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ESG performance and debt financing cost

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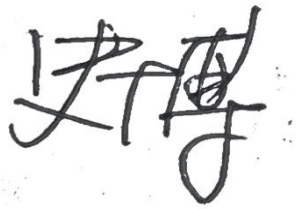
I hereby declare that this is my original work and it has been written by me in its entirety.

I have duly acknowledged all the sources of information which have been used in this dissertation.

This dissertation has also not been submitted for any degree in any university previously.



Shi Bo

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Abstract

Using the Latent Dirichlet Allocation thematic model, I calculate the comprehensiveness score of corporate ESG report and examine how the score correlates with corporate debt financing cost. Based on the empirical analysis over a sample of Chinese listed A-share firms with available ESG reports. I find that more comprehensive ESG report reduces corporate debt financing cost. Specifically, an increase by one standard deviation in ESG report comprehensiveness can decrease corporate debt financing cost by 3.88%. In heterogenous analysis, I find that the effect of ESG input on reducing corporate debt cost is stronger for state-owned firms. Good financial performance of firms can strengthen the effect of ESG report comprehensiveness on reducing corporate debt financing cost. Compared with firms processing more tangible assets, ESG report comprehensiveness plays a more valuable role in reducing debt cost for firms with more intangible assets. Higher growth opportunities can substitute lower ESG report comprehensiveness of firms.

In further analysis, I find that ESG report comprehensiveness reduces corporate debt financing cost both through decreasing the interest rate of bank loans and enlarging the size of trade credit provided by suppliers. Different types of ESG input have differentiated effects on reducing corporate debt cost. The G (Governance) pillar of

ESG has the most prominent effect on corporate debt financing cost, followed by the effect of the E (environmental) pillar, while the S (social) pillar has the least influence on reducing corporate debt financing cost. Different types of debt holders share common ESG concerns but also differ in the sensitivity to some risk related with different ESG pillars. Both banks and suppliers care about corporate governance related ESG risk. At the same time, banks pay more attention to corporate environmental performance while suppliers focus more on firm's performance related with social issues.

Keywords: ESG report comprehensiveness, corporate debt financing cost

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Acknowledgement

The year 2022 is an extraordinary year. In the face of many systemic risks at the macro and micro levels, the development of China's financial industry is also undergoing unprecedented tests. This year, I participated in some ESG related courses and have some thoughts about the ESG investing decisions in the industry where I work. I am happy to have completed this thesis, through the process of which I systematically studied the development status of ESG in China and learned a lot from the existing ESG research in the literature. I have great sense of accomplishment about my thesis. Although it may only provide tiny contribution to the existing ESG research, it’s a milestone for my study and my life journey.

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Chapter 1 Introduction

With the continuous development of the global economy, environmental problems are getting worse and worse, which has more and more affected the sustainable development of the global economy and the normal life of human beings, so that we have to pay a high cost. To this end, we must attach great importance to environmental problems. The Paris Agreement adopted in 2015 is a brand new agreement reached by world leaders based on the United Nations Framework Convention on Climate Change(Jeucken et al. 1999). From a practical perspective, it has certain historical value and significance. Today, about 200 countries have joined the Paris Agreement, including China. To strengthen action on reducing carbon emissions, the United Nations hosted the Climate Action Summit, which invited world leaders to discuss concrete actions to curb carbon emissions and protect the ecological environment on which we depend. In this context, in recent years, countries around the world have vigorously developed green finance and industrial transformation to reduce carbon emissions, reduce environmental pollution and protect the ecological environment, so as to promote the green and sustainable development of economy, society and ecology. As a major world power, China actively practices low-carbon emission reduction. On September 22, 2020, China made a commitment to "carbon peak" and "carbon neutrality" at the 75th United Nations General Assembly, proposing to peak carbon dioxide emissions by 2030 and achieve carbon neutrality by 2060.

In recent years, China's ESG responsible investment market has shown major development trends, such as continuous policy promotion, rapid increase in scale, deepening of institutional practices, and improved acceptance of asset owners and the public, and will continue to maintain a rapid development track (Cortazar 1993). ESG report provides important channel for firms to communicate ESG performance information with investors so that improving ESG disclosure is a new exploration of

the comprehensive deepening of the reform of the capital market, and it is a major issue that Chinese enterprises and the capital market have been most concerned about in the past two years. The characteristics of policy development (White 2004) can be summarized into five directions: First, the relevant standard system of ESG investment is accelerating completely; second, information disclosure is advancing steadily. Third, the incentive mechanism promotes the development of the market through multiple measures (Yu and Yan 2022); Fourth, ESG product innovation shows a trend of a hundred flowers blooming and a hundred schools of thought contending; Finally, in terms of international cooperation, more cooperation and exchanges have been achieved. Looking ahead, China's green finance and ESG policies will remain strongly driven from top to down (Li 2021).

From the market scale, the growth rate is obvious and uneven structure. According to the statistics of the overall scale of China's ESG responsible investment market on an annual basis, according to the available data caliber, the overall scale of China's ESG responsible investment market has developed rapidly (Liu and Lin 2014). In 2022, the total market size exceeded 24.6 trillion yuan, an increase of nearly 80% compared with 2020. However, the overall market structure still has uneven development. The overall market is still dominated by bank credit assets represented by green credit (Linnenluecke, Smith, and McKnight 2016). In 2022, China's green credit has reached 20.9 trillion yuan, accounting for more than 80% of the total market size. Sustainable securities represented by sustainable bonds and ESG public funds amounted to about 3.07 trillion yuan, while sustainable equity investment represented by ESG private equity amounted to about 0.6 trillion yuan. In terms of market development structure practice and product deepening, there is still a lot of room for improvement. According to the comprehensive evaluation of the development level and trend of investment institutions in ESG investment based on the international common dimension and index system, there are currently no Chinese capital management institutions that have reached the global leading level (Oláh 2019), but there are seven public funds that have reached the global good level. Most small and medium-sized institutions are still only

at a lower level. From the perspective of institutional types, the ESG investment practice of public offering fund companies has a better development level than that of insurance fund management institutions and bank fund management institutions (Scholtens 2006). From the three representative products of ESG index, ESG fund and ESG financial products, we analyze the development of ESG investment products. Since the first Chinese ESG index was published in 2005, a total of 157 ESG indexes have been published this year. Among them, the pace of new ESG index product launches have accelerated significantly over the past year. From the perspective of market performance, some of China's ESG series index products have outperformed the index benchmark in the past few years to a certain extent, reflecting in emerging markets such as China, ESG investment still has a certain effectiveness of back test.

From the perspective of market attitude, asset owners have a positive attitude towards ESG, and the public acceptance is gradually increasing(Twidell and Cabot 2003). From two dimensions, that is, asset owners and individual investors, Cahen-Fourot and Durand (2016) describes the attitudes of major market participants towards ESG responsible investment in China. As for asset owners, Institutional Open Information has conducted a global survey on the attitude of asset owners towards China's ESG responsible investment, covering 51 asset owners of various types, with total assets under management (AUM) exceeding $2.4 trillion, of which 60% are domestic institutions and 40% are overseas institutions. The survey found that global asset owners have a positive attitude towards China's practice of ESG investing. Among the factors that drive asset owners to incorporate ESGs into their investment decisions in China, the top three are regulatory requirements, fiduciary needs and investment risk avoidance (Xiong and Yao 2021). At the same time, a total of about 70% of asset managers take into consideration the ESG ability of fund managers to some extent when selecting fund managers externally.

ESG investment will play a more important role in the current context of rising global uncertainty, and to some extent become a "certainty factor" in an "uncertain" macro

environment (Gilchrist, Yu, and Zhong 2021). China's ESG responsible investment market will continue to maintain a stable and rapid development track. The current era has a particularly complex background amid multiple challenges such as the Russia-Ukraine war, inflation, energy crisis and the epidemic. In this context, the research on ESG investment is particularly meaningful for promoting ESG-related development concepts, better handling the relationship between the economy, nature, and society, and effectively increasing the efficiency of resource allocation in the real economy. One important research topic about ESG is the economic outcome of ESG investment. We need to know more about the economic incentive underlying ESG investment and how the market responds to ESG investment. This is important for asset management institutions to evaluate the economic value of ESG performance of the assets, help the majority of investors to understand ESG investment and have confidence in related products, thereby further promoting more ESG investment efforts broadly.

Prior literature has revealed various cost and benefit of corporate ESG investment (e.g., Kim et al., 2012; Dai et al., 2023; Davis et al., 2016), but we know little about the role of corporate ESG performance in corporate debt financing activities. My thesis explores ESG incentive of firms through examining how ESG performance influences corporate debt financing cost. To address this research question, I exploit corporate ESG reports publicly disclosed by listed companies in the market as samples and evaluate corporate ESG performance using the textual comprehensiveness of ESG report, which is calculated based on Latent Dirichlet Allocation (LDA hereafter) topic model. I analyze how corporate ESG report comprehensiveness are helpful to corporate debt financing. ESG report is important for outsiders to understand corporate ESG performance. In today's complex information environment, ESG report is an important tool for firms to disseminate messages on their ESG performance. Although firms have incentive to conduct greenwashing behavior and overstate their ESG performance in their ESG report, with the monitoring of the media, public, analysts, auditors, and government, such behavior is difficult and is likely to incur high cost. Therefore, ESG report generally provides reliable signal about firm's ESG performance, which is an important

consideration for outsiders to decide whether to offer higher or lower support for firm's investment and financing activities.

I discuss that firms with higher ESG report comprehensiveness have lower financing cost from the following ways (Jin and Han 2018): 1) Reduce corporate risk; 2) Improve financial performance; 3) Improve corporate reputation; and 4) Improve corporate information environment. Higher ESG report comprehensiveness indicates more ESG input and better ESG performance. If a company's ESG is performing well, it may be easier for them to get low-interest loans in green finance projects. 1) businesses with high ESG scores are generally perceived as less risky and therefore have lower overall financing costs. Statistics show that companies with good ESG performance can reduce their average financing costs by 7%-18%. 2) Improve financial performance: Companies with high ESG ratings have greater advantages in resource utilization, which can reduce operating costs and improve efficiency (Fan, Li, and Xu 2020), both of which help companies gain more market share. According to a report by the University of Oxford, 88% of companies have successfully improved their business performance by implementing solid ESG practices. 3) Improve corporate reputation: For investors, they are more inclined to buy those companies that pay attention to ESG and are less likely to have major shareholders occupying the interests of small shareholders or companies that make money but do not pay dividends. With ESG reports published by companies and ESG scores published by third-party institutions, investors can identify such companies more quickly and choose to stay away from them(Huang et al. 2019). Therefore, a good ESG performance can help a company build a good reputation and attract more investors. 4) Improve corporate information environment: Taking social responsibility reduces earnings manipulation by managers thus improve the information environment of enterprises. Better information environment reduces the monitoring cost of debtholders. In general, through better ESG performance, enterprises can demonstrate their commitment and actions in environmental, social and governance aspects, thus obtaining more financing opportunities at lower costs.

I carried out text analysis based on LDA topic classification model and used machine learning method to divide ESG report text into 15 topics according to content semantics. I used topic length to describe the attention degree of different topics. I conduct the research in the following steps: First, I test whether higher textual comprehensiveness of ESG report, which indicates good ESG performance, is negatively associated with corporate debt financing cost. The regression results confirm the positive role of ESG report comprehensiveness in reducing corporate debt financing cost. I find that an increase by one standard deviation in ESG report comprehensiveness can decrease corporate debt financing cost by 3.88%. Secondly, I explore the moderating effect of the following firm level characteristics on the negative relationship between ESG report comprehensiveness and corporate debt financing cost, including 1) equity nature; 2) largest shareholding; 3) financial performance; 4) intangibility; 5) growth opportunity. I find that the effect of higher ESG report comprehensiveness on reducing corporate debt cost is stronger for state-owned firms; for firms with good financial performance; for firms processing more intangible assets. The negative relationship between ESG report comprehensiveness and debt financing cost is greatly attenuated for firms with higher growth rate, suggesting that the market seems to show higher tolerance for the ESG performance of firms having promising prospect.

Thirdly, I further explore how corporate ESG report comprehensiveness influences different types of debt cost of firms. I decompose corporate debt into bank loans and trade credit. These two types of debt usually account for a large portion of firm's total debt and thus have great influence on corporate debt financing cost. The results show that ESG report comprehensiveness not only decreases firm's loan interest rate but also enlarges firm's trade credit. Then I go a step further to explore the differentiated effects of different ESG pillars on corporate debt financing cost. The evidence suggests that governance related ESG activities have the greatest effect on reducing corporate debt financing cost, followed by environmental ESG activities, and the ESG activities belonging to social pillar show the least influence. The results suggest that debtholders

care the most about corporate governance issues which largely determine corporate operating risk directly. By contrast, the influence of environmental and social ESG risk tend to be indirect and weak. I dig deeper to show whether different types of debtholders are differentiated in sensitivity to risk of different ESG pillars. The results show that both banks and suppliers are sensitive to ESG risk on corporate governance. The banks require lower loan interest for firms performing better in environmental pillar but are not sensitive to ESG performance in social pillar. Suppliers offer more trade credit for firms delivering a good social performance while behave neutrally in terms of corporate environmental performance.

My study makes the following contribution in existing literature. First, I innovated the methodology of ESG performance measurement by applying LDA topic classification model in textual analysis over corporate ESG reports. Most of prior studies evaluate corporate ESG performance based on the ESG ratings provided by third party (e.g., Johnston and Rock, 2005; Harris and Neely, 2016; Chen and Xie, 2022). ESG rating from third party can suffer severe problems of rating divergence, sample selection bias, and ESG shopping. Also, the timeliness of rating from third party cannot be ensured. Although reading ESG report artificially and collecting required data manually is free of sample selection bias and problem of favored rating outcome, it lacks objectivity, consistency and uniformity. More importantly, artificial reading and judgement is really time consuming and is highly vulnerable of various errors and mistakes. To solve these constraints of the current rating measures, I obtain a consistent and unbiased ESG performance evaluation through LDA approach, which saves a lot of time and artificial cost. It can be applied into analysis for all firms with available ESG reports. Based on the results obtained from LDA analysis over corporate ESG reports, I use the comprehensiveness of corporate ESG report to measure firm's ESG performance. Thus, I further complement existing ESG literature from the perspective of ESG performance measuring methodology.

Second, I extend the research scope of the economic outcome of corporate ESG performance. Prior studies have examined the benefits and costs of corporate ESG input from various perspectives. It has been found that good ESG performance could bring a lot of benefits to firms such as higher earnings quality, less tax payment, better labor market potential of management, and lower cost of capital (Kim et al., 2012; Dai et al., 2023; Davis et al., 2016; Heinkel et al., 2001; Hong and Kacperczyk, 2009). Studies also find that mandatory ESG input by government harms firm value, indicating the negative effect of inappropriate ESG investment (Hong and Kacperczyk, 2009). However, we know little about the role of corporate ESG performance in corporate debt financing activities. My thesis not only documents the effect of good ESG performance on reducing corporate debt financing cost, but also shows the differentiated influence of each ESG pillar on different types of debt. My evidence greatly enlarges our knowledge about the economic benefit of corporate ESG investment. It helps to deepen our understanding of corporate incentives to exhibit good ESG performance.

Third, my research also contributes new knowledge about the differentiated effects of ESG performance on reducing debt financing cost for firms with different characteristics. Existing literature suggests that the economic influence of ESG input on firms varies both with the outside environment and inside conditions of firms. The findings in my study further supplements the literature on heterogenous effects of ESG responsibilities from the perspective of firm's debt financing activities. The results show that currently most debt holders prioritize the fundamental risk and financial performance over ESG performance of firms. The ESG input reduces corporate debt financing cost more when firms deliver good financial performance and great growing potential can offset to some extent the adverse effect of poor ESG performance on debt financing cost. These findings help to deepen our understanding of divergent ESG incentives of firms at different development stages and firms with different financial conditions.

The remainder of this thesis is organized as the following. Section 2 introduces the development of ESG related policies around the world and its institutional background in China. Section 3 reviews important ESG research in the literature. Section 4 develops the hypotheses. Section 5 presents the sample, data, and the research design. Section 6 reports the main empirical results, heterogenous analysis, and robustness tests. Section 7 displays the results of further analysis to deep our understanding of the role of corporate ESG performance in reducing debt financing cost. Section 8 concludes the thesis and discusses the implications, drawbacks, and future research avenues.

