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Article

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Abstract: While disclosing financial information has been widely proved to reduce the financing cost of a company, the impact of non-financial information, such as sustainability information, disclosing on the financing cost of the company is still in debate. The goal of this paper is to explore the impact of disclosing sustainability-related information on the cost of equity for firms. The paper first introduces the concept of sustainability information disclosure, and then exhibits its benefit through exploring its impact on reducing a firm's financing cost. It uses the Gartner supply chain top 50 rankings to construct the experiment environment to test for the effect of sustainability information disclosure on the cost of equity capital. The study uses the Gartner top 50 supply chain rankings from 2013 to 2017 to construct the experiment environment, and test for the sustainability information disclosure's impact on reducing the cost of equity capital. The regressions, which are based on the 350 firm-year sample of the United States and the 604 global firm-year sample, indicate that sustainability information disclosure significantly reduced the cost of equity capital. This paper uses a fixed effect regression method to analyze the impact of sustainability information disclosure. According to the regression result, the sustainability information disclosure variable has a significant negative coefficient. The result is robust under many settings. Thus, the paper finds that sustainability information disclosure significantly diminishes the cost of equity capital, controlling for ESG information disclosure. It also discusses the implications of the findings and future research directions for sustainability information disclosure.

Keywords: cost of equity capital; disclosure regulations; ESG disclosure; supply chain risk factor; sustainability information disclosure

1. Introduction

Responding to the social responsibility claims sued in the year 2005, Nike paid USD 1.5 million to the Fair Labor Association (FLA) to accredit its supplier factories' compliance with the sustainability goals and published the full list of supplier factories that make footwear and clothing. With the firm's supply chain issue becoming increasingly important to its sustainable development, this paper introduces the sustainability information concept, which includes a focal firm's sustainability-related information, its suppliers and customers' sustainability-related information, and its supply chain network structure information. The sustainability information introduced in the paper would more comprehensively and accurately describe a firm's sustainability value. Therefore, the paper encourages the use of the sustainability information concept in the sustainable accounting disclosure practice, so that investors can better evaluate a firm's sustainability value. The sustainability information concept includes suppliers and customers' sustainability information of a focal

firm, which investors can use to evaluate the firm's supply chain's sustainability value. The improved accuracy in the focal firm's sustainability value evaluation is likely to bring many benefits, such as reducing the investors' cost of equity capital.

The cost of equity capital measures the financing cost for a company in the equity market. A higher cost of equity capital means a higher financing cost for the company, while a low cost of equity capital would benefit the company. External capital fuels the firm operations as the primary source, and investors make investment decisions based on their perception of firm future development potential, by analyzing information released from the firm, third-party institutions, or financial analysis suggestions. Corporate disclosure is the main method by which firms communicate signals to investors when soliciting equity investment; hence, the corporate disclosure strategy literature in finance has extensively studied the effect of enhanced firm disclosure on the cost of equity. Both theoretical and empirical evidence suggested that greater firm disclosure reduces the cost of equity capital mainly through two related thrusts: reducing transaction costs for the trading equity and diminishing nondiversifiable estimation risk (Botosan 1997; Botosan and Plumlee 2002). Botosan (1997) and Botosan and Plumlee (2002) provided comprehensive empirical testing of the negative relationship between firm disclosure level and cost of equity, considering the number of financial analysts, market risk, and firm size. As a matter of great importance and interest, the cost of equity relationship with nonfinancial information, such as sustainability information disclosure, has been touched on less.

Findings on the sustainability information disclosure and cost of capital equity relationship is mixed, but the mainstream view is that voluntary disclosure lowers the return requirement from the investors through stakeholder theory and reducing communication conflict (Ng and Rezaee 2015; Dhaliwal et al. 2011; El Ghoul et al. 2011). Sustainability information disclosure improves firm performance, such as cash flow (Longoni and Cagliano 2018), but specific country investigations found an opposite result: Dahiya and Singh (2021) documented a positive relationship in the case of manufacturing firms in the Indian market where the investors value the ESG importance less. Given the fertile amount of research, several issues remained.

First, the interaction of financial and nonfinancial disclosure has been neglected, and the endogenous concern appears if financial disclosure has not been well controlled in the model, when it is actually the omitted financial disclosure variable that causes the lower capital cost in the model. In their 2015 paper, Ng and Rezaee created the economic sustainability variable to control for the financial disclosure, when investigating the relationship between ESG disclosure measured by MSCI KLD data and cost of equity. A negative ESG disclosure and cost of equity relationship was returned, and the ESG disclosure even strengthens the financial disclosure effect, when determining the cost of equity. This paper controls for the firm financial disclosure variation by using the firms from Gartner top 50 supply chain list, where equities in the list are selected and analyzed through a similar procedure and represent the similar financial disclosure tier. Also, the paper uses the variable that analyst recommendations per equity to further capture financial disclosure variation (Botosan 1997).

Second, sustainability disclosure and verification has been blurred; Dhaliwal et al. (2011) treat sustainability disclosure as a verification of a firm's environmental, social, and governance performance. However, does greater sustainability disclosure indicate better ESG performance? It is necessary to distinguish the disclosure and verification effect, as disclosure is a voluntary decision by firms and ESG performance is a gradually evolving trend and requires huge efforts to improve. There are motivations for firms to deceive investors about the ESG performance by unethical disclosure: greenwashing or transferring the burden to lower tier suppliers (i.e., supply chain leakage, pollution haven when cross-country transfer happened), which is more unrecognized by investors (Duan et al. 2021). Hence, it is less legitimate to argue that the disclosure of sustainability information is equivalent to certification of its sustainability effort, especially for the supply chain firms with complex social network structures. Compared with the MSCI KLD data, the choice of

the Bloomberg ESG disclosure index distinguishes the ESG performance and sustainability disclosure.

Collectively, a well-designed model on sustainability information disclosure and cost of equity is needed, and the designs of this study fix the issues. The goal of this study is to provide a well-designed analysis on the effect of disclosing sustainability information on the cost of equity capital for the firm. The study distinguishes the sustainability disclosure from the disclosure verification, by controlling ESG performance with the ESG_disclosure variable (see Table 1). It also controls for financial disclosure, by conducting experiments on the Gartner list and setting the major variable as the interaction of the S_disclosure_identification variable with the ESG_disclosure degree variable (see Table 1).

Table 1. Variable definition and source.

