuable during a crisis. The insurance benefits of social capital derived from stakeholder cooperation can manifest themselves during any crisis (Lins et al., 2017). I believe social capital can better help build stakeholder trust and reduce the risk. Thus, outstanding firm performance in social pillar should pay off more when the society is in crisis which definitely contributes to stress of uncertainty and fear (e.g., during the COVID-19 pandemic).

3.1.3 Cost of Equity and Governance Performance

H1-(c): Firms with better governance performance benefit from amplified mitigation of the increase in the cost of equity during the COVID-19 pandemic.

The firms' governance performance is also relevant to shaping risk perceptions and building up confidence in future growth for investors. Firms with better governance performance are more likely to fully comply with the management, shareholders, and CSR strategy requirements in corporate governance and corporate behaviour (MSCI, 2023; LSEG, 2023). Broadly, better performance in the governance pillar enables firms to reduce expected loss from efficient management due to a lower probability of risk ex-ante and lower severity of losses ex-post (Lu et al., 2021). In addition, firms with extraordinary governance performance make more transparent decisions, and the decision-making process may involve more ethical business practices. Compared to the firms with worse performance in governance, the "G" firms gain a larger magnitude of governance transparency in board selection, payment issues, ownership & control, and tax reports (MSCI, 2023). Governance transparency minimizes the uncertainty about the corporate structure and reduces the risk in business operations, which makes firms more trustworthy for investors. Additionally, with strong governance performance, firms are prone to adjust their business interests more closely aligned with the interests of shareholders. This alignment minimizes agency costs (Lundberg, 2022) and contributes to developing the business in a healthier, more efficient approach. These explain why preeminent governance can trigger the insurance-protection mechanism of lowering a company's cost of equity during the COVID-19 pandemic.

3.2 Cost of Equity and Industries

H2: The amplified benefit that ESG tempers the increase in the cost of equity during the COVID-19 pandemic is greater for firms associated with negative industrial GDP growth.

In general, industries with wide-ranging business characteristics differ based on how the business operates, what regulations they comply with, what consumer needs they have to satisfy, and what resources they rely on. For example, the tourism and hotel industry may be more sensitive to the severity of the COVID-19 pandemic (Anguera-Torrell, 2021; Škare, 2021). That explains the difference in performance for firms from different industries. GDP is an essential index of the economy (Van, 2009; Dynan and Sheiner, 2018), and industrial GDP growth measures the improvement or deterioration of the economic health by sector. For those firms from the industry with negative industrial GDP growth in 2020, ESG may highlight greater resilience (Benabou and Tirole, 2010) since risk mitigation obtained from ESG investment can serve as insurance to cope with crisis (Amiraslani et al., 2023). Compared to firms experiencing positive industrial GDP growth during the COVID-19 pandemic, the firms with negative industrial GDP growth face more severe survival challenges. Industries with negative growth during the COVID-19 pandemic encountered higher levels of scrutiny or needed to demonstrate greater resilience. ESG practice can exhibit resilience for stability because ESG insurance mechanisms may return higher payoffs to the firms in worse financial positions.

3.3 Cost of Equity and Government Policy

H3: The amplified benefit that ESG tempers the increase in the cost of equity during the COVID-19 pandemic is greater for firms associated with more stringent COVID-19 government measures.

Although some evidence articulates that government measures effectively alleviate and control the spread of COVID-19 (Dergiades et al., 2020), major prior studies show the negative influence of stringent government COVID-19 policies on the economy (Baig et al., 2021; Li et al., 2023; Kok, 2020). Stringent COVID-19 measures can significantly disrupt and slow down business operations, but firms with superior ESG practices are more likely to have more robust insurance mechanisms (Godfrey et al., 2009; Koh, 2014; Amiraslani et al., 2023) to adapt and navigate these challenges when the business environment is worse due to strict restriction. This can reduce investors' perceived risks and associated cost of equity for firms. In this way, the amplified benefit of ESG in lowering the cost of equity for companies under more stringent COVID-19 pandemic policies can be attributed to the enhanced resilience (Benabou and Tirole, 2010) because firms with better ESG performance can exhibit greater resilience during the COVID-19 pandemic. As to the firm complied with less stringent government policy, the benefits of ESG regarding the cost of equity reduction may be diluted because the insurance mechanism may not work as effectively as when the case is worse, which makes the benefit appear weaker during the COVID-19 pandemic for those firms under loose government policy.

Chapter 4: Data and Methodology

The timeframe of my research includes the three years during the COVID-19 pandemic and the five years before the crisis. A five-year period can be constructed to effectively analyze the financial trends (Öcal, 2007). Specifically, the five-year observation of cost of equity before the COVID-19 pandemic allows the analysis to show a more comprehensive capture of the long-term trend than the symmetrical three years before the COVID-19 pandemic. Employing a series of U.S. and Canadian publicly traded firms listed on NYSE, AMEX, and NASDAQ from 2015 to 2022, my study seeks to respond to the gap by addressing whether the benefit that ESG tempers the higher cost of equity is amplified during the COVID-19 pandemic. In the construction of the variables, the data used for the construction of the variables are mainly gathered from Refinitiv, Beta Suite, and CompuStat. Some firm characteristics variables (e.g. earning volatility) need the data which are 5 years before the base year. Thus, the data 5 years before 2015 are collected as well.

I constructed different regression models responding to each hypothesis to answer the research questions and hypothesis. I summarized the descriptive statistics, identified the correlation between the key variables, and employed the univariate test before running the baseline regression models. After I achieved the results from the baseline model, the robust check (examining each ESG indicator, examining endogeneity, applying Propensity Score Matching, adding extra control variable and measurement of COVID, and examining the country effect) will be employed to test whether consistent conclusions will be generated for my hypothesis.

4.1 Cost of Equity Estimation

The Asset Pricing Model (Sharpe, 1964) explored the relationship between the market risk premium and the estimated return. Fama and French (1993) investigated the Asset Pricing Model and identified two common risks, further explaining the single-factor model. Based on the excess return on the market, “small minus big” (size) factor, and “high minus low” (value) factor from Fama-French Three-Factor Model, Carhart (1997) involves “up minus low” (momentum) to build the Fama-French & Carhart Four-Factor Model.

$$r_{i,t} - rf_t = \alpha_i + \beta_{i,mkt}(mktrf_t - rf_t) + \beta_{i,smb}SMB_t + \beta_{i,hml}HML_t + \beta_{i,umd}UMD_t + \varepsilon_{i,t}$$

where $r_{i,t}$ is the return of the security within the timeslot t

$mktrf_t$ is the excess return on the market within timeslot t

SMB_t is the "small minus big" (size) factor within timeslot t

HML_t is the "high minus low" (value) factor within timeslot t

UMD_t is the "up minus down" (momentum) factor within timeslot t

The estimated cost of equity in my thesis adopts the estimates based on the Fama-French & Carhart Four-Factor Model from WRDS Beta Suite. WRDS Beta Suite provides scholars with the estimated cost of equity based on the stocks' loading on the above risk factors on daily, weekly, and monthly frequency. In my study, I selected monthly frequency for Fama-French & Carhart Four-Factor data based on a rolling 60-month estimation window (Chen et al., 2020; Kinateder et al., 2017; McNevin and Nix, 2018). To be eligible for selection, at least 36 months of data should be available during the 60-month estimation window following the prior study (Da et al., 2014). This requirement ensures that the return used to estimate the cost of equity is based on adequate historical data. As shown in the "Number of Observations Used for Estimation" table, 85.66% of the estimated cost of equity is computed by the complete 60-month historical data on the rolling base (Table 1). This result verifies that the estimates will not be associated with bias due to lack of data.

The estimated cost of equity from 2015- 2022 is monthly return. The ESG data are reported and recorded on an annual base from Refinitiv. Thus, the monthly data are aggregated into compounded and annualized return with the help of the transformation below to match the frequency of the ESG data:

$$r_{i,ta} = (1 + r_{i,tm1})(1 + r_{i,tm2})(1 + r_{i,tm3}) \dots (1 + r_{i,tm11})(1 + r_{i,tm12}) - 1$$

where $r_{i,ta}$ is the annualized return at the end of the year t

$r_{i,tmn}$ is the monthly return for the nth month in year t

4.2 Environmental, Social, and Governance (ESG) Construction

Environmental, Social, and Governance (ESG) scores are collected from Refinitiv, a trusted and preferred institution which recognizes the significance of transparency and accuracy and provides customers with ESG data for the financial industry and investment process. Refinitiv is considered as one of the common providers of data that collect and aggregate the available ESG data from the public source (Li and Poluchronopoulos, 2020). The ESG database receives data inputs based on more than 700 trained research analysts who gather information from annual reports, NGO websites, CSR reports, company websites, stock exchange filings, and news sources. Error checks in data entry and post-production steps support their data quality. Independent audits and management reviews are also implemented to ensure Refinitiv's ESG Data. Refinitiv covers more than 12,500 public and private firms all over the world. In the North American market, around 3,800 companies are under its coverage (LSEG, 2023).

The Environmental, Social, and Governance (ESG) scores on three layers of the North American firms were gathered from Refinitiv (Figure 1). Based on the Refinitiv definition, the Total ESG performance (first layer) consists of Environmental performance (second layer), social performance (second layer), and governance performance (second layer). On the second layer, the Environmental pillar measures resource use, emission, and (environmental) innovation. Workforce, human rights, community, and product responsibility indicators are included in the social pillar. The governance pillar includes management, shareholder, and CSR strategy perspectives.

The original ESG scores for each layer range from 0 to 100. Following the previous studies (e.g., Chen et al., 2023), I scheduled to transform the numeric variables into categorical groups. I assigned firms to 10 different groups based on their ESG performance defined by Refinitiv (Table 2). After transforming the numeric scores into categorical groups, I detected that the categorical ESG histogram shows a positive skewness. The observation indicates that the highest density is between 3 and 4. It is also evident that few firms are associated with extremely superior or disappointing ESG performance (Figure 2).

4.3 Construction of Firm-characteristics Control Variables

Beta, idiosyncratic risk, momentum, leverage, book-to-market ratio, asset, growth, and earnings volatility are controlled as firm characteristics variables in my research (Appendix Table I). **Beta** stands for the firm beta. At least 36 months of return data in the past 5 years from the FF4 model are used to estimate the firm beta from WRDS Beta Suite. **Idiosyncratic risk** is calculated as the standard deviation of the residual from the market model regression (Fama-French Four-Factor Model in my thesis) with monthly returns over the past five years (Ke, 2022). Specifically, Idiosyncratic Volatility (IVOL) is calculated based on the methodology described in Ang et al. (2006). It is the volatility of the difference between realized returns and expected returns (based on respective risk models, which is FF4 in my thesis). **Momentum** is the capacity of the stock price trend, which is the natural logarithm of the compounded monthly stock returns over the one year before the cost of equity estimate (Ke, 2022). **Leverage** is the long-term debt over the total asset ratio. **B2M** is the book-to-market ratio measured by the formula [(csho* prcc_c)/ mkvalt] where csho is the common Shares Outstanding; prcc_c is the closed price, and mkvalt is the total market value. **Asset** is the nature log of the total asset. **Growth** is the earning growth rate of the firm measured by earnings before interest and tax between t+1 and t for an individual firm in year t. In a previous study (Ke, 2022), the median analyst forecast of earnings growth rate was applied in the model. Due to limited access to the I/B/E/S dataset, a growth rate based on historical data will be used in my research. **Earning Volatility** is the standard deviation of annual earnings divided by the mean over the preceding five years (Gebhardt et al., 2001 & Ke, 2022).

4.4 Industry Group Classification

To assign different industries into two groups (sensitive to the COVID-19 versus insensitive to the COVID-19), I used industry GDP change reported by the Bureau of Economic Analysis (BEA) as a criterion for division. The COVID-19 exogenous crisis started in 2020, and the corresponding GDP shock was significant in 2020 (Table 3).

According to the U.S. Bureau of Economic Analysis observation, the gross domestic product for all industries made a steady growth of 2.7%, 1.7%, 2.2%, 2.9% and 2.3% in 2015, 2016, 2017, 2018 and 2019, respectively. However, a noticeable recession of -2.8% occurred in 2020 (Table 4). This suggests that industries were negatively affected by the COVID-19 pandemic overall. Although the patterns show that industry GDP suffers from the pandemic on average, the sensitivity to the COVID-19 may differ. By sorting the industry GDP growth/recession from BEA based on the NAICS classification standard from the lowest to the highest, I assigned 50% of the industries whose industrial recession/growth for 2020 is closer to 0 into the insensitive group. Other industries are assigned into sensitive groups. By this approach, I found that the wholesale trade, professional, scientific, and technical services, agriculture, forestry, fishing, and hunting, mining, management of companies and enterprises, utilities, educational services, health care and social assistance, professional and business services, construction are less sensitive to the COVID-19 in comparison to the industry group consisting of retail trade, information, other services, except government, finance and insurance, real estate, rental leasing, transportation & warehousing, arts, entertainment & recreation, manufacturing, accommodation and food services, arts, entertainment, and recreation.

To investigate the cost of equity and the ESG impact deeply, I divided the “sensitive to the COVID-19” group into two other groups (industrial GDP growth versus industrial GDP recession). In this way, the “sensitive to the COVID-19” group consists of one group with positive industrial growth and another group with negative industrial growth during the pandemic. I found that “Information and cultural industries” (NAICS-51) and “Finance and insurance industries” (NAICS-52) are the two industries sensitive to the COVID-19 with positive GDP growth during the COVID-19 pandemic from 2020 to 2022. I am not interested in the insensitive group because the industrial GDP growth/recession is close to 0%, failing to show a significantly annual GDP change caused by the COVID-19 pandemic.

4.5 Stringency Group Classification

Blavatnik school of Government, University of Oxford, works on a COVID-19 pandemic government response tracker (OxCGRT) project to collect data on policy measurement and track the information from the beginning of 2020 to the end of 2022. There are four different policy indices provided by OxCGRT: containment and health index stringency, economic support index, and the overall index based on the total government response (Table 4). My thesis focuses on the stringency index, which tracks the portion of the policy indicators related to containment and closure, economic policies, health system policies, and vaccination policies (Hale et al., 2023). The OxCGRT Stringency Index has been used to investigate the relationship between government response and aviation stock price (Çetin, 2022). This index has also explored the short-term trade-off between stringency and economic growth (Kok, 2020). The stringency index involves 9 indicators: school closing, workplace closing, cancelled public events, restrictions on gathering size, closed public transport, stay-at-home requirements, restrictions on internal movement, restrictions on international travel, and public information campaign (Table 5).