Chapter 2 Institutional Background

2.1 The development history of ESG

In fact, since 1992, the Finance Initiative of the United Nations Environment Programme (UNEP) has advocated for financial institutions to consider a company's ESG performance as an important factor in the evaluation of their investment decisions. Subsequently, the stock exchange market, regulators and government departments also recognized the importance of ESG behavior of enterprises. The stock exchanges of the United Kingdom, Germany, Singapore, Canada, Brazil and other countries formulated and launched ESG information disclosure standards and systems for listed companies. Internationally renowned rating agencies, such as MSCI, Thomson Reuters and Dow Jones, also regularly release rating indexes of corporate ESG performance. In China, the ESG performance of enterprises has gradually attracted the attention of all stakeholders. The Shenzhen Stock Exchange and the Shanghai Stock Exchange issued the Guidelines on Social Responsibility of Listed Companies and the Guidelines on Environmental Information Disclosure of Listed Companies in 2006 and 2008 respectively. In 2007, the State Environmental Protection Bureau promulgated the "Environmental Information Disclosure Measures (Trial)"; Later, China Securities Index, Shangdao Green, Social Investment League and FTSE Russell began to disclose ESG performance ratings of enterprises in 2009, 2015, 2016 and 2018 respectively, and the Hong Kong Stock Exchange also revised the ESG Reporting Guidelines in December 2015, requiring listed companies to disclose detailed ESG information. Undisclosed companies need to explain their reasons; In June 2018, the China Securities Regulatory Commission also revised the Code of Governance for Listed Companies to clarify the requirements for listed companies to disclose ESG information. In March 2020, the General Office of the CPC Central Committee and The General Office of the State Council issued the Guiding Proposals on Building a Modern Environmental Governance System, expanding the subject of ESG information disclosure from listed companies to listed companies and bond issuing enterprises.

The history of ESG in China can be traced back to the 1970s and 1980s (Wang, Zhao, and Bi 2021). At that time, environmental protection gradually became the focus of attention, and companies began to consider the impact of environmental factors on their business. In the late 1990s and early 2000s, a number of institutional investors began to incorporate social and environmental factors into their investment decision making processes and developed the concept of sustainable investing. This is the development of ESG concept in China. Since then, the Chinese government has also strengthened the formulation and implementation of ESG-related policies, encouraged enterprises to actively fulfill their environmental and social responsibilities, and strengthened governance mechanisms. For example, in 2006, the United Nations Environment Programme (UNEP) and the Alliance of Financial Institutions (UNEP FI) collaborated to publish the Principles for Responsible Investment (PRI), which guide investors to incorporate ESG considerations into investment decisions. In addition, some international organizations and standard-setting bodies have begun to establish relevant guidelines and standards, such as the United Nations Global Compact, which was launched in 2000 to promote corporate responsibility in human rights, labor, the environment and anti-corruption. Since 2004, the ESG concept has been established and developed rapidly in China(Zhang, Yang, and Bi 2011). This period saw the ESG concept go from being officially introduced to becoming a mainstream investment concept that is widely recognized internationally.

2.2 ESG report

The ESG report mainly covers environmental protection, social responsibility and corporate governance, with the aim of enhancing corporate transparency and promoting sustainable development. Specifically, environmental protection requires companies to describe in detail the environmental measures they have taken, including energy conservation and emission reduction, resource recycling and environmental risk management. For example, some electronics companies will introduce their energy-

saving technologies and recycling measures for discarded electronic products. In terms of social responsibility, enterprises need to explain their social responsibility projects and their specific implementation. For example, some automotive companies describe their efforts to support local education programs and provide data and performance evaluations. Although ESG metrics are generally not part of mandatory financial reporting, more and more companies are disclosing ESG related content in their annual reports or stand-alone sustainability reports.

In terms of writing an ESG report, there are usually certain steps and structures that need to be followed: 1 Clarify the purpose and audience of the report: Before you start writing an ESG report, you need to clarify the purpose and audience of the report. This will help you to focus and language your report to ensure that the content of your report meets the needs of your readers. 2 Collection and collation of data: Before writing an ESG report, data collection and collation are required. This can include the company's annual financial data, sustainability related indicators, market data, and so on. Ensuring the accuracy and reliability of the data is critical, and it takes time and effort to review and verify the data. Determining ESG Key Performance Indicators (KPIs) : Determining ESG key performance indicators (KPIs) is an important step in writing ESG reports based on the company's business and strategy. These indicators should be able to measure the company's ESG performance, including environmental, social and governance performance. 4 Describe the company's ESG strategy and policies: In the ESG report, you need to describe the company's ESG strategy and policies in detail. This can include the company's environmental policies, social responsibility programs, employee welfare policies, and so on. These strategies and policies should be integrated with the company's business strategy to achieve sustainable development. Disclosure of ESG data and metrics: In ESG reporting, it is necessary to disclose ESG data and metrics, including the company's environmental, social and governance performance data. This data should be relevant to the company's business and demonstrate the effectiveness of the company's ESG strategy and policies. 6 Assess the company's ESG risks and opportunities: In the ESG report, you need to assess the company's ESG risks and opportunities. This can include the environmental, social and governance risks the

company faces, as well as the opportunities it may face in the future. These risks and opportunities should be relevant to the company's business and be able to influence the company's future development. 7 Sustainability recommendations and prospects: In the ESG report, sustainability recommendations and prospects need to be presented. This can include sustainability measures and recommendations that the company will take in the future, as well as challenges that may be faced in the future. These recommendations and outlooks should be relevant to the company's business and contribute to the company's sustainable development.

In summary, writing an ESG report requires a certain structure and steps, including clarifying the purpose and audience of the report, collecting and collating data, identifying ESG key performance indicators (KPIs), describing the company's ESG strategy and policies, disclosing ESG data and indicators, assessing the company's ESG risks and opportunities, and making recommendations and prospects for sustainable development(Lv et al. 2021). It is crucial to ensure that the content of the report meets the needs of the reader.

Chapter 3 Literature Review

3.1 Information asymmetry and agency problem in corporate finance

3.1.1 Information asymmetry theory

Information asymmetry theory, as an important inheritance and supplement of classical economics, is a basic theory in corporate finance. Classical economics posits that under the circumstance where market participants have completely shared public information, the market reaches a natural equilibrium under the direction of the "invisible hand". However, the real world cannot be frictionless. Akerlof (1970) relaxed this assumption of complete market and formally proposed the information asymmetry theory that is closer to reality. The study describes that when the information difference between the two parties in the market is large, the seller has more private information than the buyer, and the buyer is difficult to distinguish the quality of the goods at a given price. The seller hides negative information to better promote the defective goods, which creates a serious information asymmetry problem between the seller and the buyer. As a consequence of the information asymmetry problem on the market, the buyer will try to lower the price of the goods, which further weakens the willingness of the seller to sell high-quality goods and aggravates the behavior of the seller to promote the defective goods. This consequently leads to the vicious circle of “bad money drives out good money” in the market, which is called as "lemon" problem. The academic community has carried out plenty of research effort on the information asymmetry theory.

Information asymmetry is very common in the market. When the party without information realizes that it is difficult to control risks through contracts, they will increase transaction costs, leading to the reduction of market efficiency. The two most representative consequences caused by information asymmetry are "adverse selection" and "moral hazard". In terms of classification, information asymmetry can be divided into time asymmetry and content asymmetry. On the one hand, from the perspective of

time dimension, it can be divided into ex ante information asymmetry and ex post information asymmetry. Ex ante information asymmetry refers to the difference in the degree of information mastered by the two parties before one transaction. Such information asymmetry is easy to cause adverse selection problems. Ex ante information asymmetry will lead to that the party with less information increases transaction costs in order to prevent the other party from hiding information and other opportunistic behaviors. Although such steps help to ensure the interests of the party with less information, they damage the transactions. The "lemon market" of second-hand cars in Akerlof's (1970) study describes this phenomenon. Ex post information asymmetry usually causes moral hazard problems. Moral hazard refers to the ex post opportunistic behavior in which one party hides information or actions for personal gains and damages the interests of the other party. Arrow (1963) introduced the term moral hazard for the first time in the study of the insurance industry. It refers to the problem that due to the insurance company is difficult to observe the real reason for the claim, the insured may ask the insurance company to compensate losses caused by accidents due to deliberately relaxed prevention consciousness or fraud after the completion of the insurance transaction. This produces moral hazard and leads to that the insurance company is difficult to obtain positive benefits. From another perspective, information asymmetry can be caused by hidden action or hidden information, depending on whether it is the principal's information or action that is difficult to observe.

3.1.2 Principal-agent models

In the theory of information asymmetry, the party with information advantage is generally referred to as the "agent", while the party with information disadvantage is referred to as the "principal". Therefore, the principal-agent framework can encompass all the models involved in the information asymmetry theory, which can be categorized into five types: the moral hazard model of hidden actions, the moral hazard model of hidden information, the adverse selection model, the signal model, and the information screening model. The first three models are the potential adverse consequences of

information asymmetry, while the latter two models are valuable explorations by agents or principals attempting to solve the problem of prior adverse selection.

First, the moral hazard model of hidden actions refers to the case where the principal is difficult to observe the agent's behavior after signing the contract and can only judge the level of effort post ante based on the agent's outcome. A typical example is the relationship between the employer (principal) and the employee (agent), where the employer cannot observe the employee's level of work effort and can only judge it based on the employee's task performance. The employer and the employee can establish a contract linking the employee's compensation to his/her task performance to align their interests.

Second, the moral hazard of hidden information refers to the difficulty for the principal to obtain private information held by the agent (ex post), even though the principal can observe the agent's actions after signing the contract. A typical example is the relationship between department managers (principals) and salesmen (agents), where salesmen know customer preference, but department managers do not. This problem can be solved by creating contracts to motivate salesmen to adopt different sales strategies for different customers.

Third, the adverse selection model refers to the adverse consequences arising from the situation where the agent knows the private information of the product before signing a contract, but the principal does not. A typical example is the relationship between the buyer (principal) and the seller (agent), where the seller has more knowledge or information about the quality of the product than the buyer. The seller may engage in behaviors that harm the buyer, such as selling lower quality products at the same price.

Fourth, the information transmission model refers to the situation where the agent has private information about their own product before signing the contract, but the principal does not hold the information. To prove the quality of the product, the agent

chooses to send a certain signal, and the principal signs a contract with the agent based on this signal. A typical example is the relationship between the employer (principal) and the employee (agent), where the employee uses their academic degree certificate as a signal to convey their ability to the employer, and the employer determines the employee's salary level based on this signal. Spence (1973) derived the signal theory based on the theory of information asymmetry, attempting to solve the market failure dilemma caused by adverse selection problems.

Fifth, the information screening model refers to the situation where the agent holds private information before signing the contract, but the principal does not hold it. However, the principal knows the types and corresponding characteristics of the agent, thus can develop several contracts for the agent to choose. The agent can choose contracts that are beneficial to themselves based on their type and take corresponding actions. A typical example is the relationship between an insurance company (principal) and policyholder (agent), where the policyholder knows their risks while the insurance company does not know. Therefore, insurance companies have formulated different insurance contracts for different types of policyholders, and policyholders choose one insurance contract based on their own risk characteristics. Rothschild and Stiglitz (1976) proposed this information discrimination model based on the theory of information asymmetry and applied it to the study of financial markets.

3.1.3 Agency cost in corporate financing activities

For listed companies, information asymmetry mainly exists between insiders (like managers, directors, large shareholders) and outsiders (like regulators, small and medium-sized shareholders, and creditors). Insiders have an advantage in mastering information about the company's operations, while outsiders often rely on the information disclosed by insiders. The outsiders have disadvantages in terms of obtaining internal information of the firm.

In terms of corporate financing, information asymmetry leads to ex ante adverse selection and ex post moral hazard problems (the opportunistic behaviors of insiders of the company). Lower firm transparency makes it more difficult for external investors to detect and discipline managerial opportunistic behaviors (Ross, 1973). Specifically, for shareholders, on the one hand, the problem of ex ante adverse selection caused by information asymmetry indicates that company managers have an information advantage regarding the true value of the company thus may engage in seasoned equity offering for personal gains when the company is priced too high. Due to information disadvantages, shareholders find it difficult to know the truth about the company's fundamentals and managerial abilities. Therefore, they will require to purchase discounted stocks to reduce potential losses caused by information asymmetry (Myers and Majluf, 1984). In this situation, the company can only issue stocks at a discounted price, leading to an increase in equity financing costs (Bhattacharya and Spiegel, 1991; Leuz and Verrechia, 2000). On the other hand, due to the difficulty in observing the decision making of managers and the related information behind such decisions, shareholders require higher returns to compensate the risk of severe moral hazard problem caused by information asymmetry ex post. For investment decisions related to enterprise value creation, Shareholders find it difficult to understand the market demand and judge the prospects of the investment project thus they can only judge the manager's efforts based on stock price performance. Therefore, managers may choose to sacrifice future cash flows, by abandoning long-term and highly uncertain R&D and innovation investments (Holmstrom, 1989) and increasing short-term investments, to raise stock prices (Narayanan, 1985; Stein, 1988; Benmelech et al., 2010) for career consideration. In addition, managers may also engage in excessive investment to build a business empire (Jensen and Meckling, 1976) with the funds of investors for self-interest purposes, which may damage the firm value.

Creditors are also at an information disadvantage as outsiders. Faced with potential moral risks and adverse selection issues of the company, creditors require higher debt capital premiums to compensate risk, resulting in an increase in debt financing costs.

Kothari et al. (2009) find that managers generally report good news but not bad news for personal gains such as salary and promotion. Therefore, ex ante managers may conceal the risks of investment projects and non-performing loans and embellish accounting information to improve financing efficiency. Ex post, they may violate the requirements of creditors by investing in high-risk projects, engaging in aggressive investment strategy, like investing short-term capital in long-term projects, or making overinvest for personal gains. These send a signal of potential liquidity risk to creditors, increasing debt financing costs. Information asymmetry theory can be further applied to explain the principal-agent problems in the corporate equity and debt financing activities. For companies with higher levels of information asymmetry, opportunistic behavior of insiders reduces expected investment returns and increases potential investment risks. The higher reward required by external investors to compensate investment risk, the higher cost of equity and debt financing for the company, thus the company will face severe financing constraints. Information transmission theory believes that information disclosure is an important means for companies to alleviate information asymmetry problem and reduce financing costs through conveying positive signals of investment risks and returns to external investors. This constitutes the underlying theoretical basis for the impact of ESG information disclosure on company financing costs.

As one of the main theories in the fields of modern economics and management, the principal-agent theory suggests that interest conflicts exist between agents and principals in an environment of information asymmetry. Plenty of research efforts are made to explore how to design the optimal contract to mitigate the agency problems. Following the theoretical framework of information asymmetry, Jensen and Meckling (1976) pioneered an agency theory that is more in line with empirical research by scholars, opening up the “black box” of traditional enterprise models and exploring the motivation and incentive issues of managers within the “black box”. Jensen and Meckling (1976) applied the agency theory to explain firm’s capital structure, proposing that given the equity dispersion, it is not feasible to involve all shareholders

in the company's decision-making. Therefore, it is necessary to hire professional managers to manage the company's operations, forming a principal-agent relationship between shareholders and managers. Shareholders hope that managers can improve the investment return through efficient business management, while managers hope to increase personal salaries, benefits, and leisure time, thus inconsistent goals exist between shareholders and managers. Managers, positioned at an information advantage, may make inefficient investment and financing decisions out of self-interest incentives, which harms the interests of shareholders and results an agency problem. The agency problem exists not only between shareholders and managers, but also between major shareholders and small and medium-sized shareholders, as well as between shareholders and creditors.

From the perspective of corporate financing, agency costs can be divided into two types. One is the equity agency costs incurred by the agency problem between managers and shareholders in the equity financing process. It is caused by potential undesirable behaviors of managers, such as on-job consumption, inefficient investment decisions, and shirking. Another type is generated in the process of debt financing, where the company incurs debt costs caused by agency problem between shareholders and creditors. The excessive debt, inefficient investment decisions, and excessive dividend payouts will harm the interests of creditors. In a word, these two types of agency costs increase the company's equity financing costs and debt financing costs.

First, the agency cost in equity financing. Shareholders and managers develop a principal-agent relationship in the process of company's equity financing. Fama and Jensen (1983) suggest that addressing the agency problem in equity financing is a key issue in corporate governance. The agency cost in equity financing arises from the separation of management and control rights. The manager may pursue their private interests at the cost of the interests of shareholders (Jensen and Meckling, 1976). This cost composes three parts: supervision cost, guarantee cost, and residual loss. Among them, supervision cost refers to the cost paid by shareholders to supervise the

opportunistic behavior of managers, such as periodical assessments, selecting representatives to participate in board decisions, etc. The guarantee cost refers to the measures adopted by managers to eliminate shareholders' concerns and prove that managers will not harm shareholder interests, such as information disclosure. Residual loss refers to firm value damage caused by management opportunistic behaviors, such as shirking and empire building.