Variable Type	Definition	Source
Dependent variable		
r	Cost of equity capital for firm i in the year t measured using the models developed by Botosan and Plumlee (2002)	Botosan and Plumlee (2002)
Test variable		
ESG_disclosure	ESG disclosure index for firm i at year t − 1 from the Bloomberg platform	Minutolo et al. (2019); Gualandris et al. (2021)
Environmental_disclosure	ESG environmental disclosure index for firm i at year t − 1 from the Bloomberg platform	Minutolo et al. (2019); Gualandris et al. (2021)
Social_disclosure	ESG social disclosure index for firm i at year t − 1 from the Bloomberg platform	Minutolo et al. (2019); Gualandris et al. (2021)
Governance_disclosure	ESG governance disclosure index for firm i at year t − 1 from the Bloomberg platform	Minutolo et al. (2019); Gualandris et al. (2021)
S_disclosure_identification	The sustainability information disclosure identification is a categorical variable which equals 1, if firms are listed in the 2016 supply chain top 50 list in the year 2016 and 2017, and 0 otherwise.	By the authors
S_disclosure	The interaction term of S_disclosure_identification and ESG_disclosure variable	By the authors
Control variable		
BETA	Measurement of market risk with the three factor model under a five year window using at least 24 of the 60 monthly return.	Fama and French (1993)
CDP_performance_score	The CDP performance score for firm i at year t − 1 from the Bloomberg platform.	By the authors
TAR	Total analyst recommendation is the maximum number of analysts' recommendations on the firm at the year t − 1 collected from Bloomberg.	Botosan (1997)
LMVAL	Log of market value of equity at the t − 1 year ended in December from Bloomberg platform	Botosan (1997)
PPE	Property, plant, and equipment (PPE) for firm i at year t − 1 from Bloomberg platform	Botosan (1997)
Total_current_assets	Total current assets for firm i at year t − 1 from Bloomberg platform	Botosan (1997)
Sales	Sales for firm i at year t − 1 from Bloomberg platform	Botosan (1997)

This study contributes to the finance literature, by proposing the sustainability information concept and providing empirical evidence on its benefit in reducing firms' equity capital raising cost. In Section 2, the paper discusses the sustainability information concept. In Section 3, it develops and conducts the empirical test. In Section 4, it reports the findings and provides interpretations. In Section 5, it discusses the practical implications and research directions.
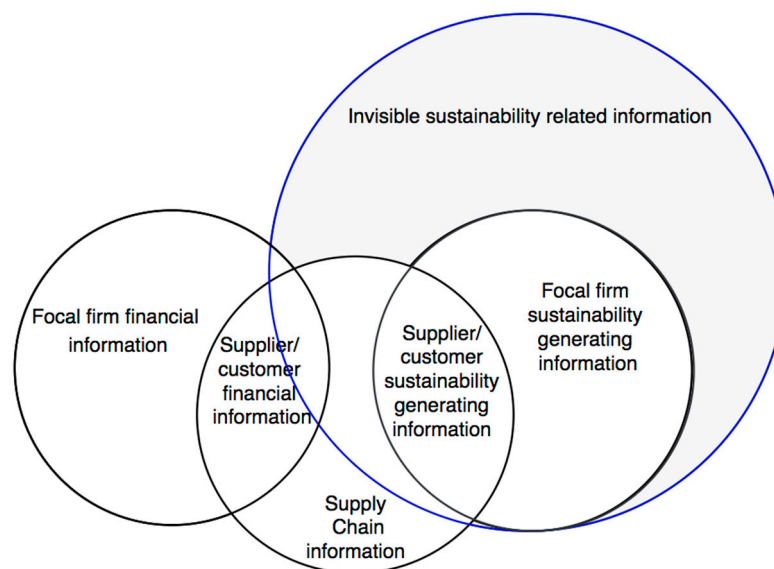
2. Sustainability Information

It is important to have a proper and accurate term to describe a firm's activities, which increase the sustainability value, because governments, firms, and investors will benefit from its use. Compared with the various investor-oriented terms, such as environmental, social, and governance (ESG), corporate social responsibility (CSR), and socially responsible investment (SRI), the sustainability information term proposed in this paper is firm-oriented, more direct, and self-explaining. A similar term is the Triple Bottom Line (TBL) standards, which are procedure-oriented. In contrast, the sustainability information term used in the paper is goal-oriented. It defines the sustainability information as any information related to the sustainability value-increasing and value-diminishing activities of a focal firm and its upstream and downstream firms. The sustainability-generating activities include both pure and mixed ones that entangle sustainability-increasing activities with economy gain. For instance, the cost-saving greenhouse gas (GHG) emission reduction practice of a supplier would be included into a focal firm's sustainability information set as mixed sustainability-generating activities. In contrast, a focal firm's usage of renewable energy would be categorized as a pure sustainability-generating activity. Compared with other terms, the sustainability information term includes more inclusive information and thus more accurately describes a firm's sustainability value.

The original concept of sustainability information comes from Elkington's 1997 definition of TBL: The overlap of planet, people, and profit is deemed the true sustainable development. After the development of the TBL concept, many other related concepts appeared. ESG means using environmental, social, and governance factors to achieve sustainability of companies (Dhaliwal et al. 2011). The ESG concept is used by firms to conduct internal and external investments to achieve sustainability-related goals. Firms also use the ESG concept to evaluate sustainability performance (Friede et al. 2015). Another related concept is CSR, which refers to practices and policies undertaken by corporations that are intended to have a positive influence on the world. The concept of CSR focuses more on the internal perspective of a company to manage sustainability goals (El Ghoul et al. 2011). However, the concepts of ESG, TBL, and CSR focus mainly on the individual firm itself and neglect the information generated along the supply chain from upper- and downstream companies. A more comprehensive concept is needed. Wang et al. (2020) point out that CSR research lacks theoretical foundation and coherence, as the term CSR is constructed both as a term to express firm behaviors and the goal of behaviors. This could lead to confusion to investors and firms. Srivastava et al. (2022) indicate that one major critique the CSR framework faces is that CSR is intrinsically ambiguous to convey its exact meaning and is not based on real concepts. As for the ESG concept, Bebchuk and Tallarita (2022) call for a more inclusive concept than ESG to include the interest of not only shareholders but also stakeholders including employees, consumers, suppliers, etc.

Compared with existing information definition paradigms, the sustainability information paradigm proposed here is more promising and fits the sustainable development goal. It includes information related to activities guided by the TBL concept for both the focal firm and its partners along its entire supply chain network structure (Elkington 1997). Compared with ESG, CSR, and TBL information, sustainability information is broader, as it covers information about the propagation of the sustainable activity from the focal firm toward lower and upstream nodes along the social network and the reverse propagation of information from the end supplier and customer toward the focal firm.

Figure 1 is a conceptual paradigm for a firm's sustainability information set. A focal firm's sustainability information set, which is indicated by the blue circle, includes the focal firm's and its suppliers and customers' sustainability-generating information, such as the focal firm's and its suppliers and customers' ESG information, the focal firm's partial supply chain information, and the focal firm's and its suppliers and customers' partial financial information. The sustainability information concept also incorporates the information visibility concept, and the gray area indicates the sustainability information that the focal

firm and its suppliers and customers generate but fail to collect at the current stage, due to the lack of awareness or technology constraints (Sodhi and Tang 2019; Marshall et al. 2016).

Figure 1. Conceptual framework of firm-level TBL-related information.

3. Empirical Analysis

In this section, we first develop a hypothesis for the sustainability information disclosure. Next, we discuss the construction method of the sample and its summary statistics. Last, we present the regression model.

3.1. Hypothesis for Sustainability Information Disclosure

Firms' sustainability information disclosure reduces the cost of equity capital by accurately revealing their sustainability value to investors (Easley and O'hara 2004; Kotsantonis et al. 2016). Sustainability information contains the suppliers and customers' related sustainability information, such as their ESG information. Investors make more accurate evaluations of firms' sustainability value by considering the sustainability value-adding and value-diminishing effects from their supply chains.