I used the median value of the three-year stringency index for all states/provinces as the cut-off benchmark. The firms in the province/state with a three-year stringency index above 39.775 will be assigned to the high stringency group; otherwise, they will be assigned to the low stringency group. This classification approach assigns state/province named "ND", "SD", "IA", "AZ", "MO", "AL", "UT", "FL", "NE", "SC", "NH", "KS", "MT", "TX", "MS", "WV", "ID", "TN", "IN", "VA", "NV", "AR", "IL", "WI", "PA", "NJ", "MN" into low stringency group. In contrast, state/province named as "OK", "CO", "MD", "GA", "AK", "VT", "CT", "OH", "MA", "MI", "NS", "NC", "OR", "KY", "RI", "ME", "DE", "BC", "WA", "CA", "NY", "DC", "NM", "LA", "ON", "HI", "QC" are assigned into the high stringency group. The median of 39.775 for the stringency index indicates that the U.S. and Canada are not imposing stringent restrictions to navigate the COVID-19 pandemic. The stringency index is only measured during the COVID-19 pandemic from 2020 to 2022.

4.6 Regression Model for Baseline

Following prior studies (De Jager, 2008; Mio et al., 2023), I used the panel data approach to pool observations on cross-section firms from 2015 to 2022. Regarding studies with a focus on panel data, scholars frequently employ a fixed-effect model as an approach to analyzing regression output. This model is in favour because inter-individual heterogeneity can be better mitigated, and the accuracy of estimates concerning the linkage between response variables and explanatory variables can be enhanced (Callaway and Karami, 2023). Considering the benefit of the fixed effect model, I employed it in my study for all the regression models. After I got the estimated coefficients and standard error from the fixed and random-effect models, the Hausman tests were conducted to double-check whether the fixed-effect model should be adopted (Mio et al., 2023).

My first hypothesis emphasizes the ESG benefits during the COVID-19 pandemic. The first four models, from 1-a to 1-d, are only constructed on the basis of the key explanatory variables. The controls are added on from regression model 1-e to 1-h. The models with a controlled firm-fixed effect are specified below.

$$COE_{i,t} = \alpha_0 + \beta_1 COVID_{i,t} + \beta_2 ESG(Total\ Scores)_{i,t-1} + \beta_3 Inter(COVID\ \&\ Total\ Scores)_{i,(t)(t-1)} + \varepsilon_{\ i,t}$$

-------------------------(1-a)

$$COE_{i,t} = \alpha_0 + \beta_1 COVID_{i,t} + \beta_2 ESG(E - Scores)_{i,t-1} + \beta_3 Inter(COVID\ \&\ E - Score)_{i,(t)(t-1)} + \varepsilon_{\ i,t}$$

-------------------------(1-b)

$$COE_{i,t} = \alpha_0 + \beta_1 COVID_{i,t} + \beta_2 ESG(\ S - Scores)_{i,t-1} + \beta_3 Inter(COVID\ \&\ S - Scores)_{i,(t)(t-1)} + \varepsilon_{\ i,t}$$

-------------------------(1-c)

$$COE_{i,t} = \alpha_0 + \beta_1 COVID_{i,t} + \beta_2 ESG(\ G - Scores)_{i,t-1} + \beta_3 Inter(COVID\ \&\ G - Scores)_{i,(t)(t-1)} + \varepsilon_{\ i,t}$$

-------------------------(1-d)

$COE_{i,t} = \alpha_0 + \beta_1 COVID_{i,t} + \beta_2 ESG(Total\ Scores)_{i,t-1} +$

$\beta_3 Inter(COVID\ \&\ Total\ Scores)_{i,(t)(t-1)} + \beta_4 Beta_{i,t} + \beta_5 Idio_{i,t} + \beta_6 Mom_{i,t} + \beta_7 Lev_{i,t-1} +$

$\beta_8 B2M_{i,t-1} + \beta_9 Asset_{i,t-1} + \beta_{10} Grow_{i,t} + \beta_{11} Eearn\_Vol_{i,t} + \varepsilon_{\ i,t}$

-------------------------(1-e)

$COE_{i,t} = \alpha_0 + \beta_1 COVID_{i,t} + \beta_2 ESG(E - Scores)_{i,t-1} + \beta_3 Inter(COVID\ \&\ E -$

$Scores)_{i,(t)(t-1)} + \beta_4 Beta_{i,t} + \beta_5 Idio_{i,t} + \beta_6 Mom_{i,t} + \beta_7 Lev_{i,t-1} + \beta_8 B2M_{i,t-1} +$

$\beta_9 Asset_{i,t-1} + \beta_{10} Grow_{i,t} + \beta_{11} Eearn\_Vol_{i,t} + \varepsilon_{\ i,t}$

-------------------------(1-f)

$COE_{i,t} = \alpha_0 + \beta_1 COVID_{i,t} + \beta_2 ESG(S - Scores)_{i,t-1} + \beta_3 Inter(COVID\ \&\ S -$

$Score)_{i,(t)(t-1)} + \beta_4 Beta_{i,t} + \beta_5 Idio_{i,t} + \beta_6 Mom_{i,t} + \beta_7 Lev_{i,t-1} + \beta_8 B2M_{i,t-1} +$

$\beta_9 Asset_{i,t-1} + \beta_{10} Grow_{i,t} + \beta_{11} Eearn\_Vol_{i,t} + \varepsilon_{\ i,t}$

-------------------------(1-g)

$COE_{i,t} = \alpha_0 + \beta_1 COVID_{i,t} + \beta_2 ESG(G - Scores)_{i,t-1} + \beta_3 Inter(COVID\ \&\ G -$

$Score)_{i,(t)(t-1)} + \beta_4 Beta_{i,t} + \beta_5 Idio_{i,t} + \beta_6 Mom_{i,t} + \beta_7 Lev_{i,t-1} + \beta_8 B2M_{i,t-1} +$

$\beta_9 Asset_{i,t-1} + \beta_{10} Grow_{i,t} + \beta_{11} Eearn\_Vol_{i,t} + \varepsilon_{\ i,t}$

--------------------------(1-h)

My second hypothesis further explores hypothesis (1) based on two different industry groups (negative industrial GDP growth versus positive industrial GDP growth). The regression models are identical to the models for the second hypothesis. My third hypothesis further explores hypothesis (1) based on two different stringency groups (Higher stringency versus lower stringency). The regression models are also identical to the models for the first hypothesis.

4.7 Robustness Check

4.7.1 Propensity Score Matching

Prior studies regarding the relationship between ESG and cost of equity suggest that propensity score matching (PSM) helps alleviate selection bias (e.g., Tanjung, 2023). I applied propensity score matching as the robust check for the baseline model to check the ESG benefit under different levels of the government COVID-19 policy. In the baseline model, the response variable is the cost of equity, and the key explanatory variables are the COVID dummy, ESG score, and ESG-COVID interaction. The control variables cover a lot of firm characteristics, such as the firm beta and the firm size. I employed the PSM as a robust check for my baseline model based on two groups to match all the firm characteristics. One group is the firms with a lower stringency level of the government covid policy, and the other group is the firms with a higher stringency level. In this way, the observational firms in my study can avoid being randomly exposed to different stringency levels of government COVID-19 pandemic policy. Instead, propensity score matching enables the companies to be matched based on the observed firm characteristics, which helps minimize the selection bias. I suppose the result in the propensity score matching for firm characteristics based on the stringency group holds. In that case, higher credibility can be added to my study, and the robust result can show a lower possibility of being driven by confounding variables.

4.7.2 ESG Variable Replacement

In the baseline model, my ESG construction involves the total environmental, social, & governance (ESG) performance and the separate environmental (E) pillar, Social (S) pillar, & governance (G) pillar performance of the firms. In my second robustness check, I am motivated to test the key themes for Refinitiv ESG under the separate environmental (E) pillar, Social (S) pillar, & governance (G), respectively. Specifically, I examined the themes of resource use, emission, and innovation under the environmental pillar; workforce, human rights, community, and product responsibility under the social pillar; management, shareholder and CSR strategy under the governance pillar (Table 2). By replacing the broad ESG variable with a more specific one, more targeted insight can be generated for the stakeholder to understand the exact theme related to performance under the ESG structure that contributes to the cost of equity capital reduction for firms.

$$COE_{i,t} = \alpha_0 + \beta_1 COVID_{i,t} + \beta_2 ESG(Resource\ Use)_{i,t-1} + \beta_3 Inter(COVID\ \&\ Resource\ Use)_{i,(t)(t-1)} + \beta_4 Beta_{i,t} + \beta_5 Idio_{i,t} + \beta_6 Mom_{i,t} + \beta_7 Lev_{i,t-1} + \beta_8 B2M_{i,t-1} + \beta_9 Asset_{i,t-1} + \beta_{10} Grow_{i,t} + \beta_{11} Eearn\_Vol_{i,t} + \varepsilon_{i,t}$$

-------------------------(R-E1)

$$COE_{i,t} = \alpha_0 + \beta_1 COVID_{i,t} + \beta_2 ESG(Emission)_{i,t-1} + \beta_3 Inter(COVID\ \&\ Emission)_{i,(t)(t-1)} + \beta_4 Beta_{i,t} + \beta_5 Idio_{i,t} + \beta_6 Mom_{i,t} + \beta_7 Lev_{i,t-1} + \beta_8 B2M_{i,t-1} + \beta_9 Asset_{i,t-1} + \beta_{10} Grow_{i,t} + \beta_{11} Eearn\_Vol_{i,t} + \varepsilon_{i,t}$$

-------------------------(R-E2)

$$COE_{i,t} = \alpha_0 + \beta_1 COVID_{i,t} + \beta_2 ESG(Innovation)_{i,t-1} + \beta_3 Inter(COVID\ \&\ Innovation)_{i,(t)(t-1)} + \beta_4 Beta_{i,t} + \beta_5 Idio_{i,t} + \beta_6 Mom_{i,t} + \beta_7 Lev_{i,t-1} + \beta_8 B2M_{i,t-1} + \beta_9 Asset_{i,t-1} + \beta_{10} Grow_{i,t} + \beta_{11} Eearn\_Vol_{i,t} + \varepsilon_{i,t}$$

-------------------------(R-E3)

$$COE_{i,t} = \alpha_0 + \beta_1 COVID_{i,t} + \beta_2 ESG(Workforce)_{i,t-1} + \beta_3 Inter(COVID\ \&\ Workforce)_{i,(t)(t-1)} + \beta_4 Beta_{i,t} + \beta_5 Idio_{i,t} + \beta_6 Mom_{i,t} + \beta_7 Lev_{i,t-1} + \beta_8 B2M_{i,t-1} + \beta_9 Asset_{i,t-1} + \beta_{10} Grow_{i,t} + \beta_{11} Eearn\_Vol_{i,t} + \varepsilon_{i,t}$$

-------------------------(R-S1)

$COE_{i,t} = \alpha_0 + \beta_1 COVID_{i,t} + \beta_2 ESG(Human\ Right)_{i,t-1} +$

$\beta_3 Inter(COVID\ \&\ Human\ Right)_{i,(t)(t-1)} + \beta_4 Beta_{i,t} + \beta_5 Idio_{i,t} + \beta_6 Mom_{i,t} + \beta_7 Lev_{i,t-1} +$

$\beta_8 B2M_{i,t-1} + \beta_9 Asset_{i,t-1} + \beta_{10} Grow_{i,t} + \beta_{11} Eearn\_Vol_{i,t} + \varepsilon_{i,t}$

-------------------------(R-S2)

$COE_{i,t} = \alpha_0 + \beta_1 COVID_{i,t} + \beta_2 ESG(Community)_{i,t-1} +$

$\beta_3 Inter(COVID\ \&\ Community)_{i,(t)(t-1)} + \beta_4 Beta_{i,t} + \beta_5 Idio_{i,t} + \beta_6 Mom_{i,t} + \beta_7 Lev_{i,t-1} +$

$\beta_8 B2M_{i,t-1} + \beta_9 Asset_{i,t-1} + \beta_{10} Grow_{i,t} + \beta_{11} Eearn\_Vol_{i,t} + \varepsilon_{i,t}$

-------------------------(R-S3)

$COE_{i,t} = \alpha_0 + \beta_1 COVID_{i,t} + \beta_2 ESG(Product\ Responsiblity)_{i,t-1} +$

$\beta_3 Inter(COVID\ \&\ Product\ Responsiblity)_{i,(t)(t-1)} + \beta_4 Beta_{i,t} + \beta_5 Idio_{i,t} + \beta_6 Mom_{i,t} +$

$\beta_7 Lev_{i,t-1} + \beta_8 B2M_{i,t-1} + \beta_9 Asset_{i,t-1} + \beta_{10} Grow_{i,t} + \beta_{11} Eearn\_Vol_{i,t} + \varepsilon_{i,t}$

-------------------------(R-S4)

$COE_{i,t} = \alpha_0 + \beta_1 COVID_{i,t} + \beta_2 ESG(Management)_{i,t-1} +$

$\beta_3 Inter(COVID\ \&\ Management)_{i,(t)(t-1)} + \beta_4 Beta_{i,t} + \beta_5 Idio_{i,t} + \beta_6 Mom_{i,t} + \beta_7 Lev_{i,t-1} +$

$\beta_8 B2M_{i,t-1} + \beta_9 Asset_{i,t-1} + \beta_{10} Grow_{i,t} + \beta_{11} Eearn\_Vol_{i,t} + \varepsilon_{i,t}$

-------------------------(R-G1)

$COE_{i,t} = \alpha_0 + \beta_1 COVID_{i,t} + \beta_2 ESG(Shareholder)_{i,t-1} +$

$\beta_3 Inter(COVID\ \&\ Shareholder)_{i,(t)(t-1)} + \beta_4 Beta_{i,t} + \beta_5 Idio_{i,t} + \beta_6 Mom_{i,t} + \beta_7 Lev_{i,t-1} +$

$\beta_8 B2M_{i,t-1} + \beta_9 Asset_{i,t-1} + \beta_{10} Grow_{i,t} + \beta_{11} Eearn\_Vol_{i,t} + \varepsilon_{i,t}$

-------------------------(R-G2)

$$COE_{i,t} = \alpha_0 + \beta_1 COVID_{i,t} + \beta_2 ESG(Strategy)_{i,t-1} + \beta_3 Inter(COVID \,\&\, Strategy)_{i,(t)(t-1)} + \beta_4 Beta_{i,t} + \beta_5 Idio_{i,t} + \beta_6 Mom_{i,t} + \beta_7 Lev_{i,t-1} + \beta_8 B2M_{i,t-1} + \beta_9 Asset_{i,t-1} + \beta_{10} Grow_{i,t} + \beta_{11} Eearn\_Vol_{i,t} + \varepsilon_{i,t}$$

------------------------(R-G3)

4.7.3 Endogeneity Check

Endogeneity is frequently considered as a concern in the research field of corporate finance (Roberts and Whited, 2013). One of the ordinary least square assumptions specifies that there should be no relationship between the explanatory variable and the error term. In practice, the error term can correlate highly with the explanatory variables due to different biases, such as measurement error and omitted variables. In this robustness check, I would like to check whether the endogenous problem exists in my baseline model by looking into the correlation between the error term (residuals from the baseline model) and each explanatory variable.