Second, the agency cost in debt financing. Jensen and Meckling (1976) argue that the agency cost in debt financing arises from conflicts of interest between creditors and shareholders. A classic example is the conflict between creditors and shareholders during a company's investment process. When the company's debt ratio is low, shareholders often choose high risk and high return investment projects to maximize their own interests. Once the project is successful, shareholders can obtain most of the profits while creditors can only receive fixed interest. If the project fails, most of the losses are borne by creditors. When a company's debt to equity ratio is high, shareholders often abandon investment projects with a positive net present value, resulting in losses for creditors (Myers, 1977). The agency cost in debt financing includes three parts: cost of wealth loss, supervision cost, and bankruptcy cost. Among them, the cost of wealth loss refers to the wealth loss caused by opportunistic behaviors harming the interests of creditors due to information asymmetry. In order to protect their own interests, creditors increase the contract loan interest rate to compensate for potential repayment risks, which does not align with the interests of shareholders. Consequently, the company gives up some potential profitable project opportunities, resulting in wealth loss for creditors. Supervision cost refers to the cost incurred by creditors in interfering with the company's operations through a series of restrictive clauses in the contract (such as avoiding high dividend payouts, new debt borrowing, high-risk investments, etc.), as well as the subsequent supervision cost. Bankruptcy cost refers to the remaining losses borne by creditors after a company's bankruptcy. Therefore, the equity agency cost and debt agency cost respectively anticipate potential equity investment risks and debt repayment risks for shareholders and creditors.

Investors will demand higher capital premiums to compensate for possible risk of losses, ultimately increasing the company's equity financing cost and debt financing cost.

3.2 ESG investing

ESG investing encompasses a large variety of activities, many of which are labeled as "socially responsible investing", "responsible investing" or other terms containing "environment", "sustainable", "green", "eco", and so on. People make ESG investments for some certain ethical belief or concern, so different types of investors make different investment judgements. Ancient Jewish law, dating back to 3500 years ago, prohibited Jews from engaging in business activities violating ethical, moral, or religious codes, such as producing non-Kosher food, destroying the environment, and selling defensive weapons, which illustrates the earliest ESG investing practices (Schwartz, 2003). The phenomenal growth of ESG investments around the world has attracted academic attention, leading to more and more research efforts spent on investigating the motivations and costs of ESG investors.

3.2.1 Cost of ESG investing

According to neo-classical financial theories, ESG investments incur extra cost and will underperform market portfolio in the long run (Cummings, 2000), since ESG assets are only subsets of desirable and profitable portfolios which are successfully diversified. Some early research has documented that ESG investors do not earn more than conventional investors (e.g., Hamilton et al., 1993) thus scholars must seek alternative explanations for ESG investing beyond financial returns. ESG investors make investment decisions consistent with their ethical or social values and are willing to accept lower financial returns (Benson and Humphrey, 2008). Therefore, the special preferences of ESG investors should be taken into consideration while building utility models of investors and we should incorporate non-financial gains into conventional asset pricing model to explain the investment behavior of ESG investors (Statman, 2000).

On the contrary to the theoretical prediction discussed above, previous literature provides limited evidence on the financial cost of ESG investing practice. Cortez et al. (2009) compares the performance of a sample of socially responsible mutual funds from seven European countries with conventional and socially responsible benchmark portfolios. The results show that European socially responsible funds at least exhibit a neutral performance compared with the two benchmarks. Renneboog et al. (2008) reviews a strand of studies presenting that socially responsible investments do not show suboptimal financial performance. However, people remain doubtful about these conclusions because the estimates produced from these research models suffer from benchmark problems. Using Carhart multi-factor model to overcome the benchmark problem plaguing prior studies, Bauer et al. (2005) still shows no significant difference in risk-adjusted returns between ethical mutual funds and conventional funds from German, UK, and US. Researchers propose that ESG investing could be an effective way to constrain corporate misconduct and improve corporate governance to explain the inconsistency between research findings and theoretical expectations (Cummings, 2000). When more and more investors begin to care about ESG, it is also possible that former ESG investors obtain extra returns from latter ESG investors. In order to examine this hypothesis, Lee and Lee (2023) examine whether ESG investor earn profit as the ESG awareness of the public increases. They employ the setting of COVID-19 pandemic which triggers broad social attention on sustainability and safety issues and test the change of expected returns for asset portfolios with high ESG rating. The results show that stocks with high ESG scores bring higher returns after the COVID-19 pandemic, supporting the notion that ESG portfolios has higher expected returns when the level of ESG awareness in the society advances. However, other voice exists arguing that socially responsible portfolios are only tools to legitimize those conventional ones. The profit of the latter offsets the loss caused by the former. So far, no study provides solid evidence to reconcile these two contradictory opinions, leaving the puzzle for future research.

3.2.2 Motivation of ESG investing

Academic community also pay attention to firms' motivation behind their ESG investing activities. Some studies argue that corporate ESG performance reflects corporate culture. Consistently, Kim et al. (2012) finds that firms taking more social responsibility have higher earnings quality. Socially responsible firms engage less in accrual and real earnings management, offer more transparent financial reports, and are less likely to be investigated by regulation authorities. Hoi et al. (2013) find that firms take more irresponsible CSR activities are more aggressive in avoiding taxes. Dai et al. (2023) find that CEOs departing from firms with strong social performance have better labor market potential. These CEOs find it easy to obtain a new executive position with higher compensation in a larger public firm. Davis et al. (2016) also finds a negative association between corporate social responsibility and corporate tax payments. They do not explain such result from a corporate culture perspective but posit that taking social responsibility substitutes tax payment. The fact that firms' CSR expenditures are positively associated with their tax lobbying expenditures supports their argument. Petrovits (2006) proposes that companies may exploit corporate philanthropy programs to manipulate earnings reporting. Consistent with the manipulation hypothesis, the study finds that firms with slight earnings increase make upward discretionary foundation funding choices. The evidence indicates charitable foundations' role as off-balance sheet reserves, providing a novel perspective for us to understand corporate charitable activities. Heinkel et al. (2001) present a model to document the longstanding argument that green investors can affect polluting decisions of firms through influencing the cost of capital. The green investors prefer environment-friendly firms and do not invest in polluting firms, resulting in lack of risk sharing among non-green investors. Consequently, polluting firms have lower stock prices. However, they show that only when green investors account over 20% in the market, polluting firms will clean up their activities under the pressure of higher cost of capital. By contrast, empirical evidence shows green investors in the market are no more than 10% at that time. Therefore, lower cost of capital cannot serve a convincing motivation for ESG investing activities of firms according to the conclusion of this research. However,

Hong and Kacperczyk (2009) provide some evidence supporting lower capital cost of firms held by ESG investors. They find that companies whose business activities exert negative influence on our society, namely those producing alcohol, tobacco, and gaming, are less held by norm-constrained institutional investors and receive less attention from analysts. As a result, these companies have higher capital cost since norm-constrained institutional investors abstain from their stocks. Although Heinkel et al. (2001) and Hong and Kacperczyk (2009) obtain totally different conclusions regarding with the effect of ESG investing on the capital cost in their studies, they reach one agreement that the size of ESG investors must be large enough to make a difference to firms' capital cost. Employing the data of 600 companies from 17 Europe countries, Priem and Gabellone (2024) find that better ESG performance, which is proxied by higher ESG score, reduces the cost of capital of the firms. But the positive effect of ESG activities on corporate financing only exists in countries with weak institutional background. This indicates that ESG investment substitutes weak institutions. Cost of capital explanation for corporate ESG investing decisions assumes that wealth transfers from ESG investors to non-ESG investors when ESG investors hold on their ethical values. Besides the preference of investors, political action is proposed as another factor motivating corporate ESG investing activities. The government can direct corporate investment to some certain areas by the means of laws, regulations, or taxes (Statman, 2000), under which case wealth transfers to the government rather than the non-ESG investors.

In line with the capital cost explanation discussed above, corporate finance theory attempts to explain ESG motivations of firms under a more comprehensive framework which encompasses the influences of stakeholders. Developing good relationships with stakeholders bring competitive advantages for corporate financing activities. Using a sample of S&P 500 firms, Hillman and Keim (2001) find that ESG investments that helps firms to maintain good relations with employees, customers, suppliers, and communities, which develops valuable intangible assets for firms, benefit shareholders' wealth while spending corporate resources on social issues harms shareholders' wealth.

Park and Lee (2023) present that ESG performance of firms could affect customer satisfaction thus a firm's ESG performance is positively associated with that of its suppliers. This indicates firms consider the ESG performance of their suppliers when making purchase decisions. Wang (2023) examines whether firms increase the intensity of ESG activities under the pressure from banks. This research finds that firms borrowing from banks locating in countries adopting ESG disclosure regulation exhibit better ESG performance. The evidence suggests that banks with a ESG focus also serve a monitoring role in promoting corporate ESG activities. Focusing on corporate environmental performance, Russo and Fouts (1997) analyze how better ESG performance increases firm profitability under a resource-based view of firm. They point out that proactive environmental policies can enhance economic performance from the following four aspects: a. improved production efficiency and valuable knowledge on pollution prevention brought by pollution reduction process through new technologies; b. integrated organization, coordinated functional units, and increased employee skills and commitment during the process of developing pollution prevention policy; c. high reputation which can attract green customers; d. good firm image which helps to gain political advantages. Using a sample of 243 firms over two years, they test their hypotheses and find evidence consistent with the positive relationship between better environmental performance and more economic profit. Exploiting the Indian regulatory change in 2013 which requires firms to spend at least 2% of their profit on CSR activities, Manchiraju and Rajgopal (2017) present a significant negative market reaction following the issuing of the mandatory CSR spending requirement. They conclude that firms have optimally chosen the level of CSR expenditure thus any exogenous forces changing firms' CSR expenditures will harm shareholder wealth.

3.3 ESG disclosure

Given the preference for socially responsible investment of ESG investors and the attention on corporate social responsibilities from various stakeholders, firms have incentives to communicate ESG information with factor, capital, and product market.

A large body of literature makes great efforts into exploring the determinants and outcomes of ESG disclosure.

3.3.1 Determinants of ESG disclosure

Baloria et al. (2019) examines how shareholder activism motivate ESG disclosure using a setting of corporate political spending disclosures. They contribute to the literature regarding shareholder activism by incorporating both proposals of shareholders that went to vote and that were withdrawn. Their findings support that the preferences of shareholders motivate firms to disclose more ESG information. Many prior studies suggest economic returns as firms' motivation to make ESG report by documenting a positive association between CSR expenditures and firms' various aspects of economic performance. For instance, Christensen (2016) proposes CSR reporting as a risk management tool for firms. CSR reporting plays a monitoring role in reducing corporate misconduct since firms can identify potential overlooked risk factors in the preparing process of CSR reports. CSR reporting also constrains corporate misconduct through managers' great incentive to report good news in CSR reports. Consistent with the monitoring and constraining hypothesis, Christensen (2016) find that corporate accountability reporting reduces the occurrence of corporate high-profile misconduct. It also finds that CSR reporting mitigates the negative reaction of stock price to the occurrence of high-profile misconduct. Glassdoor is a large job search and recruiting websites in U.S. where employees can share their experiences working for their employers. Dube and Zhu (2021) leverage the staggered timing of first-time Glassdoor reviews to examine how a firm responds to the increased workplace transparency. They find that firms improve their CSR performance related with employee relations and diversity following their exposure to Glassdoor reviews. The results indicate that CSR reporting could also serve a monitoring role in promoting corporate CSR activities as CSR disclosure increases firm transparency. By contrast to these studies, Lys et al. (2015) posit a novel notion which hypothesizes that firms make CSR reporting to signal improved future financial performance. They use some economic variables to predict optimal corporate CSR expenditures and calculate the deviation from the optimal level.

They find evidence supporting their hypothesis through documenting that a significant positive relationship exists between future financial performance of firms and the deviation from the optimal level of CSR expenditures rather than the optimal level of CSR expenditure. Lys et al. (2015) highlight the signaling role of corporate CSR reporting.

In response to the demand of investors who care about the social impact of corporate operating activities, some firms disclose ESG information voluntarily. To harmonize the heterogenous disclosure practices of firms, some regulatory authorities mandate ESG disclosure. However, both voluntary and mandatory ESG disclosures fail to achieve a desirable disclosure outcome. While the importance of ESG information is widely acknowledged, how to disclose ESG information effectively plagues both ESG information users and suppliers. The main problems about ESG disclosure quality include credibility, usefulness, and comparability of ESG information. Although several disclosure standards or framework have been proposed to guide corporate ESG reporting, investors remain unsatisfied with current ESG disclosure practice by firms because of the diversity and complexity nature of ESG information (Bernow et al., 2019). Whether companies should provide ESG information to inform investors or inform all stakeholders remains debated and the current state of ESG disclosure practices by most firms has a blended nature (Christensen et al., 2021). Investors usually find it hard to compare the ESG information disclosed by different firms. One sustainability issue which is material for the decision of investors holding firm A could be unmaterial for the decision of investors holding firm B. Response to the materiality divergence of sustainability issues across different firms and industries, the Sustainability Accounting Standards Board develops a set of ESG reporting principles to define materiality of sustainability issues for different industries. Based on these ESG reporting standards, Khan et al. (2016) map corporate sustainability investments into material and unmaterial categories and rate corporate sustainability performance according to material sustainability issues. Unsurprisingly, they find that firms with good ratings on material sustainability issues significantly outperform firms with poor

ratings on these issues. In contrast, firms with good ratings on immaterial sustainability issues do not significantly outperform firms with poor ratings on the same issues. These results confirm that the materiality of sustainability issues vary with different firms and the ESG reporting standards can improve investors' understanding of corporate ESG information. Bashir et al. (2024) investigate whether voluntary ESG reporting standards improve corporate ESG disclosure quality. They find that firms provide more material ESG information as measured by more material ESG topics and more ESG metrics following the ESG reporting standards. The research shows the positive role of ESG reporting standards in constraining strategic reporting behaviors of firms and promoting the advancing of ESG reporting quality.

3.3.2 Consequences of ESG disclosure

Whether ESG disclosure generates some real economic outcomes appeals a lot of researchers. ESG disclosure should not have any effect on corporate future economic performance assuming a firm has made its optimal disclosure decision (Manchiraju and Rajgopal, 2017). To verify whether ESG disclosure brings economic benefits to firms, researchers contribute plenty of evidence on aspects of shareholders, bondholders, and analysts. Bucaro et al. (2020) show that CSR information provided in a separate report is more useful for investors' decisions than CSR information integrated in the financial reports using an experimental research design. Schneider (2011) show that bondholders incorporate environmental performance disclosed by firms into bond pricing. For firms that have high potential environmental risk, bondholders take their pollution disclosure seriously and discount firm bonds based on their disclosed environmental performance. Dhaliwal et al. (2011) focus on a sample of U.S. firms that issue standalone CSR reports for the first time to overcome the potential problem that sticky CSR reporting might confound its economic influence. Consistent with their anticipation, they find that initiating CSR disclosure significantly reduces firms' cost of capital in the subsequent year. Initiating firms not only raise equity in a lower cost but also raise a larger amount. Using a multi-national sample, Dhaliwal et al. (2012) further documents the positive effect of CSR disclosure on analyst forecast by focusing on the first-time standalone

CSR reports. Their study also incorporates financial transparency and institutional characteristics into the research design, thus provides relative convincing evidence on the informational role of CSR reports. Although above research indicates the positive role of ESG disclosure, it is hard to distinguish whether the incremental information is sourced from ESG activities themselves or ESG-related operating activities. Besides focusing on first-time ESG reporting, exploiting variation in ESG disclosure quality is another idea to verify the usefulness of ESG information. To compare ESG disclosure quality of different firms, Muslu et al. (2019) create a disclosure score which is calculated according to a comprehensive evaluation framework simultaneously considering the reporting tone, text readability, text length, proportion of numerical content, and horizon content of standalone ESG reports. Controlling ESG activities and financial reporting characteristics of sample firms, they find higher ESG disclosure quality increases analyst forecasts. Although they contribute evidence supporting that better ESG disclosure increases the usefulness of ESG information, the comprehensive disclosure score makes it hard to establish any causal link between one specific component of disclosure quality and the judgement of analysts. Therefore, it is hard to explain the underlying rationale of the positive association between the disclosure score and analyst forecast accuracy.

Interestingly, ESG disclosure can bring benefits to firms not only under the case of reporting good news. Clarkson et al. (2004) suggest that investors value environmental capital expenditure of low-polluting firms more than high-polluting firms. They find that environmental capital expenditure is positively associated with market valuation of low-polluting firms while is not significantly associated with market valuation of high-polluting firms. Their findings suggest investors incorporate un-booked environmental liabilities into the interpretation of environmental performance information when making market valuation. Matsumura et al. (2014) find that firm value increases with carbon emissions among a sample of 841 Korean firms. On the contrary to the results of most prior studies, their research results highlight the signaling role of voluntary ESG reporting and the self-selection problem of voluntary ESG disclosure research.