Duan et al. (2021) studied the supplier's sustainability value-adding effect and found that the inclusion of information of the supplier's sustainability compliance activities into a focal firm's product information disclosure set increases consumers' purchase intentions and the firm's evaluation in the capital market. An example of the supplier's sustainability value-diminishing effect is Apple's scandal. Foxconn, an Apple supplier, required its employees to work overtime in facilities, such as Foxconn's China and Mexico locations. In 2010, Foxconn China's suicide scandal caused Apple's sudden stock fall and took almost tens of billions out of its market cap. Thus, to raise equity capital from the capital market, disclosing both its own sustainability-related information and its suppliers' sustainability-related information, such as their treatment of employees, would be cost-saving for Apple. Investors would use the supplier's sustainability-related information to evaluate the sustainability risk, such as the scandal from its supply chain, when appraising Apple's equity value. The information about the supply-chain-related activities that increase and diminish the sustainability value would help investors to better evaluate a firm's sustainability value. As a result, investors would demand a lower required rate of return for the improved valuation accuracy.

Hypothesis 1. *The sustainability information disclosure would lower the cost of equity capital.*

3.2. Methodology and Summary Statistics

This study is based on a fixed effect model with panel data of 604 observations for 91 equities from the year 2010 to 2017. The 91 equities are collected from the Gartner list. Yearly observations for each variable of 91 equites are collected from 2010 to 2017 to construct the panel data. We choose the Gartner supply chain top 50 rankings to construct the sample, because it creates a suitable environment for the hypothesis testing. Gartner selects the top 50 leading supply chain firms each year, and it started to select leading sustainable supply chain firms in 2016. To form the list, Gartner analysts construct the pool of candidate firms from the Fortune Global 500 and Forbes Global 2000 lists and calculate the composite score for each candidate firm based on objective scores calculated from firms' business data and subjective scores calculated from the votes of the expert panel, which is composed of 150–200 executives from the supply chain community. Since 2016, Gartner has started to calculate the CSR score when forming the objective score, and the CSR score was calculated from information such as the Carbon Disclosure Project (CDP) reporting and the Dow Jones Sustainability Index (DJSI world index). Figure 2a compares the composite score composition before and after 2016. Figure 2b,c are the CSR score estimation method and source data, respectively, adapted from the Gartner CSR estimation report. The CSR subjective score is formed by the votes of the expert panel, who are knowledgeable about a focal firm's sustainability information set. The 50 firms with the highest composite scores are selected as the top 50 sustainable supply chain firms.

The major reason to use the Gartner list to measure sustainability information disclosure is because the Gartner list added CSR performance in 2016. This creates an experimental environment to observe the impact of disclosing sustainability information on the cost of equity capital since 2016. Firms in the pre-2016 Gartner top 50 list are supply chain firms with high values, whereas firms in the post-2016 Gartner list are supply chain firms with high sustainability values. For instance, Amazon was ranked 1st in the Gartner 2015 list and 3rd in the Gartner 2016 list. In contrast, Unilever was ranked 1st in the Gartner 2016 list and 3rd in the Gartner 2015 list. This indicates that Amazon was recognized as a high-value supply chain firm in 2015, compared with Unilever, but it was less valued in terms of sustainability in 2016. In fact, firms in the Gartner 2016 list disclosed sustainability information to investors. We create the S_disclosure_identificaftion variable and S_disclosure variable to measure the sustainability information disclosure event and sustainability information disclosure. The S_disclosure_identification variable is a categorical variable that equals one if the firm is in the Gartner 2016 list, because firms have been evaluated by sustainability performance since 2016. This variable equals zero for all pre-2016 observations even if the company appears in the Gartner 2016 list. It models the event of disclosure of sustainability-related information to investors. The S_disclosure variable is constructed by the interaction of the S_disclosure_identification variable with the ESG_disclosure degree variable. This S_disclosure variable measures the disclosure of sustainability information, which is also the major variable in the research. Because firms in the Gartner list have already disclosed ESG information before they disclosed sustainability information, the S_disclosure variable measures the disclosure of sustainability information, controlling for the ESG information. If the sustainability information disclosure negatively impacts the cost of equity capital, the parameter estimates for the S_disclosure_identificaftion variable and S_disclosure variable should be significantly negative. The variable definitions and construction methods are presented in Table 1.

Other benefits of the Gartner list include the following: First, firms in the Gartner list share great similarities in other determinants of the cost of equity capital, such as financial disclosure level and supply chain network complexity. Second, Gartner's selection of sustainable supply chain firms in 2016 is not a decision made by firms in the list; this avoids the self-selection bias, where good-performing firms self-selected to disclose sustainability information. Third, firms in the Gartner list are leading supply chain firms, and findings based on them have guiding implications on firms' sustainability information disclosure practice.
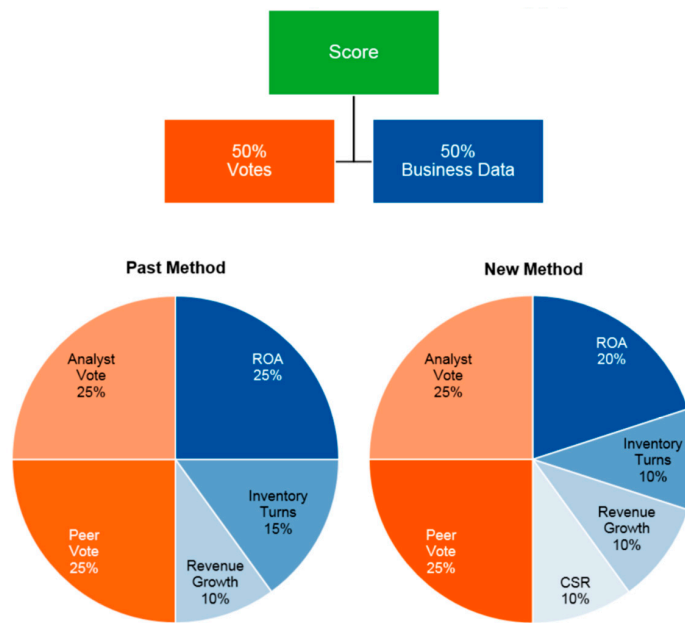
Source: Gartner (March 2016)

(**a**)

Degree	What we're looking for	Points assignment decision	Number of points awarded
Commitment Baseline	"Signatory" of UN Global Compact	Yes – is a signatory as of 1 Dec. 2015/No	**1** point if signatory
Transparency Midlevel	Reporter of CSR performance	Yes – filed report since Dec. 2014/No	**1** point for CDP reporting
		Yes – filed report since Dec. 2014/No	**2** points for reporting with either GRI or IIRC standards
Performance High-Level	High scores on CDP	Yes – achieved score > threshold/No	**1** point for achieving > threshold score on CDP reporting
	"Component" of DJSI World Index	Yes – included in 2015 index/No	**5** points for inclusion in DJSI World*
		Total Composite Score	**10** points

Source: Gartner (March 2016)

(**b**)

Degree	What we're looking for	What the data tells us	Data-source organizations
Commitment **Baseline**	"Signatory" of UN Global Compact	The company has made a public commitment to UN principles for ethical and responsible business operations.	United Nations Global Compact
Transparency **Midlevel**	Reporter of CSR performance	The company demonstrates its transparency by producing annual, publicly available CSR/ sustainability reports using widely recognized standards. The report includes data about supply chain operations and supplier networks.	Carbon Disclosure Project
			Global Reporting Initiative
			Int'l. Integrated Reporting Council
Performance **High-Level**	High achiever in specialized CSR assessment	Based on a review of the company's data, an expert party has recognized the company's exceptional performance in corporate governance, risk management, branding, climate change mitigation, supply chain standards, labor practices or other material ESG issues.	Carbon Disclosure Project
			RobecoSAM/ Dow Jones Sustainability Index (World)

(**c**)

Figure 2. (**a**) Comparison of Garter composite score calculation methods; (**b**) Gartner CSR evaluation method; (**c**) Gartner CSR source data.