4.7.4 Severity and Stringency Measurement

In the process of this robust check, I aim to examine the relationship between ESG and cost of equity during the pandemic (hypothesis 1) by measuring the severity of the COVID-19 and the stringency level of local government COVID-19 policy in the baseline regression model. Regarding the measures of COVID-19 severity, COVID-19 negative sentiment is used to estimate the impact of the pandemic (Hassan et al., 2020; Almaghrabi, 2021; Ke, 2022). I used "search interest" of "COVID" as the new variable to measure severity. The data are collected from Google Trend. I downloaded the index for search interest of "COVID" based on each state/province in the USA and Canada from 2020 to 2022. The rationality to use "search interest" as severity lies in the fact that the search intertest from Google Trend is broadly used in sentiment analysis and proxies (D'Avanzo et al., 2017; Zhang et al., 2018; Dietzel, 2016). The pessimistic sentiment is greater in the regions that are more severely affected by COVID-19 pandemic (Da and Yang, 2020). "COVID" is a negative word which can reveal the feeling of pessimism (Blanco and Lourenço, 2022). Thus, when the numbers of search for COVID is larger, the severity level of COVID in the given region is also correspondingly higher. Regarding the new variable "stringency", the stringency of government is measured by the OxCGRT indicators (Table 5 & Table 6). In my new robust check, the COVID dummy (indicating whether the observed year is a pandemic year) was dropped, but the severity variable (index for search interest of COVID) was added. The interaction term is "severity*ESG" instead of "COVID dummy*ESG". Also, the stringency variable is put on the robust regression model. The robust check models are specified as below:

$$COE_{i,t} = \alpha_0 + \beta_1 Severity_{i,t} + \beta_2 ESG(Total\ Scores)_{i,t-1} + \beta_3 Inter(Severity\ \&\ Total\ Scores)_{i,(t)(t-1)} + \beta_4 Beta_{i,t} + \beta_5 Idio_{i,t} + \beta_6 Mom_{i,t} + \beta_7 Lev_{i,t-1} + \beta_8 B2M_{i,t-1} + \beta_9 Asset_{i,t-1} + \beta_{10} Grow_{i,t} + \beta_{11} Eearn\_Vol_{i,t} + \beta_{12} Stringency_{i,t} + \varepsilon_{i,t}$$

-------------------------(R-2e)

$$COE_{i,t} = \alpha_0 + \beta_1 Severity_{i,t} + \beta_2 ESG(E-Score)_{i,t-1} + \beta_3 Inter(Severity\ \&\ E-Score)_{i,(t)(t-1)} + \beta_4 Beta_{i,t} + \beta_5 Idio_{i,t} + \beta_6 Mom_{i,t} + \beta_7 Lev_{i,t-1} + \beta_8 B2M_{i,t-1} + \beta_9 Asset_{i,t-1} + \beta_{10} Grow_{i,t} + \beta_{11} Eearn\_Vol_{i,t} + \beta_{12} Stringency_{i,t} + \varepsilon_{i,t}$$

-------------------------(R-2f)

$$COE_{i,t} = \alpha_0 + \beta_1 Severity_{i,t} + \beta_2 ESG(S-Score)_{i,t-1} + \beta_3 Inter(Severity\ \&\ S-Score)_{i,(t)(t-1)} + \beta_4 Beta_{i,t} + \beta_5 Idio_{i,t} + \beta_6 Mom_{i,t} + \beta_7 Lev_{i,t-1} + \beta_8 B2M_{i,t-1} + \beta_9 Asset_{i,t-1} + \beta_{10} Grow_{i,t} + \beta_{11} Eearn\_Vol_{i,t} + \beta_{12} Stringency_{i,t} + \varepsilon_{i,t}$$

-------------------------(R-2g)

$$COE_{i,t} = \alpha_0 + \beta_1 Severity_{i,t} + \beta_2 ESG(G - Score)_{i,t-1} + \beta_3 Inter(Severity \,\&\, G - Score)_{i,(t)(t-1)} + \beta_4 Beta_{i,t} + \beta_5 Idio_{i,t} + \beta_6 Mom_{i,t} + \beta_7 Lev_{i,t-1} + \beta_8 B2M_{i,t-1} + \beta_9 Asset_{i,t-1} + \beta_{10} Grow_{i,t} + \beta_{11} Eearn\_Vol_{i,t} + \beta_{12} Stringency_{i,t} + \varepsilon_{i,t}$$

-------------------------(R-2h)

4.7.5 Canadian Firms Removal

Regarding the study related to the cost of equity in North America, controlling for the country effect is crucial because each country differs in economic conditions, regulatory environment, political stability, tax policy, market structure, and currency risk. By controlling for the country effect (Warnes I. and Warnes P.E., 2014), I can better isolate the impact on the cost of equity due to the difference between the two countries. Before I started to control the country effect, I found that the observations based on Canadian firms account for less than 1% of my entire database, indicating that what this study concentrates on is the U.S. market. This finding suggests that it is unnecessary to employ a method to control the country effect. Therefore, I dropped the Canadian firms from my study and double-checked whether the conclusions drawn from the baseline regression still hold.

4.7.6 Original ESG Score Tests

Transforming original ESG scores into ten different groups based on 10 score intervals as a step allows me to explain the ESG benefit in risk mitigation based on one-step firm performance improvement. Although rounding numbers is useful for simplifying the structure of ESG, it comes with the limitation of the loss of precision. The detail of the exact ESG performance can be lost when I round the original ESG scores and send them into groups. In this robust check, I aim to examine the ESG benefit during the pandemic in H1 using the original ESG scores. This robust check allows for a higher accuracy of ESG benefit prediction in risk mitigation based on the improvement of a 1-point ESG score improvement.

Chapter 5: Main Results

5.1 Summary Statistics and Matrix of Correlation

The descriptive table below reports the summary statistics (Table 6). Before I dropped the missing value for each variable, there were 19208 observations in my dataset. There are fewer observations after I dropped the missing value mainly because of the absence of ESG data. Refinitiv reported less ESG data in early years (e.g., in 2015 and 2016) compared to recent years. The value of the cost of equity (COE) mainly ranges between -7.9% and 28.5%, as represented by the 25th and 75th percentiles respectively. The mean and median cost of equity (COE) are 12.30% and 9.90%, respectively. These results are slightly higher than 9.02% and 7.88% in the early evidence paper (Ke, 2022) and higher than the statistics in the previous studies (e.g., Dhaliwal et al., 2016). This data series for the COVID dummy appear to be binary or categorical, potentially indicating the presence or absence of a specific attribute. The mean value of COVID is 0.484, suggesting that around 48 percent of the observations are in the post-COVID-19 pandemic period. The ESG values are dispersed between 1 and 9, and the distribution is skewed to the right with a median of 4, a mean of 4.615, and a standard deviation of 1.952, which confirms that firms' ESG performance differ based on the samples in my research and the majority of firms do not have outstanding ESG performance. The mean value of beta, idiosyncratic volatility, momentum, leverage, B2M, asset, growth, and earning volatility is 1.042, 9.7%, 2.2%, 0.26, 1.01, 7.811 (nature log), 10.1% and 21.7% respectively, which does not indicate a significant deviation in comparison to the findings in Ke (2022).

My study also presents a correlation matrix (Table 7) that captures the relationship between key variables. Correlation analysis helps to understand how the variables are relevant to each other, which can provide information about weak/strong and positive/negative relationship between each variable. The correlation between the cost of equity and ESG is negative and significant, which supports the ESG benefit of reducing the cost of equity. The positive sign for the correlation between COVID and the cost of equity captures the increased cost of equity financing. A negative correlation between B2M and cost of equity, earning volatility, and cost of equity is not significant. The finding that the firm size (asset) can potentially increase the cost of equity is also not significant. These insignificant results explain why the sign of the coefficients is counter-intuitive and different from the prior studies (Ke, 2022). Finally, the multicollinearity problem is not detected in my research.

5.2 Univariate Test Result

First, I compared the variables before and during the COVID-19 pandemic. From the univariate comparison test (Table 8), I found that the univariate test supports the prediction that the cost of equity capital increased after the COVID-19 pandemic. There were 5708 observations before the pandemic and 5362 observations during the pandemic, which shows the observations before and after pandemic are almost symmetrical. The average cost of equity before the COVID-19 pandemic is 11.3%, while the mean value of the cost of equity during the COVID-19 pandemic is 13.3%. The 2% mean difference is statically significant at 1% level of significance. According to the comparison, other firm characteristics also changed significantly from pre-event to post-event. Thus, it is necessary to apply the OLS regression model to estimate the effect of the COVID-19 after controlling for those factors (Ke, 2022).

I also compared the firms experiencing larger GDP change to those firms experiencing smaller GDP change. As shown in Table 9, firms sensitive to the COVID-19 pandemic exhibit higher equity financing costs. However, the mean difference between firms in the sensitive and insensitive groups is only 0.2%, which is not statistically significant. For further investigation, firms "sensitive to the COVID-19" are categorized into two groups: one with positive industrial GDP growth and another with negative industrial GDP growth (recession). From the study of the two subgroups, I found that the median cost of equity of industries with negative GDP growth during the pandemic was about 3.4% percent higher than that of industries with positive GDP growth during the pandemic. This finding is statistically significant at a one-star level.

Finally, I compared the firms under stringent COVID-19 government policies to those firms under loose policies. Regarding the stringency group shown in Table 10, firms associated with higher stringency levels suffer from higher equity costs. However, the mean difference (0.6%) is also tiny and insignificant. The insignificance is due to the offsetting effects between the severity and stringency. The stringency of government policies is designed to control and limit the spread of the COVID-19 pandemic. Governments may respond by escalating the level of policy stringency when the level of severity increases. When governments impose more stringent COVID-19 policies, these measures can effectively reduce the spread of the virus, leading to a reduction in severity.

5.3 Baseline Result

The Ordinary Least Squares (OLS), Random Effects (RE), and Fixed Effects (FE) models have all been attempted for my baseline model on regression. Regarding the statistical significance, magnitude of the coefficient, and the sign of the coefficient, the model controlling the fixed effects yields the most reasonable output. The outcome from the Hausman test also indicates that the Fixed Effect model gives the best estimate (shown in Table 20). Therefore, only the regression statistics from the Fixed Effects model are reported in the result section.

I examined the impact of the COVID-19 on firms' equity costs before I investigated the relationship between ESG benefits during the pandemic and the cost of equity. Column (1) from Table 11 reports that firms' cost of equity was around 9.67% before the pandemic, and it increased by 4.06% during the pandemic. The negative impact of the COVID-19 on the cost of equity is consistent with Ke's early evidence from the U.S. market. After control variables are added, the COVID dummy variable in the multiple regression models is still statistically significant at the 1% level of significance, and its negative coefficient manifests that the COVID-19 pandemic incurs an increase of 5.87% cost of equity for firms on average when other variables are constant. The negative impact of the COVID-19 on the cost of equity is stronger after the control variables are added. Every control variable is statistically significant except for growth and earning volatility. The increasing cost of equity due to the increasing expected risk during the COVID-19 pandemic can be explained by the finding that large enterprises, due to the narrow scope of their operations, unfortunately recorded a significant decrease in production (Klimecka-Tatar and Ulewicz, 2021).

Tables 12 and 13 show the regression output when the ESG benefits have been incorporated into the previous model. As the key explanatory variables in my study, the COVID dummy, ESG performance (total ESG and its individual performance), and the interactions all exhibit strong evidence of statistical significance at 1% level. The COVID-19 pandemic contributes to a higher cost of equity for firms during the exogenous shock in all models (ESG, E, S, G). The interaction term in the models suggests that superior total ESG, environmental, social, and governance performance reward ESG firms with a lower cost of equity during the pandemic. Specifically, the amplified equity cost that total ESG performance, environmental performance, social performance, and governance performance will help reduce is 3.21%, 3.22%, 2.30%, and 2.88%, respectively, during the COVID-19 pandemic if the firms improve the corresponding scores by 10 points on average one year before the pandemic (Table 13). High Environmental scores indicate firms' better practice in resource use, emission, and environmental innovation (LSEG, 2023). These practices can help minimize the risk of regulatory fines, environmental pollutions, and reputational harm caused by the environmental issues. The superior social performance reflects firms' commitment to maintaining the good relationship between firms and the stakeholders (including employees, customers, and the community) (LSEG, 2023). The social capital gained from better "S" performance help firms obtain more trust from investors (Lins et al., 2017). Thus, the risk of employee turnover, customer turnover, and social scandal can be minimized by firms' social performance associated with trust. The superior governance performance implies more effective management for the firms (LSEG,2023). Thus, firms with better governance performance can better avoid corruptions, unethical behavior, and information asymmetry, which reduces the risk of investment for investors (Larcker et al., 2022; Lundberg, 2022). Based on the risk-reward theory (Markowitz, 1952), firms will be charged for lower cost of equity if the investors view them as less risky due to higher ESG scores. Investors pay close attention to the ESG performance, which leads to the reduction of investors' expected risk for firms with higher ESG scores (Tang, 2022). This effect is stronger during the COVID-19 pandemic due to the role of insurance that ESG plays (Godfrey et al., 2009; Amiraslani et al., 2023). These regression results from the baseline and explanations support my first hypothesis [*ESG tempers the increase in the cost of equity during the COVID-19 pandemic*] and its corresponding sub-hypothesis.