Companies with less carbon emissions have more incentives to make ESG disclosure under a voluntary ESG disclosure policy. Although most of literature supports the positive effect of ESG disclosure on firms, contrasting evidence exists showing negative corporate outcome caused by ESG disclosure. Exploiting China's mandatory CSR disclosure policy issued in 2008, Chen et al. (2018) examines whether disclosure pressure encourages firms' CSR input and affect firms' financial performance. They find that reporting firms suffer a decrease in profitability following the mandatory disclosure policy. However, they find a positive effect on environment performance at city level of the mandatory disclosure policy. Their results combine to indicate that mandatory CSR disclosure could produce positive externalities at the cost of shareholder interests. The Greenhouse Gas Reporting Program in U.S. aims to increase corporate transparency in producing greenhouse gas. A large number of facilities began to disclose their greenhouse gas emissions following requirements of the program. Tomar (2023) argues that the increased transparency of greenhouse gas emission enables peer firms to evaluate their relative emission performance thus promotes emission elimination through spurring competition among peer firms to reduce greenhouse gas emission. Consistent with such argument, the study finds that greenhouse gas emissions decrease by 7.9% following the disclosure of emission data. The research provides further evidence to support the theoretical prediction that publicity and transparency play governance roles in constraining undesirable behaviors with negative externalities through learning and competition among peers.

3.4 ESG measurement

How to evaluate corporate ESG activities and measure ESG performance of firms is one critical challenge confronting scholars showing great interest in ESG related research questions. Plenty of studies assess corporate ESG performance by the data disclosed by firms themselves. The main concern of ESG information disclosed by firms is data credibility. Prior literature theoretically predicts the incentive and ability of firms to manipulate their ESG disclosure (Clarkson et al., 2008). Both firms with

strong and weak performances are incentivized to report their ESG behaviors with upward bias to cater for shareholders and stakeholders which have an ESG focus. Freedman and Jaggi (2004) investigate the carbon dioxide emissions and the disclosure behavior of a sample of plants from the fossil burning electric industry in U.S., which is known as one of the primary industrial sources of carbon dioxide emissions. Their results suggest that the disclosed ESG information at least reflect the ESG performance of the disclosure to some extent, supported by the significant positive relationship between pollution disclosures and pollution emissions of electric utility companies. However, they confirm that in general companies do not disclose all the truth about their pollution emissions. Exploiting a larger multi-country sample consisting of firms from U.S., U.K., and Australia, Luo and Tang (2014) document a significant positive relationship between voluntary carbon disclosure and carbon performance of firms. Drawing on the signaling theory, their evidence shows the creditability of the corporate ESG disclosure and lends support to the common practice of employing ESG information disclosed by firms to capture their ESG performance in academic research. Griffin et al. (2017) obtains the greenhouse gas emissions which are voluntarily disclosed by firms to capture sample firms' environmental performance. For firms which do not disclose such information, they estimate their greenhouse emissions in a regression model based on firm and industry characteristics.

Another problem in measuring corporate ESG performance using the information disclosed by firms lies in how to make the data covering different ESG issues comprehensively comparable among different ESG performers. Cormier et al. (2011) concentrate on the value relevance of corporate disclosure on social and environmental issues. To quantify corporate social and environmental disclosure, they group social and environmental disclosure items into several dimensions following the framework built by prior studies (Aerts et al., 2007; Cormier et al., 2009) and develop social and environmental disclosure grids. Chen et al. (2023) construct a comprehensive ESG score for each firm in their sample. They first select ESG issues more relevant to their specific research setting, namely firms' future fundamentals and government policies.

They collect indicators for over twenty ESG issues focused by their research from annual financial reports, CSR reports, announcements, notices, and official websites using natural language processing techniques. The final score for each firm is the aggregate value of all the selected indicators. Although these comprehensive ESG measurements constructed by researchers make ESG performance comparable among different performers, they are subject to the judgements and values of the researchers. The great advantage of such ESG performance measurement is that they can better adapt to the research needs under some specific setting. However, the drawbacks are also prominent. On the one hand, these measurements cannot be generalized to a broader research scope. On the other hand, investors have no access to neither the imputation methodology nor the data on ESG performance measurement, thus those measurements developed in academic studies cannot be applied in investors' decision-making.

Some studies rely on the information provided by third parties. Some agencies supervise a certain type of corporate ESG activity and provide ESG information on some specific aspects. For instance, Johnston and Rock (2005) use the identification of Superfund as potentially responsible parties for environment pollution to measure corporate environmental performance. The measurements most used in academic research are various ESG ratings offered by rating agencies. Harris and Neely (2016) find that third-party rating for nonprofit organizations increases their direct donations received. Nonprofits that are consistently rated by different rating organizations receive higher donations than those rated inconsistently and negatively. Their research results indicate that donors employ information from rating agencies in making donations. Latter literature moves from simple ESG measures focusing on single type of ESG activities to more complex ESG measures which takes a comprehensive ESG conceptual framework into consideration when identifying ESG activities. Chen and Xie (2022) find that ESG investors incorporate ESG information into stock prices based on the ESG ratings of Bloomberg. Jiang et al. (2022) examine a sample of Chinese firms and find that institutional investor's visiting can improve firms' ESG performance,

proxied by ESG ratings evaluated by Huazheng. Other well-known ESG rating agencies include MSCI, Hexun, SynTao, MioTech, and so on.

Chapter 4 Hypothesis Development

4.1 ESG report comprehensiveness and corporate debt financing cost

More comprehensive ESG report usually indicates better ESG performance, which refers to the extent to which the three aspects of environmental protection, social responsibility and corporate governance are embedded in corporate investment and strategic decisions. I propose that better ESG performance could reduce corporate debt financing cost for the following reasons.

ESG performance reduces corporate risk. Compared to shareholders, debtholders are more sensitive to risk, thus they prefer assets which could bring stable returns with low uncertainty, even if high stability usually means low profitability. Corresponding to the risk preference pattern of debtholders, firms make ESG decisions according to whether to carry out ESG practice can meet the sustainable development goals. Generally speaking, business stability is the key to the sustainable development of enterprises. According to different causes of risk, enterprise risk can be divided into systemic risk and idiosyncratic risk. The former is caused by the impact of market and industry changes on enterprise stock price, while the latter is caused by the heterogeneity of individual enterprises (Wang and Chen, 2018; Fang and Chen, 2015). The differences in the causes and scope of impact of the two types of risks lead to certain differences in prevention and control measures. Existing studies have also noted that corporate social responsibility, environmental protection and other behaviors have differentiated impacts on systemic risks and idiosyncrasies (Sassen et al., 2016). Better ESG performance could reduce operational risk of firms from various aspects directly. For instance, Velte (2019) shows in his research that enterprises with better ESG performance have relatively less opportunistic behaviors such as earnings management, thus these enterprises are less likely to be sued for financial fraud or to be punished for information disclosure violations. Focusing on the quality of corporate governance requires enterprises to invest part of their resources into the construction of internal

systems, which helps to continuously safeguard the internal stability of enterprises. This could effectively reduce illegal trade, unsafe production, or managerial misconduct of firms, thereby reducing firm's operational risk.

On the other hand, changes in the external environment will also cause investors to worry about the development prospects of enterprises, which is not conducive to their sustainable development. However, from the perspective of signal transmission mechanism, fulfilling social responsibility is an important performance of enterprises to actively meet social expectations, which can convey the signal of good operation and redundant resources to the outside world, and enhance the confidence of the capital market in enterprises. Therefore, in the face of market fluctuations and industrial changes, enterprises with good ESG performance can effectively mitigate stock price fluctuations caused by investor concerns (Campbell, 2007; Wang, 2018). Broadstock et al. (2021) analyzed the role of ESG performance in coping with the financial crisis, and found that during the financial crisis, the stock performance of enterprises with good ESG performance was significantly better than that of enterprises with average ESG performance and concluded that ESG had the effect of reducing financial risks.

In addition, from the perspective of noise trading, ESG value returns have the characteristics of recessive and lagging, which helps enterprises filter out irrational investors (He and Zhuang, 2023). Li et al. (2021) also pointed out in their research that ESG is more likely to attract the attention of some long-term investors and institutional investors with value discrimination ability, while it is often disliked by irrational investors. Therefore, after a period of investor change, irrational investors are reduced, rational investors are increased, noise trading is effectively suppressed, and the stock crash risk level of enterprises is further reduced (Wang et al, 2019).

In summary, lower operational risk, financial risk and stock crash risk enables good ESG performers to maintain stable operation. Debtholders investing in good ESG performers are exposed to lower level of uncertainty, thus they require less returns.

ESG performance improves corporate reputation. Some existing literature regards the value effect of ESG as a process of acquiring external resources and believes that enterprises' investment in ESG is an important embodiment of safeguarding stakeholders' rights and interests, which helps enterprises to improve their credit level and accumulate reputation resources in the market, so as to obtain the recognition and resource support of stakeholders (Ullah and Sun, 2021; Servaes and Tamayo, 2013). Good reputation can exert the risk resistance effect thus help to maintain the business stability of enterprises. Giang and Dung (2022), based on a sample of 1193 enterprises in Asia and Europe, found that external activities such as CSR can help enterprises mitigate the impact of risks and improve performance. And this process is realized through the corporate reputation effect, that is, the performance of corporate social responsibility can effectively respond to the expectations of stakeholders, so that the enterprise can obtain a good social reputation, and then avoid losses in adverse economic shocks.

Studies based on stakeholder theory hold that the sustainable development of an enterprise is the result of joint governance by all stakeholders, and an enterprise's active commitment to social responsibility helps to form credit capital and reputation resources among stakeholders. In the face of risk impact, it can obtain timely support and input from stakeholders to mitigate the impact of risks on enterprises (Brogi and Lagasio, 2019; Kushwaha and Sharma, 2016; Ghoul et al., 2017). Wang and Sarkis(2017) also believe that through ESG investment, enterprises can establish a good social image and increase social influence, thus attracting stakeholders to follow and improving market competitiveness. Cui et al. (2018) and Li Zhibin et al. (2020) even point out that social responsibility, environmental protection and other behaviors with high externalities are tools for enterprises to establish and maintain interest relations, with the purpose of seeking scarce market resources.

Better reputation can also help to protect firms from systematic risk. Systemic risk is caused by market and industry level factors that affect all enterprises. The higher the sensitivity of enterprises to systematic risks indicates that enterprises are weaker in coping with environmental changes and more likely to suffer losses when the economic environment deteriorates (Wang and Chen, 2018; Fang and Chen, 2015). Good ESG performance can effectively mitigate the impact of market and industry changes on enterprises. Specifically, the deterioration of market environment and industrial upheaval have the most direct impact on enterprises, which is to cause the loss of stability of enterprises' access to external resources. However, positive social responsibility behaviors help strengthen the cooperative relationship between enterprises and stakeholders, so that enterprises can obtain effective resource support in time when faced with external market changes. Moreover, better ESG performance also help enterprises to establish a good image of "responsibility" and win reputation resources in the market, which can further mitigate the impact of systemic risks on enterprises.

In a word, good reputation obtained from high quality ESG investing activities mitigate the negative impact on firms when they suffered from adverse shocks, which further decreases their operational risk and reduces uncertainty faced by debtholders. Therefore, good ESG performers have lower debt financing cost.

ESG performance could improve corporate financial performance. Most prior studies hold a positive attitude towards the value effect of ESG. Friede et al. (2015) sorted out and analyzed more than 2,200 research results on the value output of ESG performance since 1970 and found that more than 90% of the studies believed that enterprises' ESG performance had good value output and such value output was sustainable. However, in terms of the value output path of ESG performance, the existing literature focuses on different aspects. Some studies mainly focus on the value benefits brought by the externalities of ESG performance to enterprises, while the other focuses on the value creation of ESG behavior itself. It should be noted that the

investment of enterprises in environmental protection, social responsibility and corporate governance is itself closely related to their internal production and management activities, which can promote the sustainable development of enterprises by optimizing the production process, improving management efficiency and building organizational culture. Therefore, scholars also pay close attention to the value creation effect of ESG within enterprises. ESG involves an enterprise's concern about environmental protection, social responsibility and corporate governance. From the perspective of the costs and benefits of these three behaviors, environmental protection overdraws the strategic resources of the enterprise in the short term, but helps to improve the cost efficiency of the enterprise in the long run (Wang and Yang, 2018). For example, Yang et al. (2022) pointed out that good ESG performance means that enterprises will invest more in green energy and clean production, which will help enterprises to improve energy efficiency and reduce environmental regulations and reduce production costs. A focus on social responsibility helps companies win recognition from stakeholders, build partnerships, and gain external support. The value effect of ESG also contributes to the negative effect of ESG performance on enterprise risk, which further increases creditor's preference for firms with better ESG performance, and this core issue has been extensively discussed in existing studies. In the context of ecological civilization construction, environmental protection and people's well-being have become the focus of attention of local governments and the public, good ESG performance can also help enterprises to be recognized by the government and obtain the support of fiscal and tax policies (Gao et al., 2017).

ESG performance improves the information environment of firms, so that it takes lower cost for debtholders to monitor the investment decisions of firms. The construction of ESG in social responsibility and environmental protection projects has reduced the external regulatory pressure of enterprises and optimized the cost structure (Wang and Chu, 2019), which will also enhance the confidence of managers in information disclosure and improve the information environment of enterprises. In addition, ESG also involves the improvement of corporate governance structure. Gu

and Zhou (2017), Li and Kong (2013) pointed out that corporate governance is an enterprise mechanism to alleviate the principal-agent problem and restrict the opportunistic behavior of management. After a period of time, the obstructing effect of organizational inertia is reduced, and the reformed governance mechanism can regulate the information disclosure of the management and restrain its opportunistic behavior, so as to further optimize the enterprise information environment. Better information environment reduces the monitoring cost of debtholders. Debtholders are easier to protect their interests against some agency problems. Therefore, they require less compensation for investment in firms with good ESG performance.

Therefore, I propose the first hypothesis of this research:

H1: Better ESG performance is negatively associated with corporate debt financing cost.

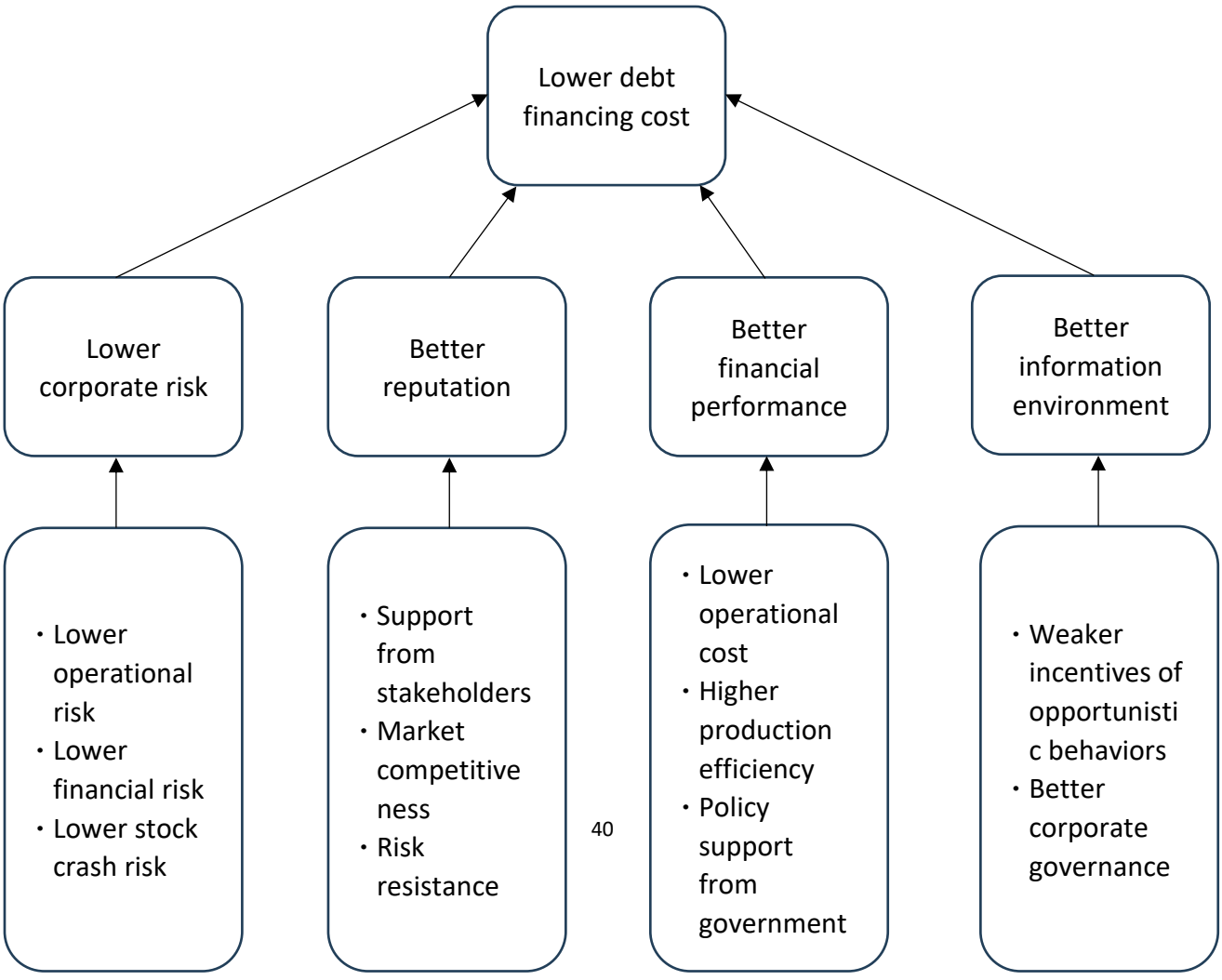

Figure 4-1 Theoretical framework of H1

4.2 The moderating effect of firm characteristics

In this section, I discuss how some firm characteristics can moderate the effect of ESG report comprehensiveness on corporate debt financing cost. Specifically, from the perspective of attributes of corporate governance, I examine how the effect of ESG activities on debt cost reducing can differ between SOEs and non-SOEs. Then I attempt to touch the question of how such effect can vary with firm's financial conditions. To do this, I focus on the moderating role of firm's financial performance and asset tangibility in the relationship between the comprehensiveness of ESG report and corporate debt cost. Lastly, I dig further to explain how divergent prospect evaluation potential, which is measured by the sales growth rate, can moderate the effect of more comprehensive ESG report on corporate debt cost.