Table 2 is the sample construction procedure. A total of 91 equities are collected from the Gartner supply chain top 50 ranking lists from 2013 to 2017. The panel data for 91 equities from 2010 to 2017 are collected from the Bloomberg platform. The cost of equity capital calculation data (e.g., equity price and dividends), beta estimation data (e.g., monthly stock return), ESG disclosure index, and control variables' calculation data (e.g., market capitalization and total analyst recommendation number) are collected from the Bloomberg platform. Observations with incomplete records are dropped. As a result, 343 United States firm-year observations for 47 equities and 604 cross-country firm-year observations for 79 equities were collected. We select the United States sample as the main result. For equities in the global market, we estimate r using local currency and other variables, such as beta and market value, using the US dollar.

Table 2. Summary of sample selection procedure.

	No.
Firms in the Gartner list from 2010 to 2017	736
Firms with sufficient r estimation data	639
Firms with sufficient beta estimation data	628
Firms with sufficient ESG disclosure data	624
Firms with sufficient control variables data	604
Firms belonging to foreign countries	254
Firms in United States	350

Table 3 provides the summary statistics for 604 global observations, grouped by the Global Industry Classification Standard (GICS) category. Consistent with the supply chain industry development trend proposed by Lee and Tang (2018), consumer staples and consumer discretionary industries dominate the leading supply chain firms, because they represent fundamental consumer needs, while materials, health care, Information Technology (IT), and energy industries follow. Among all industry categories, materials have the highest cost of equity capital of 11.35%, and industrials have the second highest cost of equity capital of 11.24%, which indicates high investment risks for the two industries. The health care and energy industries have the highest average market cap size of USD 1102.19 and 1007.04 billion, respectively. The materials industry has the highest GHG CO_2 emissions. The IT, materials, and energy industries have the high ESG disclosure degrees, and more attention should be directed to the three industries.

Table 3. Summary statistic by GICS industry for global sample.

	Consumer Staples	Consumer Discretionary	Health Care	Industrials	Information Technology	Materials	Energy
	Mean (Standard Deviation)						
Cost of equity capital	7.62% (0.07)	9.9% (0.11)	9.96% (0.08)	11.24% (0.09)	8.37% (0.11)	11.35% (0.11)	−4.53% (0.10)
ESG disclosure	44.85 (12.33)	41.41 (14.41)	47.51 (12.51)	43.53 (11.98)	48.34 (13.40)	49.95 (16.07)	48.55 (13.13)
Environmental disclosure	40.96 (13.51)	37.29 (17.73)	46.34 (13.61)	37.02 (15.68)	48.37 (15.72)	46.12 (20.49)	40.99 (12.78)
Social disclosure	40.87 (16.14)	36.14 (17.56)	41.18 (13.75)	40.70 (14.97)	37.99 (15.11)	49.17 (17.85)	52.63 (22.72)
Governance disclosure	61.46 (9.30)	59.18 (6.98)	63.11 (7.71)	61.43 (7.88)	62.98 (7.22)	59.57 (9.29)	61.83 (6.40)
Market cap in billion	818.19 (654.63)	564.97 (518.25)	1102.19 (684.63)	485.08 (264.95)	967.05 (1549.85)	335.36 (278.85)	1007.04 (153.44)
BETA	0.79 (0.29)	1.16 (0.55)	0.73 (0.24)	1.25 (0.36)	1.27 (0.36)	1.17 (0.41)	1.41 (0.19)
TAR	25.85 (8.52)	30.42 (9.17)	28.80 (7.01)	25.00 (5.94)	36.18 (13.17)	22.28 (11.33)	37.25 (4.92)
Total GHG emission	3.32 (4.41)	2.50 (2.76)	1.10 (0.68)	1.92 (1.81)	1.20 (1.17)	8.20 (10.01)	2.23 (0.39)
Count/percentage	191/31.62%	130/21.52%	99/16.39%	80/13.25%	60/9.93%	36/5.96%	8/1.32%

Table 4 shows the descriptive statistics for the cost of equity capital estimates, grouped by country region and emission levels. Based on the Wilcoxon rank sum test, firms in the United States have a significantly higher cost of equity capital compared with foreign firms. Firms in the low-emission group in the United States have a significantly higher cost of equity capital compared with firms in the high-emission group. This indicates that the majority U.S. firms are still profit-oriented, and that the importance of sustainability remains to be improved.

Table 4. Descriptive statistics for cost of equity capital estimates.

	No.	**Mean**	**1%**	**25%**
Full sample	604/100%	9.11%	−14.24%	3.61%
United States	350/57.95%	10.58%	−11.49%	4.70%
Foreign countries	254/42.05%	7.09%	−18.05%	2.35%
Low emission in USA	203/71.23%	11.19%	−9.82%	5.30%
High emission in USA	82/28.77%	8.30%	−11.49%	3.37%

Difference between the United States subsample and foreign subsample is significant at the 5% level, using Wilcoxon Rank Sum Test and *t*-test. Difference between high emission and low emission subsamples is significant at the 5% level, using Wilcoxon Rank Sum Test and *t*-test. The record is categorized into the high emission group, if the Total GHG CO_2 emissions value is higher than or equal to the mean 2.65.

3.3. Model Constructions

Equations (1)–(7) are the regression equations used in this paper. The basic regression equations are Equations (1) and (2). Equation (1) tests for the ESG disclosure impact on the cost of equity capital without sustainability information disclosure (Botosan 1997; Botosan and Plumlee 2002). Equation (2) tests for the sustainability information disclosure impact on the cost of equity capital, controlling for the ESG disclosure impact. Equations (3)–(5) test for the sustainability information disclosure impact on the cost of equity capital, controlling for both the ESG disclosure and the three pillars of the ESG disclosure. Equation (6) tests for the mechanism of the sustainability disclosure's impact on the cost of equity capital. Equation (7) controls for additional financial factors. Equation (8) controls for firms' environmental performance. The fixed effect regression method is selected.