After analyzing the regression output on how ESG performance benefits firms in exhibiting a lower cost of equity capital due to greater ESG pay-off during the pandemic, I examined whether the impacts of COVID and ESG differ across industries. Table 14 and Table 15 show that the greater ESG benefit during the pandemic and COVID shock are both statistically significant at 1% level for all models based on both the positive industrial GDP growth group and negative industrial GDP growth group. To further examine whether the amplified benefit of ESG is stronger for industries sensitive to the COVID-19 pandemic with negative industrial GDP growth, I employed Fisher's permutation test with bootstrap sampling (Efron and Tibshirani,1994; Lian, 2016) to test the difference in coefficients (Negative GDP Growth - Positive GDP Growth) in my study. In the Fisher permutation test framework, the coefficient difference between two groups is defined as $d=b_1-b_0$. The null hypothesis assumes the difference (d) is equal to 0, whereas the alternative hypothesis assumes that the difference (d) is non-zero. The Monte Carlo simulation is applicable to calculate the p-value for the coefficient difference test if the adherence of "d" to a standard normal distribution [$d \sim N(0,1)$] is certain. However, the conformity of "d" to a standard normal distribution is not guaranteed, which may limit the applicability of the Monte Carlo simulation method in the thesis. Thus, it is recommended to resample the existing data to obtain the empirical samples due to the uncertain distribution of "d". The new samples are used to construct the empirical distribution of the coefficient difference statistics "d". In addition, sampling with replacement is allowed to provide bootstrap evidence to support the fixed effect model test. Based on the sampling evidence, the p-value to support the null hypothesis can be computed. The P-value is calculated as:

$$\hat{p} = \frac{\#\{d^{S_j} > \hat{d}_0\}}{K}$$

$\hat{d}_0$ denotes the estimated coefficient difference between $\hat{\beta}_1$ from group 1 and $\hat{\beta}_0$ from group 0

S denotes the sum of the observations from the two groups
K denotes the numbers of replications of the sampling
S_j denotes the superscript, indicating the estimate obtained using the j empirical sample
$\#\{d^{S_j} > \hat{d}_0\}$ denotes the numbers of d^{S_j} greater than $\hat{d}_0$

Table 16 reports the coefficient difference for “COVID*Total ESG”, “COVID*Environment”, “COVID*Social”, and “COVID*Governance”. I observed that “COVID*Environmental” with a coefficient difference of -0.012 and “COVID*Governance” with a coefficient difference of -0.008 are both statistically significant at 5% level of significance. The negative coefficients and significant results indicate that firms experiencing negative industrial GDP growth and investing in the “Environmental” and the “Governance” pillar benefited from greater cost of equity reduction during the COVID-19 pandemic than those firms which experienced positive industrial GDP during the COVID-19 pandemic. Firms experiencing negative GDP during the COVID-19 pandemic enjoy amplified ESG benefit than firms experiencing positive GDP growth, which signals the resilience of the ESG insurance mechanism (Palmi et al., 2018; Benabou and Tirole, 2010; Godfrey et al., 2009; Amiraslani et al., 2023). However, the “COVID*Total ESG” and “COVID*Social” coefficient differences are not statistically significant, even at 10% level of significance. The Total ESG coefficient difference is not significant because the social pillar coefficient difference shows statistical insignificance. Firms’ better social performance shapes the solid trust between investors and the firms, and the trust built through investments in social capital pays off when the overall level of trust in corporations and markets suffers a negative shock (Lins et al., 2017). The COVID-19 crisis is less relevant to a trust crisis, so the insurance mechanism based on the payoff of trust is weaker. This may explain why the social pillar coefficient difference between negative industrial GDP growth and positive industrial GDP growth firms is not significant. To sum up, it is reasonable to conclude that H2 [*The amplified benefit that ESG tempers the increase in the cost* *of equity during the COVID-19 pandemic is greater for firms associated with negative industrial GDP growth*] is partially supported.

Finally, the regression model examines the relationship between the cost of equity and amplified ESG benefits in cost of equity reduction during the COVID-19 pandemic based on the level of stringency about the policy in response to the COVID-19. The regression outputs in Table 17 and Table 18 reveal that the coefficients and statistical significance are consistent with the regression outputs in H1, which indicates that firms suffer from higher cost of equity due to the COVID-19 and that firms benefit from better ESG performance regardless of the level of stringency about the policy in response to the COVID-19. Conducting Fisher's permutation test with bootstrap sampling again, I obtained the coefficient difference (High Stringency -Low Stringency) associated with the p-value for the four interaction terms: "COVID*Total ESG", "COVID*Environment", "COVID*Social", and "COVID*Governance". I observed that "COVID*Environmental" with a coefficient difference of -0.011 and "COVID*Governance" with a coefficient difference of -0.011 are both statistically significant at 5% level of significance (as shown in Table 19). The negative coefficient difference means the amplified ESG benefit in cost of equity reduction during the pandemic is stronger for firms under a high stringency level of the COVID-19 government measures, which indicates the benefit of ESG resilience (Palmi et al., 2018; Benabou and Tirole, 2010; Godfrey et al., 2009; Amiraslani et al., 2023). Again, the Total ESG coefficient difference and the social pillar coefficient difference are not statistically significant. The Total ESG coefficient difference cannot be significantly explained due to the insignificance of the social pillar coefficient difference. The social pillar coefficient difference shows an insignificant result because the pay-off of social capital is stronger during the trust crisis than during the COVID-19 crisis. A trust crisis arises due to the loss of trust; a case in point is the 2008 financial crisis, which resulted from the loss of trust in financial institutions and regulatory systems (Earle, 2009; Guynn et al., 2010). The nature of the COVID-19 pandemic is relevant to lockdowns, limitation on production and other measures (Priya et al., 2023), which is different from the endogenous trust crisis. In summary, my last hypothesis H3 [*The amplified benefit that ESG tempers the increase in the cost of equity during the COVID-19 pandemic is greater for firms associated with more stringent COVID-19 government measures*] is partially supported.

5.4 Robust Check Result

The robust check for ESG replacement with the third sub-layer theme checks (Table 20-No.5-No.14) reveals that firm performance in resource use, emission, workforce, human rights, community, product responsibility, management, shareholder, CSR strategy pays off in reducing the cost of equity for firms during the COVID-19 pandemic. The innovation contributions in the environmental pillar are not significantly helpful in reducing firms' cost of equity. Thus, the first hypothesis that ESG tempers the increase in the cost of equity during the COVID-19 pandemic is almost totally supported by this robust check.

After applying the propensity score match for the stringency group with a one-to-one approach, the total observations drop to around 7,000 with 2,200 unique firms for total ESG, environmental, social, and governance models. However, the existing observations are still enough for a valid regression. The result is consistent with the result in the baseline model. COVID, ESG-related, and interaction variables are statistically significant in each model. The statistical significance of COVID remains unchanged after the propensity score match for the firm characteristic variables. The outcome (as shown in Table 21) from the PSM robust check supports my first hypothesis that ESG tempers the increase in the cost of equity during the COVID-19 pandemic is almost totally supported by this robust check.

To check endogeneity, I investigated the correlations between the error-term and each independent variables. After running the baseline model on regression regarding my first hypothesis, I predicted the residual and saved it in my dataset. From the correlation matrix (Table 22), the strongest correlation between the error term and the explanatory variables is 0.193 (correlation between the error term and the Total ESG). The correlation between the error-term and other independent variables is even weaker: -0.037 between COVID and error-term; 0.035 between interaction and the COVID; -0.031 between the beta and the error-term; 0.117 between the Idiosyncratic risk and error term; -0.063 between momentum and the error term; 0.067 between leverage and the error term; -0.024 between the B2M and the error-term; 0.122 between asset and the error-term; 0.001 between growth and error-term; and -0.028 between earning volatility and the error-term. Thus, I conclude that my study does not detect the serious endogeneity problem. However, this does not completely rule out the possibility of endogenous issues.

The robust check with stringency and severity control added (Table 23) reveals that the joint ESG performance can significantly reduce firms' equity cost at the 1% level of significance just like the individual component of ESG is beneficial during the pandemic. I also confirm the statistical significance and the positive sign of "Stringency" and "Severity". These show that the stricter policy announced by the government restricts business, and the research interest of "COVID" reveals negative sentiment which leads to a higher cost of equity for firms. This robust check reports that Total Environmental, Social, and Governance (ESG) performance can either jointly or separately reduce firms' cost of equity during the pandemic after COVID-19 stringency and COVID-19 severity have been controlled.

After I removed all the Canadian firms, I ran the regression for my baseline model in hypothesis (1). Compared with the results in Table 13, I found that the level of significance for the variables in Table 24 does not change. The Canadian firms merely occupy less than 1% of the observations in my dataset. Thus, the country effect may not be a significant concern in my study if it is not under control.

The primary focus of my thesis is the application of categorical ESG variables. For an additional robustness check, I incorporate the original, continuous ESG scores into the baseline model as a replacement for the categorical ESG variables. The findings in Table 25 are consistent with the results from the baseline models for H1. Specifically, these robust models demonstrate the negative sign and statistical significance for all interaction terms. The coefficient of "COVID*Total ESG" in Table 25 is 0.331%, compared to 3.21% in Table 13. The interaction coefficients in Table 25 approximate those in Table 13, scaled down by a factor of ten, with a negligible methodological difference of 0.01% between 0.331% and 0.321%, and this difference is even smaller for the individual E, S, and G models. The consistent results indicate the validity of the ESG transformation approach and conclusions drawn from the baseline model. The original continuous ESG scores exhibit a standard deviation of 19.29 (Table 6). The coefficient of the original "Total ESG" from Table 25 is -0.00463, and the coefficient of the original "COVID*Total ESG" from Table 25 is -0.0031. Economically, these translate to the benefits that ESG provides fundamental risk mitigation of 9% in the cost of equity and an additional 6% reduction during the COVID-19 pandemic for firms with 19.29 ESG scores above the benchmark (mean). Although the cost of equity increased by 26% due to the COVID-19 pandemic (Table

25, Column 1), ESG can effectively temper the risk perceived by investors, offsetting the 15% increased cost of equity during the COVID-19 pandemic.

Chapter 6: Conclusion

The COVID-19 pandemic started in early 2020 and brought investors uncertainty and concerns about volatility, liquidity, credit, and future growth of securities. Risk mitigation is considered a vital driver of sustainable development (Schaltegger and Burritt, 2018), and ESG is regarded as an emerging concept that prevents firms from the higher cost of equity capital. My thesis examines the amplified benefits of ESG during the pandemic and probes into how the amplified benefits vary under different industry groups and policy stringency groups from the risk-reward perspective (Markowitz, 1952). Based on more than 2000 unique firms whose stocks were publicly traded via NYSE, AMEX, and NASDAQ from 2015 to 2022, I explore the regression models and confirm that the ESG performance functions as the insurance for firms' equity financing. On average, one level rating (10 scores) higher in total ESG performance allows the firm to mitigate the cost of equity by an extra 3.21% lower during the COVID-19 pandemic, which confirms ESG as the effective insurance (Godfrey et al., 2009; Amiraslani et al., 2023) for the cost of equity. The significance of ESG benefits for firms to offset the higher cost of equity due to the COVID-19 shock has been examined by robust checks. Regarding the two industry groups with different natures of GDP growth, firms with better E & G performance experiencing negative industrial GDP growth benefited from higher ESG reduction during the COVID-19 pandemic. Regarding the two stringency groups, firms with better E & G performance under stricter COVID-19 government policy also benefited from higher ESG reduction during the COVID-19 pandemic. These results also signal the insurance mechanism

(Godfrey et al., 2009; Amiraslani et al., 2023) and better resilience (Benabou and Tirole, 2010) for firms under worse conditions.

From an investor's standpoint, adopting the Environmental, Social, and Governance (ESG) practices constructs a diligent strategy, especially in the face of exogenous shocks. This is attributed to the ESG insurance mechanisms, which can effectively mitigate systematic risk during a crisis. The findings of my study also lend support to the potential benefits of ESG practices from a corporate perspective, suggesting that during the pandemic, firms with higher ESG performance may be perceived as less risky. Thus, lower expected returns are required from investors, reducing the firms' cost of equity. Additionally, from a policy-making point of view, the benefit of risk mitigation facilitated by ESG achievements—both under normal conditions and during crises—encourages policymakers to advocate for ESG practices.

Chapter 7: Limitations and Future Research

From the perspective of the level of analysis, the existing research focuses on studies based on firm-level research when exploring the topic of sustainability. [e.g., 62 percent of research papers based on corporate social responsibility are built on firm-level analysis (Fatima and Elbanna, (2023)]. Based on the literature review, I find that studies investigating ESG at the national level of analysis are limited. The United Nations (2020) has improved the sustainable development goal index, which applies a standardized approach to evaluate a country's sustainability performance and this new index can be used as a reliable indicator to measure a country's economic and sustainable development (Verk et al., 2021). In this way, future studies can be conducted at the macro and country levels, significantly contributing to the existing literature.

My present study predominantly focuses on the impact of COVID and ESG on the U.S. market. To cultivate a more encompassing understanding and arrive at conclusions with broader applicability and universality, I need to conduct investigations in the future to extend focus toward analyzing other international markets. Such a future research agenda not only promises a more expansive perspective but also facilitates the generation of comparative insights into the influences of ESG components between developing markets and the developed ones. Lozano and Martinez-Ferrero (2022) investigate the difference between developing markets and developed markets, focusing on Governance (G) performance between 2012 and 2018. Furthermore, the unique, unprecedented context provided by the COVID-19 pandemic represents a fertile ground for potential research endeavours to dissect and understand the differential impacts and performance related to ESG amid the global health crisis (2020-2022).

Another limitation is related to the measurement of the stringency level of government policies. The COVID-19 pandemic government response tracker (OxCGRT) developed by the University of Oxford research team is the most authoritative source that measures the government's attitude and policy on the COVID-19 pandemic. However, the indices of stringency do not ideally assess the effectiveness or appropriateness of a government's policy. The index reflects the number and strictness of policy for the given province or state (Hale et al., 2021). For future research, if any reliable indexes efficiently measure the effect of the government response to the COVID-19 pandemic, my study can be further robust.

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Appendix 1- Variables Definition

Table I: Variables Construction

This appendix reports the definition of the important variables in my study. The table articulates the explanations of COE, COVID, ESG, Stringency Index, Interaction, Severity, Beta, Idiosyncratic Risk, Momentum, Leverage, Book-To-Market, Growth rate, and Earning Volatility.

Cost of Equity (COE)	**COE** is the estimated cost of equity based on the FF4 model at the year-end from 2014 to 2022.
COVID	**COVID** is a dummy variable assigned 1 if the COE is generated during the pandemic timeslot; otherwise, “0”.
Environmental, Social, and Governance Scores	**ESG** is the categorical variable which ranges from 0 to 10 based on the raw ESG score from Refinitiv (e.g., ESG=1 indicates the original ESG scores from Refinitiv is between 0 and 10; ESG=10 indicates the original ESG scores from Refinitiv is between 91 and 100).
Stringency Index	**Stringency Index** is the aggregated score calculated from 8 containment & closure indicators and one indicator in the health system.
Interaction	**Interaction** represents the interaction effect between ESG after assignment transformation (range from 0 to 10 based on the raw ESG score from Refinitiv) and COVID-19 on the cost of equity.
Severity	**Severity** is measured by the search interest of the key word “COVID” by region from Google Trend. It ranges from 0 to 100.
Beta	**Beta** is the firm beta estimated by WRDS-Beta Suite based on the FF4 model.
Idiosyncratic Risk	**Idiosyncratic risk** is the Idiosyncratic volatility, which is calculated as the standard deviation of the residual from the market model regression with monthly returns over the past five years (Ke,2022). Specifically, Idiosyncratic Volatility (IVOL) is calculated based on the methodology described in Ang et al. (2006). It is the volatility of the difference between realized returns and expected returns (based on respective risk models, which is FF4 in my thesis).