State-owned enterprises. (SOEs hereafter) have stronger incentives to promote ESG practices in operating activities and to achieve better ESG performance. For SOEs, the ESG concept conforms to a series of development requirements such as green development, carbon peak carbon neutrality, modern governance, and building a community with a shared future for mankind, which are proposed by the central government. In recent years, regulators including the State-owned Assets Supervision and Administration Commission of the State Council (SASAC) have continuously established and improved the ESG ecosystem from the macro management level. In March 2022, the SASAC established the Social Responsibility Bureau, which clearly proposed to "do a good job in the construction of the central corporate social responsibility system, guide and promote enterprises to actively practice the ESG

concept, actively adapt to and lead the formulation of international rules and standards, and better promote sustainable development", releasing a clear signal of actively promoting the construction of enterprise ESG system. Central enterprises are supposed to play a leading and exemplary role in enhancing value creation capabilities, improving corporate governance capabilities, strengthening the disclosure of ESG reports, and fulfilling social responsibilities. Compared to non-SOEs, SOEs are under stronger ESG performance pressure from the central government. Therefore, good ESG performance is more valuable for SOEs to meet the development requirements of China's government. When SOEs deliver a good ESG performance, they will obtain more support from the government and then achieve better development. Thus, SOEs with good ESG performance have lower corporate risk and remain higher stability. Therefore, I propose the second hypothesis of my research:

H2: The negative effect of good ESG performance on debt cost is more significant for SOEs.

Financial performance. ESG performance is more important for firms with good financial performance. Highly profitable firms usually attract more attention from the public. With increasing social influence, firms are supposed to take more social responsibility rather than making profit. Firms with good financial performance are intensely monitored by regulators and market. If they do not comply to ESG norms in their daily operation, they will receive more harsh punishment and suffer more negative market response. For firms with poor financial performance, the benefits brought by ESG practices are very limited. These firms are supposed to prioritize survival and making money for shareholders. Overinvesting in ESG activities may crowd out other profitable investment projects for poor financial performance firms, thus leading to their lower profitability. Compared to firms with poor financial performance, debtholders pay more attention to corporate risk and operational stability of firms with good financial performance. After all, only profitable firms can survive in the market in the long run and operational resilience is only meaningful for survived firms. As

debtholders care more about the ESG performance of highly profitable firms, I propose another hypothesis of this research as followed:

H3: The negative effect of good ESG performance on debt cost is more significant for firms with good financial performance.

Firm tangibility. Tangible assets are characterized by finite monetary value and a physical form. Tangible assets can typically always be transacted for some monetary value though the liquidity of different markets will vary. Firms signal their profitability and stability through delivering good ESG performance. Such signal is more valuable for outsiders to judge the operational risk of firms with assets of high uncertainty. For firms with lower tangibility, their value is subject to high level of uncertainty. They have fewer collateral assets thus debtholders need more guarantee from other aspects, such as good signals from the ESG performance. Debtholders pay more attention to the ESG performance of firms with lower tangibility to collect more information about their operational stability. Since good ESG performance decreases debt financing cost through reducing corporate risk, such effect is supposed to attenuate when firm asset has a low level of risk. Therefore, I have another hypothesis in this research, listed as followed:

H4: The negative effect of good ESG performance on debt cost is less significant for firms of high tangibility.

Growth opportunities. Debtholders consider corporate ESG performance because they need to control the risk of their investment. Good ESG performance reduces corporate risk thus debtholders require less compensation for their investment. Firms with high growth potential are expected to earn much profit in the future, which offer more guarantee for repayment of debt. Under this case, debtholders rely less on the ESG performance to collect information on the probability of repayment in the future. In other words, higher growth potential to some extent compensates more ESG risk thus debtholders require less ESG input for firms with more growth opportunities. For a growing firm, investing resources on business activities bring higher returns than ESG

activities. Therefore, the capital market has lower ESG expectation for fast growing firms. In addition, fast growing firms are subject to more uncertainty unrelated to ESG but closely correlated with their business operation. Debtholders put more weight on these business risks rather than ESG risks while considering investment decisions of these high growth firms. As a result, good ESG performance plays a weak role in reducing debt cost for firms of high growth potential. I propose the last hypothesis of my research as followed:

H5: The negative effect of good ESG performance on debt cost is less significant for firms with high growth opportunities.

Chapter 5 Research Design

5.1 Sample and data

To measure corporate ESG performance, I applied textual analysis over ESG reports of firms. I collected the ESG reports disclosed by China's A-share listed companies using the Python software from Wind database and manually dropped the duplicated reports and the English versions. The final sample consists of 8,792 ESG reports, covering the period from 2010 to 2023. The financial data of sample firms is obtained from CSMAR database. I excluded all the observations from financial industry and all the ST samples. Observations with missing values for some variables required in the regression are also dropped. All continuous variables are winsorized at 1% to 99%.

5.2 Model specification

I examine whether good ESG performance reduces corporate debt cost using the following empirical model:

$$Debtcost_{it}(Bankloan_{it}/Tradecredit_{it}) = \beta_0 + \beta_1 ESG\_topic_{it} + \beta_2 Size_{it} + \beta_3 Lev_{it} + \beta_4 ROA_{it} + \beta_5 Growth_{it} + \beta_6 TobinQ_{it} + \beta_7 ListAge_{it} + \beta_8 TOP1_{it} + \beta_9 Tangibility_{it} + \beta_{10} SOE_{it} + \sum Year + \sum Industry + \varepsilon_{it}$$

I measure corporate debt cost using financial expenses scaled by average total debt (*Debtcost1*). I also alternatively use interest expenses scaled by average total debt (*Debtcost2*) to measure debt cost in robustness test. The ESG performance is measured based on topic analysis over ESG reports using LDA approach (*ESG_topic*). Please see section *5.3. The measurement of ESG performance* for detailed information about the data processing and the calculation method of the measurement. In order to control other firm characteristics that potentially affect corporate debt cost, I also include a series of control variables in the model, including firm size (*Size*), financial risk (*Lev*), financial performance (*ROA*), growth opportunities (*Growth*), market value (*TobinQ*),

listing age (*ListAge*), the shareholding of the largest shareholder (*TOP1*), tangible assets (*Tangibility*), and equity nature (*SOE*). I also include year fixed effects and industry fixed effects in the model to control for the influence of other unobservable factors that vary across time and industries. The detailed definitions for all the control variables are displayed in Table 5-1.

Table 5-1 Variable definitions

Variables	Definition
Dependent variables	
Debtcost1	Financial expenses scaled by average of the total debt at the beginning and the end of the year.
Debtcost2	Interest expenses scaled by average of the total debt at the beginning and the end of the year.
Bankloan	Financial expenses scaled by the average sum of short-term and long-term bank loans.
Tradecredit	Payables scaled by total asset.
Independent variables	
ESG_topic	The comprehensiveness of the content of corporate ESG report, measured as the opposite value of the standard deviation of all the 15 topic probability values. The 15 topics are obtained through LDA-based textual analysis.
E_topic	The text length of content related with E aspect in the ESG report, calculated as the sum of the probability of each E-related topic multiplying the total words of the whole ESG report. The E-related topics are manually identified based on the key words of each topic obtained from LDA analysis.

S_topic	The text length of content related with S aspect in the ESG report, calculated as the sum of the probability of each S-related topic multiplying the total words of the whole ESG report. The S-related topics are manually identified based on the key words of each topic obtained from LDA analysis.
G_topic	The text length of content related with G aspect in the ESG report, calculated as the sum of the probability of each G-related topic multiplying the total words of the whole ESG report. The G-related topics are manually identified based on the key words of each topic obtained from LDA analysis.
Control variables	
Size	Natural logarithm of total assets at the beginning of the year.
Lev	Total debt divided by total assets.
ROA	The net income divided by total assets.年末净利润/总资产
Growth	Annual percentage change in sales.
TobinQ	Total market value of equity plus the book value of liabilities, divided by the book value of total assets, minus intangible assets and goodwill.
ListAge	Natural logarithm of years being listed plus one.
TOP1	The ratio of the largest shareholding.
Tangibility	Total assets minus intangible assets and goodwill, divided by total assets.
SOE	Indicator that equals 1 if the firm is a state-owned enterprise and 0 otherwise.
Year	Indicator variables for the years.
Industry	Indicator variables for the industries, defined based on the industry classifications published by the China Securities Regulatory Commission in 2012.

5.3 The measurement of ESG performance

Most of prior studies evaluate corporate ESG performance based on the ESG ratings provided by third party (e.g., Johnston and Rock, 2005; Harris and Neely, 2016; Chen and Xie, 2022). ESG rating from third party has three main problems. The first one is that different rating agency develops different rating framework. A given firm could receive a totally different rating outcome according to the rating framework of different rating agencies. This leads to severe rating divergence problem. Therefore, the research measuring ESG performance using ESG rating data provided by third parties could be largely sensitive to the selection choice of rating data source, making the research results unreliable. Second, the data availability completely depends on the decision of third parties. Rating agencies only rates the ESG performance of a limited number of firms, which could lead to severe selection bias for academic research. Also, it always takes some time for those rating agencies to conduct rating process therefore the rating data cannot be timely enough. Last but not least, the rating processes of third parties are usually not transparent, making ESG shopping possible. Firms may bribe rating agencies for favored ESG evaluation. The rating agencies may also have incentives to favor firms with which they share close business networks. These can all lead to biased rating outcome. Some researchers evaluate corporate ESG performance through reading ESG report artificially and collecting required data manually. Although such hand-collected data is free of sample selection bias and problem of favored rating outcome, it always lacks objectivity. In addition, the massive reading tasks usually need to be divided into several parts and are completed by different people. It is hard to ensure the consistency and uniformity of the ESG performance evaluation. More importantly, artificial reading and judgement is really time consuming and is highly vulnerable of various errors and mistakes. To solve these constraints of the current rating measures, I construct a consistent and unbiased ESG performance evaluation through LDA approach in the following subsections.

5.3.1 Textual analysis based on LDA topic model

I measure corporate ESG performance from the perspective of the comprehensiveness of corporate ESG reports. Firms reporting their ESG activities on various aspects in their ESG reports are expected to have delivered good ESG performance. On the contrary, those firms which have only covered a limited ESG items in their ESG reports are usually deemed as poor ESG performers. In order to quantitively estimate the comprehensiveness of corporate ESG performance, I conducted textual analysis applying the Latent Dirichlet allocation (LDA) approach. LDA is a probabilistic topic model first proposed by Blei (Blei， Ng 2019), which can divide documents into different topics according to semantics. The essence of the topic model is to simulate the production process from the topic (implicit) to the lexical item (visible). Based on the preset optimal number of topics, the LDA model can represent each document as a probability distribution on different topics, and each topic can be regarded as a probability distribution of(Bao and Datta 2014) words. In recent years, LDA subject classification model has been gradually applied in the research of financial economy: Bao and Datta(Bao， Datta 2014)used the subject model to study how risk disclosure in 10-K statements affects investors' risk cognition. Dyer et al. (Dyer 2017) used the LDA topic model to analyze financial statements and found that the increase in information disclosure of the three topics of "fair value", "internal control" and "risk factors" was the most important reason for the increase in the length of financial statements. Huang et al.(Huang 2018) compared the topic content of a large number of analyst reports released immediately after the earnings conference call with the topic content of the conference call itself, so as to explore the role of analyst information discovery and information interpretation. However, Bellstam et al. (Bellstam 2021) use the LDA method to extract the topics related to enterprise innovation in analyst reports and measure enterprise innovation activities based on this method, which is no longer limited to traditional indicators such as the number of patents. When extracting the text content of ESG reports, compared with traditional text analysis methods, LDA topic model has the following advantages: First, LDA can quickly mine its potential semantic information from massive heterogeneous text data, which is very suitable for text genres

such as reports with huge length and diverse topic content. Second, compared with the use of manual reading, dictionary method and other ways to identify text content, LDA topic model is objective, reproducible and efficient. Third, LDA topic model is not limited by chapters and paragraphs. Different from the method of summarizing and organizing information by chapter, the LDA topic model can infer the probability distribution that the same document and paragraph belong to multiple topics. This is especially important for texts such as ESG reports, where the same topic may appear multiple times throughout the text.

5.3.2 Acquisition and processing of text corpus

On the basis of using crawler technology to obtain the original document pdf from related websites, the following operations are carried out: First, text preprocessing. Using Python to convert the original document in pdf format to text format, while eliminating punctuation, headers and footers; Second, Chinese word segmentation, choose the stop word table for the Harbin Institute of Technology, Sichuan University compiled the stop word table. Company names, geographical terms, accounting and financial terms, professional terms, etc. are collected manually from the original text, and user dictionaries are constructed. The Chinese word segmentation of ESG report text is performed using Python's jieba word segmentation package. Thirdly, further processing of textual corpus. Words that frequently appear in all topics, such as "corporate governance" and "corporate social responsibility", will affect the interpretation of the topic. In order to ensure that the topic distribution of the output of the LDA topic model is not occupied by high-frequency words and ultimately affect the quality of the topic, refer to Dyer et al. (Dyer 2017). This paper manually reviewed the 100(1000) words with the highest frequency in ESG report and the 100(1000) words with the highest coverage in all texts and added the meaningless words into the stop word list. In addition, English, numbers, special characters, single words and words with frequency number 1 are further deleted to form the report text corpus for subject classification.