$$r_{i,t} = b_0 + b_1 * ESG\_disclosure_{i,t-1} + b_2 * BETA_{i,t} + b_3 * LMVAL_{i,t-1} + b_4 * TAR_{i,t-1} + \varepsilon_{i,t} \tag{1}$$

$$r_{i,t} = b_0 + b_1 * ESG\_disclosure_{i,t-1} + b_2 * S\_disclosure\_identification_{i,t} + b_3 * S\_disclosure\_identification_{i,t} * ESG\_disclosure_{i,t-1} + b_4 * BETA_{i,t} + b_5 * LMVAL_{i,t-1} + b_6 * TAR_{i,t-1} + \varepsilon_{i,t} \tag{2}$$

$$r_{i,t} = b_0 + b_1 * ESG\_disclosure_{i,t-1} + b_2 * S\_disclosure\_identification_{i,t} + b_3 * Environmental\_disclosure_{i,t-1} + b_4 * S\_disclosure\_identification_{i,t} * Environmental\_disclosure_{i,t-1} + b_5 * BETA_{i,t} + b_6 * LMVAL_{i,t-1} + b_7 * TAR_{i,t-1} + \varepsilon_{i,t} \tag{3}$$

$$r_{i,t} = b_0 + b_1 * ESG\_disclosure_{i,t-1} + b_2 * S\_disclosure\_identification_{i,t} + b_3 * Social\_disclosure_{i,t-1} + b_4 * S\_disclosure\_identification_{i,t} * Social\_disclosure_{i,t-1} + b_5 * BETA_{i,t} + b_6 * LMVAL_{i,t-1} + b_7 * TAR_{i,t-1} + \varepsilon_{i,t} \tag{4}$$

$$r_{i,t} = b_0 + b_1 * ESG\_disclosure_{i,t-1} + b_2 * S\_disclosure\_identification_{i,t} + b_3 * Governance\_disclosure_{i,t-1} + b_4 * S\_disclosure\_identification_{i,t} * Governance\_disclosure_{i,t-1} + b_5 * BETA_{i,t} + b_6 * LMVAL_{i,t-1} + b_7 * TAR_{i,t-1} + \varepsilon_{i,t} \tag{5}$$

$$r_{i,t} = b_0 + b_1 * ESG\_disclosure_{i,t-1} + b_2 * S\_disclosure\_identification_{i,t} + b_3 * S\_disclosure\_identification_{i,t} * ESG\_disclosure_{i,t-1} + b_4 * ESG\_disclosure_{i,t-1} * TAR_{i,t-1} + b_5 * ESG\_disclosure_{i,t-1} * TAR_{i,t-1} * S\_discloure\_identification_{i,t} + b_6 * BETA_{i,t} + b_7 * LMVAL_{i,t-1} + b_8 * TAR_{i,t-1} + \varepsilon_{i,t} \tag{6}$$

$$r_{i,t} = b_0 + b_1 * ESG\_disclosure_{i,t-1} + b_2 * S\_disclosure\_identification_{i,t} + b_3 * S\_disclosure\_identification_{i,t} *$$
$$ESG\_disclosure_{i,t-1} + b_6 * BETA_{i,t} + b_7 * LMVAL_{i,t-1} + b_8 * TAR_{i,t-1} + b_9 * PPE_{i,t-1} + b_{10} \tag{7}$$
$$* Total\_current\_assets_{i,t-1} + b_{11} * Sales_{i,t-1} + \varepsilon_{i,t}$$

$$r_{i,t} = b_0 + b_1 * ESG\_disclosure_{i,t-1} + b_2 * S\_disclosure\_identification_{i,t} + b_3 * S\_disclosure\_identification_{i,t} *$$
$$ESG\_disclosure_{i,t-1} + b_6 * BETA_{i,t} + b_7 * LMVAL_{i,t-1} + b_8 * TAR_{i,t-1} \tag{8}$$
$$+ b_9 * Environmental\_performance_{i,t-1} + \varepsilon_{i,t}$$

4. Results and Discussion

Table 5 shows the parameter estimation results for Equations (1)–(5) on the sample with 350 firms of the United States. Models 1 and 2 use Equations (1) and (2), and models 3 to 8 use Equations (3)–(5). Based on the findings from models 1 to 8, the ESG disclosure insignificantly negatively predicts the cost of equity capital. This is consistent with the literature that the ESG disclosure might not help investors to make accurate firm evaluations (Richardson and Welker 2001; Weber 2018; Song et al. 2023). Based on the findings from models 2, 4, 6, and 8, the S_disclosure variable's parameter estimates are significantly negative, which indicates that sustainability information disclosure significantly decreases the cost of equity. The S_disclosure_identification variable's parameter estimate is significantly positive, which could be explained as follows. The sustainability information disclosure releases supply-chain-related sustainability information to the investors, and the increased information causes a greater effort in the evaluation process, and so investors increase the cost of equity capital to cover the additional effort for evaluation. We use the interaction term of the TAR, ESG_disclosure, and S_disclosure_identification variables to test for the additional effort explanation in models 1 and 2 in Table 5. The significantly positive parameter estimate for the interaction term of the TAR, ESG_disclosure, and S_disclosure_identification variables in Equation (7) supports the explanation. The increased sustainability information might cause variance of analysts' opinions on firms' evaluation, and investors spend more time and effort to verify and integrate different viewpoints to form their own evaluation when making investment decisions. Further, the market value negatively predicts the cost of equity, which is consistent with the "size effect" in Botosan (1997). As for the coefficients on the individual ESG pillars, the coefficients are significantly negative for the interactions of S_disclosure_identification and the three ESG pillars. This indicates that the sustainability information disclosure affects the cost of equity capital through all three individual channels of environmental, social, and governance. The findings are consistent after controlling for both the year fixed effect and equity fixed effect. The R-squared ratio increased after adding more variables into the regressions and this supports the validity of adding the additional variables of interaction terms such as S_disclosure_identification*ESG_disclosure. The increased R-squared ratio means that the interaction term adds more explaining power to the regression model.

Tables 6 and 7 show the parameter estimation results for Equations (1)–(5) on the high and low GHG emission subsamples. The GHG emission index from the Bloomberg platform is the sum of a focal firm's scope 1 direct GHG emissions and a focal firm's upstream activities' scope 2 GHG emissions. Scope 1 emissions are direct greenhouse gas emissions that occur from sources that are controlled or owned by an organization. And scope 2 emissions are indirect emissions from the generation of energy that is purchased from a utility provider or a district energy system. We use the mean of the total GHG emission index (2.65) from the sample as the cutoff point to divide it into high and low GHG emission subsamples. The ESG disclosure's negative impact on the cost of equity capital is significant for the low GHG emission subsample. The sustainability information disclosure's negative impact on the cost of equity capital is significant for the high GHG emission subsample. This phenomenon can be explained by the finding that investors are more assured on the ESG information disclosure's validity for firms with better environmental performance (Weber 2018). The result is robust when using the median of the entire sample's GHG

emission index (1.47) as the cutoff point. According to coefficients for interactions of S_disclosure_identification and three ESG pillars, the environmental and social channels are the major channels that the sustainability information disclosure uses to affect the cost of equity capital for low GHG emission samples. The findings are consistent after controlling for both year fixed effect and equity fixed effect. The R-squared ratio increased after adding more variables into the regressions.

Table 5. Fixed effect regression of sustainability information disclosure impact on cost of equity capital.