Momentum	**Momentum** is the capacity of the stock price trend, which is the natural logarithm of the compounded monthly stock returns one year before the cost of equity estimate (Ke,2022).
Leverage	**Leverage** is the long-term debt over total asset ratio
Book-To-Market	**B2M** is the book-to-market ratio measured by [(csho* prcc_c)/ mkvalt] where csho is the common Shares Outstanding; prcc_c is the closed price; and mkvalt is the total market value
Asset	**Asset** is the nature log of the total asset from the firm.
Growth Rate	**Growth** is the earning growth rate of the firm measured by [(Eearning$_{t+1}$-Earning$_t$)/Earning$_t$].
Earning Volatility	**Earning Volatility** is the standard deviation of annual earnings divided by the mean over the preceding five years (Gebhardt et al., 2001 & Ke, 2022)

Appendix 2: Tables

Table 1: Number of Observations Used for Estimation

This table demonstrates the historical observations used to compute my study's monthly cost of equity (COE). The first column indicates the number of observations, showing that 36 months within 60 months is the minimum estimation window for my study. The frequency column counts the COEs computed based on the number of historical data in the first column. The table indicates the weights of the individual frequency based on the total frequency, revealing that most COEs are estimated based on the complete 60 months.

Number of Observations	Frequency	Weights
36	4078	0.64%
37	4025	0.64%
38	4009	0.63%
39	3997	0.63%
40	3969	0.63%
41	3948	0.62%
42	4034	0.64%
43	3952	0.62%
44	3838	0.61%
45	3808	0.60%
46	3818	0.60%
47	3713	0.59%
48	3736	0.59%
49	3771	0.60%
50	3723	0.59%
51	3672	0.58%
52	3636	0.57%
53	3694	0.58%
54	3675	0.58%
55	3554	0.56%
56	3484	0.55%
57	3528	0.56%
58	3442	0.54%
59	3690	0.58%
60	542164	85.66%

Table 2: Environmental, Social, and Governance (ESG) Transformation

This table indicates how original ESG scores from Refinitiv are transformed in this study. The original ESG score ranges from 0 to 100. The original scores are assigned into 1 to 10 integers based on the interval of 10 scores. Thus, “1” represents the original ESG score between 0 and 10. “2” represents the original ESG score between 11 and 20. The maximum integer 10 indicates that the original ESG score falls between 91 and 100.

Original ESG Scores	After Transformation
0 to 10	1
11 to 20	2
21 to 30	3
31 to 40	4
41 to 50	5
51 to 60	6
61 to 70	7
71 to 80	8
81 to 90	9
91 to 100	10

Table 3: Contributions to Percent Change in Gross Domestic Product by Industry

This table demonstrates the percent change in gross domestic product by industry from the U.S. Bureau of Economic Analysis (BEA). The North American Industry Classification System (NAICS) defines the industry/sector on the BEA platform. The annual industrial GDP change from 2015 to 2022 includes Agriculture, forestry, fishing, and hunting (11), Mining (21), Utilities (22), Construction (23), Manufacturing (31-33), Wholesale trade (41), Retail trade (44-45), Transportation and warehousing (48-49), Information (51), Finance and insurance (52), Real estate and rental and leasing (53), Professional, scientific, and technical services (54), Administrative and waste management services (56), Educational services (61), Health care and social assistance (62), Arts, entertainment, and recreation (71), Accommodation and food services (72), and Other services, except government (81). The third row records the overall GDP change from the previous year based on all industries/sectors. The individual industrial GDP change on an annual basis is recorded in the row associated with each industry/sector.

	2015	2016	2017	2018	2019	2020	2021	2022
Percent change:								
Gross domestic product	2.7	1.7	2.2	2.9	2.3	-2.8	5.9	2.1
Percentage points:								
Private industries:	2.67	1.55	2.08	2.79	2.23	-2.8	5.83	1.89
Agriculture, forestry, fishing, and hunting (11)	0.07	0.05	-0	0.02	-0.1	0.02	-0.1	-0.03
Mining (21)	0.17	-0.1	0.02	0.02	0.18	-0	-0.2	-0.18
Utilities (22)	0	0.09	0.02	-0	0.01	0.06	-0.1	-0.04
Construction (23)	0.17	0.15	0.14	0.09	0.06	-0.2	0.1	-0.43
Manufacturing (31-33)	0.13	-0	0.37	0.47	0.18	-0.5	0.71	0.04
Wholesale trade (41)	0.26	-0.1	0.02	0.06	-0	0	0.34	0.02
Retail trade (44-45)	0.21	0.21	0.18	0.17	0.12	-0.2	0.15	-0.22
Transportation and warehousing (48-49)	0.08	0.05	0.13	0.12	0.03	-0.4	0.21	0.07
Information (51)	0.49	0.43	0.32	0.41	0.3	0.21	0.75	0.43
Finance and insurance (52)	0.26	0.12	-0.1	0	0.26	0.22	0.61	0.06
Real estate and rental and leasing (53)	-0	0.09	0.21	0.36	0.28	-0.2	0.42	0.42
Professional, scientific, and technical services (54)	0.32	0.22	0.25	0.44	0.32	-0	0.85	0.55
Management of companies and enterprises (55)	0.05	0.02	0.13	0.13	0.13	0.03	0.21	0.14
Administrative and waste management services (56)	0.04	0.01	0.19	0.13	0.08	-0.2	0.41	0.3
Educational services (61)	0.01	0.04	-0	0.03	0.03	-0.1	0.04	0.05
Health care and social assistance (62)	0.31	0.21	0.17	0.21	0.22	-0.1	0.36	0.29
Arts, entertainment, and recreation (71)	-0	0.04	0.04	0.04	0.01	-0.4	0.26	0.2
Accommodation and food services (72)	0.14	0.03	0.07	0.03	0.07	-0.8	0.65	0.16
Other services, except government (81)	0.01	-0	0.01	0.06	0.01	-0.2	0.11	0.08

Table 4: OxCGRT Indices Definition

This table exhibits four indices from the University of Oxford Pandemic Government Response Tracker (OxCGRT) prepared by the Blavatnik School of Government. The Government Response Index, Containment and Health Index, Stringency Index, and Economic Support Index are aggregated based on different indicators. The "k" column summarizes how many indicators have been used to estimate the corresponding index. C1 to C8, E1-E4, H1-H8, and V1-V4 represent the possible indicators to support the aggregation of the index. These four indices are all state or province-specific, reflecting the actions of the COVID-19 pandemic within a state or province. The definition of each indicator will be specified in Table 6.

Index/Indicators	k	C1	C2	C3	C4	C5	C6	C7	C8	E1	E2	E3	E4	H1	H2	H3	H4	H5	H6	H7	H8	M1	V1	V2	V3	V4
Government Response	16	x	x	x	x	x	x	x	x	x	x			x	x	x			x	x	x					
Containment and health	14	x	x	x	x	x	x	x	x					x	x	x			x	x	x					
Stringency	9	x	x	x	x	x	x	x	x					x												
Economic support	2									x	x															

Table 5: OxCGRT Indicators Definition

This table lists the concrete definitions for each indicator under Containment and Closure (C1-C8), Economic Response (E1-E4), Health Systems (H1-H8), Vaccine Policies (V1-V4), and Miscellaneous categories (M1). C1-C8, E1-E2, H1-H3, and H6-H8 measure the Government Response index. C1-C8, H1-H3, and H6-H8 calculate the Containment and health index. C1-C8 and H1 measure the Stringency index. E1 and E2 measure the economic support index.

ID	Name	Type	Targeted/General	Differentiation based on vaccination status?
Containment and Closure				
C1	School closing	Ordinal	Geographic	Yes
C2	Workplace closing	Ordinal	Geographic	Yes
C3	Cancel public events	Ordinal	Geographic	Yes
C4	Restrictions on gathering size	Ordinal	Geographic	Yes
C5	Close public transport	Ordinal	Geographic	Yes
C6	Stay-at-home requirement	Ordinal	Geographic	Yes
C7	Restrictions on internal movement	Ordinal	Geographic	Yes
C8	Restrictions on international travel	Ordinal	No	Yes
Economic Response				
E1	Income support	Ordinal	Sectoral	No
E2	Debt/contract relief for households	Ordinal	No	No
E3	Fiscal measures	Numeric	No	No
E4	Giving international support	Numeric	No	No
Health Systems				
H1	Public information campaign	Ordinal	Geographic	No
H2	Testing policy	Ordinal	No	No
H3	Contact tracing	Ordinal	No	No
H4	Emergency investment in healthcare	Numeric	No	No
H5	Investment in COVID-19 vaccines	Numeric	No	No
H6	Facial coverings	Ordinal	Geographic	Yes
H7	Vaccination policy	Ordinal	Cost	No
H8	Protection of elderly people	Ordinal	Geographic	Yes
Vaccine Policies				
V1	Vaccine prioritization	Categorical	No	No
V2	Vaccine eligibility/availability	Categorical	No	No
V3	Vaccine financial support	Categorical	No	No
V4	Mandatory vaccination	Binary	No	No
Miscellaneous				
M1	Other responses	Text	No	n/a

Table 6: Summary Statistics

The summary statistics reports the number of observations, the 25% percentile, the median, the 75% percentile, the mean, the minimum value, the maximum value, and the standard deviation for the dependent variable (COE), the key independent variables (COVID and Total ESG), and the control variables (Firm Beta, Idiosyncratic risk, Momentum, Leverage, Book-to-Market ratio, Asset, Growth rate, and earning volatility) on the baseline model.

	N	p25	Median	p75	Mean	min	max	Std. Dev.
COE	11070	-0.079	0.099	0.285	0.123	-0.524	1.385	0.317
COVID	11070	0.000	0.000	1.000	0.484	0.000	1.000	0.500
ESG (1-10)	11070	3.000	4.000	6.000	4.615	1.000	9.000	1.952
ESG (1-100)	11070	26.020	38.050	55.460	41.450	9.370	86.280	19.290
Beta	11070	0.680	1.009	1.344	1.042	-0.358	2.87	0.562
Idiosyncratic	11070	0.054	0.077	0.118	0.097	0.030	0.346	0.062
Momentum	11070	-0.183	0.065	0.282	0.022	-1.478	1.156	0.446
Leverage	11070	0.076	0.240	0.382	0.260	0.000	1.020	0.214
B2M	11070	1.000	1.000	1.000	1.010	0.701	1.511	0.094
Asset	11070	6.594	7.782	9.019	7.811	3.137	12.460	1.845
Growth	11070	-0.035	0.092	0.229	0.101	-5.881	8.794	1.209
Earning_vol	11070	0.073	0.201	0.430	0.217	-9.643	9.362	1.778

Table 7: Matrix of Correlation

The matrix of the correlation table reports the relationship among the dependent variable (COE), the key independent variable (COVID and Total ESG), and the control variables (Firm Beta, Idiosyncratic risk, Momentum, Leverage, Book-to-Market ratio, Asset, Growth rate, and earning volatility) on the baseline model. The significance of the correlation has also been reported, followed by the correlations. Three stars indicate the p-value is less than 0.01. Two stars indicate that the p-value is less than 0.05. One star indicates that the p-value is less than 0.1.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) COE	1.000										
(2) COVID	0.031***	1.000									
(3) ESG	-0.029***	0.092***	1.000								
(4) Beta	0.218***	0.064***	-0.032***	1.000							
(5) Idiosyncratic	0.010	0.245***	-0.359***	0.290***	1.000						
(6) Momentum	0.393***	-0.093***	0.051***	-0.034***	-0.165***	1.000					
(7) Leverage	0.082***	0.075***	0.136***	0.100***	-0.024**	0.032***	1.000				
(8) B2M	-0.003	0.102***	-0.004	-0.000	-0.023**	-0.037***	0.001	1.000			
(9) Asset	0.007	-0.102***	0.610***	-0.029***	-0.580***	0.088***	0.212***	0.002	1.000		
(10) Growth	-0.011	0.006	-0.002	0.012	0.016*	-0.009	-0.002	-0.012	-0.012	1.000	
(11) Earning_vol	-0.009	-0.005	0.024**	-0.025***	-0.099***	0.036***	0.013	0.006	0.069***	-0.018*	1.000

Table 8: Univariate Comparison (COVID)

This table reports the univariate comparison based on the 5 years (2015-2019) before the COVID-19 pandemic and the 3 years (2020-2022) during the pandemic. The univariate comparison involves the dependent variable (COE), the key independent variable (Total ESG), and the control variables (Firm Beta, Idiosyncratic risk, Momentum, Leverage, Book-to-Market ratio, Asset, Growth rate, and earning volatility). The observations falling into the period before the pandemic are assigned to "COVID=0". The observations falling into the period during the pandemic are assigned to "COVID=1". The observations before the pandemic and during the pandemic are symmetrical. The median and mean difference tests are constructed by "(0)-(1)". Three stars indicate the p-value is less than 0.01. Two stars indicate the p-value is less than 0.05. One star indicates that the p-value is less than 0.1.

	COVID=0 (2015-2019)			**COVID=1 (2020-2022)**			**Difference (0) - (1)**	
Variable	N	Median	Mean	N	Median	Mean	Median	Mean
COE	5708	0.097	0.113	5362	0.102	0.133	-0.005	-0.020***
ESG	5708	4	4.441	5362	5	4.800	-1***	-0.359***
Beta	5708	0.99	1.007	5362	1.029	1.079	-0.039***	-0.072***
Idiosyncratic	5708	0.067	0.082	5362	0.091	0.113	-0.024***	-0.032***
Momentum	5708	0.098	0.062	5362	0.026	-0.021	0.072***	0.083***
Leverage	5708	0.226	0.244	5362	0.259	0.276	-0.033***	-0.321***
B2M	5708	1	1.001	5362	1	1.020	0***	-0.193***
Asset	5708	7.968	7.994	5362	7.585	7.617	0.383***	0.377***
Growth	5708	0.09	0.095	5362	0.096	0.108	-0.006	-0.014
Earning_vol	5708	0.184	0.226	5362	0.227	0.208	-0.043***	0.017

Table 9: Univariate Comparison (Industry)

Similar to Table 9, this table reports the results from univariate comparison tests. The univariate comparison in Table 10 consists of two panels: Panel (A) and Panel (B). Regarding Panel (A), the “Insensitive (0)” group includes 50% of firms associated with annually industrial GDP change closer to 0%. Then, the “Sensitive (1)” group consists of the 50% of firms associated with annually industrial GDP change far from 0%. Regarding Panel (B), the firms in the “Sensitive” group are further assigned into sub-groups: “Sensitive[-GDP] (0)” and “Sensitive[+GDP] (1)”. This approach allows us to distinguish between firms experiencing positive and negative GDP growth during the pandemic. The median and mean difference tests are constructed by “(0)-(1)” in both panels. Three stars indicate the p-value is less than 0.01. Two stars indicate the p-value is less than 0.05. One star indicates that the p-value is less than 0.1.