5.3.3 LDA thematic model training and model extraction

As a machine learning method, LDA topic model is essentially to fit the topic distribution of existing text data, and the learning results of this LDA topic model are highly correlated with the text corpus used for training. In order to avoid the problem of sample imbalance, the sample categories in the training text corpus should be controlled as much as possible. The training results of the LDA topic model will be significantly biased towards the report type text corpus with superior proportion in the text corpus, which can achieve effective topic extraction. Therefore, according to Lowry et al. (Lowry 2020), the LDA topic model is trained on the corpus of ESG report text, so as to obtain the topic distribution. In addition, the LDA model needs to artificially set a preset number of topics, which will affect the generation of topics and the interpretability of the model results. Setting the number of topics too low will lead to too broad and vague topics, while setting the number of topics too high may introduce economically meaningless topics. According to Bao and Datta (Bao, Datta 2014), the corpus is divided into 80% training set and 20% test set. Moreover, Perplexity score was used as an index of evaluation models. Perplexity score was proposed by Blei et al. (Blei and Ng 2019) to evaluate the quality of language models. A small perplexity score means that the models have a better prediction effect on new texts. Confusion degree is a measure of probability model or probability distribution prediction, which is used to evaluate the quality of the model. It is an evaluation index derived from the concept of entropy in information theory, indicating that when an article is given a topic, this topic is mapped to the degree of certainty of each word, the stronger the certainty, the lower the degree of confusion, so a better clustering model corresponds to a lower degree of confusion. Consistency refers to the degree of differentiation between different subject words, which describes the distance between different subject distributions. Therefore, for LDA modeling, the higher the consistency, the stronger the analytical ability between different subjects learned. This paper will combine confusion degree and consistency to determine the number of topics, the basic purpose is to ensure that the confusion degree is relatively low, and the consistency is relatively high. For detailed calculation, please see equation (1). Where D is the set of text information in the test

data, M is the number of texts contained in it, in M text, N_m is the number of words contained in the text, and $p(w_m)$ represents the probability of the word w_m in the m-th text. In this paper, on the training corpus corresponding to ESG report, different topic number K is set for training, and the most suitable model corresponding to topic number K is selected by using the confusion degree judgment.

$$Perplexity(D) = exp\left(\frac{\sum_{m=1}^{M} ln_D\, p(w_m)}{\sum_{m=1}^{M} N_m}\right)$$

The relationship between the number of preset topics reported by ESG and the model confusion score is shown in Figures 5-1 and 5-2. Although the confusion score continues to decline as the number of topics increases, a larger number of topics may also introduce topics that do not make economic sense. Therefore, although the model with less confusion should be chosen, the related problems caused by the increase in the number of topics should be considered at the same time. To sum up, on the basis of using the confusion score evaluation model, the number of topics is further adjusted according to the explanatory ability of the topics. It can be seen from Figure 1 that for the LDA topic model of inquiry letter, after the number of topics K > 15, the rate of decline of confusion tends to be gradual with the further increase of the number of topics, and the marginal utility brought by further increasing the number of topics is not large. In this paper, the optimal number of topics in the review inquiry letter is fixed in the range of 15 or so. Further, according to the explainability of the output topic distribution of the LDA model under the preset number of topics, the number of topics is adjusted. Finally, the preset number of topics is K=15, and the corresponding model is trained as the LDA topic model of the inquiry letter.

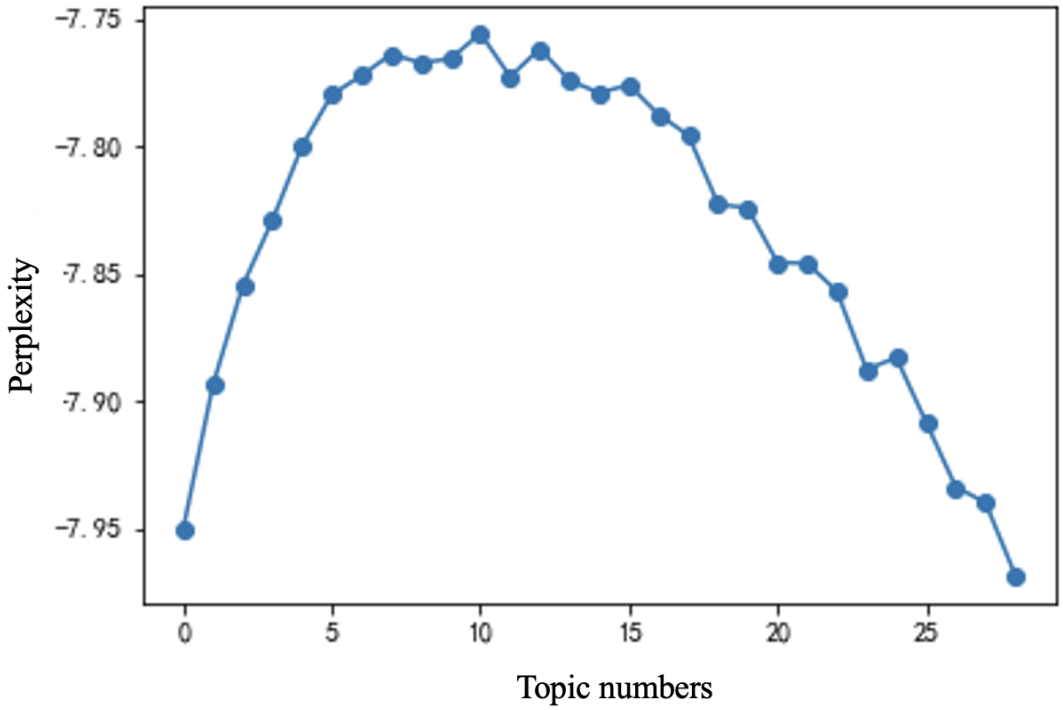

Figure 5-1 The relationship between topic numbers and perplexity

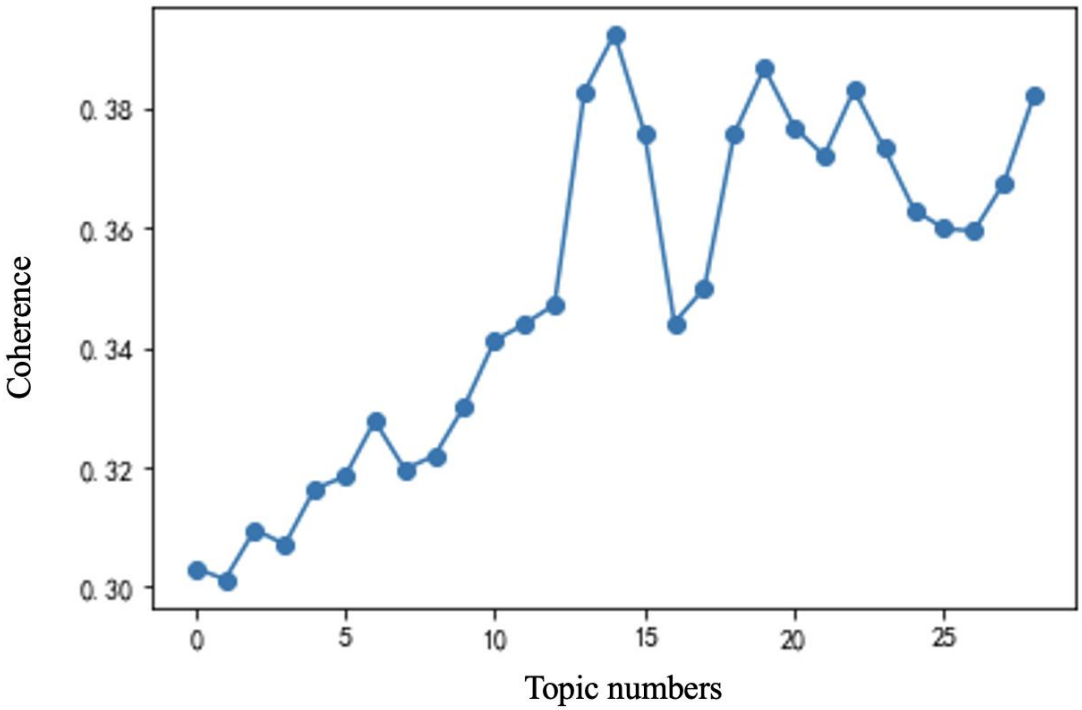

Figure 5-2 The relationship between topic numbers and coherence

The descriptive statistics of the report topics are shown in Table 5-2. The LDA topic model divides the report corpus into 15 topics to be summarized according to the preset optimal topic number. To measure the textual comprehensiveness of the content in ESG reports, I estimated the probabilities of each report belonging to the 15 ESG topics, which have been defined by the LDA analysis. Then I calculated the standard deviation of all the 15 topic probability values. A larger standard deviation means more concentrated ESG reporting content while a smaller standard deviation value means more balanced coverage of different ESG topics. For the convenience of data interpretation, I use the opposite value of the topic probability standard deviation to measure the textual comprehensiveness of each ESG report, making the indicator positively associated with corporate ESG performance.

Table 5-2 Key words of each ESG topic obtained from LDA analysis.

Topics	**Key words**
Topic 1	Employees（员工), projects（项目), green（绿色), management systems(管理体系), Participation(参与), indicators(指标), plans(计划), Needs(需求), Public benefits(公益), Directors(董事)
Topic 2	Capacity(能力), control(控制), major(重大), development(开发), emission reduction(减排), materials(材料), subject(主题),organization(举办), ship(船舶), Supervisory Board(监事会)
Topic 3	Communication(沟通),finance(金融), including(包括), important(重要), enhanced(强化), level(水平), environmental protection(环境保护), planning(规划), medical(医疗), advanced(先进)
Topic 4	Promotion(提升),Technology(技术), Year(年度), Information(信息), data(数据), implementation(落实), Process(流程), Core(核心), Ecology(生态),Special(专项)
Topic 5	Product(产品), relevance(相关), organization(组织), system(体系), investor(投资者), intelligence(智能), critical(关键), audit(审计), logistics(物流), happen(发生)

Topic 6	Committee(委员会), use(利用), safety(平安), concern(关注), team(团队), audit(审核), excellence(优秀), care(关爱), disposition(处置), demonstration(示范)
Topic 7	Liability(责任), Supplier(供应商), international(国际), standards(标准), disclosure（披露), system(制度), protection(保护),philosophy(理念),people(人员),case(案例)
Topic 8	Limited company(有限公司), innovation(创新), interest(利益), organization(机构), staff(职工), learning(学习), laws and regulations(法律法规),post(岗位), participation(参加), contribution(贡献)
Topic 9	Offer(提供), Quality(质量), Strategy(战略), Global(全球), Technology(科技), Issues(问题), Transformation(转型), World(世界), Business(商业), Chairman(董事长)
Topic 10	Security(保障), shares(股份), situation(情况), raise(提高), Board(董事会), input(投入), poverty alleviation(扶贫), identification(识别),approach(办法),growth(增长)
Topic 11	Health(健康), profession(专业), Content(内容), Department(部门), Manufacturing(制造). practice(实践), network(网络), transformation(改造), operations(作业), results(成果)
Topic 12	Market(市场),culture(文化), fulfillment(履行), holding(控股), establishment(设立), cultivation(培养),link(环节), role(作用), emissions(排放量), hand in hand(携手)
Topic 13	Reporting(报告),Society(社会), Governance(治理), platforms(平台), systems(系统), resources(资源), engineering(工程), degradation(降低), publishing(发布), evaluation(评价)
Topic 14	Establishment(建立), formulation(制定), energy conservation(节能), value(价值), procurement(采购), reduction(减少), relationship(关系), coverage(覆盖), government(政府), facilities(设施)

Topic 15	Environment(环境), economy(经济), mechanism(机制), architecture(建筑), principles(原则), construction(构建), equity(权益), efficiency(效率),organization(编制), adoption(采取)

Chapter 6 Empirical Results

6.1 Summary statistics

Table 6-1 reports the summary statistics of all variables used in the baseline regression. The average *ESG_topic* value is -0.025. The maximum value near to 0 means that the focal ESG report covers each ESG topic almost equally so that its content is regarded as the most comprehensive. The distributions of all the firm financial variables are similar to those reported by prior studies (Chen et al., 2018; Chen and Xie, 2022).

Table 6-1 Descriptive statistics.

Descriptive statistics

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max	(6) p25	(7) p50	(8) p75
ESG_topic	8,792	-0.025	0.062	-0.239	0.000	-0.003	-0.002	-0.001
Debtcost1	8,792	0.0272	0.054	0.000	0.065	0.009	0.022	0.034
Bankloan	8,792	0.0580	0.039	0.000	0.286	0.025	0.051	0.076
Tradecredit	8,792	0.1340	0.162	0.000	0.304	0.041	0.075	0.125
Size	8,792	22.00	1.363	11.35	28.64	21.06	21.82	22.73
Lev	8,792	0.489	0.153	0.070	0.877	0.268	0.433	0.596
ROA	8,792	0.058	0.096	-0.353	0.328	0.011	0.036	0.066
Growth	8,792	0.161	0.419	-0.809	4.008	-0.029	0.113	0.284
Tobinq	8,792	2.788	2.160	0.609	14.810	1.198	1.533	2.200
ListAge	8,792	8.489	4.153	2	32	6	9	12
Tangibility	8,792	0.333	0.289	0.006	0.820	0.194	0.375	0.425
Top1	8,792	0.348	0.159	0.090	0.899	0.230	0.323	0.451

Notes: All variable definitions are provided in Table 5-1.

6.2 Baseline results

I report the regression results of the research model displayed in Section 5.2 in Table 6-2. In column (1) of Table 6-2, I show the regression result when all the control variables are not included while in column (2) of Table 6-2 I display the regression result when the control variables are added into the model. In column (3) of Table 6-2, I further control the industry fixed effects and year fixed effects for consideration about the unobservable factors that vary across time and industries and are closely correlated with corporate debt financing cost, such as the macro-economic conditions and industrial policies of the government. The coefficients on *ESG_topic* are significantly negative at least at 5% level across column (1) to column (3) of Table 6-2. The result indicates that more comprehensive textual content of ESG reports is negatively associated with the interest rate of corporate debt. This evidence supports my first hypothesis in this thesis that better ESG performance can reduce corporate debt financing cost.

Table 6-2 Baseline results.

	Without controls	With controls	Fixed effects
	(1)	(2)	(3)
VARIABLES	*Debtcost1*	*Debtcost1*	*Debtcost1*
ESG_topic	-0.012***	-0.018**	-0.017***
	(-3.29)	(-2.31)	(-3.14)
Size		-0.000	-0.001**
		(-0.61)	(-2.15)
Lev		0.000*	0.000
		(1.95)	(1.00)
ROA		0.000	0.000
		(1.41)	(0.58)

Growth		-0.000	0.000
		(-0.53)	(1.38)
TobinQ		-0.000**	-0.000
		(-2.01)	(-0.69)
ListAge		-0.004	-0.000
		(-0.82)	(-0.96)
Top1		-0.000***	0.001*
		(-2.70)	(2.34)
Tangibility		-0.013**	0.002
		(-2.48)	(0.33)
SOE		0.000	0.000
		(0.71)	(0.27)
Constant	0.017***	0.024***	0.039***
	(36.54)	(6.23)	(2.95)
Year fixed effects	No	No	YES
Industry fixed effects	No	No	YES
Observations	8,792	8,792	8,792
R-squared	0.631	0.652	0.675

Notes: This table reports the baseline results on the influence of the ESG performance on the corporate debt financing cost. All continuous variables are winsorized at the 1% level. Please see Table 1 for detailed variable definition. Robust standard errors are reported in parentheses; ***, **, and * represent p<0.01, p<0.05, and p<0.1 respectively.

6.3 Heterogeneous analysis

6.3.1 The moderating effect of equity nature

In this section, I examine the moderating effect of firm's equity nature to show how the economic benefits brought by ESG inputs vary in state-owned firms and non-state-owned firms. I add the interaction item of *ESG_topic* and *SOE* into the basic regression model shown in Section 5.2. The regression results are reported in Table 6-3. Column (1) of Table 6-3 shows the regression result when all the control variables are not included while column (2) of Table 6-3 displays the regression result when the control variables are incorporated into the model. In column (3) of Table 6-3, the industry fixed effects and year fixed effects are further controlled. In column (1) and column (2) of Table 6-3, the coefficients on *ESG_topic* are significantly negative at least at the 10% level and the interaction items of *ESG_topic* and *SOE* are also significantly negative at least at the 5% level in column (2) and column (3) of Table 6-3. The result indicates that the negative relationship between more comprehensive textual content of ESG reports and the interest rate of corporate debt is stronger in state-owned firms. This evidence is consistent with my second hypothesis proposed in Section 4 which argues that better ESG performance can reduce corporate debt financing cost more for state-owned firms.

Table 6-3 The moderating effect of equity nature.

	Without controls	With controls	Fixed effects
	(1)	(2)	(3)
VARIABLES	*Debtcost1*	*Debtcost1*	*Debtcost1*
ESG_topic	-0.029**	-0.027*	-0.0207
	(-2.02)	(-1.74)	(-1.394)
*ESG_topic*SOE*	-0.015***	-0.014***	-0.0104**
	(-3.85)	(-3.39)	(-2.572)

Size		-0.000	-0.0010**
		(-0.65)	(-2.116)
Lev		0.000**	0.0002
		(1.96)	(1.033)
ROA		0.000	0.0001
		(1.43)	(0.620)
Growth		-0.000	0.0000
		(-0.59)	(1.358)
TobinQ		-0.000**	-0.0000
		(-2.02)	(-0.696)
ListAge		-0.000**	-0.000
		(-2.01)	(-0.69)
Top1		-0.000***	-0.0000
		(-2.65)	(-0.892)
Tangibility		-0.013**	0.0024
		(-2.46)	(0.361)
SOE		-0.000	-0.0001
		(-0.54)	(-0.288)
Constant	0.017***	0.036***	0.0393***
	(33.31)	(4.16)	(2.963)
Year fixed effects	No	No	Yes
Industry fixed effects	No	No	Yes
Observations	8,792	8,792	8,792
R-squared	0.602	0.605	0.607

Notes: This table reports the moderating effect of equity nature on the relationship between ESG performance and debt cost of firms. All continuous variables are winsorized at the 1% level. Please see Table 1 for detailed variable definition. Robust

standard errors are reported in parentheses; ***, **, and * represent p<0.01, p<0.05, and p<0.1 respectively.