	ESG Disclosure		Environmental Disclosure		Social Disclosure		Governance Disclosure	
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**
ESG_disclosure	−0.001	−0.001	−0.002	−0.002	−0.001	−0.001	−0.001	−0.001
	(0.528)	(0.538)	(0.483)	(0.420)	(0.756)	(0.753)	(0.420)	(0.238)
S_disclosure_identification		0.132 ***		0.084 ***		0.101 **		0.292 ***
		(0.001)		(0.000)		(0.026)		(0.005)
S_disclosure_identification * ESG_disclosure		−0.003 ***						
		(0.002)						
Environmental_disclosure			0.001	0.001				
			(0.705)	(0.569)				
S_disclosure_identification * Environmen-tal_disclosure				−0.002 ***				
				(0.003)				
Social_disclosure					−0.000	−0.000		
					(0.962)	(0.975)		
S_disclosure_identification * Social_disclosure						−0.002 **		
						(0.037)		
Governance_disclosure							0.000	0.001
							(0.942)	(0.560)
S_disclosure_identification * Governance_disclosure								−0.004 ***
								(0.009)
LMVAL	−0.066 ***	−0.073 ***	−0.069 ***	−0.075 ***	−0.066 ***	−0.072 ***	−0.066 ***	−0.070 ***
	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)
TAR	0.001	0.000	0.000	0.000	0.001	0.001	0.001	0.000
	(0.688)	(0.808)	(0.918)	(0.923)	(0.687)	(0.707)	(0.689)	(0.846)
BETA	−0.018	−0.019	−0.030	−0.030	−0.018	−0.023	−0.018	−0.020
	(0.679)	(0.629)	(0.450)	(0.402)	(0.674)	(0.592)	(0.679)	(0.616)
Intercept	3.464	3.457	1.329	1.301	3.421	3.808	3.465	3.136
	(0.570)	(0.685)	(0.784)	(0.842)	(0.595)	(0.646)	(0.571)	(0.725)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Equity fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	350	350	334	334	350	350	350	350
R-squared	0.109	0.125	0.104	0.118	0.109	0.124	0.109	0.124

The left hand side variable is r (cost of equity capital). *p*-value is in parentheses and standard errors are clustered by GICS industry category. *** $p < 0.01$, ** $p < 0.05$.

Table 8 shows the parameter estimation results for Equations (1)–(5) on 604 global samples. We conduct the global analysis to test whether the relationship is driven by the specific factors of the United States. The findings are consistent in the global analysis. The primary difference is that the sustainability information disclosure effect is more significant in the environmental disclosure pillar. This can be explained by the fact that the cross-country investors' attitudes are more consistent on the environmental aspect, compared with the social and governance aspects. According to coefficients for interactions of S_disclosure_identification and three ESG pillars, the environmental channel is the major channel that the sustainability information disclosure uses to affect the cost of equity capital for international samples, for the reason mentioned above. The findings are consistent after controlling for both year fixed effect and equity fixed effect. The R-squared ratio increased after adding more variables into the regressions.

Table 6. Subsample regression for low GHG emission firms.

	ESG Disclosure		Environmental Disclosure		Social Disclosure		Governance Disclosure	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
ESG_disclosure	−0.003 * (0.056)	−0.002 ** (0.033)	−0.002 (0.642)	−0.001 (0.658)	−0.003 ** (0.029)	−0.003 * (0.076)	−0.003 ** (0.050)	−0.003 ** (0.023)
S_disclosure_identification		0.037 (0.281)		−0.005 (0.906)		0.054 * (0.078)		0.302 (0.218)
S_disclosure_identification * ESG_disclosure		0.000 (0.608)						
Environmental_disclosure			−0.001 (0.718)	−0.001 (0.712)				
S_disclosure_identification * Environmental_disclosure				0.000 (0.516)				
Social_disclosure					0.001 (0.673)	0.001 (0.706)		
S_disclosure_identification * Social_disclosure						−0.001 (0.314)		
Governance_disclosure							0.000 (0.784)	0.001 (0.449)
S_disclosure_identification * Governance_disclosure								−0.004 (0.256)
LMVAL	−0.040 (0.195)	−0.034 (0.347)	−0.039 (0.182)	−0.033 (0.338)	−0.038 (0.191)	−0.033 (0.342)	−0.040 (0.198)	−0.034 (0.336)
TAR	−0.001 (0.783)	−0.001 (0.772)	−0.001 (0.791)	−0.001 (0.794)	−0.001 (0.785)	−0.001 (0.784)	−0.001 (0.789)	−0.002 (0.668)
BETA	−0.064 ** (0.045)	−0.059 * (0.079)	−0.063 ** (0.045)	−0.061 * (0.062)	−0.062 ** (0.048)	−0.060 * (0.069)	−0.064 ** (0.043)	−0.060 * (0.067)
Intercept	9.286 (0.460)	13.191 (0.406)	9.787 (0.445)	13.248 (0.405)	9.946 (0.431)	13.257 (0.413)	9.402 (0.467)	12.680 (0.446)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Equity fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	203	203	203	203	203	203	203	203
R-squared	0.158	0.161	0.159	0.163	0.160	0.165	0.158	0.172

The left hand side variable is r (cost of equity capital). Low emission subsample includes firms with Total GHG emission index lower than 2.65. *p*-value is in parentheses and standard errors are clustered by GICS industry category. ** $p < 0.05$, * $p < 0.1$.

Table 7. Subsample regression for high GHG emission firms.

	ESG Disclosure		Environmental Disclosure		Social Disclosure		Governance Disclosure	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
ESG_disclosure	0.000 (0.834)	0.000 (0.910)	−0.001 (0.767)	−0.003 (0.545)	0.000 (0.888)	0.001 (0.666)	0.001 (0.673)	0.001 (0.608)
S_disclosure_identification		0.276 *** (0.000)		0.190 *** (0.001)		0.321 *** (0.008)		0.094 (0.762)
S_disclosure_identification * ESG_disclosure		−0.005 *** (0.001)						
Environmental_disclosure			0.001 (0.531)	0.003 (0.302)				
S_disclosure_identification * Environmental_disclosure				−0.004 *** (0.005)				
Social_disclosure					0.000 (0.990)	−0.001 (0.686)		
S_disclosure_identification * Social_disclosure						−0.007 ** (0.023)		
Governance_disclosure							−0.001 (0.668)	−0.001 (0.657)
S_disclosure_identification * Governance_disclosure								−0.001 (0.800)

Table 7. *Cont.*

	ESG Disclosure		Environmental Disclosure		Social Disclosure		Governance Disclosure	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
LMVAL	−0.046	−0.033	−0.043	−0.031	−0.046	−0.023	−0.053	−0.043
	(0.544)	(0.579)	(0.642)	(0.666)	(0.568)	(0.671)	(0.545)	(0.568)
TAR	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
	(0.777)	(0.929)	(0.748)	(0.911)	(0.765)	(0.814)	(0.748)	(0.500)
BETA	0.016	0.019	0.018	0.024 *	0.016	0.021	0.021	0.017
	(0.354)	(0.321)	(0.270)	(0.066)	(0.461)	(0.254)	(0.384)	(0.342)
Intercept	15.072	18.974	15.103	16.981	15.065	20.641 *	14.489	21.337 *
	(0.419)	(0.105)	(0.423)	(0.142)	(0.409)	(0.054)	(0.454)	(0.086)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Equity fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	83	83	82	82	83	83	83	83
R-squared	0.184	0.263	0.178	0.263	0.184	0.311	0.188	0.200

The left hand side variable is r (cost of equity capital). High emission subsample includes firms with Total GHG emission index higher than 2.65. *p*-value is in parentheses and standard errors are clustered by GICS industry category. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 8. Global analysis on the effect of sustainabiliy informaion disclosure impact on the cost of equity capital.