Univariate Comparison (Industry_Panel[A])								
	Insensitive (0)			**Sensitive (1)**			**Difference (0)-(1)**	
Variable	N	Median	Mean	N	Median	Mean	Median	Mean
COE	2289	0.09	0.122	8394	0.101	0.124	-0.011	-0.002
COVID	2289	0	0.454	8394	0	0.493	0***	-0.039***
ESG	2289	5	4.911	8394	4	4.547	1***	0.364***
Beta	2289	0.931	0.967	8394	1.025	1.063	-0.094***	-0.097***
Idiosyncratic	2289	0.08	0.095	8394	0.077	0.098	0.003	-0.003**
Momentum	2289	0.08	0.052	8394	0.06	0.011	0.02***	0.041***
Leverage	2289	0.273	0.279	8394	0.229	0.255	0.044***	0.024***
B2M	2289	1	1.009	8394	1	1.010	0	-0.002
Asset	2289	8.2	8.191	8394	7.672	7.703	0.528***	0.488***
Growth	2289	0.079	0.064	8394	0.096	0.112	-0.017***	-0.475*
Earning_vol	2289	0.188	0.212	8394	0.202	0.211	-0.014	0.001
Univariate Comparison (Industry_Panel[B])								
	Sensitive[-GDP] (0)			**Sensitive[+GDP] (1)**			**Difference (0)-(1)**	
Variable	N	Median	Mean	N	Median	Mean	Median	Mean
COE	6390	0.109	0.127	2004	0.075	0.114	0.034*	0.013
COVID	6390	0	0.492	2004	0	0.498	0	-0.006
ESG	6390	4	4.637	2004	4	4.261	0***	0.376
Beta	6390	1.048	1.090	2004	0.965	0.976	0.083***	0.114***
Idiosyncratic	6390	0.082	0.104	2004	0.063	0.079	0.019***	0.025***
Momentum	6390	0.062	0.008	2004	0.049	0.022	0.013	-0.0136
Leverage	6390	0.251	0.271	2004	0.114	0.207	0.137	0.064***
B2M	6390	1	1.011	2004	1	1.008	0	0.003
Asset	6390	7.496	7.502	2004	8.254	8.344	-0.758***	-0.842***
Growth	6390	.093	0.108	2004	0.109	0.125	-0.016**	-0.017
Earning_vol	6390	.202	0.213	2004	0.201	0.205	0.001	0.009

Table 10: Univariate Comparison (Stringency)

This table reports the univariate comparison results based on the stringency level. Observations associated with stringency index in the top/highest 50% are allocated into group “Stringency=0”; otherwise group “Stringency=1”. The univariate comparison involves the dependent variable (COE), the key independent variable (COVID and Total ESG), and the control variables (Firm Beta, Idiosyncratic risk, Momentum, Leverage, Book-to-Market ratio, Asset, Growth rate, and earning volatility). The median and mean difference tests are constructed by “(0)-(1)”. Three stars indicate the p-value is less than 0.01. Two stars indicate that the p-value is less than 0.05. One star indicates that the p-value is less than 0.1.

	Stringency=0 (High)			**Stringency=1 (Low)**			**Difference (0)-(1)**	
Variable	N	Median	Mean	N	Median	Mean	Median	Mean
COE	5620	0.101	0.126	5450	0.096	0.120	0.005	0.006
COVID	5620	0	0.492	5450	0	0.477	0	0.015
ESG	5620	4	4.678	5450	4	4.551	0***	0.127***
Beta	5620	1.014	1.046	5450	1.003	1.038	0.011	0.008
Idiosyncratic	5620	0.079	0.101	5450	0.075	0.093	0.004***	0.008***
Momentum	5620	0.063	0.017	5450	0.067	0.027	-0.004	-0.01
Leverage	5620	0.224	0.250	5450	0.255	0.270	-0.031***	-0.02***
B2M	5620	1	1.010	5450	1	1.010	0	0
Asset	5620	7.716	7.748	5450	7.861	7.877	-0.145***	-0.129***
Growth	5620	0.098	0.110	5450	0.087	0.093	0.011**	0.017
Earning_vol	5620	0.185	0.152	5450	0.217	0.285	-0.032***	-0.133***

Table 11: Outputs for Pre-Hypothesis 1 (COVID and COE)

This table reports the regression outputs for the pre-hypothesis. This regression model explores the relationship between COVID-19 and the cost of equity (COE). Thus, ESG-related variables are not incorporated into this model. Column (1) reports the coefficients for the COVID-COE simple model. Control variables are involved in the "multiple" model under column (2). The number of observations, companies, and the corresponding R-square are reported at the end of the table. Three stars indicate the p-value is less than 0.01. Two stars indicate that the p-value is less than 0.05. One star indicates that the p-value is less than 0.1. The regression models capture the firm-fixed effect.

VARIABLES	(1) Simple	(2) Multiple
COVID	0.0406***	0.0587***
	(0.00501)	(0.00634)
Beta		0.169***
		(0.00757)
Idiosyncratic		-1.423***
		(0.133)
Momentum		0.303***
		(0.00625)
Leverage		0.0799***
		(0.0272)
B2M		0.0762***
		(0.0275)
Asset		-0.0278***
		(0.00892)
Growth		-0.00153
		(0.00227)
Earning_vol		-0.00151
		(0.00154)
Constant	0.0967***	0.166**
	(0.00311)	(0.0748)
Observations	18,088	14,557
R-squared	0.004	0.212
Number of company	3,135	2,866

Table 12: Outputs for Hypothesis 1 (COVID, ESGs, and COE without Controls)

This table reports the coefficients and the statistical significance of the Total ESG model (1), Environmental model (2), Social model (3), and Governance model (4) based on all observations to support the first hypothesis. Each model examines the firm ESG performance from a different perspective. This table only includes the COVID, ESG and their interaction term. Control variables are not added to the regression model. The number of observations, companies, and the corresponding R-square are reported at the end of the table. Three stars indicate the p-value is less than 0.01. Two stars indicate that the p-value is less than 0.05. One star indicates that the p-value is less than 0.1. The regression models capture the firm-fixed effect.

VARIABLES	(1) Total ESG	(2) Environmental	(3) Social	(4) Governance
COVID	0.233***	0.235***	0.187***	0.191***
	(0.0163)	(0.0177)	(0.0157)	(0.0178)
Total ESG	-0.0389***			
	(0.00417)			
COVID*Total ESG	-0.0303***			
	(0.00315)			
Environmental		-0.0195***		
		(0.00334)		
COVID*Environmental		-0.0323***		
		(0.00278)		
Social			-0.0406***	
			(0.00397)	
COVID*Social			-0.0234***	
			(0.00295)	
Governance				-0.0235***
				(0.00307)
COVID*Governance				-0.0250***
				(0.00289)
Constant	0.254***	0.160***	0.282***	0.233***
	(0.0180)	(0.00977)	(0.0178)	(0.0168)
Observations	13,500	12,205	12,828	12,934
R-squared	0.032	0.023	0.031	0.024
Number of company	3,004	2,959	2,974	2,977

Table 13: Outputs for Hypothesis 1 (COVID, ESGs, and COE with Controls)

This table reports the coefficients and the statistical significance of the Total ESG model (1), Environmental model (2), Social model (3), and Governance model (4) based on all observations to support the first hypothesis. Each model examines the firm ESG performance from a different perspective. This table includes the COVID, ESG and their interaction term and incorporates control variables (Firm Beta, Idiosyncratic risk, Momentum, Leverage, Book-to-Market ratio, Asset, Growth rate, and earning volatility). The number of observations, companies, and the corresponding R-square are reported at the end of the table. Three stars indicate the p-value is less than 0.01. Two stars indicate that the p-value is less than 0.05. One star indicates that the p-value is less than 0.1. The regression models capture the firm-fixed effect.

VARIABLES	(1) Total ESG	(2) Environmental	(3) Social	(4) Governance
COVID	0.264***	0.276***	0.216***	0.247***
	(0.0172)	(0.0186)	(0.0166)	(0.0189)
Total ESG	-0.0284***			
	(0.00436)			
COVID*Total ESG	-0.0321***			
	(0.00318)			
Environmental		-0.0196***		
		(0.00360)		
COVID*Environmental		-0.0322***		
		(0.00285)		
Social			-0.0316***	
			(0.00409)	
COVID*Social			-0.0230***	
			(0.00298)	
Governance				-0.0134***
				(0.00318)
COVID*Governance				-0.0288***
				(0.00296)
Beta	0.195***	0.209***	0.203***	0.203***
	(0.00969)	(0.0103)	(0.0101)	(0.0100)
Idiosyncratic	-1.933***	-1.408***	-1.923***	-1.480***
	(0.176)	(0.190)	(0.189)	(0.185)
Momentum	0.320***	0.314***	0.312***	0.316***
	(0.00748)	(0.00801)	(0.00786)	(0.00778)
Leverage	0.0348	-0.0251	0.0331	-0.0113
	(0.0338)	(0.0363)	(0.0361)	(0.0354)
B2M	0.0234	0.0503	0.0215	0.0579*
	(0.0336)	(0.0360)	(0.0351)	(0.0349)
Asset	-0.0298***	-0.0556***	-0.0441***	-0.0567***
	(0.0113)	(0.0121)	(0.0122)	(0.0118)
Growth	-0.00247	-0.00167	-0.000181	-0.00194

	(0.00260)	(0.00278)	(0.00275)	(0.00269)
Earning_vol	-0.00113	-0.000382	0.00159	0.000333
	(0.00188)	(0.00201)	(0.00202)	(0.00195)
Constant	0.379***	0.444***	0.510***	0.474***
	(0.0965)	(0.103)	(0.104)	(0.101)
Observations	11,070	9,983	10,488	10,569
R-squared	0.254	0.254	0.248	0.249
Number of company	2,729	2,662	2,684	2,682

Table 14: Outputs for Hypothesis 2 (Negative Industrial GDP Growth)

This table reports the coefficients and the statistical significance of the Total ESG model (1), Environmental model (2), Social model (3), and Governance model (4) based on firms experiencing negative industrial GDP growth during the pandemic. Testing these models allows us to check whether the ESG-risk mitigation effect holds for firms experiencing industrial decline due to COVID. The number of observations, companies, and the corresponding R-square are reported at the end of the table. Three stars indicate the p-value is less than 0.01. Two stars indicate that the p-value is less than 0.05. One star indicates that the p-value is less than 0.1. The regression models capture the firm-fixed effect.

VARIABLES	(1) Total ESG	(2) Environmental	(3) Social	(4) Governance
COVID	0.262***	0.298***	0.200***	0.266***
	(0.0233)	(0.0257)	(0.0225)	(0.0260)
Total ESG	-0.0275***			
	(0.00589)			
COVID*Total ESG	-0.0320***			
	(0.00429)			
Environmental		-0.0196***		
		(0.00494)		
COVID*Environmental		-0.0362***		
		(0.00397)		
Social			-0.0270***	
			(0.00537)	
COVID*Social			-0.0218***	
			(0.00394)	
Governance				-0.0166***
				(0.00439)
COVID*Governance				-0.0326***
				(0.00412)
Beta	0.196***	0.227***	0.212***	0.215***
	(0.0127)	(0.0133)	(0.0131)	(0.0130)
Idiosyncratic	-1.697***	-1.100***	-1.545***	-1.185***
	(0.229)	(0.242)	(0.245)	(0.238)
Momentum	0.308***	0.294***	0.296***	0.295***
	(0.00985)	(0.0105)	(0.0103)	(0.0102)
Leverage	0.0732*	-8.91e-05	0.0673	0.0267
	(0.0428)	(0.0458)	(0.0453)	(0.0446)
B2M	-0.00950	0.0343	-0.00397	0.0355
	(0.0451)	(0.0485)	(0.0468)	(0.0464)
Asset	-0.0347**	-0.0684***	-0.0514***	-0.0634***
	(0.0150)	(0.0160)	(0.0159)	(0.0156)
Growth	0.00390	0.00320	0.00665*	0.00359
	(0.00376)	(0.00406)	(0.00396)	(0.00391)

Earning_vol	-0.00306	0.000811	0.00385	0.00171
	(0.00289)	(0.00309)	(0.00312)	(0.00297)
Constant	0.412***	0.492***	0.516***	0.503***
	(0.124)	(0.133)	(0.133)	(0.130)
Observations	6,390	5,807	6,119	6,150
R-squared	0.243	0.247	0.235	0.242
Number of company	1,502	1,477	1,478	1,487

Table 15: Outputs for Hypothesis 2 (Positive Industrial GDP Growth)

This table reports the coefficients and the statistical significance of the Total ESG model (1), Environmental model (2), Social model (3), and Governance model (4) based on firms experiencing positive industrial GDP growth during the pandemic. Testing these models allows us to check whether the ESG-risk mitigation effect holds for firms experiencing industrial growth during the pandemic. The number of observations, companies, and the corresponding R-square are reported at the end of the table. Three stars indicate the p-value is less than 0.01. Two stars indicate that the p-value is less than 0.05. One star indicates that the p-value is less than 0.1. The regression models capture the firm-fixed effect.

VARIABLES	(1) Total ESG	(2) Environmental	(3) Social	(4) Governance
COVID	0.303***	0.245***	0.269***	0.247***
	(0.0395)	(0.0382)	(0.0394)	(0.0391)
Total ESG	-0.0149			
	(0.0110)			
COVID*Total ESG	-0.0381***			
	(0.00793)			
Environmental		-0.0157*		
		(0.00852)		
COVID*Environmental		-0.0244***		
		(0.00616)		
Social			-0.0410***	
			(0.0109)	
COVID*Social			-0.0276***	
			(0.00767)	
Governance				-0.00157
				(0.00737)
COVID*Governance				-0.0249***
				(0.00660)
Beta	0.204***	0.182***	0.194***	0.197***
	(0.0291)	(0.0300)	(0.0309)	(0.0289)
Idiosyncratic	-3.177***	-2.796***	-3.012***	-2.694***
	(0.619)	(0.653)	(0.645)	(0.622)
Momentum	0.405***	0.421***	0.429***	0.429***
	(0.0188)	(0.0193)	(0.0192)	(0.0189)
Leverage	-0.0992	-0.112	-0.122	-0.121
	(0.0799)	(0.0843)	(0.0850)	(0.0829)
B2M	0.137	0.120	0.0670	0.121
	(0.0929)	(0.0935)	(0.0981)	(0.0935)
Asset	-0.00116	-0.0192	0.0271	-0.0285
	(0.0243)	(0.0247)	(0.0269)	(0.0242)
Growth	-0.0147***	-0.00996*	-0.0138**	-0.0125**
	(0.00553)	(0.00558)	(0.00570)	(0.00539)

Earning_vol	0.00756*	0.00977**	0.0101**	0.00750*
	(0.00439)	(0.00453)	(0.00496)	(0.00444)
Constant	0.0454	0.192	0.00651	0.220
	(0.231)	(0.235)	(0.252)	(0.233)
Observations	2,004	1,855	1,913	1,938
R-squared	0.327	0.339	0.349	0.341
Number of company	672	641	660	649

Table 16: Two Groups Coefficient Difference Test (H2)

This table reports the results of the two-group coefficient difference tests for H2. The coefficient difference test is performed based on the negative and the positive GDP growth group. The test focuses on the interaction term (COVID*Total ESG, COVID*Environmental, COVID*Social, and COVID*Governance), which captures the special ESG payoff during the COVID-19 pandemic. I used the bootstrap sample to perform Fisher's permutation test (which supports fixed effect model regressions) to examine the significance of the coefficient difference. b_1 is the estimate of the interaction from the group with negative industrial GDP Growth. b_0 is the estimate of the interaction from the group with positive industrial GDP Growth. ESG benefits in risk mitigation signal a negative sign for b_0 and b_1. Therefore, a negative coefficient difference (b_1-b_0), revealing that the absolute value of b_0 is larger, will support H2 and confirm the amplified ESG benefit during the pandemic for firms experiencing negative GDP growth. Three stars indicate the p-value is less than 0.01. Two stars indicate that the p-value is less than 0.05. One star indicates that the p-value is less than 0.1. The regression models capture the firm-fixed effect.