6.3.2 The moderating effect of financial performance

In this section, I examine the moderating effect of firm's financial performance to show whether ESG inputs have different levels of importance for firms with different levels of profitability. I use ROA (*ROA*) to measure a firm's financial performance and add the interaction item of *ESG_topic* and *ROA* into the basic regression model shown in Section 5.2. The regression results are reported in Table 6-4. Column (1) of Table 6-4 shows the regression result when all the control variables are not included while column (2) of Table 6-4 displays the regression result when the control variables are incorporated into the model. In column (3) of Table 6-4, the industry fixed effects and year fixed effects are further controlled. From column (1) to column (3) of Table 6-4, the coefficients on *ESG_topic* are significantly negative at least at 10% level and the interaction items of *ESG_topic* and *SOE* are also significantly negative at least at 5% level. The result indicates that the negative relationship between more comprehensive textual content of ESG reports and the interest rate of corporate debt is stronger for firms delivering good financial performance. This evidence is consistent with the notion that debt holders prioritize firm's profitability over its responsibility. Good ESG performance shows only a limited effect on reducing corporate debt cost when firm's financial performance is poor while imposes a more prominent effect on reducing corporate debt cost when the firm can make a lot of money. This supports my third hypothesis proposed in Section 4. The role of good ESG performance in cutting corporate debt cost premises on firm's high profitability. Compared with good ESG performance, debtholders value good financial performance more thus ESG input by unprofitable firms bring them less economic benefits.

Table 6-4 The moderating effect of financial performance.

	Without controls	With controls	Fixed effects
	(1)	(2)	(3)
VARIABLES	*Debtcost1*	*Debtcost1*	*Debtcost1*
ESG_topic	-0.017**	-0.019**	-0.0137*
	(-2.27)	(-2.48)	(-1.833)
*ESG_topic*ROA*	-0.001**	-0.090***	-0.1011***
	(2.17)	(4.71)	(5.351)
Size		-0.000	-0.0011**
		(-0.70)	(-2.195)
Lev		0.001***	0.0009***
		(4.05)	(3.666)
ROA		0.005***	0.0055***
		(4.81)	(5.381)
Growth		-0.000	0.0000
		(-0.54)	(1.374)
TobinQ		0.000	0.0000**
		(1.05)	(2.486)
ListAge		-0.000*	-0.0000
		(-1.65)	(-0.600)
Top1		-0.000***	-0.0000
		(-2.69)	(-0.984)
Tangibility		-0.014***	0.0010
		(-2.70)	(0.154)
SOE		0.000	0.0001
		(0.68)	(0.143)
Constant	0.017***	0.037***	0.0404***
	(33.64)	(4.25)	(3.051)

Year fixed effects	No	No	Yes
Industry fixed effects	No	No	Yes
Observations	8,792	8,792	8,792
R-squared	0.641	0.636	0.642

Notes: This table reports the moderating effect of financial performance on the relationship between ESG performance and debt cost of firms. All continuous variables are winsorized at the 1% level. Please see Table 1 for detailed variable definition. Robust standard errors are reported in parentheses; ***, **, and * represent $p<0.01$, $p<0.05$, and $p<0.1$ respectively.

6.3.3 The moderating effect of tangibility

In this section, I examine the moderating effect of firm's tangibility to show how debtholders put different weights to ESG inputs of firms having different levels of asset risk when making their borrowing decisions. I use the ratio of tangible assets (*Tangibility*) to measure the value uncertainty of a firm's asset and add the interaction item of *ESG_topic* and *Tangibility* into the basic regression model shown in Section 5.2. The regression results are reported in Table 6-5. Column (1) of Table 6-5 shows the regression result when all the control variables are not included while column (2) of Table 6-5 displays the regression result when the control variables are incorporated into the model. In column (3) of Table 6-5, the industry fixed effects and year fixed effects are further controlled. From column (1) to column (3) of Table 6-5, the coefficients on *ESG_topic* are significantly negative at least at 5% level while the interaction items of *ESG_topic* and *Tangibility* are significantly positive at least at 5% level. The result indicates that the negative relationship between more comprehensive textual content of ESG reports and the interest rate of corporate debt is stronger for firms possessing more intangible assets. This evidence lends support to the complementary role of ESG risk for firm's asset risk. For firms able to provide enough collaterals of real assets, debtholders show less sensitivity to their ESG risk. For firms

with more intangible assets which lack active market and are hard to price, debtholders pay more attention to their ESG related risk. This is consistent with the notion that debt holders prioritize firm's tangibility over its responsibility. Good ESG performance is more important for firms with plenty of intangible assets. This supports my fourth hypothesis proposed in Section 4. The role of good ESG performance in cutting corporate debt cost is more significant for firms of lower tangibility.

Table 6-5 The moderating effect of tangibility.

	Without controls	With controls	Fixed effects
	(1)	(2)	(3)
VARIABLES	*Debtcost1*	*Debtcost1*	*Debtcost1*
ESG_topic	-0.009***	-0.071**	-0.0721***
	(-4.09)	(-2.12)	(-2.85)
*ESG_topic*Tangibility*	0.009***	0.095***	0.0906**
	(3.24)	(2.71)	(2.46)
Size		-0.000	-0.0010**
		(-0.60)	(-2.168)
Lev		0.000*	0.0002
		(1.96)	(0.997)
ROA		0.000	0.0001
		(1.41)	(0.578)
Growth		-0.000	0.0000
		(-0.53)	(1.376)
TobinQ		-0.000**	-0.0000
		(-2.00)	(-0.687)
ListAge		-0.000***	-0.0000
		(-2.69)	(-0.984)

Top1		-0.000***	-0.0000
		(-2.70)	(-0.945)
Tangibility		-0.016***	-0.0004
		(-2.78)	(-0.054)
SOE		0.000	0.0001
		(0.71)	(0.291)
Constant	0.017***	0.038***	0.0417***
	(33.64)	(4.28)	(3.104)
Year fixed effects	No	No	Yes
Industry fixed effects	No	No	Yes
Observations	8,792	8,792	8,792
R-squared	0.641	0.645	0.642

Notes: This table reports the moderating effect of tangibility on the relationship between ESG performance and debt cost of firms. All continuous variables are winsorized at the 1% level. Please see Table 1 for detailed variable definition. Robust standard errors are reported in parentheses; ***, **, and * represent $p<0.01$, $p<0.05$, and $p<0.1$ respectively.

6.3.4 The moderating effect of growth opportunity

In this section, I examine the moderating effect of firm's growth opportunity to show how debtholders tradeoff between ESG risk and firm's growing prospect when making their borrowing decisions. I use the percentage change of sales from year t to t-1 (*Growth*) to measure a firm's growing opportunities and add the interaction item of *ESG_topic* and *Growth* into the basic regression model shown in Section 5.2. The regression results are reported in Table 6-6. Column (1) of Table 6-6 shows the regression result when all the control variables are not included while column (2) of Table 6-6 displays the regression result when the control variables are incorporated into

the model. In column (3) of Table 6-6, the industry fixed effects and year fixed effects are further controlled. From column (1) to column (3) of Table 6-6, the coefficients on *ESG_topic* are significantly negative at least at 10% level while the interaction items of *ESG_topic* and *Tangibility* are significantly positive at least at the 10% level. The result indicates that the negative relationship between more comprehensive textual content of ESG reports and the interest rate of corporate debt is weaker for firms showing greater growth potential. This evidence lends support to the substitutive role of corporate ESG efforts for firm's growing prospect in reducing corporate debt financing cost. For firms showing great growth potential, debtholders show less sensitivity to their ESG risk. For firms with usual growing trend, debtholders rely more on their ESG effort to make their borrowing decisions. This is consistent with the notion that debt holders prioritize firm's growing potential over its responsibility. Good ESG performance is more important for firms with moderate growing speed. This supports my fifth hypothesis proposed in Section 4. The role of good ESG performance in cutting corporate debt cost is more significant for firms of lower growth rate.

Table 6-6 The moderating effect of growth opportunity.

	Without controls	With controls	Fixed effects
	(1)	(2)	(3)
VARIABLES	*Debtcost1*	*Debtcost1*	*Debtcost1*
ESG_topic	-0.017**	-0.018**	-0.0125*
	(-2.27)	(-2.32)	(-1.666)
*ESG_topic*Growth*	0.001***	0.002**	0.003*
	(2.86)	(2.40)	(1.763)
Size		-0.000	-0.0010**
		(-0.62)	(-2.165)
Lev		0.000*	0.0002
		(1.95)	(1.000)

ROA		0.000	0.0001
		(1.41)	(0.581)
Growth		-0.000	0.0000
		(-0.41)	(1.529)
TobinQ		-0.000**	-0.0000
		(-2.01)	(-0.690)
ListAge		-0.016***	-0.0004
		(-2.78)	(-0.054)
Top1		-0.000***	-0.0000
		(-2.69)	(-0.941)
Tangibility		-0.013**	0.0022
		(-2.48)	(0.329)
SOE		0.000	0.0001
		(0.71)	(0.278)
Constant	0.017***	0.036***	0.0393***
	(33.66)	(4.10)	(2.959)
Year fixed effects	No	No	Yes
Industry fixed effects	No	No	Yes
Observations	8,792	8,792	8,792
R-squared	0.412	0.416	0.425

Notes: This table reports the moderating effect of growth opportunity on the relationship between ESG performance and debt cost of firms. All continuous variables are winsorized at the 1% level. Please see Table 1 for detailed variable definition. Robust standard errors are reported in parentheses; ***, **, and * represent $p<0.01$, $p<0.05$, and $p<0.1$ respectively.

6.4 Robustness tests

6.4.1 Reverse causality

It is reasonable to expect that firms which can obtain debt capital at lower cost have lower capital cost, which can increase their profitability. Consequently, these firms have deep pockets to afford expensive ESG investment. Based on this logic, my findings in this thesis are plagued by reverse causality problem. To mitigate such endogeneity concern, I alter the time window of the dependent variable in the baseline regression. I first regress the cost of debt in year t-1 on the *ESG_topic* in year t with all the other control variables included. The regression result is reported in column (1) of Table 6-7. The coefficient on *ESG_topic* is insignificant, suggesting that no statistically significant association exits between one year lagged debt cost and concurrent ESG performance. This evidence does not support that it is lower debt cost that enables firms to conduct more ESG activities. Then I change the dependent variable with the debt cost in year t+1. The regression result is reported in column (2) of Table 6-7. The coefficient on *ESG_topic* is significantly negative, suggesting the effect of better ESG performance in the current period on reducing corporate debt cost in one period ahead. This evidence indicates that good ESG performance still has some lagging effect on reducing corporate cost in the next period. The regression results in Table 6-7 combine to rule out the likelihood of reverse causality and lend further support to my argument that good ESG performance decreases corporate debt financing cost.

Table 6-7 Robustness test: ruling out reverse causality.

	(1)	(2)
VARIABLES	$Debtcost1_{t-1}$	$Debtcost1_{t+1}$
ESG_topic	-0.802	-0.870***
	(-1.37)	(-13.89)
Size	-0.002	0.000

	(-0.37)	(0.08)
Lev	-0.001	0.001
	(-0.49)	(0.52)
ROA	-0.000	0.000
	(-0.61)	(0.64)
Growth	0.000***	-0.000***
	(5.96)	(-3.07)
TobinQ	0.000**	-0.000**
	(2.22)	(-2.19)
ListAge	-0.016***	-0.0004
	(-2.78)	(-0.054)
Top1	0.000	-0.000
	(0.58)	(-0.64)
Tangibility	-0.090	0.069
	(-1.30)	(1.13)
SOE	-0.003	0.001
	(-0.51)	(0.13)
Constant	0.767***	0.244*
	(5.27)	(1.90)
Year fixed effects	Yes	Yes
Industry fixed effects	Yes	Yes
Observations	8,792	8,792
R-squared	0.613	0.638

Notes: This table reports the results on the influence of ESG performance on corporate debt cost when *Debtcost1* is lagged or preceded by one year. All continuous variables are winsorized at the 1% level. Please see Table 1 for detailed variable

definition. Robust standard errors are reported in parentheses; ***, **, and * represent p<0.01, p<0.05, and p<0.1 respectively.

6.4.2 Omitted variables

My study is also plagued by the endogeneity issue of omitted variables challenging most of prior literature on the economic benefits brought by ESG inputs of firms. For instance, high quality firms with fabulous profitability and low operational risk are favored by borrowers, and they also have more stakeholder-oriented corporate culture, leading to their more ESG input. The omission of the idiosyncratic feature of firms could result in spurious correlation between ESG performance and debt cost. I have controlled many firm characteristics like firm size, financial performance, financial risk, and so on in my research model to incorporate firm-specific characteristics as more as possible. To further control unobservable firm-level factors invariant to time, such as corporate culture and organizational leadership style, I include firm-fixed effects in the regression and the result is displayed in column (1) of Table 6-8. With firm-fixed effects controlled, the significance and the magnitude of the coefficient on *ESG_topic* remain similar with that reported in the baseline regression. This suggests that my findings are not likely to be driven by severe omitted variables at firm level.

Table 6-8 Robustness test: controlling for firm fixed effects and alternative debt financing cost measurement.

	(1)	(2)
VARIABLES	*Debtcost1*	*Debtcost2*
ESG_topic	-0.702***	-0.630***
	(-2.71)	(-4.67)
Size	-0.002	0.000
	(-0.52)	(0.15)
Lev	-0.000	0.000

	(-0.03)	(0.26)
ROA	-0.000	0.000
	(-0.27)	(0.44)
Growth	0.000***	-0.000***
	(6.95)	(-5.74)
TobinQ	0.000**	-0.000**
	(2.24)	(-2.19)
ListAge	-0.000	0.000
	(-0.61)	(0.64)
Top1	0.000	-0.000
	(0.77)	(-0.38)
Tangibility	-0.054	0.037
	(-1.01)	(0.83)
SOE	-0.003	0.004
	(-1.31)	(1.50)
Constant	0.738***	0.253***
	(8.02)	(3.20)
Year fixed effects	Yes	Yes
Firm fixed effects	Yes	No
Industry fixed effects	No	Yes
Observations	8,792	8,792
R-squared	0.656	0.661

Notes: This table reports the results on the influence of the ESG performance on the corporate debt financing cost with firm fixed effect controlled or for alternative debt financing cost measurement. All continuous variables are winsorized at the 1% level. Please see Table 1 for detailed variable definition. Robust standard errors are reported in parentheses; ***, **, and * represent $p<0.01$, $p<0.05$, and $p<0.1$ respectively.

6.4.3 Measurement errors

I also make some efforts to control the contamination of measurement errors of key variables. First, I replace the dependent variable which measures debt cost as the financial expenses scaled by average total debt with another one which measures debt cost as interest expenses scaled by average total debt. The regression results after replacement, as reported in column (2) of Table 6-8, remain similar with those from baseline regression. Second, to show that the textual analysis and data calculation process in my research can capture corporate ESG performance accurately and stably, I reset the topic number in LDA analysis process to a smaller value of 12 and a larger value of 18 separately. The results are reported in column (1) and column (2) of Table 12. The coefficients on *ESG_topic* in column (1) and column (2) of Table 6-9 are both negative and significant at 1% level, consistent with my argument in this thesis that good ESG performance decreases corporate debt cost. These supplementary tests strengthen the robustness of the evidence found in the baseline regression.

Table 6-9 Robustness test: alternative topic numbers in LDA analysis.

	(1)	(2)
VARIABLES	*Debtcost1*	*Debtcost1*
ESG_topic_r	-0.539***	-0.730***
	(-4.34)	(-4.67)
Size	0.002	0.000
	(0.95)	(0.15)
Lev	-0.000	0.000
	(-0.40)	(0.26)
ROA	-0.000	0.000
	(-0.35)	(0.44)
Growth	-0.000	-0.000***

	(-1.45)	(-5.74)
TobinQ	0.000	-0.000**
	(0.18)	(-2.19)
ListAge	0.000***	-0.000***
	(6.95)	(-5.74)
Top1	0.000	-0.000
	(0.02)	(-0.38)
Tangibility	0.019	0.037
	(0.78)	(0.83)
SOE	0.002	0.004
	(1.15)	(1.50)
Constant	-0.030	0.253***
	(-0.62)	(3.20)
Year fixed effects	Yes	Yes
Industry fixed effects	Yes	Yes
Observations	8,792	8,792
R-squared	0.680	0.684

Notes: This table reports the robustness test of alternative topic numbers in LDA analysis. All continuous variables are winsorized at the 1% level. Please see Table 1 for detailed variable definition. Robust standard errors are reported in parentheses; ***, **, and * represent $p<0.01$, $p<0.05$, and $p<0.1$ respectively.