	ESG Disclosure		Environmental Disclosure		Social Disclosure		Governance Disclosure	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
ESG_disclosure	0.000	0.000	−0.001	−0.001	0.000	0.000	0.001	0.000
	(0.886)	(0.795)	(0.764)	(0.735)	(0.965)	(0.992)	(0.765)	(0.768)
S_disclosure_identification		0.120 ***		0.090 ***		0.063 **		0.108
		(0.000)		(0.000)		(0.019)		(0.278)
S_disclosure_identification * ESG_disclosure		−0.002 ***						
		(0.002)						
Environmental_disclosure			0.001	0.001				
			(0.640)	(0.536)				
S_disclosure_identification * Environmental_disclosure				−0.002 ***				
				(0.003)				
Social_disclosure					0.000	0.000		
					(0.783)	(0.756)		
S_disclosure_identification * Social_disclosure						−0.001		
						(0.153)		
Governance_disclosure							−0.001	0.000
							(0.441)	(0.620)
S_disclosure_identification * Governance_disclosure								−0.001
								(0.396)
LMVAL	−0.075 ***	−0.074 ***	−0.076 ***	−0.076 ***	−0.074 ***	−0.074 ***	−0.075 ***	−0.073 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
TAR	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	(0.272)	(0.380)	(0.342)	(0.491)	(0.250)	(0.274)	(0.252)	(0.260)
BETA	−0.001	−0.003	−0.007	−0.008	−0.001	−0.003	−0.001	0.000
	(0.976)	(0.925)	(0.811)	(0.774)	(0.975)	(0.912)	(0.976)	(0.989)
Intercept	12.426 **	15.559 **	11.588 **	14.734 **	12.639 **	15.851 **	12.481 **	15.744 **
	(0.026)	(0.034)	(0.037)	(0.044)	(0.031)	(0.038)	(0.025)	(0.034)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Equity fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	604	604	580	580	604	604	604	604
R-squared	0.175	0.186	0.169	0.182	0.175	0.182	0.176	0.181

The left hand side variable is r (cost of equity capital). *p*-value is in parentheses and standard errors are clustered by GICS industry category. *** $p < 0.01$, ** $p < 0.05$.

Table 9 shows the parameter estimation results for Equations (1)–(5), controlling for S&P 500 portfolio's yearly average cost of equity capital. The sustainability information disclosure's negative impact on the cost of equity capital residual remains significant. As for the coefficients on the individual ESG pillars, the coefficients are significantly negative for the interactions of S_disclosure_identification and three ESG pillars. This indicates that the sustainability information disclosure affects the cost of equity capital through all three individual channels of environmental, social, and governance. The findings are consistent

after controlling for both year fixed effect and equity fixed effect. The R-squared ratio increased after adding more variables into the regressions.

Table 9. Analysis controlling for S&P 500 yearly average cost of equity capital.

	ESG Disclosure		Environmental Disclosure		Social Disclosure		Governance Disclosure	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
ESG_disclosure	−0.001	−0.001	−0.002	−0.002	0.000	−0.001	−0.001	−0.001
	(0.632)	(0.510)	(0.525)	(0.439)	(0.911)	(0.806)	(0.521)	(0.263)
S_disclosure_identification		0.107 ***		0.062 ***		0.075 **		0.248 **
		(0.001)		(0.001)		(0.043)		(0.011)
S_disclosure_identification * ESG_disclosure		−0.002 ***						
		(0.001)						
Environmental_disclosure			0.001	0.001				
			(0.654)	(0.555)				
S_disclosure_identification * Environmen-tal_disclosure				−0.002 ***				
				(0.003)				
Social_disclosure					0.000	0.000		
					(0.866)	(0.910)		
S_disclosure_identification * Social_disclosure						−0.002 **		
						(0.025)		
Governance_disclosure							0.000	0.001
							(0.925)	(0.674)
S_disclosure_identification * Governance_disclosure								−0.004 **
								(0.013)
LMVAL	−0.072 ***	−0.080 ***	−0.072 ***	−0.081 ***	−0.072 ***	−0.079 ***	−0.072 ***	−0.078 ***
	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)
TAR	0.002	0.001	0.001	0.001	0.002	0.001	0.002	0.001
	(0.397)	(0.518)	(0.559)	(0.724)	(0.399)	(0.433)	(0.400)	(0.551)
BETA	−0.010	−0.011	−0.018	−0.017	−0.010	−0.014	−0.010	−0.011
	(0.805)	(0.774)	(0.621)	(0.618)	(0.800)	(0.722)	(0.805)	(0.760)
Intercept	−19.379 ***	−23.722 **	−21.021 ***	−25.558 ***	−19.548 ***	−23.394 **	−19.377 ***	−23.909 **
	(0.006)	(0.017)	(0.002)	(0.006)	(0.009)	(0.016)	(0.006)	(0.020)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Equity fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	350	350	334	334	350	350	350	350
R-squared	0.080	0.097	0.086	0.103	0.080	0.096	0.080	0.095

The left hand side variable is r (cost of equity capital) minus S&P 500 yearly average cost of equity capital. *p*-value is in parentheses and standard errors are clustered by GICS industry category. *** $p < 0.01$, ** $p < 0.05$.

Table 10 shows the parameter estimation results for Equation (7). The disclosure of sustainability information significantly diminished the cost of equity capital for domestic companies. The sustainability information disclosure impact is significant, after controlling for sales; property, plant, and equipment (PPE); and total current assets (Botosan 1997). The findings are consistent after controlling for both year fixed effect and equity fixed effect. The R-squared ratio increased after adding more variables into the regressions.

Table 11 shows the parameter estimation report for Equation (8). The sustainable information disclosure's negative impact on the cost of equity capital remains significant, after controlling for firms' environmental performance measured by CDP performance scores from the Bloomberg platform. As for the coefficients on the individual ESG pillars, the coefficients are significantly negative for the interactions of S_disclosure_identification and three ESG pillars. This indicates that the sustainability information disclosure affects the cost of equity capital through all three individual channels of environmental, social, and governance. The findings are consistent after controlling for both year fixed effect and equity fixed effect. The R-squared ratio increased after adding more variables into the regressions.

Table 10. Robustness test controlling for additional financial ratios.