VARIABLE	b_1-b_0	P-Value
COVID*Total ESG	0.006	0.408
COVID*Environmental	-0.012	0.002***
COVID*Social	0.006	0.290
COVID*Governance	-0.008	0.016**

Table 17: Outputs for Hypothesis 3 (High Stringency)

This table reports the coefficients and the statistical significance of the Total ESG model (1), Environmental model (2), Social model (3), and Governance model (4) based on firms experiencing higher levels of stringency in COVID-19 government policies. Testing these models allows us to check whether the ESG-risk mitigation effect holds for firms with higher stringency levels of COVID-19 policies. The number of observations, companies, and the corresponding R-square are reported at the end of the table. Three stars indicate the p-value is less than 0.01. Two stars indicate that the p-value is less than 0.05. One star indicates that the p-value is less than 0.1. The regression models capture the firm-fixed effect.

VARIABLES	(1) Total ESG	(2) Environmental	(3) Social	(4) Governance
COVID	0.316***	0.335***	0.255***	0.305***
	(0.0254)	(0.0274)	(0.0249)	(0.0277)
Total ESG	-0.0301***			
	(0.00628)			
COVID*Total ESG	-0.0371***			
	(0.00461)			
Environmental		-0.0238***		
		(0.00524)		
COVID*Environmental		-0.0376***		
		(0.00417)		
Social			-0.0317***	
			(0.00597)	
COVID*Social			-0.0253***	
			(0.00435)	
Governance				-0.0130***
				(0.00470)
COVID*Governance				-0.0345***
				(0.00435)
Beta	0.186***	0.203***	0.202***	0.199***
	(0.0141)	(0.0150)	(0.0148)	(0.0146)
Idiosyncratic	-1.928***	-1.393***	-2.064***	-1.473***
	(0.255)	(0.276)	(0.273)	(0.269)
Momentum	0.331***	0.326***	0.328***	0.330***
	(0.0108)	(0.0116)	(0.0113)	(0.0113)
Leverage	-0.0210	-0.0857*	-0.0172	-0.0760
	(0.0459)	(0.0492)	(0.0485)	(0.0482)
B2M	0.0140	0.0675	0.0144	0.0669
	(0.0493)	(0.0529)	(0.0516)	(0.0512)
Asset	-0.0565***	-0.0801***	-0.0723***	-0.0849***
	(0.0157)	(0.0166)	(0.0167)	(0.0163)
Growth	-0.00498	-0.00449	-0.00139	-0.00485
	(0.00382)	(0.00409)	(0.00406)	(0.00398)

Earning_vol	-0.00540*	0.000136	0.000437	-0.000268
	(0.00304)	(0.00331)	(0.00334)	(0.00321)
Constant	0.625***	0.641***	0.766***	0.693***
	(0.135)	(0.143)	(0.143)	(0.141)
Observations	5,620	5,096	5,344	5,376
R-squared	0.268	0.268	0.264	0.265
Number of company	1,413	1,373	1,385	1,386

Table 18: Outputs for Hypothesis 3 (Low Stringency)

This table reports the coefficients and the statistical significance of the Total ESG model (1), Environmental model (2), Social model (3), and Governance model (4) based on firms experiencing lower levels of stringency in COVID-19 government policies. Testing these models allows us to check whether the ESG-risk mitigation effect holds for firms with lower stringency levels of COVID-19 policies. The number of observations, companies, and the corresponding R-square are reported at the end of the table. Three stars indicate the p-value is less than 0.01. Two stars indicate that the p-value is less than 0.05. One star indicates that the p-value is less than 0.1. The regression models capture the firm-fixed effect.

VARIABLES	(1) Total ESG	(2) Environmental	(3) Social	(4) Governance
COVID	0.215***	0.214***	0.180***	0.188***
	(0.0232)	(0.0252)	(0.0221)	(0.0257)
Total ESG	-0.0258***			
	(0.00604)			
COVID*Total ESG	-0.0276***			
	(0.00437)			
Environmental		-0.0147***		
		(0.00491)		
COVID*Environmental		-0.0268***		
		(0.00387)		
Social			-0.0305***	
			(0.00558)	
COVID*Social			-0.0214***	
			(0.00407)	
Governance				-0.0138***
				(0.00428)
COVID*Governance				-0.0231***
				(0.00401)
Beta	0.203***	0.213***	0.203***	0.205***
	(0.0132)	(0.0142)	(0.0138)	(0.0136)
Idiosyncratic	-1.873***	-1.377***	-1.698***	-1.443***
	(0.244)	(0.262)	(0.261)	(0.255)
Momentum	0.308***	0.301***	0.294***	0.300***
	(0.0104)	(0.0110)	(0.0109)	(0.0107)
Leverage	0.102**	0.0450	0.0952*	0.0660
	(0.0505)	(0.0545)	(0.0546)	(0.0528)
B2M	0.0300	0.0295	0.0222	0.0463
	(0.0456)	(0.0485)	(0.0476)	(0.0473)
Asset	0.00300	-0.0239	-0.00558	-0.0205
	(0.0165)	(0.0177)	(0.0181)	(0.0173)
Growth	0.000310	0.00131	0.00134	0.00103
	(0.00353)	(0.00375)	(0.00371)	(0.00360)

Earning_vol	0.00159	-0.00109	0.00199	0.000304
	(0.00234)	(0.00246)	(0.00248)	(0.00239)
Constant	0.0704	0.186	0.164	0.186
	(0.139)	(0.149)	(0.153)	(0.146)
Observations	5,450	4,887	5,144	5,193
R-squared	0.243	0.242	0.234	0.235
Number of company	1,316	1,289	1,299	1,296

Table 19: Two Groups Coefficient Difference Test (H3)

This table reports the results of the two-group coefficient difference tests for H3. The coefficient difference test is performed based on the higher and lower stringency groups. The test focuses on the interaction term (COVID*Total ESG, COVID*Environmental, COVID*Social, and COVID*Governance), which captures the special ESG payoff during the COVID-19 pandemic. I used the bootstrap sample to perform Fisher's permutation test (which supports fixed effect model regressions) to examine the significance of the coefficient difference. b_1 is the estimate of the interaction from the group associated with a higher stringency index. b_0 is the estimate of the interaction from the group associated with a lower stringency index. ESG benefits in risk mitigation signal a negative sign for b_0 and b_1. Therefore, a negative coefficient difference (b_1-b_0), revealing that the absolute value of b_0 is larger, will support H3 and confirm the amplified ESG benefit during the pandemic for firms in the higher stringency group. Three stars indicate the p-value is less than 0.01. Two stars indicate that the p-value is less than 0.05. One star indicates that the p-value is less than 0.1. The regression models capture the firm-fixed effect.

VARIABLE	b_1-b_0	P-Value
COVID*Total ESG	-0.010	0.106
COVID*Environmental	-0.011	0.011**
COVID*Social	-0.004	0.326
COVID*Governance	-0.011	0.048**

Table 20: All Regression Model Output (OLS, FE, RE, Hausman, Comments)

This table summarizes the outcome of the regression based on the OLS, FE, and RE approach for every component in each ESG layer. There are 14 specified models. The Yes/No in the third column shows whether the sign of the COVID, ESG, COVID & ESG interaction terms are reasonable/expected and whether the variable is statistically significant for OLS, FE & RE, respectively. The fourth column shows which model is preferable by the Hausman Test. The last column records the comments or reason for the choice of Y/N in the third column. The five percent significance level is used as the benchmark in this table. The regression models capture the firm-fixed effect.

Layer(s)	Model Specification	Sign and Coeff Rationality*	Hausman Test**	Comments/Reasons for Y/N
1. ESG	Total ESG	N, Y, N	Fixed Effect	OLS: ESG-related insignificant; RE: ESG-related insignificant;
2. ESG-E	Environment	N, Y, N	Fixed Effect	OLS: positive sign for ESG-related; RE: ESG-related insignificant
3. ESG-S	Social	N, Y, N	Fixed Effect	OLS: positive sign for ESG-related; RE: ESG-related insignificant
4. ESG-G	Governance	N, Y, N	Fixed Effect	OLS: ESG-related insignificant; RE: ESG-related insignificant
5. ESG-E-RE	Resource Use	N, Y, N	Fixed Effect	OLS: positive sign for ESG-related; RE: ESG-related insignificant
6. ESG-E-E	Emission	N, Y, N	Fixed Effect	OLS: positive sign for ESG-related; RE: ESG-related insignificant
7. ESG-E-I	Innovation	N, N, N	Fixed Effect	OLS: ESG-related insignificant; FE: ESG-related insignificant; RE: ESG-related insignificant
8. ESG-S-W	Workforce	N, Y, N	Fixed Effect	OLS: positive sign for ESG-related; RE: ESG-related insignificant
9. ESG-S-HR	Human Rights	N, Y, N	Fixed Effect	OLS: positive sign for ESG-related; RE: ESG-related insignificant
10. ESG-S-C	Community	N, Y, N	Fixed Effect	OLS: ESG-related insignificant; RE: ESG-related insignificant
11. ESG-S-PR	Product Responsibility	N, Y, N	Fixed Effect	OLS: positive sign for ESG-related; RE: ESG-related insignificant
12. ESG-G-M	Management	N, Y, N	Fixed Effect	OLS: ESG-related insignificant; RE: ESG-related insignificant;
13. ESG-G-S	Shareholder	N, Y, N	Fixed Effect	OLS: ESG-related insignificant; RE: ESG-related insignificant;
14. ESG-G-CS	CSR Strategy	N, Y, N	Fixed Effect	OLS: ESG-related insignificant; RE: ESG-related insignificant;

Table 21: Robust Check with Propensity Score Match for Stringency

The table aims to cope with potential selection bias in examining the relationship between ESG and the cost of equity (COE). I also employ Propensity Score Matching (PSM) as a robustness check. The PSM technique was applied to create matched samples from two groups differentiated by the stringency of government COVID-19 policies, ensuring that firms were compared on a like-for-like basis with respect to various characteristics. The one-to-one matching process generated regression results for the Total ESG, Environmental, Social, and Governance models. Consistent results with those in the baseline model can reinforce the validity of my initial findings. The number of observations, companies, and the corresponding R-square are reported at the end of the table. Three stars indicate the p-value is less than 0.01. Two stars indicate that the p-value is less than 0.05. One star indicates that the p-value is less than 0.1. The regression models capture the firm-fixed effect.

VARIABLES	(1) Total ESG	(2) Environmental	(3) Social	(4) Governance
COVID	0.299***	0.324***	0.238***	0.298***
	(0.0232)	(0.0251)	(0.0227)	(0.0254)
Total ESG	-0.0314***			
	(0.00574)			
COVID*Total ESG	-0.0344***			
	(0.00422)			
Environmental		-0.0250***		
		(0.00483)		
COVID*Environmental		-0.0359***		
		(0.00382)		
Social			-0.0333***	
			(0.00547)	
COVID*Social			-0.0230***	
			(0.00400)	
Governance				-0.0126***
				(0.00430)
COVID*Governance				-0.0339***
				(0.00397)
Beta	0.180***	0.195***	0.195***	0.192***
	(0.0129)	(0.0137)	(0.0136)	(0.0134)
Idiosyncratic	-1.962***	-1.464***	-2.145***	-1.594***
	(0.231)	(0.253)	(0.250)	(0.246)
Momentum	0.335***	0.329***	0.327***	0.331***
	(0.00992)	(0.0106)	(0.0104)	(0.0103)
Leverage	-0.0164	-0.0845*	-0.0116	-0.0778*
	(0.0431)	(0.0463)	(0.0458)	(0.0454)
B2M	0.0183	0.0612	0.0149	0.0671
	(0.0452)	(0.0486)	(0.0478)	(0.0470)
Asset	-0.0479***	-0.0765***	-0.0686***	-0.0816***

	(0.0145)	(0.0155)	(0.0155)	(0.0152)
Growth	-0.00537	-0.00448	-0.00136	-0.00493
	(0.00353)	(0.00379)	(0.00377)	(0.00369)
Earning_vol	-0.00366	0.000607	0.000717	0.000201
	(0.00268)	(0.00293)	(0.00290)	(0.00284)
Constant	0.565***	0.638***	0.756***	0.685***
	(0.125)	(0.134)	(0.134)	(0.132)
Observations	7,195	6,505	6,823	6,875
R-squared	0.270	0.272	0.264	0.267
Number of company	2,294	2,205	2,244	2,247

Table 22: Robust Check with Endogeneity

This table depicts the results of the analysis of endogeneity. Following the regression analysis tied to the first hypothesis, I examined the correlations between the error term and each independent variable. Predicting and saving the residuals within the dataset generated a correlation matrix to assess potential endogeneity issues. The regression models capture the firm-fixed effect.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) Error_term	1.000											
(2) COVID	-0.037	1.000										
(3) Total ESG	0.193	0.092	1.000									
(4) COVID*T_ESG	0.035	0.870	0.425	1.000								
(5) Beta	-0.031	0.064	-0.032	0.046	1.000							
(6) Idiosyncratic	0.117	0.245	-0.359	0.053	0.290	1.000						
(7) Momentum	-0.063	-0.093	0.051	-0.052	-0.034	-0.165	1.000					
(8) Leverage	0.067	0.075	0.136	0.119	0.100	-0.024	0.032	1.000				
(9) B2M	-0.024	0.102	-0.004	0.081	-0.000	-0.023	-0.037	0.001	1.000			
(10) Asset	0.122	-0.102	0.610	0.135	-0.029	-0.580	0.088	0.212	0.002	1.000		
(11) Growth	0.001	0.006	-0.002	0.004	0.012	0.016	-0.009	-0.002	-0.012	-0.012	1.000	
(12) Earning_vol	-0.028	-0.005	0.024	0.013	-0.025	-0.099	0.036	0.013	0.006	0.069	-0.018	1.000

Table 23: Robust Check with added Stringency and Severity Control

This table reports the coefficients and the statistical significance of the Total ESG model (1), Environmental model (2), Social model (3), and Governance model (4) based on all observations to robust the first hypothesis with model modification. A new control variable, "Stringency," is added to the regression model. In addition, in this robustness check, the COVID dummy variable in the original baseline models is replaced with this new severity measure, creating an interaction term "severity*ESG" to assess the nuanced effects of pandemic severity on the ESG-COE relationship. Three stars indicate the p-value is less than 0.01. Two stars indicate that the p-value is less than 0.05. One star indicates that the p-value is less than 0.1. The regression models capture the firm-fixed effect.