Chapter 7 Further analysis

7.1 ESG report comprehensiveness and the cost of different types of debt

In this section, I further examine how corporate ESG report comprehensiveness influences different types of debt cost of firms. I disaggregate the total debt of firm into bank loans and trade credit. These two types of debt account for a salient portion of total asset for most of firms and serve as important sources of debt capital of firm. I first examine whether corporate ESG report comprehensiveness reduces the bank loan cost. The dependent variable of the baseline regression is substituted with the interest expenses divided by the sum of short loans and long-term loans. The results are reported in the column (1) of Table 7-1. The coefficient on *ESG_topic* is negatively significant at 1% level, confirming the effect of good ESG performance on lowering the interest rate of bank loans. Since firms usually don't need to pay interest for trade credit offered by suppliers, I examine how the size of trade credit varies with corporate ESG report comprehensiveness to see whether better ESG performance strengthens the financing ability of firms through increasing the willingness of suppliers to offer trade credit. In column (2) of Table 7-1, the dependent variable is replaced with trade credit scaled by total assets. As reported in the column (2) of Table 7-1, the coefficient on *ESG_topic* is positively significant at 1% level, suggesting good ESG performers have larger size of trade credit. Collectively, the results in Table 7-1 show that good ESG performance reduces corporate debt financing cost not only through lowering interest rate required by banks but also through increasing the willingness of suppliers to offer more trade credit.

Table 7-1 Further analysis: ESG report comprehensiveness and different types of debt cost.

	Bank loan	Trade credit
	(1)	(2)

VARIABLES	*Bankloan*	*Tradecredit*
ESG_topic	-0.086***	0.130***
	(-3.04)	(4.79)
Size	0.263	-0.019
	(0.61)	(-0.58)
Lev	0.002	0.004
	(1.15)	(1.50)
ROA	-0.052***	0.052***
	(-3.71)	(131.10)
Growth	-0.000	-0.000
	(-0.06)	(-0.11)
TobinQ	-0.083***	-0.001***
	(-4.84)	(-68.15)
ListAge	-0.000	0.000
	(-0.03)	(0.26)
Top1	-0.002	-0.001***
	(-0.73)	(-3.66)
Tangibility	-1.307***	0.101***
	(-2.94)	(3.39)
SOE	0.005	-0.006***
	(0.18)	(-2.85)
Constant	3.337***	-0.237***
	(4.08)	(-3.97)
Year fixed effects	Yes	Yes
Industry fixed effects	Yes	Yes
Observations	8,792	8,792
R-squared	0.712	0.714

Notes: This table reports how ESG performance influences different types of corporate debt cost. All continuous variables are winsorized at the 1% level. Please see Table 1 for detailed variable definition. Robust standard errors are reported in parentheses; ***, **, and * represent p<0.01, p<0.05, and p<0.1 respectively.

7.2 The differentiated effects of E, S, and G pillars

In this section, I dig deeper to reveal the differentiated effects of different ESG pillars on corporate debt financing cost. The evidence reported in Table 7-2 suggests that governance related ESG activities have the greatest effect on reducing corporate debt financing cost, followed by environmental ESG activities, and the ESG activities belonging to social pillar show the least influence. The results suggest that debtholders care the most about corporate governance issues which largely determine corporate operating risk directly. By contrast, the influence of environmental and social ESG risk tend to be indirect and weak. I also attempt to show whether banks and suppliers are differentiated in sensitivity to risk related with different ESG pillars. The results reported in Table 7-3, Table 7-4 and Table 7-5 show that both banks and suppliers are sensitive to ESG risk on corporate governance. The banks require lower loan interest for firms performing better in environmental pillar but are not sensitive to ESG performance in social pillar. Suppliers offer more trade credit for firms delivering a good social performance while behave neutrally in terms of corporate environmental performance.

Table 7-2 Further analysis: the effect of different ESG components on corporate debt financing cost.

	(1)	(2)	(3)	(4)
VARIABLES	*Debtcost1*	*Debtcost1*	*Debtcost1*	*Debtcost1*

E_topic	-0.016***			-0.022***
	(-2.78)			(-2.72)
S_topic		-0.029***		-0.018**
		(-2.92)		(-2.57)
G_topic			-0.034***	-0.048***
			(-3.65)	(-2.73)
Size	-0.001**	-0.001**	-0.0011**	-0.00102**
	(-2.15)	(-2.14)	(-2.194)	(-2.1411)
Lev	0.000	0.000	0.0002	0.00021
	(0.98)	(0.99)	(1.002)	(0.9968)
ROA	0.000	0.000	0.0001	0.00005
	(0.56)	(0.57)	(0.579)	(0.5721)
Growth	0.000	0.000	0.0000	0.00000
	(1.40)	(1.39)	(1.407)	(1.3794)
TobinQ	-0.000	-0.000	-0.0000	-0.00000
	(-0.67)	(-0.69)	(-0.690)	(-0.6813)
ListAge	0.017***	0.036***	0.0393***	0.083***
	(33.31)	(4.16)	(2.963)	(4.84)
Top1	-0.000	-0.000	-0.0000	-0.00005
	(-0.95)	(-0.96)	(-0.960)	(-0.9370)
Tangibility	0.002	0.002	0.0019	0.00201
	(0.29)	(0.31)	(0.284)	(0.3040)
SOE	0.000	0.000	0.0001	0.00013
	(0.26)	(0.27)	(0.214)	(0.2841)
Constant	0.040***	0.040***	0.0397***	0.26679***
	(3.04)	(2.98)	(2.994)	(3.1667)
Year fixed effects	Yes	Yes	Yes	Yes

Industry fixed effects	Yes	Yes	Yes	Yes
Observations	8,792	8,792	8,792	8,792
R-squared	0.604	0.601	0.610	0.615

Notes: This table reports the effect of different ESG components on corporate debt financing cost. All continuous variables are winsorized at the 1% level. Please see Table 1 for detailed variable definition. Robust standard errors are reported in parentheses; ***, **, and * represent p<0.01, p<0.05, and p<0.1 respectively.

Table 7-3 Further analysis: the effect of E pillar on different types of corporate debt cost.

	Bank loan	Trade credit
	(1)	(2)
VARIABLES	*Bankloan*	*Tradecredit*
E_topic	-0.001***	-0.002
	(-3.66)	(-0.72)
Size	-0.086***	0.010***
	(-3.05)	(4.44)
Lev	0.035	0.130***
	(1.55)	(134.80)
ROA	-0.052***	0.052***
	(-3.71)	(131.10)
Growth	-0.000	-0.000
	(-0.06)	(-0.11)
TobinQ	-0.083***	-0.001***
	(-4.84)	(-68.16)
ListAge	-0.052	0.003

	(-0.93)	(0.61)
Top1	0.0019	0.00201
	(0.284)	(0.3040)
Tangibility	-1.317***	0.101***
	(-2.96)	(3.39)
SOE	0.005	-0.006***
	(0.17)	(-2.85)
Constant	3.378***	-0.239***
	(4.12)	(-3.99)
Year fixed effects	Yes	Yes
Industry fixed effects	Yes	Yes
Observations	8,792	8,792
R-squared	0.691	0.693

Notes: This table reports the effect of E pillar on different types of corporate debt cost. All continuous variables are winsorized at the 1% level. Please see Table 1 for detailed variable definition. Robust standard errors are reported in parentheses; ***, **, and * represent p<0.01, p<0.05, and p<0.1 respectively.

Table 7-4 Further analysis: the effect of S pillar on different types of corporate debt cost.

	Bank loan	Trade credit
	(1)	(2)
VARIABLES	*Bankloan*	*Tradecredit*
S_topic	-0.035	0.130***
	(-1.55)	(4.80)
Size	-0.086***	0.010***

	(-3.05)	(4.44)
Lev	0.063	-0.005
	(1.01)	(-0.95)
ROA	-0.052***	0.052***
	(-3.72)	(131.11)
Growth	-0.000	-0.000
	(-0.06)	(-0.12)
TobinQ	-0.083***	-0.001***
	(-4.84)	(-68.16)
ListAge	0.000	0.0002
	(0.99)	(1.002)
Top1	-0.002	-0.001***
	(-0.72)	(-3.67)
Tangibility	-1.317***	0.101***
	(-2.96)	(3.40)
SOE	0.005	-0.006***
	(0.17)	(-2.85)
Constant	3.325***	-0.236***
	(4.06)	(-3.95)
Year fixed effects	Yes	Yes
Industry fixed effects	Yes	Yes
Observations	8,792	8,792
R-squared	0.691	0.693

Notes: This table reports the effect of S pillar on different types of corporate debt cost. All continuous variables are winsorized at the 1% level. Please see Table 1 for detailed variable definition. Robust standard errors are reported in parentheses; ***, **, and * represent $p<0.01$, $p<0.05$, and $p<0.1$ respectively.

Table 7-5 Further analysis: the effect of G pillar on different types of corporate debt cost.

	Bank loan	Trade credit
	(1)	(2)
VARIABLES	*Bankloan*	*Tradecredit*
G_topic	-0.086***	0.010***
	(-3.04)	(4.43)
Size	0.002	0.002
	(0.29)	(0.31)
Lev	0.036	0.130***
	(1.57)	(134.80)
ROA	-0.052***	0.052***
	(-3.70)	(131.10)
Growth	-0.000	-0.000
	(-0.07)	(-0.11)
TobinQ	-0.083***	-0.001***
	(-4.84)	(-68.16)
ListAge	-0.010	0.011
	(-0.06)	(0.85)
Top1	-0.002	-0.001***
	(-0.73)	(-3.66)
Tangibility	-1.301***	0.101***
	(-2.93)	(3.38)
SOE	0.005	-0.006***
	(0.18)	(-2.86)
Constant	3.323***	-0.236***
	(4.06)	(-3.96)

Year fixed effects	Yes	Yes
Industry fixed effects	Yes	Yes
Observations	8,792	8,792
R-squared	0.605	0.609

Notes: This table reports the effect of G pillar on different types of corporate debt cost. All continuous variables are winsorized at the 1% level. Please see Table 1 for detailed variable definition. Robust standard errors are reported in parentheses; ***, **, and * represent $p<0.01$, $p<0.05$, and $p<0.1$ respectively.

Chapter 8 Conclusion and discussions

8.1 Summary of results

My thesis contributes new evidence on the economic incentives of firms to conduct ESG investment. In a nutshell, my thesis draws the following conclusions based on the empirical analysis over a sample of Chinese listed A-share firms with available ESG report. First, more comprehensive ESG report reduces corporate debt financing cost, which is manifest in that an increase by one standard deviation in ESG report comprehensiveness can decrease corporate debt financing cost by 3.88%. Second, I explore the moderating effect of several firm level characteristics on the negative relationship between ESG report comprehensiveness and corporate debt financing cost. I find that the effect of ESG input on reducing corporate debt cost is stronger for state-owned firms. Good financial performance of firms can strengthen the effect of ESG report comprehensiveness on reducing corporate debt financing cost. In other words, compared with firms with poor financial performance, the market cares more about the ESG performance of those profitable firms. Compared with firms processing more tangible assets, ESG report comprehensiveness plays a more valuable role in reducing debt cost for firms with more intangible assets. The assets of more intangible firms are of higher uncertainty and thus they provide less compensation for the loss of creditors in case of debt default of firms. Higher growth opportunities can substitute lower ESG report comprehensiveness of firms. In other words, the market seems to show higher tolerance for the ESG performance of firms having promising prospect. The negative relationship between ESG report comprehensiveness and debt financing cost is greatly attenuated for firms with higher growth rate. Third, ESG report comprehensiveness reduces corporate debt financing cost both through decreasing the interest rate of bank loans and enlarging the size of trade credit provided by suppliers. Fourth, different types of ESG input have differentiated effects on reducing corporate debt cost. The G (Governance) pillar of ESG has the most prominent effect on corporate debt financing cost, followed by the effect of the E (environmental) pillar, while the S (social) pillar

has the least influence on reducing corporate debt financing cost. Last, different types of debt holders share common ESG concerns but also differ in the sensitivity to some risk related with different ESG pillars. Both banks and suppliers care about corporate governance related ESG risk. At the same time, banks pay more attention to corporate environmental performance while suppliers focus more on firm's performance related with social issues.

8.2 Implications

My findings of this thesis have valuable implications for investors, firm managers, and regulators. First, investors should pay more attention to corporate ESG performance. The negative relationship between good ESG performance and corporate debt financing cost indicates that debt holders take the ESG risk into serious consideration while making borrowing decisions. As a major component of comprehensive capital cost, the debt financing cost significantly influences corporate investment decisions and thereby affecting firm's profitability and financial performance. Second, enterprises should actively implement the concept of ESG development and improve ESG performance. This study shows that good ESG performance can effectively improve corporate reputation and help enterprises to obtain more partners, thereby alleviating financing constraints. Therefore, enterprises should strengthen environmental protection, social responsibility and corporate governance. At the same time, in order to make ESG investment more rewarding, enterprises should further improve the disclosure of ESG information, so that their customers and suppliers can more accurately, timely and comprehensively understand the good ESG performance of enterprises and ease the information asymmetry between enterprises and customers and suppliers. Managers should make ESG input decisions depending on the financial and operational conditions of firms. Good ESG performance exerts different effects on reducing debt financing cost for firms with different characteristics. Some firms benefit a lot from more ESG input while others may only obtain marginal cost reduction in debt financing activities. Therefore, managers should have a sufficient consideration and trade off the benefits

and costs of ESG input on the whole before making ESG investment decisions. Besides, different debt holders have different preferences over corporate ESG performance in different ESG pillars. Managers should consider the importance of different types of debt holders and cater for their divergent preferences for ESG performance strategically. Third, the differentiated effects of ESG performance on corporate debt financing cost for firms with different characteristics and differentiated sensitivity of debtholders to different types of corporate ESG risk also hold important implications for policy making by regulators. The regulatory authorities should consider the divergent ESG investment preferences of firms and divergent ESG information need from the market while regulating corporate ESG investing behaviors and corporate ESG disclosure practices. The disclosure of ESG report is in line with the principles of marketization and sustainable development, which is the basis for ensuring that the market regulation role is fully played in the development process of enterprises. It is a regulatory means to continuously urge enterprises and intermediaries to disclose information truthfully, accurately and completely. From the perspective of providing high-quality ESG reports, financial institutions can achieve: first, actively implement ESG development concepts and strictly implement green policies; The second is to implement the external incentive measures to promote the development of ESG and regulate the cost of capital; The third is to invest in research and development to innovate products that meet the needs of enterprises.

8.3 Limitations and future research

Importantly, I have to acknowledge that my study has the following shortcomings. First, although the methodology of measuring ESG performance I employed in this research can overcome many shortcomings compared with prior ESG performance measurements, it still has its own deficiencies which could threat the reliability and generalizability of my research conclusions. The LDA analysis process is conducted in a black box thus we can hardly know the underlying rationale of the topic classification. As a result, it is hard to explain what each topic captures accurately. This could make

the topic definition full of noise and thus sensitive to preset parameters in the textual analysis process. Second, as most of prior studies which measure corporate ESG performance based on information disclosed by firms themselves, my research is also plagued by the self-reporting problem. We are not sure whether firms have told the truth in their ESG report or else they just give some cheap talk or do some window dressing. If that is the case, the results in my research could only be driven by ESG disclosure rather than ESG performance. In other words, the validity of my research depends on the assumption that the ESG performance is accurately reflected by corporate ESG disclosure. Therefore, I can further explore the relationship between ESG performance and ESG disclosure and check the moderating conditions for the correlation between these two variables. Closely related with the ESG concept, green finance is also a hot topic in academic research. With reference to the framework of the current green finance development system, the high-quality disclosure of the ESG report examines the main issues in terms of the level of development, the mechanism of development, and the financing of development by demand actors and suppliers. Since the relevant research on the development level, development problems and realization path of China's green finance needs to be further in-depth, I believed that the follow-up research can be carried out from three aspects in the future: First, to further clarify the multi-level green financial system in China, sort out and summarize the investment and financing behaviors of green enterprises and the innovation and development of green financial products of financial institutions, and study the contribution of green financial market to the development of green finance and green economy. This paper has not verified other non-listed small and medium-sized green enterprises, which can be used as the direction of further research in the future. Second, the greening of state-owned finance and non-state-owned finance can be further studied by comprehensively using a variety of methods and perspectives.

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