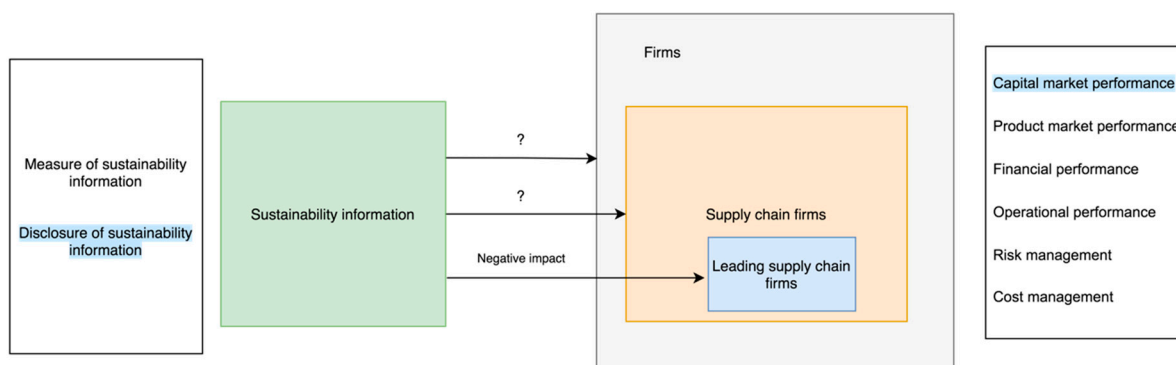|	ESG Disclosure					
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
ESG_disclosure	0.002 (0.907)	0.001 (0.933)	−0.001 (0.641)	−0.001 (0.659)	0.002 (0.854)	0.002 (0.883)
S_disclosure_identification		0.110 ** (0.020)		0.116 ** (0.016)		0.100 * (0.070)
S_disclosure_identification * ESG_disclosure		−0.006 ** (0.038)		−0.002 ** (0.013)		−0.005 ** (0.043)
ESG_disclosure * TAR	−0.001 (0.859)	−0.001 (0.896)			−0.001 (0.809)	−0.001 (0.852)
S_disclosure_identification * ESG_disclosure * TAR		0.001 * (0.091)				0.001 (0.184)
LMVAL	−0.067 *** (0.003)	−0.072 *** (0.002)	−0.070 *** (0.002)	−0.073 *** (0.002)	−0.071 *** (0.001)	−0.072 *** (0.001)
TAR	0.002 (0.803)	0.001 (0.883)	0.000 (0.893)	0.000 (0.976)	0.002 (0.816)	0.001 (0.885)
BETA	−0.018 (0.658)	−0.018 (0.645)	−0.006 (0.891)	−0.009 (0.842)	−0.007 (0.876)	−0.008 (0.846)
Total_current_assets			0.000 (0.374)	0.000 (0.357)	0.000 (0.280)	0.000 (0.256)
PPE			0.000 (0.130)	0.000 (0.113)	0.000 (0.123)	0.000 (0.116)
Sales			0.000 (0.427)	0.000 (0.328)	0.000 (0.433)	0.000 (0.351)
Intercept	3.460 (0.568)	3.899 (0.649)	5.737 (0.323)	5.870 (0.372)	5.801 (0.316)	6.180 (0.355)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Equity fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	350	350	350	350	350	350
R-squared	0.109	0.129	0.138	0.150	0.139	0.153

The left hand side variable is r (cost of equity capital). *p*-value is in parentheses and standard errors are clustered by GICS industry category. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 11. Robustness test controlling for additional environmental performance variable.

	ESG Disclosure		Environmental Disclosure		Social Disclosure		Governance Disclosure	
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**
ESG_disclosure	−0.001 (0.516)	−0.001 (0.615)	0.000 (0.866)	−0.001 (0.810)	−0.001 (0.646)	−0.001 (0.682)	−0.001 (0.307)	−0.001 (0.171)
CDP_performance_score	0.001 (0.907)	0.001 (0.845)	0.001 (0.887)	0.001 (0.894)	0.001 (0.906)	0.002 (0.765)	0.001 (0.889)	−0.001 (0.920)
S_disclosure_identification		0.103 *** (0.005)		0.056 ** (0.016)		0.085 ** (0.044)		0.255 ** (0.049)
S_disclosure_identification * ESG_disclosure		−0.002 *** (0.004)						
Environmental_disclosure			0.000 (0.864)	0.000 (0.990)				
S_disclosure_identification * Environmental_disclosure				−0.001 * (0.058)				
Social_disclosure					0.000 (0.929)	0.000 (0.917)		
S_disclosure_identification * Social_disclosure						−0.002 ** (0.034)		
Governance_disclosure							0.001 (0.312)	0.002 (0.131)
S_disclosure_identification * Governance_disclosure								−0.004 * (0.052)
LMVAL	−0.080 ** (0.049)	−0.081 ** (0.044)	−0.080 * (0.055)	−0.080 * (0.054)	−0.080 * (0.054)	−0.083 ** (0.045)	−0.079 * (0.054)	−0.077 * (0.051)
TAR	0.000 (0.868)	−0.001 (0.757)	0.000 (0.858)	−0.001 (0.763)	0.000 (0.870)	0.000 (0.839)	0.000 (0.865)	−0.001 (0.693)

Table 11. *Cont.*

	ESG Disclosure		Environmental Disclosure		Social Disclosure		Governance Disclosure	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
BETA	−0.048	−0.049	−0.051 *	−0.050 *	−0.048	−0.052 *	−0.048	−0.051 *
	(0.133)	(0.101)	(0.079)	(0.071)	(0.112)	(0.079)	(0.115)	(0.068)
Intercept	3.998	6.101	4.372	6.403	4.117	5.997	3.966	3.742
	(0.548)	(0.309)	(0.501)	(0.311)	(0.542)	(0.314)	(0.543)	(0.524)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Equity fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	268	268	265	265	268	268	268	268
R-squared	0.134	0.144	0.137	0.143	0.134	0.147	0.136	0.150

The left hand side variable is r (cost of equity capital). p-value is in parentheses and standard errors are clustered by GICS industry category. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

5. Practical Implications and Future Research Directions

This study developed a comprehensive definition of sustainability information and empirically explored the impact of disclosing sustainability information on the cost of equity capital based on both domestic and international firms. Based on the fixed effect regression, this paper finds that disclosing sustainability information negatively affects the cost of equity capital. The finding is consistent under robustness tests. The empirical finding is informative for firms' disclosure activity, investors' sustainable investment activity, and governments' disclosure regulation activity. The study calls for firms' preparation and disclosure of sustainability information. Also, it calls for governments to restructure the content of the sustainability-related information disclosure and include suppliers and customers' sustainability-related information into a focal firm's information set. Still, the paper calls for investors' attention to the focal firm's suppliers' and customers' sustainability-related activities when evaluating the firm's value. This study provides guidance for firms' sustainability information disclosure practice. Firms could prepare and disclose the sustainability information to gain lower cost of equity capital in the capital market. The study also provides guidance for the sustainability information disclosure regulation-making activities. It shows the empirical evidence that the sustainability disclosure is superior to that of ESG disclosure in reducing the cost of equity capital. So, this study suggests that the disclosure format standard-setting institutions, like the Sustainability Accounting Standards Board (SASB), should consider including supply-chain-related sustainable information in the information disclosure format. The study also advises the sustainability-oriented investors to consider suppliers' and customers' sustainability-related information to derive a more accurate evaluation of a firm's value.

Still, this study directs portfolio managers to explore the supply chain risk factor, shown in Table 9. The S&P 500 equities can be viewed as the market portfolio proxy for systematic risk. The parameter estimation of the sustainable disclosure variables on the individual firm's cost of equity capital residual is significant over the yearly average cost of equity capital of the S&P 500 market portfolio. It indicates that the sustainable information contains the risk factor, and that supply chain appears to be the major risk factor.

We describe the research directions for sustainability information in Figure 3. This study is an empirical research study on the impact of sustainability information disclosure on the capital market fund-raising performance of leading supply chain firms (marked in blue). Future empirical research could expand research objects to supply chain firms and firms in general. In addition to firms' capital market performance, the sustainability information impacts on firms' product market performance, financial performance, and operational performance worth further investigation. Also, how firms could utilize the sustainability information to manage risk and cost worths investigation. Still, the measure of sustainability information is another important research direction. Similar works include Gualandris et al. (2021), where they use the Bloomberg SPLC database to create the weighted ESG disclosure index at the supply chain network level. However, there is more work to be done, since the Bloomberg SPLC database has less than 50% of the entire supply connections in the real situation.

Figure 3. Sustainability information future research directions.

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