VARIABLES	(1) Total ESG	(2) Environmental	(3) Social	(4) Governance
Severity	0.00436***	0.00426***	0.00315***	0.00373***
	(0.000715)	(0.000776)	(0.000704)	(0.000768)
Total ESG	-0.0452***			
	(0.00396)			
Severity*Total ESG	-0.000489***			
	(9.25e-05)			
Environmental		-0.0312***		
		(0.00339)		
Severity*Environmental		-0.000573***		
		(8.41e-05)		
Social			-0.0475***	
			(0.00374)	
Severity*Social			-0.000252***	
			(8.60e-05)	
Governance				-0.0229***
				(0.00301)
Severity*Governance				-0.000432***
				(8.68e-05)
Beta	0.187***	0.199***	0.198***	0.194***
	(0.00943)	(0.0101)	(0.00988)	(0.00979)
Idiosyncratic	-2.170***	-1.665***	-2.225***	-1.775***
	(0.170)	(0.185)	(0.182)	(0.180)
Momentum	0.297***	0.293***	0.287***	0.295***
	(0.00737)	(0.00793)	(0.00773)	(0.00771)
Leverage	-0.0412	-0.0902**	-0.0428	-0.0836**
	(0.0328)	(0.0353)	(0.0349)	(0.0345)
B2M	-0.0579*	-0.0358	-0.0592*	-0.0278
	(0.0327)	(0.0351)	(0.0342)	(0.0341)
Asset	-0.0594***	-0.0923***	-0.0795***	-0.0978***
	(0.0107)	(0.0114)	(0.0114)	(0.0111)
Growth	-0.00146	-2.12e-05	0.00143	-0.000200

	(0.00255)	(0.00276)	(0.00271)	(0.00268)
Earning_vol	-0.00139	-0.000636	0.000704	-0.000248
	(0.00183)	(0.00197)	(0.00197)	(0.00191)
Stringency	0.00326***	0.00371***	0.00331***	0.00324***
	(0.000407)	(0.000434)	(0.000417)	(0.000416)
Constant	0.785***	0.863***	0.957***	0.950***
	(0.0898)	(0.0961)	(0.0963)	(0.0942)
Observations	10,912	9,822	10,324	10,396
R-squared	0.308	0.303	0.304	0.297
Number of company	2,700	2,630	2,652	2,651

Table 24: Robust Check with Canadian Firms Removed

This table reports the coefficients and the statistical significance of the Total ESG model (1), Environmental model (2), Social model (3), and Governance model (4) based on all observations to robust the finding of the first hypothesis by removing the Canadian firm. The outputs below prevent themselves from noise due to the isolation of the country effect. Three stars indicate the p-value is less than 0.01. Two stars indicate that the p-value is less than 0.05. One star indicates that the p-value is less than 0.1. The regression models capture the firm-fixed effect.

VARIABLES	(1) Total ESG	(2) Environmental	(3) Social	(4) Governance
COVID	0.266***	0.276***	0.217***	0.247***
	(0.0172)	(0.0187)	(0.0166)	(0.0189)
Total ESG	-0.0283***			
	(0.00438)			
COVID*Total ESG	-0.0329***			
	(0.00319)			
Environmental		-0.0195***		
		(0.00362)		
COVID*Environmental		-0.0324***		
		(0.00285)		
Social			-0.0316***	
			(0.00410)	
COVID*Social			-0.0235***	
			(0.00300)	
Governance				-0.0135***
				(0.00319)
COVID*Governance				-0.0291***
				(0.00297)
Beta	0.194***	0.210***	0.204***	0.204***
	(0.00981)	(0.0105)	(0.0103)	(0.0101)
Idiosyncratic	-1.930***	-1.428***	-1.949***	-1.504***
	(0.179)	(0.193)	(0.192)	(0.188)
Momentum	0.320***	0.313***	0.311***	0.315***
	(0.00750)	(0.00804)	(0.00787)	(0.00780)
Leverage	0.0402	-0.0211	0.0378	-0.00749
	(0.0339)	(0.0364)	(0.0361)	(0.0354)
B2M	0.0193	0.0458	0.0171	0.0537
	(0.0337)	(0.0360)	(0.0352)	(0.0349)
Asset	-0.0279**	-0.0541***	-0.0422***	-0.0550***
	(0.0113)	(0.0121)	(0.0122)	(0.0118)
Growth	-0.00281	-0.00222	-0.000708	-0.00246
	(0.00261)	(0.00279)	(0.00276)	(0.00269)
Earning_vol	-0.00139	-0.000523	0.00146	0.000180
	(0.00189)	(0.00202)	(0.00203)	(0.00196)

Constant	0.366***	0.436***	0.500***	0.466***
	(0.0967)	(0.103)	(0.104)	(0.101)
Observations	10,982	9,900	10,405	10,484
R-squared	0.254	0.254	0.249	0.249
Number of company	2,710	2,643	2,665	2,663

Table 25: Robust Check with Original ESG Scores

This table reports the coefficients and the statistical significance of the Total ESG model (1), Environmental model (2), Social model (3), and Governance model (4) based on all observations to robust the finding of the first hypothesis by employing the original ESG scores. In this case, the interpretation of the ESG is based on the improvement of one point in firms' ESG scores rather than the improvement of one step. Three stars indicate the p-value is less than 0.01. Two stars indicate that the p-value is less than 0.05. One star indicates that the p-value is less than 0.1. The regression models capture the firm-fixed effect.

VARIABLES	(1) Total ESG	(2) Environmental	(3) Social	(4) Governance
COVID	0.260***	0.272***	0.206***	0.244***
	(0.0154)	(0.0162)	(0.0145)	(0.0169)
Total ESG	-0.00463***			
	(0.000467)			
COVID*Total ESG	-0.00331***			
	(0.000311)			
Environmental		-0.00206***		
		(0.000317)		
COVID*Environmental		-0.00327***		
		(0.000264)		
Social			-0.00313***	
			(0.000396)	
COVID*Social			-0.00234***	
			(0.000281)	
Governance				-0.00168***
				(0.000309)
COVID*Governance				-0.00294***
				(0.000285)
Beta	0.200***	0.204***	0.200***	0.203***
	(0.00937)	(0.00943)	(0.00943)	(0.00944)
Idiosyncratic	-1.824***	-1.791***	-1.861***	-1.789***
	(0.173)	(0.174)	(0.174)	(0.174)
Momentum	0.313***	0.316***	0.315***	0.314***
	(0.00726)	(0.00730)	(0.00730)	(0.00731)
Leverage	-0.00935	-0.0154	-0.00545	-0.0143
	(0.0333)	(0.0335)	(0.0335)	(0.0335)
B2M	0.0356	0.0409	0.0488	0.0434
	(0.0324)	(0.0326)	(0.0326)	(0.0326)
Asset	-0.0387***	-0.0527***	-0.0410***	-0.0550***
	(0.0112)	(0.0112)	(0.0113)	(0.0112)
Growth	-0.00151	-0.00209	-0.00189	-0.00219
	(0.00254)	(0.00255)	(0.00256)	(0.00256)
Earning_vol	-0.00126	-0.00150	-0.00116	-0.00158

	(0.00182)	(0.00183)	(0.00183)	(0.00183)
Constant	0.492***	0.461***	0.451***	0.515***
	(0.0947)	(0.0952)	(0.0953)	(0.0955)
Observations	11,676	11,676	11,676	11,676
R-squared	0.260	0.251	0.251	0.250
Number of company	2,740	2,740	2,740	2,740

Appendix 3: Figures

This figure presents the Refinitv ESG Structure with its components on each layer. The parent, total ESG performance consists of environmental pillar (E), social pillar (S), and governance (G) pillar as sub-categories. Each pillar is measured by the indicators specified in the third layer. The environmental pillar considers resource use, emission, and innovation. The social pillar highlights workforce, human rights, community, and product responsibility. The governance pillar emphasizes management, shareholder, and CSR strategy. My baseline models focus on layer#1 and layer#2 components, while the robust check explores the specific indicators on layer#3.

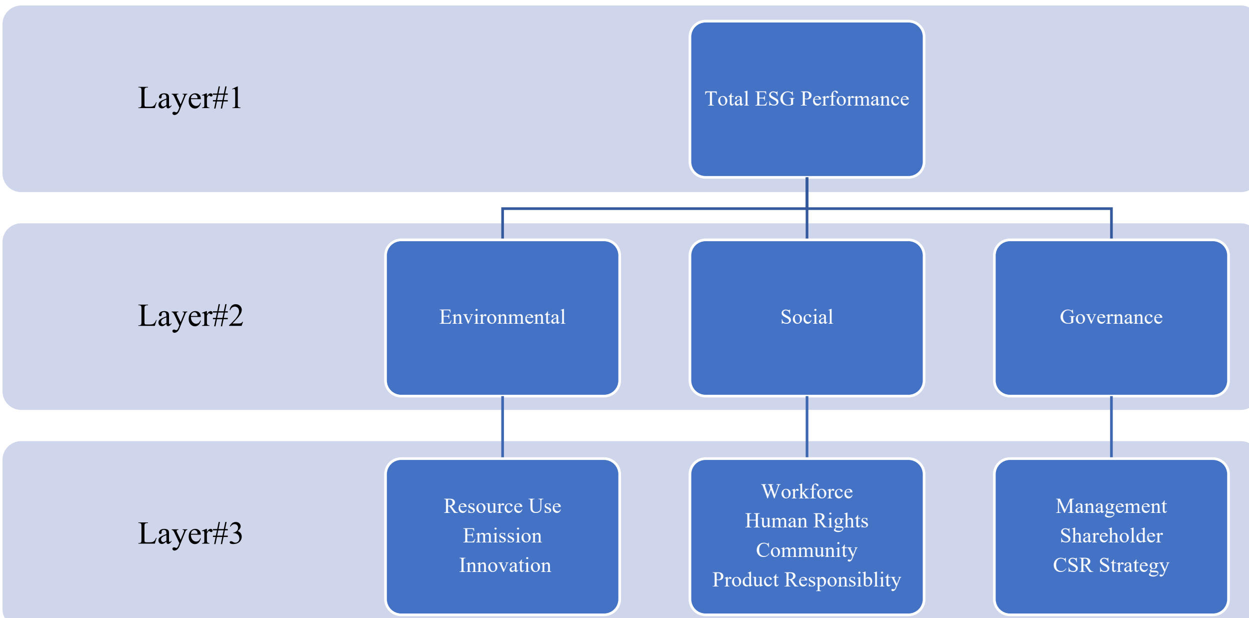

Figure 1: Environmental, Social, and Governance (ESG) Layers Structure

This figure shows how ESG distributes after transformation. The x-axis indicates the integer group to which the new ESG variable belongs. The y-axis reveals the density based on each group, and the height of the green bar is scaled by density, allowing the graph to show where the data is centralized.

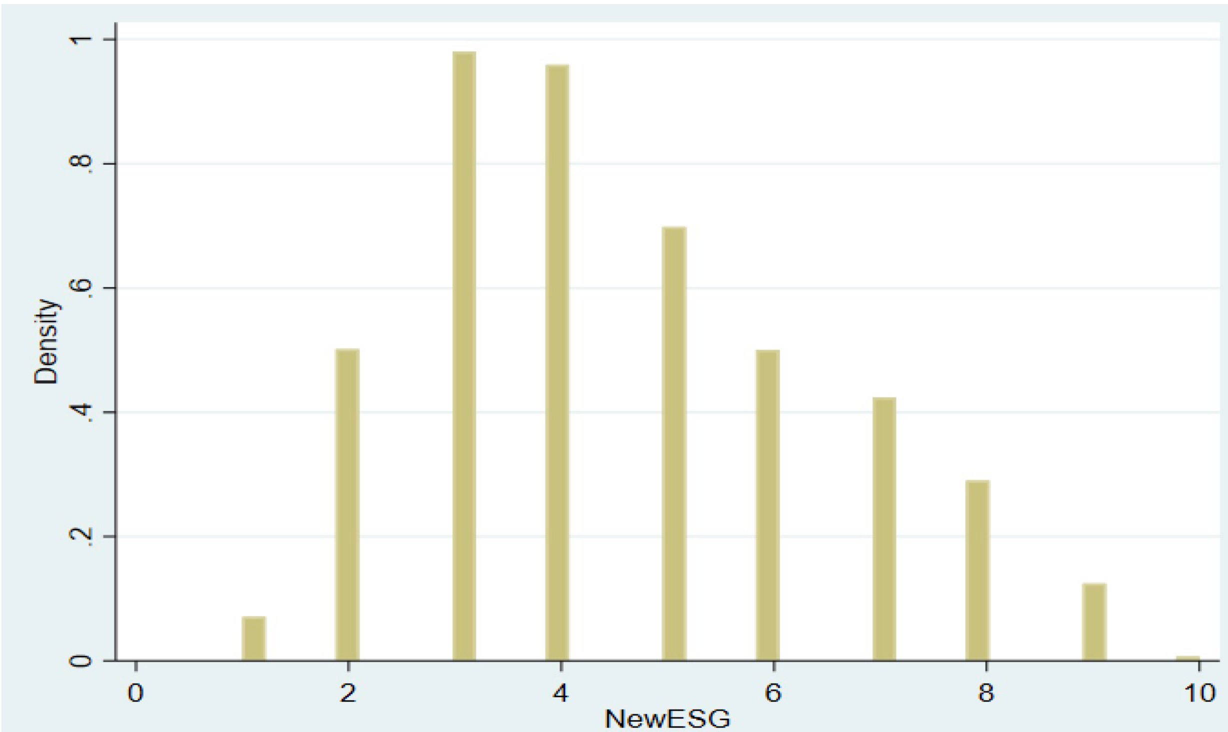

Figure 2: Environmental, Social, and Governance (ESG) Transformation